

Economic Impacts from the Installation of Residential Fire Sprinklers in Estero, Florida



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Introduction

In 2013, Florida saw over 50,000 fires which generated \$460 million in property damage. Furthermore, there was a loss of life of 124 people, and injuries to nearly 2,300 fireman and over 800 civilians. Seventy percent of these civilian deaths were due to fires in the home and 41% of these deaths were of people older than age 61. This is despite the fact that persons over the age of 61 only account for 23.8% of the population. One method that will help to reduce property damage, death, and injury by fire is the introduction of fire sprinklers within residential homes. This report determines the economic impact of such a policy change for the Census Designated Place of Estero, Florida.

Characteristics and Summary of the Study Area

For the purpose of this study, the area under investigation is Estero, Florida (hereafter “Estero”) which is a Census Designated Place located in Lee County, Florida. It is part of the Cape Coral-Fort Myers metro area with a metro population of 661,115 in 2013. According to the Census Bureau, Estero has a population of slightly over 23,000 in 2013. For comparison, Estero had a population of only 9,503 in the 2000 census. Therefore, the Estero population has grown at the annual rate of 7.03% since 2000 while the state of Florida has only grown at 1.5%, and the Cape Coral-Fore Meyers metro area has grown 3.1% per annum in the same time frame.

Figures 1A and 1B shows a breakdown of the different ages of the population for Estero and for Florida as a percentage of their respective population. As one can see, Estero has a much higher concentration of senior citizens and retirees than the population for Florida or the US. For example, in Florida, 9.5% of the population is between the ages of 65 to 74 while in Estero this number is 25.4%. In the United States, only 7.6% of the population is between 65 and 74. Similarly, people ages 25 to 34 represent over 12% of the population in Florida, 13.5% of the population in the United States, but they are only slightly more than 5% of the population in Estero. A breakdown of the population by age is important since the risk of death and injury from fire varies based upon age. According to the 2013 State Fire Marshal report, there were 124 civilian deaths from fires in Florida. Of these, 51 or 41% are people over the age of 60. This is despite that fact that this age group only represents 23% of the population in Florida—therefore, it is clear that people over the age of 60 die disproportionately from fires. In Estero, people over the age of 60 represent 55% of the population indicating that Estero actually has a higher probability of civilian deaths from fire than the state as a whole.

Figure 1A. Population Breakdown by Age

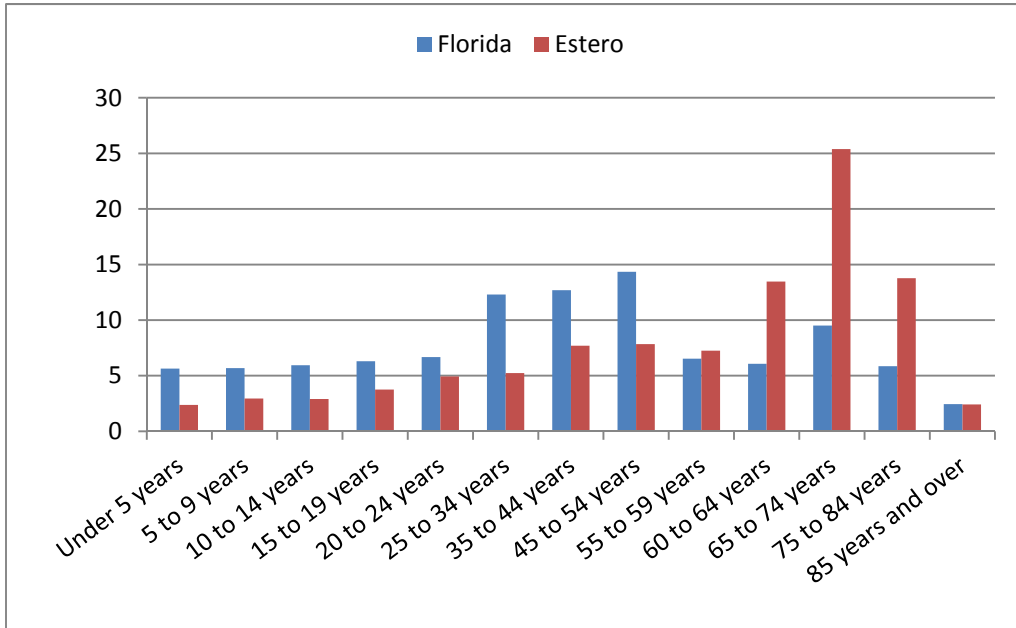
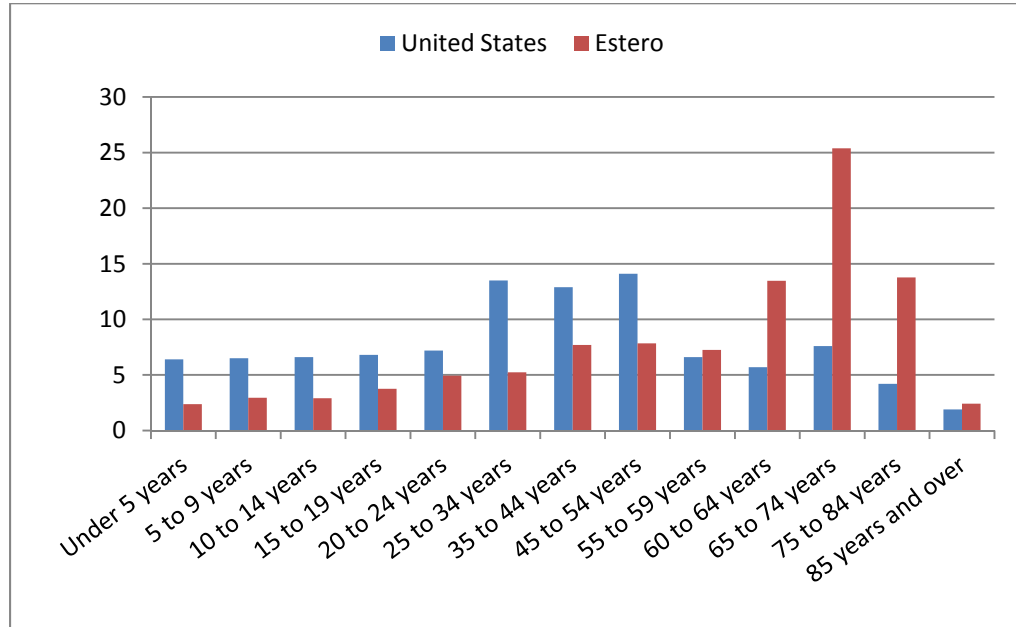


Figure 1B. Population Breakdown by Age



Similarly, Estero is relatively affluent compared to the rest of the state and the country. The mean household income in Estero is \$96,231 while it is only \$66,368 in Florida and \$73,487 in the US (See Figure 2A). In other words, household incomes average 30% higher in Estero than the US and 45% higher than Florida. Figures 2B and 2C show that while in Florida almost 8% of all households earn less than \$10,000, this percentage in Estero is half that state average. Furthermore, in Florida 18% of households earn more than \$100,000. In Estero this number is almost 35%. This has important implications for two different reasons. The first is ‘affordability’ in that, keeping everything else constant, richer households tend to be better able to ‘afford’ to install sprinkler systems within their homes. Secondly, richer households tend to have larger, more expensive homes and more possessions within those homes. Therefore, a fire will, statistically speaking, have a larger dollar value of property damage in a richer home than in a poorer home.

Figure 2A. Mean Household Income

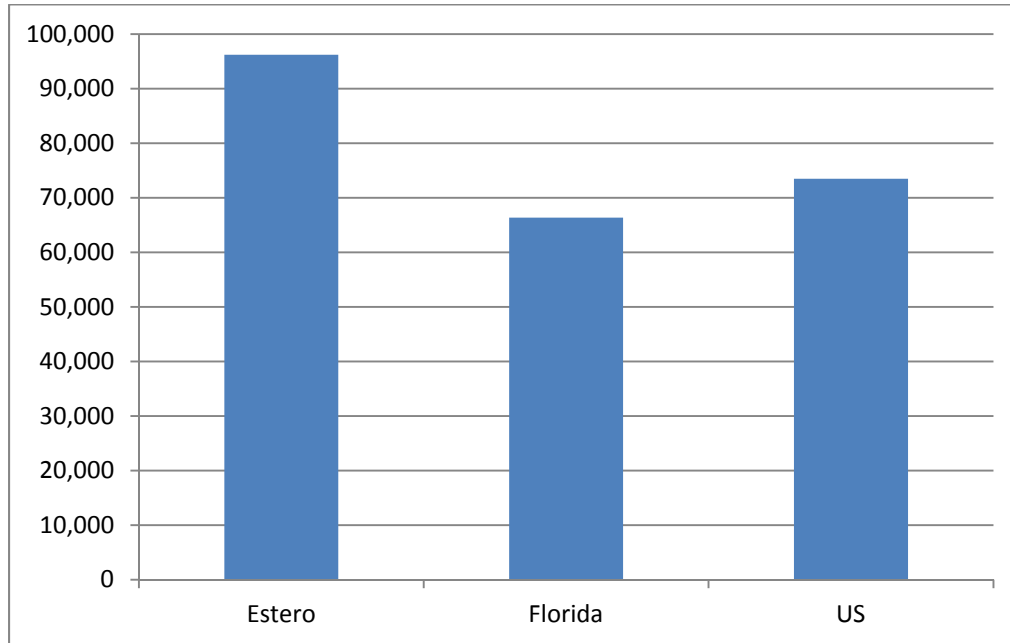


Figure 2B. Household Income Breakdown (Estero and Florida)

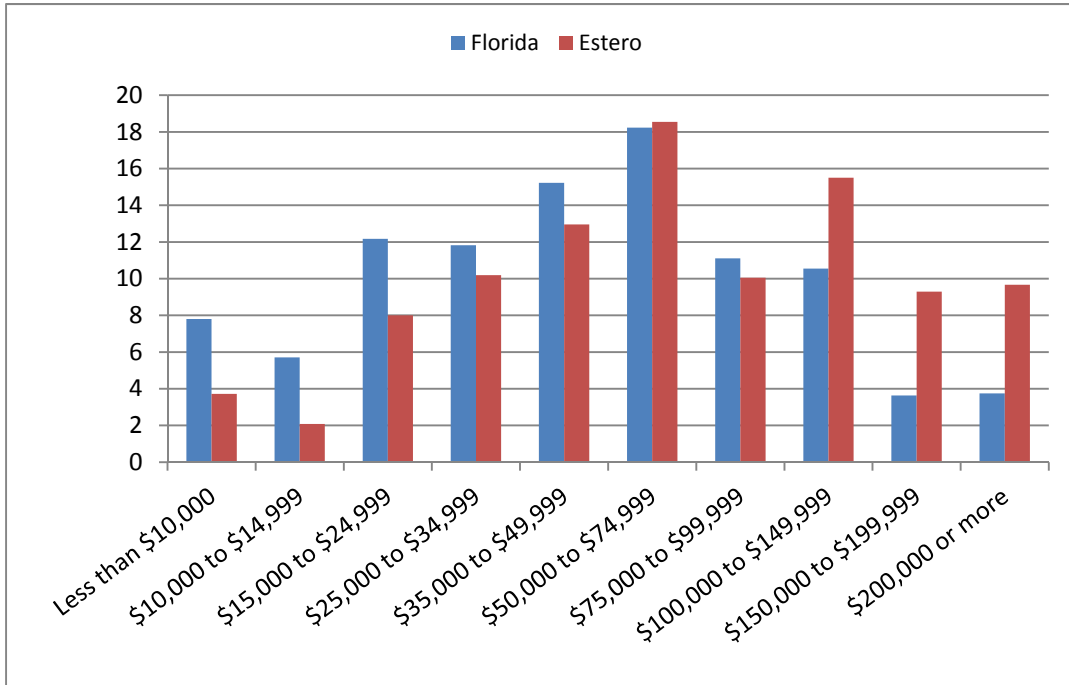
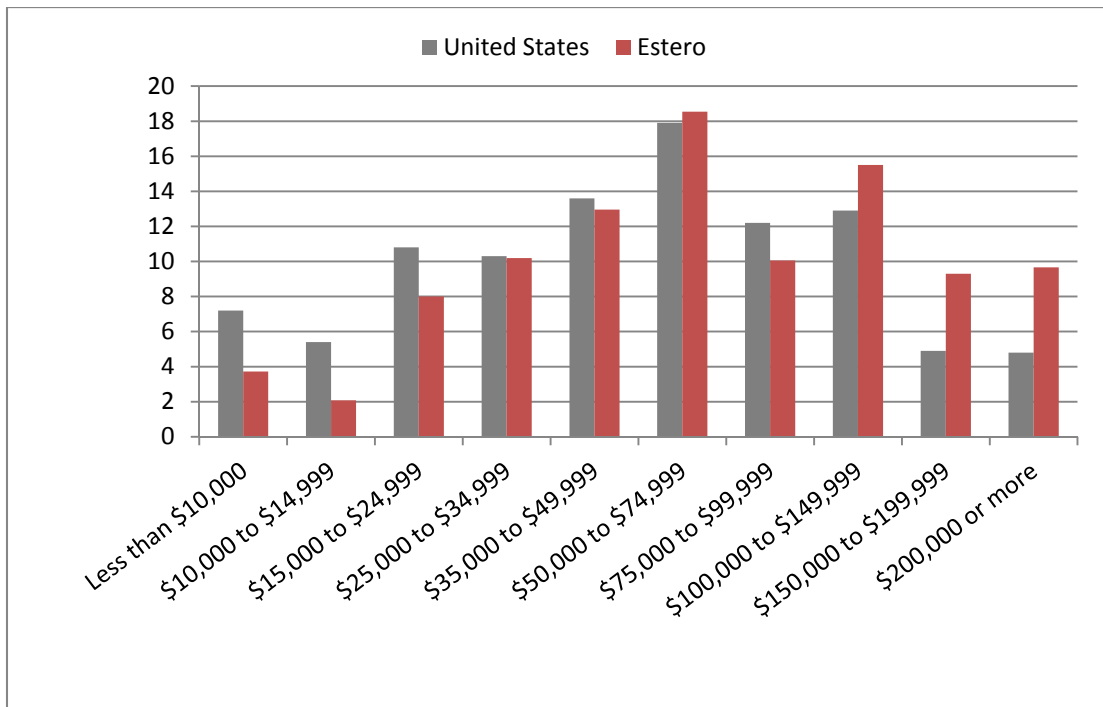


Figure 2C. Household Income Breakdown (Estero and United States)



The fact that fires can produce more damage in Estero can be seen in Figures 3A and 3B which outline the value and age of homes in Estero compared to the state and the nation. In the nation, only 15.3% of the total housing stock has been built after 2000, while in Florida this number is 21%. For comparison purposes, it is 61% in Estero. This relatively young age of the housing stock helps to reinforce the rapid level of population growth that Estero has experienced in recent years. Also, the housing stock appears to be of a higher value in Estero than in the nation or the state. The median home value in Estero is \$248,800 while it is only \$160,200 in Florida and \$176,700 in the nation. For example, 38% of all homes in Estero are worth more than \$300,000. In the state of Florida only 19% of homes are worth more than \$300,000 while the nation sees 26% of all homes worth more than \$300,000. Furthermore, almost 5% of all homes in Estero are worth more than \$1 million. In the US and Florida respectively only 2% and 1.8% of all homes fit this criteria.

Figure 3A. Age of the Housing Stock

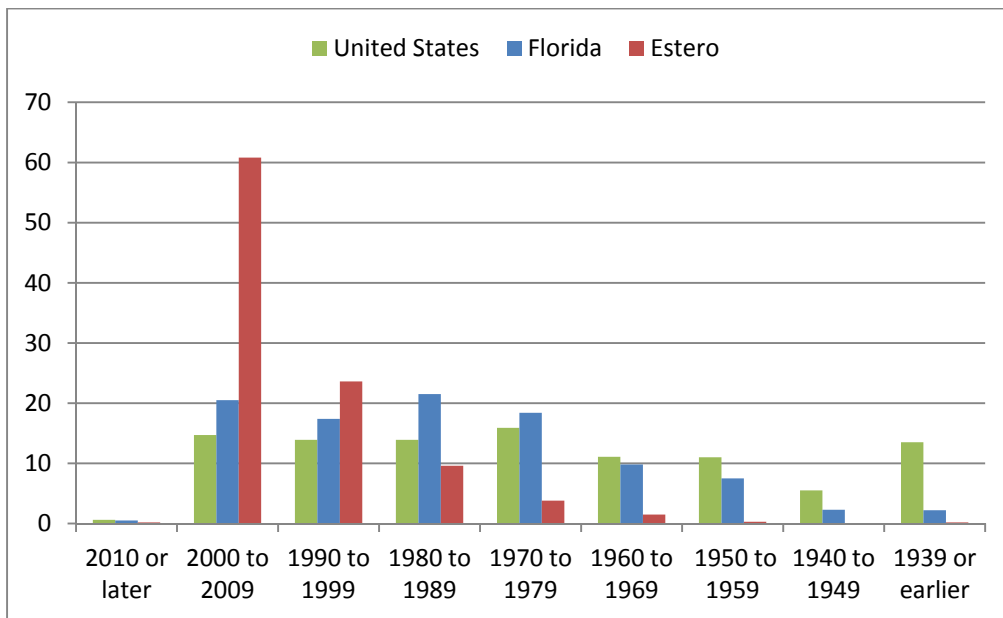


Figure 3B. Value of the Housing Stock

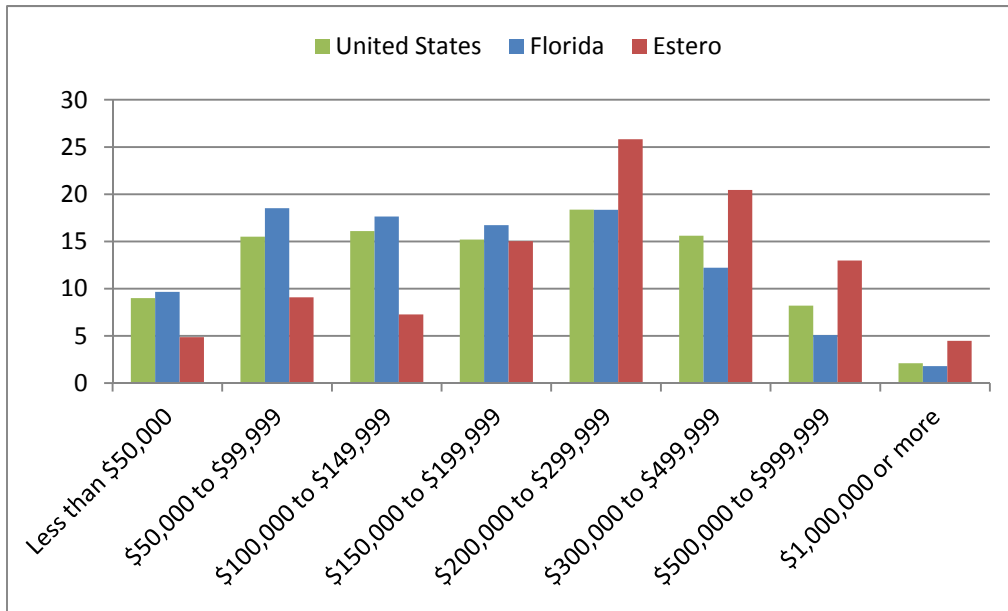
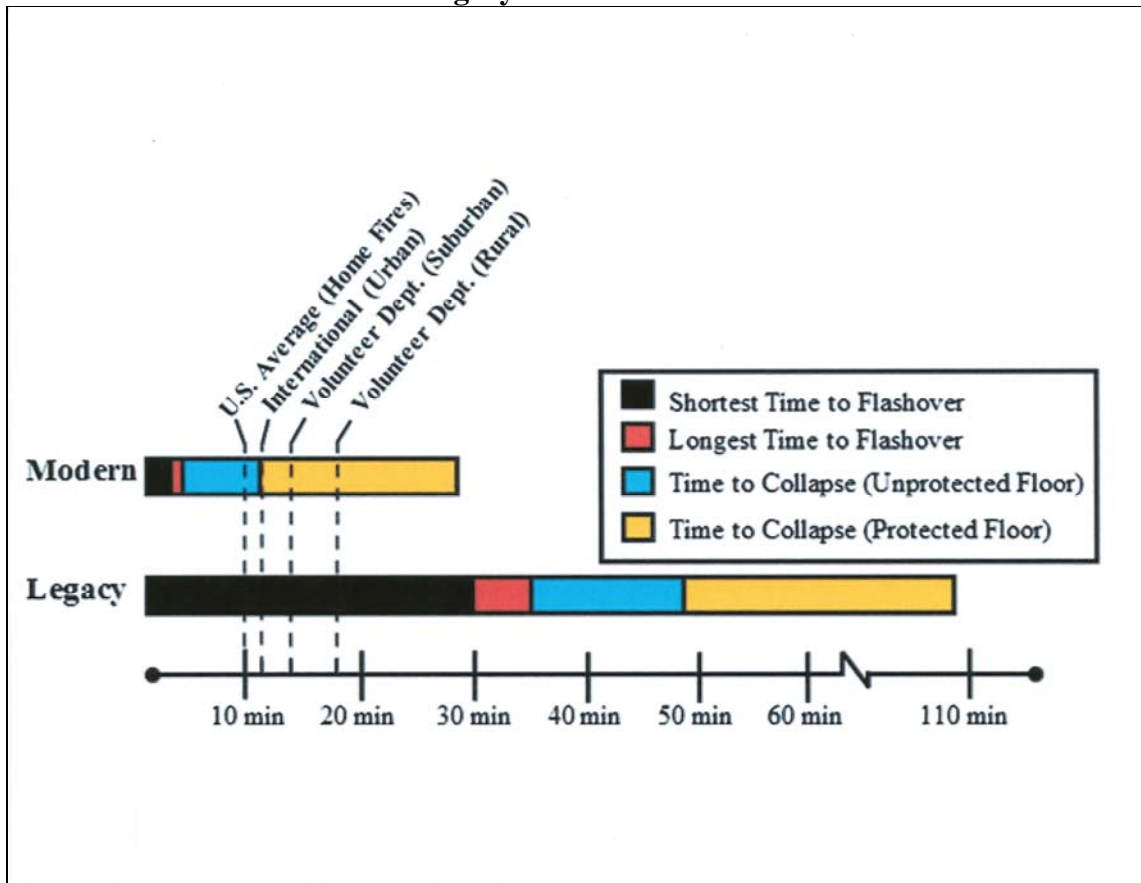


Figure 4. Average Fire Department Response Times and Building Destruction For Legacy and Modern Homes



In summary, Estero has a relatively high percentage of its population that is elderly and in expensive homes meaning that fires in Estero will, statistically speaking, cause more monetary damage and result in more deaths and injuries than in the rest of the state or nation. Furthermore, Estero has a relatively ‘new’ housing stock. This can be problematic as evidenced by Figure 4 which shows that modern houses ‘flashover’ and are engulfed in fire faster than older homes. Often times for modern homes this flashover and engulfment occurs ***before*** the fire department even arrives on the scene. This means that residential fire sprinklers can give people, especially younger and older people, the critical minutes to get out of a burning house.

Methodology of Measuring the Net Present Value

Policy changes tend to create both costs and benefits for society. Often times, not only do these costs and benefits accrue at different times but they accrue to different stakeholders. Many times, one group of stakeholders might face higher costs than benefits from a policy change while a different group of stakeholders receives higher benefits than costs. Cost-Benefit Analysis, CBA, is a method of economic analysis that can be used to determine whether a particular project should be undertaken. It adds up the costs and benefits that accrue from a policy to determine its net economic impact. Furthermore, since costs or benefits that occur at different times are not comparable¹, it allows one to accurately measure all intertemporal costs and benefits and convert them to their present value for comparison. Once all of the benefits and costs of a policy have been calculated and converted to their present value, it become relatively easy to see if the policy is worth engaging in. If the value of the benefits minus the costs is positive, the present value of the net benefits is positive meaning that the project has benefits that exceed its costs and should be considered for undertaking. If the project has costs that are larger than the benefits, then the present value of the net benefits is negative and the project should be rejected since there are probably other avenues of policy that can yield positive net benefits to society.

The formula for determining the present value of the benefits is as follows:

$$(1) \quad PVB = \sum_{t=0}^T \frac{B_t}{(1+i)^t}$$

and the formula for determining the present value of costs is similar such that,

$$(2) \quad PVC = \sum_{t=0}^T \frac{C_t}{(1+i)^t}$$

¹ Costs and benefits that occur at different times have to be discounted to their appropriate current value. For example, receiving \$100 of benefits today is not equivalent to receiving \$100 in benefits a year from now. Many people think this is because of inflation. Although inflation plays a role, it is not the primary reason per se. One hundred dollars invested today at 10% will grow to \$110 in one year’s time. Alternatively, \$90.90 invested at 10% will grow to \$100 in one year. Therefore, the present value of \$100 received in one year at a discount rate of 10% is \$90.90.

In both formulas 1 and 2, T represent time in annual years and is equal to 30 for this report, while i is the discount rate and is equal to the interest rate of 30 year Federal government bonds which are currently at 3.05%. Since changes in the discount rate can alter the outcome of the results, sensitivity analysis is often done with CBA. For our purposes, this entails using the current 10 year US Treasury note interest rate of 2.26% and the for the interest rate on the State and Local 20 year general obligation bond index of mixed quality which is currently 3.49%.² B_t represents the benefits that occur in each year while C_t represents the costs in any given year. PVB and PVC are the present value of these benefits and costs respectively. To determine if a policy should be undertaken, the PVC are subtracted from the PVB to determine the Present Value of Net Benefits, $PVNB$...

$$(3) \quad PVNB = PVB - PVC$$

For the purposes of this report, costs and benefits were determined by examining what impact installing residential fire sprinklers would have in Estero, Florida. Most of these costs include the design, installation, and material costs of physically installing a fire sprinkler system into a home. Other costs include the costs of installing backflow preventers. Since there is water in the sprinkler system, should the system ever lose pressure, the water inside the pipes might backflow into the utility's water lines and cause contamination issues. There are also additional benefits which include lower insurance premiums, decreased probability of death and injury to both civilians and firefighters, and a decrease in the probability and severity of property damage.

Methodology of measuring costs and benefits

When examining the costs and benefits of residential fire sprinklers, we need to rely on the use of statistics which tells us the probability of an event occurring. When this probability is combined with dollar values for these costs and benefits, one determines the expected value of the event. For example, suppose that the probability of a fire occurring in any given year is 1% and if a fire occurs it will produce \$50,000 in property damage. Therefore, the expected value of property damage in any given year is the amount of damage times its probability of occurring (Pr) as outlined in equation 4.

$$(4) \quad \text{Expected Value (EV)} = (Pr) * (\$ \text{ amount of damages})$$

In this example, the probability of damages is .01 (1%) and the dollar amount is \$50,000 so that the expected value of damages in any given year is \$500. Now suppose that residential fire sprinklers are installed and with them we see a reduction in the amount of damages that will occur should a fire start within the home. Now the level of damages is \$15,000 should a fire occur in the home. Therefore, the expected value of damages is now \$150 for a savings of \$350. Consequently, to determine the costs, but especially the benefits, this report will use statistics

² These interest rates are available from Bloomberg.com and from the St. Louis Federal Reserve Bank. (research.stlouisfed.org and www.bloomberg.com/markets/rates-bonds/government-bond/us)

such as the probability of a fire occurring, and the probability of death and injury from fire. When these probabilities are combined with the values for expected property damage, injury costs, and the value of a statistical life, we will have determined the benefits of residential fire sprinklers.

At the national level, in 2013 there were 271,500 fires in single family and two-family homes which resulted in 2,430 deaths and 8,300 injuries. These fires cause \$5.6 billion in property damages meaning that each house fire causes \$20,626 in property damage on average.³ Since there are 79,771,048 single and two-family homes in the nation, the probability of a fire in any home is 0.0034 or 0.34%--in other words, there are 34 home fires for every 10,000 homes.⁴ For every 10,000 house fires, there were 90 civilian deaths, 306 injuries, and \$206.2 million in property damage. Table 1 compares these statistics for the nation, state of Florida, and Estero.⁵ Estero has a low and high estimate to account for the fact that the state of Florida and the nation produce different estimates of the amount of total property damage relative to the median home value. For example, fires in the nation on average are producing property damage of 11.6729% of the median home's value while in Florida this percentage is only 7.1988%. Therefore, both of these estimates are used in this analysis. As one can see by Table 1, this means that fires in Estero can create on average between \$17,911 to \$29,042 in property damage per home.

Table 1. Benefit Estimation Statistics

	US	Florida	Estero (low)	Estero (high)
Annual Probability of Fire	0.0034	0.0039	0.0034	0.0034
Deaths/10,000 fires (No Sprinklers)	89.502	58.235	25.412	25.412
Injury/10,000 fires (No Sprinklers)	305.709	309.491	317.572	317.572
Median Housing Value	176,700	160,200	248,800	248,800
Property Damage (\$)/ fire (No Sprinklers)	20,626	11,533	17,911	29,042

The presence of sprinklers in homes reduces the probability of death and injury. It also reduces the amount of property damage. The size of this reduction has been studied and quantified by the National Institutes of Standards and Technology (NIST).⁶ For example, the NIST report found that residential fire sprinklers reduced fatalities by 100% during the study period of 2002-2005. However, recent reports by the National Fire Protection Association suggest that sprinklers reduce home fire civilian death rates by 82% and decrease property

³ National Fire Protection Association, 2013 Research Reports and Statistics, <http://www.nfpa.org/research/reports-and-statistics/fires-by-property-type/residential/one-and-two-family-home-fires>

⁴ Census Bureau, 2013 American Community Survey.

⁵ The data for the state of Florida comes from "Florida Fires: 2013 Annual Report" from the Florida State Fire Marshal's Office. The Estero data is from Lee County data.

⁶ Butry, David T., Hayden Brown, and Sieglinde Fuller. "Benefit-Cost Analysis of Residential Fire Sprinkler Systems" US Dept. of Commerce, National Institute of Standards and Technology, September 2007.

damage by 68% while as the same time reducing firefighter injuries by 65%.⁷ Civilian injuries are reduced by 56.79%.

To determine the costs and benefits, several sample homes in Estero were examined in several different neighborhoods. These homes were both single family homes and recently constructed duplexes. Table 1 outlines their characteristics. The square footage listed for the duplex is 2,868 square feet with each subunit being ½ of the structure in size—1,434 square feet. Building plans, including structural and electrical drawings were obtained for the four different homes from Lee County Department of Community Development. These plans were sent to seven local and regional fire sprinkler system installation companies to obtain estimates for the cost of installing a NFPA 13D system with a backflow preventer and relevant other fees.⁸ The lowest cost estimate was used for each home and the price of residential fire sprinklers per square foot was determined. The average price to install NFPA 13D residential fire sprinklers systems in Estero is \$1.61/square foot. Although this is higher than the 2013 national average of \$1.35 it is still within the range of prices for residential sprinklers.⁹

Table 2. Characteristics of Model Homes Used in the Study

	Type	Bedrooms	Bath	Square Footage	Price of Residential Fire Sprinkler	RFS Cost/sq. foot	Reduction in Insurance
Home #1	SFH	3	2	2,013	\$3,160	\$1.56	\$116
Home #2	Duplex	2	2	2,868	\$5,350	\$1.87	\$174
Home #3	SFH	3	3	2,828	\$4,240	\$1.48	\$210
Home #4	SFH	2	2	1,968	\$2,970	\$1.51	\$126

There are also benefits to residential fire sprinklers. These include lower homeowners insurance premiums, lower death and injury rates for both civilians and firefighters, and decreases in the extent and severity of property damage. In order to determine how much residential fire sprinklers reduced insurance premiums, information on the sampled homes was sent to eight local insurers. Insurers were asked to determine how much the homeowners

⁷ Hall, John. “US Experience with Sprinklers”, National Fire Protection Association, June 2013. The statistic on the reduction in the number of injuries to firefighters is anecdotal and can not be shown to be statistically valid since the number of firefighter injuries at homes with sprinklers is too low. In short, there are not enough data points yet to show the estimate of a 65% reduction is valid.

⁸ Backflow preventers were required to be installed by both of the local utilities—Lee County Utilities and Bonita Springs utilities. Other fees include permit fees and inspection fees—however, Estero Fire and Rescue is waiving fees for inspection.

⁹ The range of national prices identified in the latest report is \$0.81 to \$2.47 per sprinkled square foot with a mean price of \$1.35. This study was done in 2013 and examined costs in 51 homes in 17 different communities. Interestingly enough, the cost of sprinkling a home has decreased since the last national report in 2008. In that report, prices ranged from \$0.38 to 3.66 per square foot with a mean price of \$1.61. This data was from “Home Fire Sprinkler Cost Assessment—2013” report prepared by Newport Partners for The Fire Protection Research Foundation. <http://www.nfpa.org/sprinklercst>

insurance premium would be with and without sprinklers in each of the homes. The highest and lowest estimates were dismissed and the remaining estimates were averaged. The average yearly reduction in insurance was \$157 or about 5.66% reduction in the yearly insurance premium. This amounts to an average 6.4 cents per square foot.

However, the analysis of the benefit of lower insurance premiums doesn't stop there. In order to determine the value of residential fire sprinklers over the 30 year life of the study, one has to determine how much savings in insurance premiums homeowners will collect over the project life. This is done by projecting forward how much insurance premiums are going to rise and then using the average yearly reduction of 5.66% to determine the savings to the home owner. Interestingly enough, Florida has the highest homeowners insurance premiums in the country and has experienced growth rates in its average insurance premiums that exceed the national average.¹⁰ From 2004 to 2012, average homeowners insurance premiums in the nation have grown at an annual rate of 4.4% from \$729 to \$1,034. In Florida, it has grown at an annual rate of 10.24% from \$786 in 2002 to \$2,084 in 2012. However, these dollar amounts are in nominal terms and need to be corrected for inflation. When they are converted into 2015 dollars we see that the average annual rate of insurance premiums increases at a rate of 2.0% nationwide and at a rate of 7.6% in real inflation adjusted dollars in the state of Florida. For this analysis, homeowners insurance premium savings were projected forward at the national average rate of 2% per year. However, it is unlikely that homeowners insurance premiums will increase at this low rate. Therefore, the median value between the growth of insurance premiums in Florida and the nation was also used—a rate of 4.8%. Finally, the historical growth rate of insurance premiums in Florida of 7.6% was used to project premium savings.

The value of a life saved is the largest unseen component of the benefits from residential fire sprinklers. Recall that without sprinklers, there will be slightly more than 58 deaths in Florida for every 10,000 fires and that sprinklers reduce this death rate by 82%. Therefore, with sprinklers, deaths will be reduced to 10.48 per 10,000 fires. In Estero, the results are even more dramatic. Estero can expect 25.412 deaths per 10,000 fires. With the introduction of residential sprinklers, the number of deaths is reduced to 4.57 deaths per 10,000 fires for a saving of 20.842 lives per 10,000 fires. The only question one has to answer is how much is a life worth? If one was to ask the person on the street, undoubtedly the majority of people would reply, 'priceless'. However, we know that people often engage in activities for leisure and work that increase their probability of dying. For example, the fatal injury rate at work per 100,000 people for workers in Finance and Insurance is 0.6 meaning that for every 100,000 people employed in the industry, 0.6 are expected to die on the job in any given year. For someone working in the air transportation industry, the rate is 5.8 meaning that for every 100,000 people employed in the

¹⁰ “2015 Annual Homeowners Insurance Report”, National Association of Insurance Commissioners, http://www.naic.org/documents/prod_serv_statistical_hmr_zu.pdf and the Insurance Information Institute (<http://www.iii.org/fact-statistic/homeowners-and-renters-insurance>)

industry, 5.8 are expected to die in any given year.¹¹ If these jobs were completely identical in every respect except the fatal injury death rate, we would expect wages in the air transportation industry to be higher to compensate people for the increased risk, however small, of dying on the job. By analyzing different wages between different industries in conjunction with the probability of fatal injuries on the job, one can estimate a value that a person places on his/her life. Current estimates at the Department of Transportation suggest a value of \$9.1 million in base year 2012 with a growth rate in median real wages of 1.07%, and hence the value of a statistical life, over the next 30 years¹². Converting this into 2015 dollars means that the value of a statistical life is currently worth \$9.434 million.

Similar analysis is done with reductions in injury. Currently, we can expect 317.572 injuries for every 10,000 fires in Estero.¹³ Implementing residential fire sprinklers reduces this by 56.79% to 137.223 injuries per 10,000 fires. Using a similar methodology to determine the value of a statistical life, we can determine how much people are willing to pay to avert injury. The US Consumer Product Safety Commission has conducted different studies examining how much more people are willing to pay for fire retardant mattresses and upholstery. Based upon the costs of fire retardant upholstery and mattresses and the decreased probability of fire related injury, they calculated that in 2005 people were willing to pay between \$150,000 to \$187,000 to avert fire related injuries.¹⁴ Taking the midpoint value and converting into today's dollars we find that people are willing to pay \$206,193 to avert injury. It is assumed that this value also increases on an annual basis at the rate of growth of median real wages—1.07%.¹⁵

Exploration of residential fire sprinklers also shows that the reduction in property damage is a significant contributor to the benefits of such a system. Contrary to popular belief, in the presence of a fire, only the sprinklers in the area (room) where a fire has begun will activate. Furthermore, the temperature levels necessary to activate a fire sprinkler are high—meaning that if one burns Sunday night's dinner on the stove, the smoke will not activate the fire sprinkler. Most of the time, residential fire sprinklers will act to minimize fire and smoke damage to the room where the ignition began. Without sprinklers, there is more opportunity for a fire to spread

¹¹ Census Bureau, "2011 Census of Fatal Occupational Injuries", 2011, http://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2011hb.pdf

¹² US Department of Transportation, "Guidance on Treatment of the Economic Value of a Statistical Life in US Department of Transportation Analyses", 2013 <http://www.transportation.gov/regulations/economic-values-used-in-analysis>

¹³ Analysis based upon the number of reported injuries per the number of residential fires in Lee County. This data is from "Florida Fires: 2013 Annual Report" from the Florida State Fire Marshal's Office. Data on the number of fire related injuries was not available at the city level. Therefore, the county injury rate is being used as a proxy for the Estero injury rate.

¹⁴ Zamula, W. "Memorandum to Gregory B. Rodgers, Costs for Non-Fatal Addressable Residential Civilian Injuries Associated with Mattress and Bedding Fires" US Consumer Product Safety Commission, 2005. See also Zamula W., "Memorandum to Gregory B. Rodgers, Costs for Non-Fatal Addressable Residential Civilian Injuries Associated with Upholstered Furniture Fires", US Consumer Product Safety Commission, 2004.

¹⁵ US Department of Transportation, "Guidance on Treatment of the Economic Value of a Statistical Life in US Department of Transportation Analyses", 2013 <http://www.transportation.gov/regulations/economic-values-used-in-analysis>

to other rooms and create more damage. That is why homes that are sprinkled face a reduction in property damage of 68%. In Estero, property damage ranges from \$17,911 per fire to \$29,402 per fire depending upon whether one uses national or state data for estimating property damage relative to median housing values. Therefore, residential fire sprinklers can reduce property damage to between \$5,731 to \$9,408 per fire. For the purpose of this study, both of these numbers will be used to generate a lowest and highest estimate of benefits from residential fire sprinklers.

According to the Survey of Consumer Finance which is conducted by the Federal Reserve Bank of the United States on a triannual basis, in 1989 the average family had a net worth of \$336,100 when measured in inflation adjusted dollars. Today they have an average of \$534,600 in net worth which is a growth rate in the real value of assets of 1.9526% per annum. Of these assets, 40.8% are 'financial' in nature such as stocks, bonds, and certificates of deposit with the remaining percentage devoted to 'real' assets such as computers, furniture, clothes, etc.¹⁶ It is assumed that the value of these real assets is growing at the same rate as a family's net worth and the value of property damage averted due to residential fire sprinklers has been adjusted to reflect this.

Finally, there are reductions in indirect costs. These are the costs that occur after a fire and include legal bills, hotel expenses while the one's home is being repaired after a fire, and the like. Estimates from the NIST report show that these costs are \$1,076 in inflation adjusted 2015 dollars. Furthermore, the NIST report estimates that residential fire sprinklers reduce this indirect cost by 31.66%. It is estimated that these costs grow at the rate of inflation over the time period of the study.

Benefit and Cost Estimates

A median home size of 2,060 was chosen for the cost and benefit calculations since many of the installation costs and benefits are dependent upon the home size. At an installation cost of \$1.61 per square foot for the residential fire sprinkler system and the installation of the backflow preventer yielded an initial cost of \$4,516. Insurance benefits were 6.4 cents per square foot and amounted to a reduction in the homeowners insurance premium of \$132. Once initial values for costs and benefits were estimated they were inputted into a spreadsheet. It was assumed that the costs of installing the residential sprinklers occurred in the current year (year 0), with additional costs, such as maintenance, testing, and inspections, of the residential fire sprinklers occurring every year for the next 30 years. However, according to Florida law, homeowners can conduct these procedures themselves and do not need to hire a contractor. It was also assumed that benefits did not begin until the homeowner moved into the home (year 1) and that these benefits accrued to the homeowner over the next 30 years. The probability of a fire occurring was calculated using data in Table 1. The change in the number of deaths and injuries averted was

¹⁶ Federal Reserve Bank, "2013 Survey of Consumer Finances" Tables 4 and 5, <http://www.federalreserve.gov/econresdata/scf/scfindex.htm>

also calculated and multiplied by the probability of occurrence which was then multiplied by the value of a statistical life and the value of injuries averted for that year. The expected value of property damage averted was calculated for each year for both the high and low estimates for Estero. Currently, Florida is experiencing the highest growth rate in the rate of increase for homeowner’s insurance. Nevertheless, the growth in savings of homeowners insurance premiums was calculated according to the three different methods previously discussed. All of these values were then discounted by the three discount rates that were mentioned earlier— 2.26%, 3.05%, and 3.49%.

Tables 3 and 4 outline the Present Value of Net Benefits of installing residential fire sprinklers in Estero. Recall that there were three assumptions for the increase in homeowner’s insurance premiums and hence there are three different estimates of the savings to homeowners in reduced insurance premiums. These are labeled Low Growth (2%), Medium Growth (4.8%), and High Growth (7.6%). Also recall that currently Florida is experiencing High Growth in its rate of increase in insurance premiums. Finally, there were the two different estimates of the amount of property damage to homes in Estero from fires. Table 3 outlines the PVNB for the lower estimate of property damage while Table 4 incorporates the higher estimates of property damage.

As one can see from the Tables, the larger increases in projected homeowners insurance premiums, and hence the larger savings for the homeowner from residential fire sprinklers, the larger the positive net benefit to homeowners. If however insurance premiums increase at a low or medium rate, then the benefit to homeowners is smaller, but it still significantly positive.

Table 3. Present Value of Net Benefits Estimates with Low Appraisal of the Level of Property Damage from a Fire

Discount Rate	Low Growth (2%)	Medium growth (4.8%)	High Growth (7.6%)
2.26	5,759	7,679	10,937
3.05	4,663	6,296	9,094
3.49	4,145	5,639	8,139

Table 4. Present Value of Net Benefits Estimates with High Appraisal of the Level of Property Damage from a Fire

Discount Rate	Low Growth (2%)	Medium growth (4.8%)	High Growth (7.6%)
2.26	6,506	8,425	11,683
3.05	5,329	6,961	9,706
3.49	4,771	6,264	8,765

To see why this is true, consider the annual savings for homeowners on their insurance premiums in 30 years. Recall that currently homeowners in the sample home would be saving \$132 a year. If insurance premiums increased at the national rate over the next 30 years, annual insurance premium savings would be \$234 in the 30th year. However, if insurance premiums continue their historical rate of increase, savings to homeowners would be over \$1,100 in the 30th year. This is why the present value of the net benefits is so much larger under the historical rate of increase for homeowners insurance. Furthermore, the insurance premium savings is the largest component of net benefit to the homeowner under this scenario. If insurance premiums increase at the national rate or at the median rate, then homeowners still see a positive net benefit from installing residential fire sprinklers but now the largest components of net benefit to the homeowner is the value of a statistical life that is saved from not dying in a fire and the reduced expected value of property damage from a fire.

This study's results mirrors results found in other studies that have examined the cost and benefits of residential fire sprinklers. These other studies have also discovered positive net benefits. A recent study from Cape Coral, Florida found that sprinklers had a positive net benefit impact of \$6,180.¹⁷

Finally, there are other benefits that have not been included in Tables 3 and 4. With the advent of residential fire sprinklers, there is a reduced need for public infrastructure of many forms. For example, in a study from The Fire Protection Research Foundation, they found that spacing between residential fire hydrants could be increased. Furthermore road minimum widths, which are needed to allow for the passage of fire trucks, could be reduced.¹⁸ These cost savings were estimated to be \$1,387 per building lot in 2015 inflation adjusted dollars. In addition to this, cul-de-sac can be reduced in width which will save local cities and counties \$11,733 per cul-de-sac and will allow an additional 5 building lots on dead-end streets. If Estero were to alter its infrastructure requirements with the passage of residential fire sprinklers, the savings would be included in the cost-benefit analysis as an additional benefit. Whether these benefits accrue to the city or to the homeowner in the form of reduced permit fees is irrelevant—the benefit is there.¹⁹

Tables 5 and 6 calculate the Present Value of Net Benefits with these infrastructure benefits included. Since they are reductions in costs, it is assumed that they occur in the year that the home is being built which for calculation purposes is year 0. Since they occur in year

¹⁷ Newport Partners, LLC, "Economic Cost Benefit Analysis of Residential Fire Sprinkler Systems Cape Coral, FL" July 2012.

¹⁸ Newport Partners, LLC, "Incentives for the Use of Residential Fire Sprinklers Systems in US Communities", October, 2010.

¹⁹ This ignores the savings to the city of \$10,752 per cul-de-sac and is only including the cost savings of \$1,271 per building lot. It is assumed that this reduction in the cost of the building lot will be passed to the homeowner in lower permit fees. The lower cost per cul-de-sac has the potential to add additional benefits to homeowners and further strengthen the case for residential fire sprinklers if these lower costs are also passed to them in lower permit fees.

0, they are not discounted and in essence increase the PVNB by \$1,387 in each of the different scenarios. As one can see from Tables 5 and 6, even under a worst case scenario, there are substantial positive net benefits to installing residential fire sprinklers in Estero.

Table 5. Present Value of Net Benefits Estimates with Low Appraisal of the Level of Property Damage from a Fire with Possible Infrastructure Changes

Discount Rate	Low Growth (2%)	Medium growth (4.8%)	High Growth (7.6%)
2.26	7,146	9,066	12,324
3.05	6,050	7,683	10,481
3.49	5,532	7,026	9,526

Table 6. Present Value of Net Benefits Estimates with High Appraisal of the Level of Property Damage from a Fire with Possible Infrastructure Changes

Discount Rate	Low Growth (2%)	Medium growth (4.8%)	High Growth (7.6%)
2.26	7,893	9,812	13,070
3.05	6,716	8,348	11,093
3.49	6,158	7,651	10,152

Further benefits that were not calculated for this study include reduced water usage when fighting fires. Studies have shown that sprinkled homes use about 341 gallons of water to fight a fire as opposed to non-sprinkled homes which consume nearly 3,000 gallons to put out a fire.²⁰ Furthermore, sprinkled homes are much less likely to lead to injury or death of firefighters. 94% of all firefighter deaths occur not in industrial or commercial fires, but in single family homes. This means that there is a reduced probability of Estero firefighters making worker’s compensation or permanent disability claims from on the job activities. This can lead to a reduction in the Estero’s insurance premiums. Finally, sprinkled communities need less firefighting equipment such as trucks, pumpers, and even more importantly, fire stations. A typical fire station costs between \$814,000 to \$910,000 to build depending upon whether union or non-union labor is used to construct it. Furthermore, according to the proposed budget for Estero Fire and Rescue, the city of Estero spends \$11.1 million per year on personnel and operations. Since Estero has 4 fire stations, this averages out to \$2.7 million per year per station to man and maintain said station. Similarly, firefighters spend less time fighting fires at sprinkled homes versus fighting fires at nonsprinkled homes. There is a reduced need for reserve

²⁰ Dewar, Buddy, “Managing Community Growth: Building Fire Safe Communities--A Life Safety Guide”, 2013.

firefighters (and hence reduced salary and overtime pay) to be called up to man stations where firefighters have been dispatched from. This means a reduction in taxes that are paid for equipment and personnel.

Impact on Construction Industry

Interestingly enough, there is little to no evidence of slower housing growth when residential sprinklers are mandated by local codes—in fact, evidence indicates the exact opposite. Residential sprinklers have been mandated in different Maryland counties since the late 1980's. The impact that these code changes had on housing prices and growth in the number of newly constructed homes was studied. Study results indicated that changing the local building codes to require residential fire sprinklers actually led to increases in the number of newly built homes in these counties compared to neighboring counties that did not implement such standards. Furthermore, prices for homes in counties with residential fire sprinklers actually increased faster than counties without these requirements indicating that home owners see residential fire sprinklers as adding value to the property.²¹

Conclusion

This report has examined the economic costs and benefits from installing residential fire sprinklers in Estero. Real installation costs in real homes in Estero were used. Home plans for four different houses, three single family and one duplex, were given to different fire sprinkler installation companies in the Estero area to determine these installation costs. These costs were \$1.61 per square foot. Other costs, such as the cost of installing backflow preventers, were also included. Residential fire sprinklers also have benefits that can be quite substantial. They reduce insurance costs and thus save homeowner's insurance premiums. They do not decrease building activity of newly constructed homes and are seen by homeowners as adding value to a home. They also decrease the probability of death and injury for occupants of the home as well as reduce the expected value of property damage from a fire. These costs and benefits were calculated over a 30 year period and were discounted to determine the present value of net benefits. Diverse scenarios of property damage and the growth in insurance premiums with different discount rates were calculated. The present value of these net benefits ranged from \$4,145 to \$11,683 depending upon the scenario. Other benefits included public infrastructure paybacks vis-à-vis reduced costs on things such as road width and fire hydrant spacing. When these benefits are included the present value of net benefits from residential fire sprinklers increases from \$5,532 to \$13,070.

²¹ National Fire Protection Association, "Comparative Analysis of Housing Cost and Supply Impacts of Sprinkler Ordinances at the Community Level", June 2009.

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