State of Illinois
Illinois Department of Public Health

Clear-Win Program
Pilot Phase Evaluation

IDPH
ILLINOIS DEPARTMENT OF PUBLIC HEALTH

EVALUATION OF THE PILOT PHASE OF CLEAR-WIN PROGRAM

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EXECUTIVE SUMMARY

In 2007, the Illinois General Assembly passed Public Act 095-0492, establishing the Comprehensive Lead Education, Reduction, and Window Replacement Program (Clear-Win). The primary stated goal of Clear-Win was "to assist residential property owners to reduce lead paint hazards through window replacement in pilot communities." This report examines the activities, costs, and benefits of the initial pilot phase of the Clear-Win program, including all projects completed through March 31, 2013.

The Clear-Win program was active in two Illinois localities: the city and county of Peoria, and the Englewood and West Englewood neighborhoods on the south side of Chicago. Both these areas have a large stock of pre-1940 homes, and high rates of childhood lead poisoning.

Program Activities/Descriptive Statistics

- Clear-Win completed work on 379 properties containing 466 housing units. 85% of the properties were single family houses. Single family homes were of modest size, with a median size of 1,082 ft^2.
- Childhood lead poisoning is predominant in pre-1940 buildings. Clear-Win focused its efforts on older buildings, as 84% of the properties were built prior to 1940. This was particularly true in the Chicago region, where 87% of the buildings were constructed prior to 1930. The median construction date in Peoria was 1928; in Chicago, 1913.
- 1412 occupants resided in the properties at the time of treatment. This included 251 children under the age of six - the population most vulnerable to the ill effects of lead poisoning.
- Clear-Win replaced a total of 7,747 windows, an average of 17 windows per housing unit. Windows were replaced with highly efficient (R-5) windows manufactured in Illinois.
- 28 Illinois-based building contractors performed the window replacements. Of these, 23 contractors were EPA-certified lead abatement contractors. The other five contractors were trained in accordance with the United States Environmental Protection Agency's (EPA) Lead Renovation, Repair, and Painting Rule (RRP) requirements.

Clearance Study

All Clear-Win projects were subject to clearance testing by dust wipe sampling, the standard protocol for lead hazard control projects. Over both regions, 22% of the projects failed the initial clearance test, requiring additional cleaning and clearance testing. While RRP contractors had a higher failure rate than abatement contractors (31% to 21%), the difference was not significant. This finding leads to the following conclusions:

- In a program involving full replacement of the old windows, lead dust hazards that are not eliminated by initial cleaning are common.
- If the Clear-Win program continues beyond the pilot phase, full clearance testing featuring dust wipe sampling will remain critical.
- Since most window replacement in the U.S. happens outside of an environmental lead context, there is reason for concern that lead hazards may be too common following the window replacement work, particularly in pre-1940 buildings.

Clear-Win Costs

Total costs for the project period ending on March 31, 2014 were $3,451,841. Total costs included:

- Window purchase: $1,376,635 (40% of total costs)
- Contractor costs: $1,642,692 (49% of total costs)
- Local Administration: $380,000 (11% of total costs)

The mean cost per building was $9,108. The mean cost per housing unit was $7,407. IDPH administrative costs are not included in this total.

Energy and Environmental Benefits

Energy savings from the installation of highly energy efficient (R-5) windows resulted in the reduction of natural gas consumption of 86,718 therms in the first year following treatment. At 2014 prices, this energy reduction led to utility bill savings of $76,500 in the first year. A conservative estimate of long term savings anticipates 1,734,000 therms of gas, and $1,530,000 in utility bill savings, over 20 years.

As a result of savings in natural gas usage, the Clear-Win program reduced greenhouse gas emissions by nearly 460 metric tons in the first year, or about 1.2 metric tons per building in the program. This is the equivalent of the total energy use of 41.9 homes. As with the energy savings, the environmental benefits will multiply annually. Clear-Win is expected to reduce emissions by 9,196 metric tons over the next twenty years. This is the equivalent of nearly 9.9 million pounds of coal not being burned.

Health Benefits

The monetized health benefit of lead-safe window replacement reflects the present value of higher earnings (in 2010 dollars) associated with avoided preschool lead exposure, based on, (1) the present value of lifetime earnings associated with a one point increase in IQ, and, (2) IQ points lost per 1 mcg/dl increase in blood lead. This estimate shows lead safe window replacement yields weighted average health benefits per resident child ages 6-30 months, in 2010 dollars, of:

- $24,571 in housing built before 1940,
- $10,068 in 1940-1959 housing, and
- $2,572 in 1960-1977 housing.

Based on this analysis, the total monetized health benefit for Clear-Win is estimated to be $3,611,360. This is a conservative estimate, as other health costs associated with childhood lead poisoning are not included in the total.

Market Benefits

Window replacement adds to the value of a home due to enhanced appearance, functionality, and anticipated (and ultimately realized) energy savings. Based on national survey data, increased market value from window replacement in Clear-Win neighborhoods was $400/window. About one half of this market value is the embedded energy savings. Total additional resale value is estimated to be $1,568,826, or about $4100/building, an average 5% increase in estimated market value for the homes in the program.

Job Creation

Illinois companies manufactured and installed the windows and managed the program. Clear-Win directly created nearly 14 jobs per year (13.95 jobs) for each of the two years of program operation. Considering the Illinois State income tax of 5%, an estimated total of $51,128 was returned to the Illinois treasury as a result of job creation.

Cost/Benefit Summary

Over the long term, the Clear-Win pilot program should realize net benefits of over $3.3 million. Total benefits include energy saving benefits of $1.5 million, additional market value benefits of $1.57 million, lead poisoning prevention health benefits of nearly $3.6 million, and tax benefits of $51,000. These benefits are well in excess of installed window costs of $3.1 million and local administrative costs of $0.4 million. An expansion of Clear-Win into other older, low-income neighborhoods in Illinois is warranted, and would result in continued substantial benefits.

Clear-Win Long Term Benefits	
Installed Window Cost (A)	$3,071,841
Windows Replaced	7747
Long Term Energy Benefit	$1,529,974
Other Market (Resale)Value	$1,568,826
Total Market Value Benefit (B)	$3,098,800
Children Realizing Health Benefit:	
Children 6–30 months in Pre-1940 Housing	136
Children 6–30 months in 1940-59 Housing	25
Children 6–30 months in 1960's Housing	7
Pre-1940 Health Benefit ($24,571/child)	$3,341,656
1940–59 Health Benefit ($10,068/child)	$251,700
1960's Health Benefit ($2,572/child)	$18,004
Total Monetized Health Benefit [C]	$3,611,360
State Income Tax Return on Job Creation (D)	$51,128
Administrative Cost [E]	$380,000
Net Benefits [B+C+D-A-E]	$3,309,447

INTRODUCTION

In 2007, the Illinois General Assembly passed Public Act 095-0492, establishing the Comprehensive Lead Education, Reduction, and Window Replacement Program (Clear-Win). The primary stated goal of Clear-Win was "to assist residential property owners to reduce lead paint hazards through window replacement in pilot communities." The Clear-Win program is an innovative lead poisoning prevention program seeking to reduce childhood lead poisoning through proactive window replacement in low income neighborhoods. This report examines the activities, costs, and benefits of the initial pilot phase of the Clear-Win program.

The Illinois General assembly mandated that the Illinois Department of Public Health (IDPH) administer the program. Though the law became effective on January 1, 2008, funds were not appropriated until 2010. The planning stage of the Clear-Win program was initiated in that year, and the program became operational in 2011. IDPH selected two regions in which to pilot the program: the city and county of Peoria, and the Englewood and West Englewood neighborhoods on the south side of Chicago. Both these areas have a large stock of pre-1940 homes, and high rates of childhood lead poisoning. The Peoria region includes urban, suburban, and rural housing, and the Englewood neighborhoods in Chicago are exclusively urban.

Partner agencies in each pilot region worked with IDPH to administer the Clear-Win program. In Peoria, the Peoria City/County Health Department (PC/CHD) was responsible for operating the program. PC/CHD also operated a United States Department of Housing and Urban Development (HUD) sponsored lead hazard reduction program, and many of their Clear-Win projects were performed in conjunction with that program. [1]CNT Energy operated the program in Chicago. CNT Energy is nonprofit organization established by the Chicago-based Center for Neighborhood Technology (CNT). These agencies were responsible for all local activities associated with Clear-Win, including promotion and recruitment, client intake, property inspection, window purchasing, contracting and contract management, and clearance testing.

Two window manufacturers participated in the program supplying highly energy efficient replacement windows. Both window manufacturers were based in Illinois, and Illinois workers manufactured the windows in Chicago assembly plants. Additionally, 28 Illinois building contractors participated in Clear-Win by installing the replacement windows. The majority of the building contractors were licensed lead abatement contractors; five contractors were renovation contractors that, while not licensed lead abatement contractors, were trained to United States Environmental Protection Agency's (EPA) Lead Renovation, Repair, and Painting Rule (RRP).

All contractors were expected to follow a "lead-safe window replacement" approach that included the following four steps:

- Establish containment to prevent the spread of lead dust during the performance of the work;
- Replace single-pane windows with energy-efficient windows;
- Remove containment and perform specialized cleaning to remove any lead-contaminated dust; and
- Do post-project clearance tests to confirm absence of lead in dust after cleanup.

A certified third party performed clearance testing on all projects by dust wipe sampling, which is required by the legislation. If any dust wipe sample exceeded clearance thresholds, the contractor was required to re-clean and the project area was subject to a second round of clearance testing. This is standard protocol in the lead hazard reduction field.

[1] *CNT Energy changed its name in 2014, and is now known as "Elevate Energy".*

It was anticipated that the Clear-Win program would achieve multiple benefits:

1. **Reduce childhood lead exposure.** Elevated blood lead in young children results in many types of neuro-developmental damage. Preventing childhood lead poisoning is the primary initiative of the Clear-Win program.
2. **Energy and environmental.** Replacing single-pane windows with energy-efficient windows can reduce home energy consumption and lower utility bills, with associated reductions in greenhouse gas emissions.
3. **Increase home values.** New windows increase home values both for the energy efficiency benefits, but also for their appearance and maintenance benefits.
4. **Job creation.** Window replacement is a labor intensive activity that creates jobs for window manufacturers and housing renovation workers. The program employed Illinois window manufacturers and building contractors, enhancing job creation in the state.

This report examines and quantifies these benefits. The report is presented in 7 sections:

Section 1: Background discusses the research and field experience that prompted the development of the Clear-Win program.

Section 2: Descriptive Statistics provides an overview of the housing units and core activities of the program, including types of buildings, building age, number of occupants and children, contractors employed, number and type of windows replaced, and additional work performed.

Section 3: Clearance Study looks at the results of the initial clearance dust wipe sampling and the implications for future window replacement programs.

Section 4: Clear-Win Costs presents and categorizes the program expenses.

Section 5: Energy and Environmental calculates the savings in energy, energy costs, and greenhouse gases associated with reduced energy use.

Section 6: Economic Benefits discusses the health benefits, market value benefits, and summarizes the net benefits with respect to program costs.

Section 7: Job Creation estimates the direct job creation resulting from the window manufacturing, window installation, and the local administration of the program.

This report includes the data that was submitted to the Illinois Sustainable Technology Center (ISTC) from the start of the program on December, 1, 2010, through March 31, 2013. It includes data on 379 buildings containing 466 housing units. In the Chicago region, the operational phase of the program ended on June 30, 2013. The Peoria region was granted an extension to complete their planned production.

Section 1: BACKGROUND

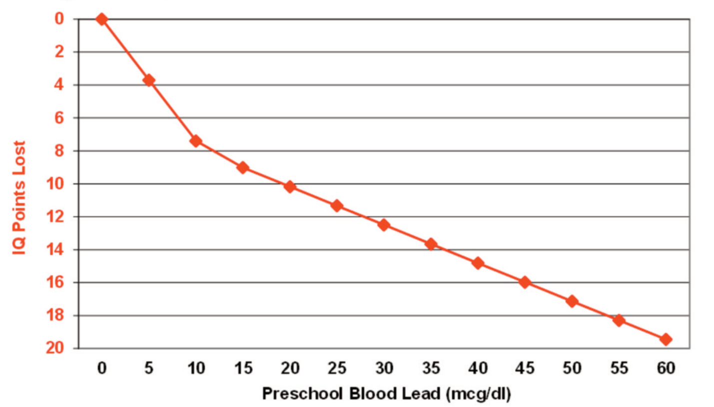
In the years since Congress passed the Residential Lead-Based Paint Hazard Reduction Act of 1992, a large body of knowledge has accrued regarding the nature of lead paint hazards and the methods that best protect young children from this hazard. Scholarly research, extensive federally sponsored field experience, and evaluation of that field experience has provided a better understanding of the nature of the problem. Clear-Win, a primary lead poisoning prevention program, is based on a synthesis of the research and experience of the last twenty years.

Lead has been a component in paint for centuries, valued for its durability and weather resistance. Per capita use of lead in paint peaked in the U.S. from 1900 to 1930. The Great Depression saw a steep decline in housing construction, and thus, the use of lead paint declined. Following the Second World War, growing concern over the toxicity of lead resulted in a further decline use of lead in paint. Per capita use of lead in paint fell over 90% from the late-1920's to 1960. Lead was banned from residential paint in 1978. As a result, pre-1940 housing has lead paint on more interior surfaces and higher concentrations of lead in paint. The National Survey of Lead and Allergens in Housing (NSLAH) found lead hazards in 68% of pre-1940 homes, but just 43% in homes built between 1940 and 1959, and 8% in homes constructed 1960-1977, after which lead was banned in residential paint.

While severe lead poisoning can be caused by lead paint chip ingestion, the most common exposure pathway for children today is lead-contaminated dust from deteriorating lead paint. Lead in dust, ingested via normal hand-to-mouth activity as children learn to crawl, travels through the bloodstream to a child's brain, where elevated blood lead causes many types of neurodevelopmental damage. Elevated preschool blood lead lowers IQ, education attainment, and lifetime earnings. Lead poisoning can also cause mental retardation, which comes with a huge burden of costs with respect to education and care. Additionally, it is estimated that an extra 290,000 cases of childhood ADHD results from lead poisoning. Other research offers a growing body of evidence that preschool lead poisoning is linked to crime and increases in impulsive behavior later in life.[8,9,10,11] Clearly, there are massive societal costs associated with childhood lead poisoning.

Of particular importance to this report is the extensive research documenting a relationship between preschool blood lead, commonly measured in micrograms of lead per deciliter of blood (mcg/dl), and lower IQ later in life. Meta-analyses have shown an average loss of 7.4 IQ points as preschool blood lead increases from 1 to 10 mcg/dl, a loss of one-third of an IQ point for every one mcg/dl increase in blood lead from 10 to 15 mcg/dl, and a loss of one-quarter IQ point for every one mcg/dl increase in blood lead above 15 mcg/dl.[12,13] Figure 1 combines these data to show IQ losses associated with preschool blood lead of one to 60 mcg/dl.

Figure 1: IQ Points Lost due to Elevated Preschool Blood Lead

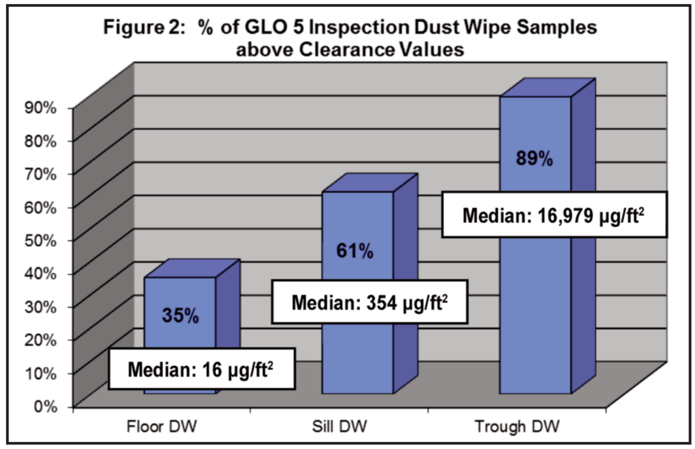


Thanks to federally sponsored lead hazard control grants, the country began to investigate lead in residential properties on a large scale in the mid-1990's. The importance of lead hazards associated with windows soon became evident.

With lead hazard control grant funding from HUD, IDPH operated the Get the Lead Out program (GLO) through five phases from 1995 to 2011. GLO operated in several regions throughout the State of Illinois, including Peoria and Chicago. Data from the lead paint investigations were compiled for each phase. The importance of windows to lead hazard control in Illinois became unmistakable:

- Based on XRF sampling, windows proved to have the highest concentration of lead-based paint of any interior component. Over all GLO phases, 63% of XRF samples taken on windows exceeded the threshold of 1 milligram per square centimeter (mg/cm2).
- In judging the surface condition of painted surfaces for the extent of paint deterioration (good, fair, or poor), GLO inspectors found windows to be the least likely component to be judged "good", and the most likely component to be judged "poor" by a large margin.
- Based on lead content and surface condition, GLO inspectors assigned each component to a risk category (low, moderate, or high). As the XRF sampling and paint condition assessments would imply, windows were the component least likely to be judged a "low risk", and the most likely to be judged a "high risk". During the final GLO phase, 58% of windows were placed in the "high risk" category, more than any interior or exterior building component. The other GLO phases had similar results.

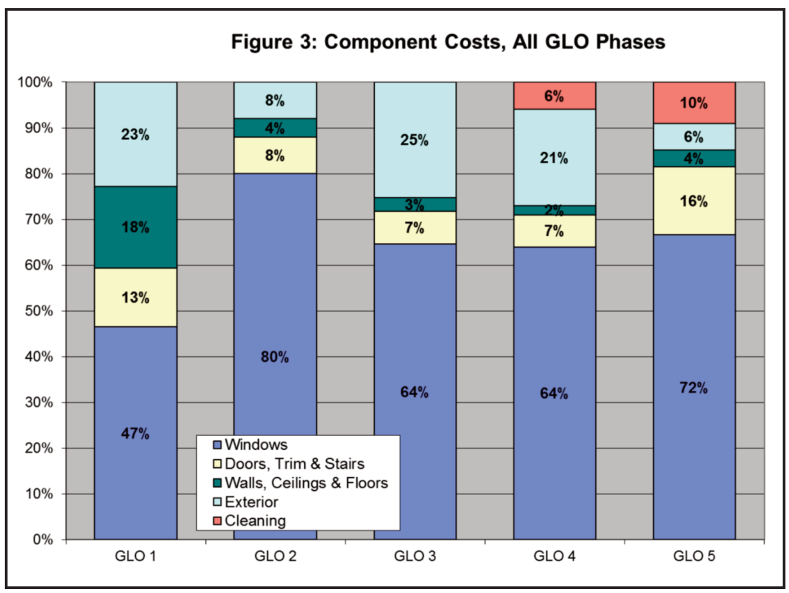
GLO inspectors also performed dust wipe sampling as part of their risk assessment. Samples were taken from floors, windowsills, and window troughs (the horizontal space between the primary sash and the storm window). Figure 2 shows the percent of dust wipe samples that exceeded the federal standards during the last phase of GLO. The results from the window components are dramatic:



- Just 35% of the floor dust wipes exceeded the threshold for floors of 40 µg/ft², with a median value of 16 µg/ft².
- 61% of dust wipes from windowsills exceeded the threshold for sills of 250 µg/ft², with a median value of 354 µg/ft².
- A full 89% of dust wipes from window troughs exceeded the threshold of 400 µg/ft². The median value was 16,979 µg/ft², over 40 times the federal standard (and over 80 times the Illinois standard of 200 µg/ft².)

The inspection results from Illinois were similar to other programs around the country. The National Survey of Lead and Allergens in Housing (2001) found that geometric mean dust lead loadings on windowsills and troughs were roughly 10 and 100 times higher than floor dust lead loadings, respectively. Windows with lead paint are a common cause of lead-contaminated dust in older homes.

Given the lead hazards identified, it is not surprising that lead hazard reduction programs were compelled to perform extensive work on windows. Figure 3 presents the distribution of hazard control costs by component category for all phases of the GLO program.



In the last phase of the GLO program, 72% of remediation costs resulted from window work, primarily window replacement. This level of window work was consistent with the previous three phases, where window remediation accounted for between 64% and 80% of lead remediation costs. In the first phase of the GLO program, window work was also the largest component of cost, but was contained to 47% of remediation costs as the program featured other, less expensive, treatments to window remediation (selective paint removal, jamb liners, etc.). After the initial GLO phase, window replacement was heavily favored over other treatments. The experience in the Illinois program was repeated in lead hazard control programs around the country. The national evaluation of the HUD lead hazard reduction grant program showed that window replacement is a common hazard control strategy adopted by many local governments receiving HUD grants.[14]

Evaluation of lead hazard control programs over the long term has pointed to the value of window replacement over other window treatments. A recent study examined lead dust levels in homes 12 years after they were enrolled in the HUD Lead Hazard Control Grant program.[15] A set of 189 treated homes were divided into homes where all windows were replaced, homes where some of the windows were replaced, and homes that had no window replacement. Twelve years after intervention, homes with all replacement windows had floor dust lead loadings 41% lower than non-replacement homes. Windowsill dust lead loading were 51% lower in the homes with all replacement windows.

Windows have taken a central place in planning for the prevention of childhood lead poisoning. A model developed for the President's Task Force on Environmental Health Risks and Safety Risks to Children[16] forecasts a decline in lead paint hazard and elevated blood lead prevalence based primarily on window replacement rates. In 2006, Jacob and Nevins published, *Windows of Opportunity, Lead Poisoning Prevention, Housing Affordability, and Energy Conservation*.[17] This paper discussed the validation of the model developed for the Task Force, and concluded that window replacement explains a large part of the substantial reduction in lead poisoning in recent years. The paper goes on to advocate for a public-private effort to increase window replacement rates, recognizing the range of benefits such an effort could impact: benefits relating to health, energy, environment, and housing affordability. Two years later, the same authors (with co-authors) estimated the monetary benefits of lead-safe window replacement.[18] It was estimated that lead-safe window replacement in all pre-1960 US housing would yield net benefits in excess of $67 billion. (Note: This referenced paper establishes the methodology for the economic benefits described in this report, and will hereafter be referred to as "Nevin 2008".)

The large body of research, field experience, and program evaluation, described above, established the basis for the development of the Clear-Win program. It is the first window replacement program to be run by a public health agency, instead of a housing authority or weatherization program. While the primary purpose of Clear-Win is the prevention of childhood lead poisoning, there are substantial other benefits. This report examines the activities, costs, and benefits of the pilot phase of the program.

Section 2: DESCRIPTIVE STATISTICS

The data generated by the program were submitted by the regional administrators, PC/CHD, and CNT Energy, to the Illinois Sustainable Technology Center (ISTC). The submissions included spreadsheets containing basic information about the properties and occupants, as well as work orders, window invoices, dust wipe sampling forms and lab results, and contractor invoices. The data were entered into a master database and validated at ISTC.

A total of 379 properties, containing 466 housing units, were treated in the Clear-Win program during the reporting period. Note that Peoria classified its lone multifamily property (a duplex) as two separate projects, while Chicago treated all multifamily buildings as single projects. Thus, there were 380 coded projects involving 379 buildings in Clear-Win. Table 1 presents a summary of the types of buildings in the program.

2.A. Building Type

A sizable majority (85%) of the Clear-Win projects involved single family homes. The two regions differed in this regard. In the Peoria region, all but one of the projects was a single family home. The Chicago region worked on 57 multifamily buildings (primarily duplex or two-flat apartment buildings) in addition to 191 single family buildings. The largest building in the program contained 6 units in Chicago.

Table 1: ClearWin Building Type

	Peoria		Chicago		ClearWin Total	
	number	%	number	%	number	%
Single Family	130	98.5%	191	77.0%	321	84.7%
Duplex	1	1.5%	44	17.7%	45	11.9%
Triplex	0	0.0%	3	1.2%	3	0.8%
Four flat	0	0.0%	7	2.8%	7	1.8%
> four units	0	0.0%	3	1.2%	3	0.8%
Total Buildings	131	100.0%	248	100.0%	379	100.0%
Total Units	132		334		466	

2.B. Building Size

Single family homes, representing 85% of the Clear-Win projects, were of modest size. The median size of single family homes was 1,082 ft^2. A full 80% of the single family homes were smaller than 1,500 ft^2. This was true in both Clear-Win regions, which showed little difference in the distribution of building size, as seen in Table 2. As expected, multi-family buildings in Chicago were larger. The largest building in the program was the six unit building in Chicago, measuring 7,641 ft^2 including the common areas.

Table 2: Single Family Building Size (ft^2)

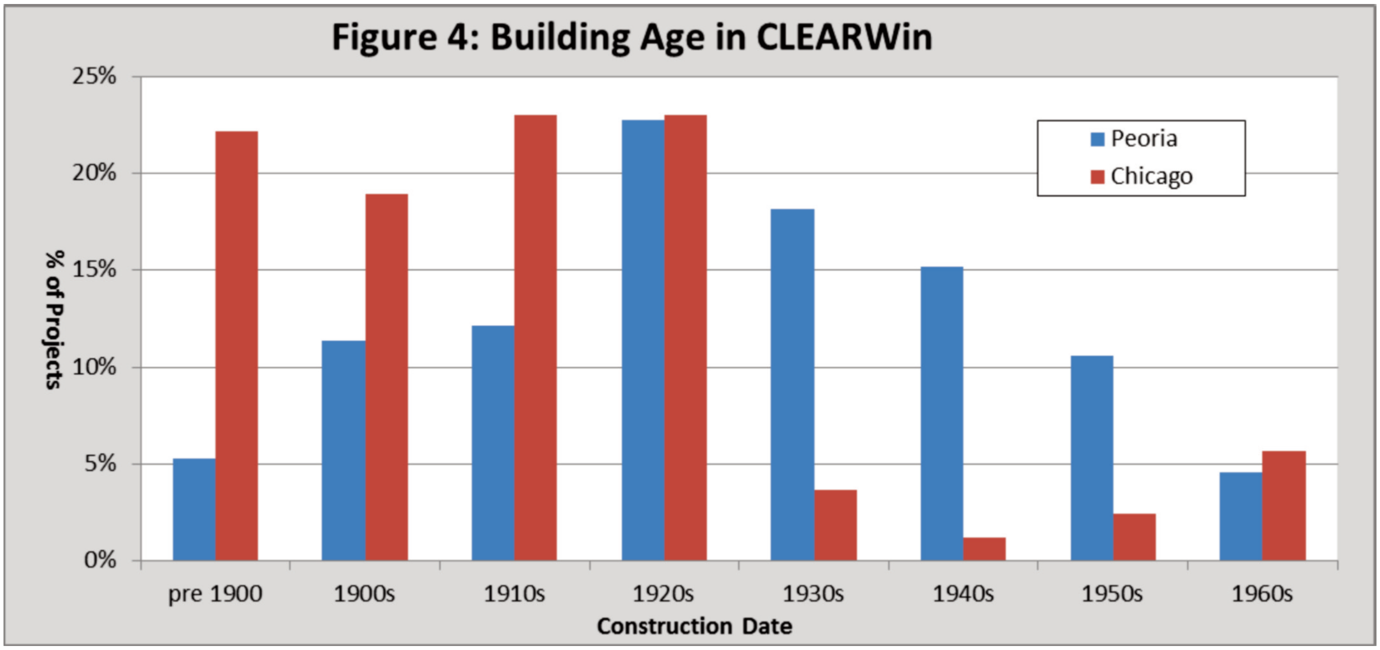
	Peoria		Chicago		ClearWin Total	
	Number	%	Number	%	Number	%
< 1000	41	32%	74	39%	115	36%
1000 - 1500	62	48%	78	41%	140	44%
1500 - 2000	18	14%	22	12%	40	12%
2000-2500	6	5%	8	4%	14	4%
> 2500	3	2%	9	5%	12	4%
Total	130	100%	191	100%	321	100%
mean	1,265		1,255		1,259	
median	1,171		1,056		1,082	

2.C. Building Age

All of the buildings in the program were required to be built prior to 1978, the year that lead was taken out of residential paint. Table 3 and Figure 4 present the age of the buildings by decade of construction. There were no buildings from the 1970's in the program. In both regions, building constructed in the 1920's, when use of lead in paint was at its peak, were the most common, constituting 23% of the properties in the program. Outside of that, there are noticeable differences between the two regions.

Table 3: Building Age by Decade

	Peoria		Chicago		ClearWin Total	
	number	%	number	%	number	%
pre 1900	7	5%	55	22%	62	16%
1900s	15	11%	47	19%	62	16%
1910s	16	12%	57	23%	73	19%
1920s	30	23%	57	23%	87	23%
1930s	24	18%	9	4%	33	9%
1940s	20	15%	3	1%	23	6%
1950s	14	11%	6	2%	20	5%
1960s	5	5%	14	6%	19	5%
Total	131	100%	248	100%	379	100%



What is immediately notable is the extreme age of the buildings treated in Chicago. 87% of the buildings in the Chicago program were constructed in the 1920's or earlier. This was true for only around half (51%) of the buildings in Peoria. Nearly a third of the buildings in Peoria (31%) were built in the 1940's or later; just 9% of the buildings in Chicago were of that more modern vintage. The distribution of construction dates reported by PC/CHD, which operated the program throughout the city and county of Peoria, likely mirrors the overall age distribution of low-income housing throughout their jurisdiction. Englewood and West Englewood are south side neighborhoods roughly bounded by Garfield Blvd. (55th St.) to the north, and 76th St. to the south, between Racine Ave. to the west, and the railroad tracks to the east. The development of these neighborhoods seems to have started soon after the Chicago fire of 1871, and was substantially completed by the end of the 1920's. Buildings constructed after 1930 are few in this neighborhood, and likely represent replacement buildings and in-fill construction.

The predominance of older buildings in the Chicago region, and thus in the Clear-Win program overall, is significant. As discussed previously, the age of housing units correlates to the presence of lead hazards, and ultimately to the incidence of childhood leads poisoning. The 1999-2002 National Health and Nutrition Examination Survey (NHANES) found that, while children in pre-1940 housing account for only 10% of children aged 1-5, they accounted for 40% of children with blood lead over 10 mcg/dl.[19] (30% of EBL children in the dataset did not have housing data recorded, so the 40% is likely far higher).

In calculating health benefits from lead poisoning prevention, building age is a critical factor. The analysis of health benefits later in this report utilizes the building age data reported in Clear-Win.

2.D. Occupants

Table 4 presents the data relating to the occupants in the Clear-Win program. A total of 1,412 occupants were served by the program, an average of 3.03 occupants per housing unit. The Peoria region had a slightly higher density (3.34 occupants per unit) compared with the Chicago region (2.91 occupants per unit).

Children below the age of six years old, those most vulnerable to lead poisoning, totaled 251 occupants, or about 18% of the total occupation. There was a noticeable difference between the two regions in this regard. Peoria averaged nearly one young child (0.9) per project, with over 63% of the projects including a child as an occupant. By comparison, only 35% of the Clear-Win projects in Chicago included young children, with an average of 0.4 children per housing unit. The data on the prevalence of young children was used in the economic analysis.

Table 4: Occupants in ClearWin Properties

	Peoria	Chicago	ClearWin Total
Total Occupants	441	971	1412
Occupants/Property	3.37	3.92	3.73
Occupants/Unit	3.34	2.91	3.03
Children <6	118	133	251
Children <6/Property	0.90	0.54	0.66
Children <6/Unit	0.89	0.40	0.54
Properties w/ Children	63.4%	35.1%	44.9%
Vacant Properties	4	1	5

This regional difference in child occupation likely reflects the difference in recruitment resulting from the nature of the local programs. As previously noted, the Peoria City/County Health Department bundled the Clear-Win program funding with their HUD-funded lead hazard control program, which prioritizes properties with young children. Per state statute, the health department also investigates the residences of reported EBL (children with elevated blood level) cases, and it is natural that those property owners are referred to the lead hazard reduction program. This circumstance likely increased the prevalence of young children in the Peoria Clear-Win program. The Chicago program managed by CNT Energy recruited broadly in the Englewood neighborhood of Chicago, without reference to EBL cases. There was no requirement related to the presence of young children in Clear-Win projects.

2.E. Building Contractors

Window replacement work was performed by qualified contractors in both regions of the Clear-Win program. To qualify, a building contractor had to be a either certified by EPA as a lead abatement contractor, or have been certified according to EPA's Lead Renovation, Repair, and Painting Rule (RRP).

A lead abatement contractor is qualified to perform lead abatement projects. Training for lead abatement professionals (inspectors, assessors, and abatement contractors) was established by EPA in accordance with Title X, Residential Lead-Based Paint Hazard Reduction Act of 1992. In Illinois, lead abatement contractors are licensed by IDPH. A lead abatement project is any project initiated and designed to permanently eliminate lead-based paint hazards.

All other activities that disturb lead-based paint in homes (renovation, remodeling, window replacement, weatherization, etc.) require building contractors certified in accordance to the RRP rule. These certified contractors are trained by EPA-approved trainers and follow lead-safe work practices. Required training is less extensive for RRP contractors than for lead abatement contractors, and there are other differences between the classifications regarding the regulations relating to lead safe practices. One area of difference is in clearance testing, which is discussed further in Section 3: Clearance Study.

The Clear-Win program, while principally a lead poisoning prevention program, was not strictly designed to eliminate all lead hazards in every house permanently. Rather, Clear-Win was a window replacement program with anticipated benefits in preventing childhood lead poisoning. It was determined by IDPH that both abatement contractors and RRP contractors could work in the program.

Each region supplied information on contractors in the program, and identified the contractor for each project. Table 5 presents the breakdown of contractors and projects in Clear-Win. Each region employed 15 different contractors during the reporting period. Two lead abatement contractors had jobs in both regions, so a total of 28 contractors participated in the program.

Table 5: ClearWin Contractors

		Peoria	Chicago	ClearWin Total
Participating Contractors	Lead Abatement Contractors	15	10	23
	RRP Contractors	0	5	5
	Total Participating Contractors	15	15	28
Projects Completed	Lead Abatement Contractors	132	205	337
	RRP Contractors	0	43	43
	Total Projects	132	248	380

Clear-Win employed mostly lead abatement contractors. Of the 28 contractors, 23 (82%) were lead abatement contractors, while only five were RRP contractors. All of the RRP contractors worked in the Chicago region; Peoria employed only abatement contractors. In the projects where PCCHD bundled the Clear-Win program with its HUD-funded lead hazard control program, this was a HUD requirement. Because the lead hazard control projects are designed to eliminate lead hazards, lead abatement contractors are required by federal and state statute, as well as by the HUD-funded program requirements.

Lead abatement contractors, while 82% of the contractor base, were responsible for 89% of the projects (337 of 380). RRP contractors were responsible for only 11% of the projects (43 of 380). Considering just Chicago, the 10 abatement contractors performed 83% of the work, while the 5 RRP contractors were responsible for only 17% of the work.

2.F. Windows Replaced

In order to maximize energy benefits, the specification in the Clear-Win protocol called for very high efficiency (R-5) replacement windows. This level of efficiency exceeds EPA's Energy Star standard (R-3.3) for efficient windows in Illinois' climate zone. The Clear-Win program also determined that, to maximize job creation and economic benefit to Illinois, every effort should be made to identify Illinois window manufacturers for the program. Two window manufacturers in Illinois were identified that could meet the high efficiency window specifications: Armaclad Windows and Serious Windows, both with manufacturing facilities in Chicago. The original plan was for Serious to provide replacement windows for the Chicago area, while Armaclad provided windows for the Peoria region. Early in the program, Serious Windows closed its Chicago manufacturing facility. Following that development, Armaclad supplied the replacement windows for both regions in the Clear-Win program. In the end, Armaclad supplied 87% of the windows in the program (6,754 of 7,747).

It should be noted that Armaclad was a participant in both phases of DOE's High Performance Windows Volume Purchase (WVP) Program, a market transformation program designed to accelerate and reduce the costs of highly insulating windows. This program, active from 2009 to 2012, established specifications to meet minimum standards for thermal and structural performance. Windows used in the Clear-Win program met those standards.

Table 6: Windows Replaced by ClearWin

	Peoria	Chicago	ClearWin Total
Total Windows Replaced	2316	5431	7747
Mean Windows/Building	17.7	21.9	20.4
Mean Windows/Housing Unit	17.5	16.3	16.6
Mean Window Area (ft^2)	10.1	11.3	10.9
Mean Aggregate Area/Building (ft^2)	177.8	247.9	223.6
Mean Aggregate Area/Unit (ft^2)	176.4	184.0	181.9

A total of 7,747 windows were replaced during the reporting period (Table 6), an average of 20.4 windows per building, or 16.6 windows per housing unit. Considering single family houses only, Peoria averaged 17.6 windows per house, and Chicago averaged 18.7 windows per house.

Mean window size was 10.9 ft^2 per window overall, with the replacement windows in Chicago about 10% larger on average. Mean aggregate window area was 184 ft^2 per housing unit. These window areas were used to calculate heat loss and energy savings (Section 5).

All of the windows that were replaced were single pane windows. Double-pane windows did not become widely used in cold climates until the 1980s, after lead paint was banned. As a result, double-pane windows in older housing are an indicator that original windows (often with lead paint) have already been replaced. Generally, windows were replaced with windows of the same operational type (double hung, casement, etc.). Table 7 presents the replaced windows according to the operational type of window. The great majority of windows (85%) were double hung (vertically sliding) windows. Another 8% of replaced windows were horizontally sliding windows. Hinged windows (casement and awning) accounted for 4% of the total, while 2% of the windows were fixed, non-operational windows.

Table 7: Window Replaced by Type

	Peoria		Chicago		ClearWin Total	
	#	%	#	%	#	%
Double Hung	1689	73%	4886	90%	6575	85%
Slider	376	16%	280	5%	656	8%
Casement	14	1%	83	2%	97	1%
Awning	201	9%	35	1%	236	3%
Fixed	36	2%	147	3%	183	2%
Total Windows	2316	100%	5431	100%	7747	100%

2.G. Additional work performed by Clear-Win

Window replacement was the predominant activity in Clear-Win projects, accounting for more than 98% of the project costs. However, when other critical lead hazards were identified, these items could be added to the Clear-Win work orders. Additional work relating to the windows themselves, and work beyond the scope of a standard window replacement (rotted frames, missing trim, enclosure of exterior window elements, etc.) constituted some of this additional work.

As noted previously, PCCHD bundled Clear-Win funds with its HUD-funded lead hazard reduction program. For this reason, full lead risk assessments were performed and all lead hazards addressed through the combined program. This allowed Clear-Win funds to be used exclusively for the window replacement portion of the projects. Based on the change orders submitted with the data, only ten projects (8%) had additional work billed to the Clear-Win program. Typically, this work involved additional window work beyond the scope of a standard window replacement. Just $3,480, less than 1% of project costs, was identified in the change orders.

CNT submitted contractor invoices for all of the projects, allowing for the identification of additional costs beyond the standard window installation. A total of 1,325 additional hours were billed to the program. Labor cost for these hours, along with associated material costs, totaled $49,034, or 4.1% of total project costs in Chicago. The Chicago region did not have the advantage of other lead hazard control funds to address additional lead hazards, so while much of the additional cost related to expanded window work (rotted frames, missing trim, etc.), there were clear cases of other acute lead hazards being addressed. Some examples include:

- C005 – Paint pillars on front porch and paint front porch ceiling due to flaking and peeling paint
- C008 – Wet scrape and stabilize front porch
- C013 – Wet scrape and paint front entry way and replace bad wood
- C027 – Repair plaster and paint bathroom ceiling
- C073 – Paint front vestibule, walls, ceiling, trim, and doors

While window replacement was the primary function of Clear-Win, it is clear that the program addressed other, obvious lead hazards as required.

Section 3: CLEARANCE STUDY

All Clear-Win projects were subject to clearance testing by dust wipe sampling, the standard protocol for lead hazard control projects. Clearance testing is performed to ensure that a dwelling is lead safe, and not contaminated with lead dust as a result of the remediation work. Certified technicians were required to perform the dust testing. In Peoria, staff of PCCHD performed this function. In Chicago, dust sampling was performed either by staff from the Chicago Department of Public Health, or by a qualified third party environmental company. Dust samples were taken from floors, windowsills, and window troughs, and were submitted to the IDPH laboratory to determine lead concentration. In order to pass the clearance test, lead concentrations could not exceed the clearance standards determined by Illinois statute[2]:

- Floors – 40 μg/ft^2
- Windowsills – 200 μg/ft^2
- Window troughs - 200 μg/ft^2

If one of the initial dust samples exceeded the standard, that project was said to have failed the clearance test. Contractors were then required to return to the house for additional cleaning, and were subject to a second round of clearance testing. The process was continued until the project passed clearance testing. This is a standard protocol for lead hazard reduction work.

Both regions submitted sampling forms and the laboratory results of the initial clearance tests. Of the 380 projects in Clear-Win, a total of 375 (98%) offered complete initial clearance testing data. Table 8 presents the results of the initial clearance tests.

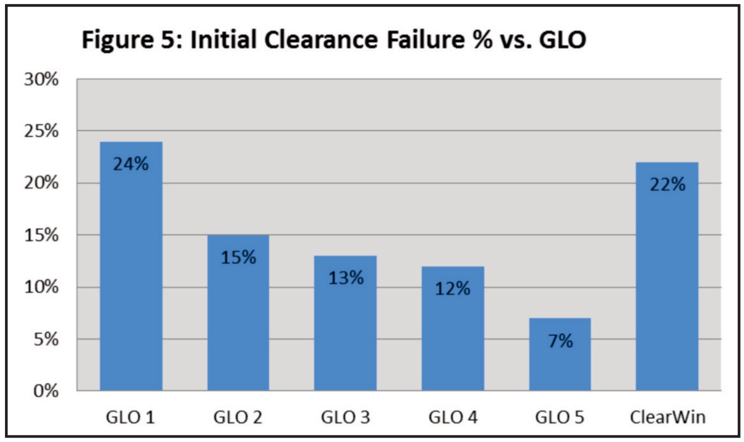
Table 8: Initial Clearance Testing

	Peoria				Chicago				ClearWin Total			
	Pass		Fail		Pass		Fail		Pass		Fail	
	#	%	#	%	#	%	#	%	#	%	#	%
Lead Abatement Contractors	108	82%	24	18%	156	78%	45	22%	264	79%	69	21%
RRP Contractors	0	na	0	na	29	69%	13	31%	29	69%	13	31%
All Contractors	108	82%	24	18%	185	76%	58	24%	293	78%	82	22%

Over both regions, 22% of the projects failed the initial clearance test. In other words, just greater than one in five dwellings had a level of lead dust contamination in one or more locations that required additional cleaning after the window replacement was completed. There was a slight difference between the regions, with Peoria having fewer initial clearance failures (18%) than Chicago (24%). In both cases, this was a relatively high failure rate. This failure rate, however, does not imply that the window replacement work necessarily created the lead dust hazards. Clear-Win clearance testing may have identified lead dust hazards that existed prior to the work. As dust wipe testing prior to window replacement was not part of the program protocol, the extent of pre-existing lead dust hazards cannot be determined. It is likely that the relatively high clearance failure rate results from some combination of both pre-existing lead dust levels, and lead contamination from the window replacement work. Figure 5 compares the initial clearance failure rate of Clear-Win with the five phases of the GLO program.

[2] Illinois clearance standards are more stringent than the federal EPA standards (floors – 40μg/ft^2, sills – 250μg/ft^2, troughs - 400μg/ft^2).

The GLO program, the HUD-funded and IDPH-operated lead hazard reduction program, was active in five phases from 1994 through 2011. The initial clearance failure rates for GLO phases are shown in Figure 5. Over the life of the GLO program, initial clearance failure rate fell consistently, from 24% to just 7%. The clearance failure rate of Clear-Win was well above GLO in each of its last four phases, exceeding only the first phase of the GLO program. While GLO projects did include some window replacement, they rarely featured the replacement of all windows, as in the Clear-Win program. This indicates that in a program of complete window replacement such as Clear-Win, dust containment during intervention and comprehensive cleaning is critical.



Of the principal Clear-Win contractors (those responsible for more than ten projects), all had at least one initial clearance failure. Failure rates for these contractors ranged from 7% to 39%, with a median rate of 20%.

Table 8 breaks down the initial clearance test results by the type of contractor: lead abatement contractors and RRP contractors. Contractors trained in lead abatement are taught specialized cleaning in order to pass dust wipe sampling clearance protocol, the process described above. Dust wipe clearance testing is normal for these contractors. RRP protocols call for a lesser standard for clearance. Project involving remodeling and renovation are not subject to dust wipe sampling with laboratory results. Rather, clearances for these jobs are subject to visual inspection, essentially a "white glove" test that does not quantify lead dust concentrations. This difference is perhaps the most controversial aspect of EPA's RRP rule. The concern is that, without the feedback of regular dust wipe clearance testing on projects, it is possible that RRP contractors may not clean sufficiently to prevent introducing lead hazards. Many advocates for lead poisoning prevention support clearance by dust wipe sample for RRP projects to ensure that work disturbing lead-based paint does not introduce lead dust hazards. Because Clear-Win employed both RRP and lead abatement contractors in Chicago to perform the same work, it is possible that initial clearance results may shed light on this question, at least as it pertains to one specific RRP activity – window replacement.

Of the 243 projects with initial clearance testing data in Chicago, 201 were performed by lead abatement contractors, and 42 by RRP contractors. The lead abatement contractors had an initial clearance failure rate of 22%. The RRP contractors, likely facing dust wipe sampling clearance for the first time, had a somewhat higher failure rate of 31%. This offers some evidence that contractors trained only in RRP protocols are more likely to leave lead hazards following window replacement, even when they know that dust wipe sampling will take place at clearance. The difference is not large, however, and owing to the small sample size of RRP contractors, not statistically significant at the 90% confidence level. In either case, whether 20% or 30% of projects indicate lead dust hazards following window replacement, both levels present unacceptable risks for residents. The study of initial clearance levels points to the following conclusions:

1. In a program involving full replacement of the old windows, lead dust hazards that are not eliminated by initial cleaning are common. This was the case in 22% of Clear-Win projects following cleanup.
2. While there is some evidence that RRP contractors may leave more lead hazards than lead abatement contractors, that evidence is not conclusive. Both categories of contractors experienced excessive number of failures at clearance.
3. If the Clear-Win program continues beyond the pilot phase, full clearance testing featuring dust wipe sampling will remain critical, regardless of the training and qualifications of the contractors.
4. Since most window replacement in the U.S. happens outside of an environmental lead context, there is reason for concern that lead hazards may be too common following the window replacement work, particularly in pre-1940 buildings.

Section 4: CLEAR-WIN COSTS

Table 9 presents the costs associated with the Clear-Win program during the reporting period. Three categories of cost are identified:

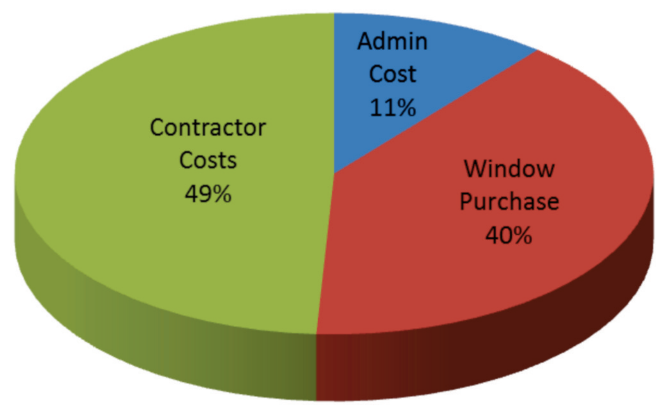
1. Regional administrative costs
2. Window purchase costs, and
3. Contractor costs

Table 9: ClearWin Costs				
Overall Cost Totals		Peoria	Chicago	ClearWin Total
	Regional Admin Cost	$ 132,000	$ 248,000	$ 380,000
	Window Purchase	$ 423,725	$ 952,910	$ 1,376,635
	Contractor Installation	$ 497,151	$ 1,145,541	$ 1,642,692
	Contractor Additional	$ 3,480	$ 49,034	$ 52,514
	Contractor Subtotal	$ 500,631	$ 1,194,575	$ 1,695,206
	Total Costs	$ 1,056,356	$ 2,395,485	$ 3,451,841
Cost Statistics		Peoria	Chicago	ClearWin Total
Local Administrative Costs	Mean Cost/Building	$ 1,008	$ 1,000	$ 1,002.64
	Mean Cost/Unit	$ 1,000	$ 743	$ 815.45
	% of Total Project Costs	12%	10%	11%
Window Purchase Costs	Mean Cost/Window	$ 183	$ 175	$ 178
	Mean Cost/Building	$ 3,235	$ 3,842	$ 3,632
	Mean Cost/Unit	$ 3,210	$ 2,853	$ 2,954
	% of Total Project Costs	40%	40%	40%
Contractor Costs	Mean Cost/Window	$ 215	$ 211	$ 212
	Mean cost/Building	$ 3,822	$ 4,817	$ 4,473
	Mean Cost/Unit	$ 3,793	$ 3,577	$ 3,638
	% of Total Project Costs	47%	50%	49%
Total Costs	Mean Cost/Building	$ 8,064	$ 9,659	$ 9,108
	Mean Cost/Unit	$ 8,003	$ 7,172	$ 7,407
	Maximum	$ 17,757	$ 47,802	$ 47,802
	Median	$ 7,432	$ 8,516	$ 8,121
	Minimum	$ 2,600	$ 2,333	$ 2,333

The regional administrative costs were established at $1,000 per project. This funding was provided to PCCHD and CNT to cover the costs of administering the program in each region, including recruitment, housing inspection, window purchasing, contracting and contract management, clearance testing, record keeping, data submission, and general project oversight. This work was labor intensive, and it is expected that most of the funds were dedicated to personnel costs. Unlike PC/CHD, a health department with the capacity to perform clearance testing in-house, CNT subcontracted clearance testing to third parties, and administrative funds were also used for that purpose in Chicago. Overall, 11% of program funds were spent on regional administrative costs. This does not take into account any central administrative costs incurred and billed to Clear-Win by IDPH, costs which are not included in the total costs in Table 9.

For data on window purchase costs, both regions submitted the complete factory invoices, providing both the size and cost of each window ordered for Clear-Win. A total of $1,376,635 was spent on purchasing the 7,747 replacement windows in the program, accounting for 40% of the project costs, both in each region and for the overall program. Pricing for windows was negotiated and based on a "United Inches" formula (height + width = united inches). This formula for bulk purchasing proved quite favorable to the Clear-Win program, resulting in an average window cost of $178. While replacement window costs can vary greatly depending on window type, composition, and quality, this is an exceptional price for high performance windows meeting DOE specifications. No doubt Clear-Win benefitted from DOE's WVP program. The WVP program was successful in reducing the incremental cost premium for highly insulating windows. Prior to the program in 2008, the incremental cost premium (for the average size window in the Clear-Win program of 10.9 ft^2) was between $74 and $109. At the conclusion of the program in 2012, the incremental cost premium was reduced to between $17 and $64, a reduction of approximately $50.[20] By working with a window manufacturer (Armaclad) participating in the WVP program, the economy of scale accomplished by WVP likely saved the program between $350,000 and $400,000 on window purchasing costs.

Figure 6: ClearWin Cost Distribution



A total of 28 building contractors participated in Clear-Win. CNT submitted contractor invoices to track installation costs. PCCHD did not submit the contractor invoices, but provided work orders, change orders, and reported total contractor costs. Contractors were paid a flat fee for window installation. After some negotiation and subsequent adjustment early in the program, the fee settled at $221.80/window, and remained at that level for the remainder of the program. Overall, the average cost for window installation in Clear-Win was $212, with little difference between the two regions. This cost covered both labor and a consideration for necessary materials. Window installation is typically estimated between $150 and $300, which places the Clear-Win average cost near the midpoint of the range. It should be remembered, however, that Clear-Win required lead-safe practices, including setting up containment, handling lead-contaminated materials safely, specialized cleaning, removal and disposal of containment materials, and re-cleaning if clearance testing failed. Given these requirements, it can be concluded that the negotiated rate for window installation was reasonable and cost effective. Overall, contractor costs accounted for 49% of the project costs in the Clear-Win program.

Totaling the purchase cost and installation cost, average installed cost per window was $390. If the regional administrative is applied, the average installed cost per window was $439.

The average building cost for Clear-Win was $9,108. Because Chicago had so many multifamily buildings, there was a higher average cost in Chicago than Peoria ($9,659 vs $8,064.) When calculated per housing unit, the order of average cost was reversed between the two regions: Chicago - $7,172; Peoria - $8,003. The maximum cost spent on an individual building was $47,802, occurring on a six unit apartment in Chicago where 110 windows were replaced. The above figures include the regional administrative cost.

Note that Peoria treated its lone multifamily property (a duplex) as two separate projects, each subject to a separate administration fee. By contrast, Chicago treated each building as a single project regardless of the number of units in the building. This explains the differences in the administrative cost averages and percentages that appear in Table 9.

Section 5: ENERGY and ENVIRONMENTAL BENEFITS

Clear-Win specified extra high efficiency replacement windows (R-5) for the program. For this reason, the buildings treated in the program will experience lower energy usage, and the clients will see lower energy bills. Additionally, lower energy usage will result in a smaller contribution of greenhouse gases that contribute to climate change. This section examines the energy and environmental benefits of the Clear-Win program. Short and long term reduction in energy usage is calculated, along with the utility bill savings, and the reduction in greenhouse gases.

5.A. Methodology

Wintertime conductive heat loss through the total window area of the each house was calculated with the following heat loss formula:

Heat Loss (Btus) = (Area (ft^2) * HDD (F days) * 24 hr/day)/R-value (ft^2 * F * hr/Btu)

Inputs to the formula were as follows:

Area: Window invoices provided the area of each window replaced. The sum of the area of the windows replaced provided the total window area of the building.

HDD (Heating Degree Days): This measure of winter climate severity was taken from the HUD HDD database.[21] Peoria airport weather station – 6097 HDD. Chicago Midway airport weather station – 6083.

R-value: The R-value of the replacement windows were R-5. The R-value of the older windows that were replaced depended on the presence of storm windows. R-0.9 was used for windows without storms. The R-value for windows with storms was R-1.5. In cases where the presence of storm windows was not known, the distribution of storms vs. no storms in each region was applied to those cases.

The total heat loss from the windows was then adjusted by the estimated heating efficiency of the furnace, resulting in total fuel consumed to provide for the heat loss through the windows. Furnace efficiency was not measured, but inspectors provided an estimate of efficiency (70%, 80%, or 90%). This estimate was provided for all projects in Peoria. For cases in Chicago where the furnace efficiency was not estimated, the distribution in efficiency of the known cases was applied to the unknown cases. The output in Btu's was converted to therms of natural gas. (A therm is a unit of natural gas equal to 100,000 Btus.)

For each building in the program, the formula was calculated twice, once for the original windows and R-value, and again for the replacement windows at R-5. The difference between the two calculations represents the estimated energy savings in therms of natural gas.

First year savings in dollars was calculated based on the mean cost for natural gas in the winter of 2013-2014 (September through March) in each region. For Chicago, the mean cost was available from the Bureau of Labor Statistics ($0.955/therm). Mean cost in Peoria ($0.722) was taken directly from Ameren billings.

The energy savings presented in this section represent a conservative estimate for two reasons:

1. *Summer cooling energy savings were not estimated.* While Illinois is primarily a heating climate, there is an energy demand for cooling in the summer. Conductive heat loss savings in the summer will work similarly as in the heating season calculation. However, insufficient data were provided to determine the presence of air conditioning in most buildings in Clear-Win, with no data from the Chicago region. The data from Peoria showed that only about one third of the projects were air conditioned in the summer. There was, no doubt, some additional energy savings on the cooling side, but those savings would be small in comparison to the savings from the heating season. The Cooling Degree Day (CDD) base for the calculation is about one sixth of the HDD base (about 900 CDD compared to 6100 HDD). If it held true that one third of the Clear-Win buildings were air conditioned, one would expect that total energy savings from summer cooling would be about 6% of the savings realized in the winter.

2. *Convective heat loss was not estimated.* Heat loss by convection, from air leaking in and out of a building, is also a factor in energy use. Convective heat loss occurs in many locations in a building, including around operable windows. In replacing older windows with new windows, Clear-Win likely reduced the convective heat loss in addition to the conductive heat loss that was calculated. DOE's WVP program included a specification for convective heat loss, and the Armaclad windows used in the Clear-Win program met those specifications. Air leakage around windows, however, is often overstated. Analysis of DOE's WAP program has shown that most convective heat loss is not associated with window air leakage, but rather with larger bypasses in the building envelope. For this reason, weather-stripping (or replacement) of windows is almost never a part of the WAP program. Furthermore, estimating convective heat loss is far more problematic than conductive heat loss, requiring numerous questionable assumptions on leakage area, environmental conditions, and convective driving forces. As with the energy savings from air conditioning, there were almost certainly some savings by reducing air leakage with window replacement, but the savings were likely minor, likely around 5% to 6% of the calculated savings from conductive heat loss.

Considering these two reasons together, it is clear that the energy savings in this section represent a conservative estimate of the actual total energy savings. It is likely that the actual savings are 10% to 12% greater than stated.

5.B. Energy Savings

Table 10 presents the energy savings that resulted from window replacement in the Clear-Win program. Note: a therm is a unit of natural gas equal to 100,000 Btus.

Table 10: Energy Savings from ClearWin Window Replacement

		Peoria	Chicago	ClearWin Total
Year One	Energy savings (therms)	27,152	59,566	86,718
	Energy savings/building (therms)	207	229	228
	Energy cost savings	$ 19,596	$ 56,903	$ 76,499
	Energy cost savings/building	$ 150	$ 229	$ 201
LongTerm (20 Years)	Energy savings (therms)	543,041	1,191,323	1,734,363
	Energy savings/building (therms)	4,145	4,589	4,564
	Energy cost savings	$ 391,920	$ 1,138,054	$ 1,529,974
	Energy cost savings/building	$ 2,992	$ 4,589	$ 4,026

In the first winter, it is estimated that the Clear-Win program saved 86,718 therms of natural gas, or 228 therms per building. Average savings per building was slightly more than $200, with a total estimated cost savings to the clients of $76,499. The money saved by low income clients in reduced utility bills becomes available for, and is transferred into, additional economic activity in the local economy.

The reduction in energy use and utility bills have longer term implications. The reduction will be realized each year over the life of the windows, which can be assumed to be 20 years. Table 11 provides a calculation covering a 20 year period. The average savings in energy use (therms) per year will be fairly consistent over time. It is estimated that the Clear-Win program will reduce energy use by 1,734,363 therms over 20 years, a reduction of 4,564 therms per building. Long term energy cost savings are more difficult to estimate. Until recently, it was commonly assumed that energy costs would continue to escalate due to shrinking supplies and increasing demand. However, recent advancement in extraction technology has resulted in increased supply of natural gas and a real reduction in cost over the last few years. (The above first year energy cost estimate, based on 2013-2014 prices, is from a favorable natural gas economy.) Some estimates of future natural gas prices are available. The IMF Commodity Price Forecast (12/2014) predicts a stable price for natural gas in the U.S. through 2020, with little to no price escalation. The EIU Economic and Commodity Forecast (10/2014) predicts a 17% increase for natural gas in the U.S. over the same period. The World Back Commodity Forecast (10/2014) calls for a 29% increase in the U.S. by 2020.[22] Past 2020, future prices are even more indeterminate. The 20 year savings presented above, $1,529,974 in 2014 dollars, is a conservative estimate. It assumes that the price for natural gas will remain flat over the time period. A real price increase of 3% per year over the period (consistent with the EIU forecast extended for 20 years) would result in an energy cost savings over $2 million. A price increase of 5% per year over the period (consistent with the World Bank forecast) would imply an energy cost savings of over $2.5 million.

The conservative estimate of long term energy savings is included as a component of the market value benefit in the Cost/Benefit Summary (Table 12) in section 6.C.

5.C. Environmental Benefits

For every therm of natural gas that is burned as fuel, carbon dioxide is released into the atmosphere. Table 11 presents the reduction in CO2 emissions that result from the energy savings achieved by the Clear-Win program. (The conversion used in the calculation is 0.005302 metric tons of CO2 per therm.)

The Clear-Win program reduced greenhouse gas emissions by nearly 460 metric tons in the first year, or about 1.2 metric tons per building in the program. The EPA provides a calculator that allows for translating the abstract measurement (metric tons) into equivalencies that are more concrete.[23] For example, the first year CO2 reduction is equivalent to:

- The annual greenhouse gas emissions of 96.8 vehicles
- The energy use of 41.9 homes
- The carbon sequestered by 377 acres of U.S. forest

Table 11: CO2 Reduction from ClearWin Window Replacement

		Peoria	Chicago	ClearWin Total
Year One	CO2 reduction (metric tons)	144.0	315.8	459.8
	CO2 reduction/building (metric tons)	1.10	1.27	1.21
LongTerm (20 Years)	CO2 reduction (metric tons)	2,879	6,316	9,196
	CO2 reduction/building (metric tons)	22.0	25.5	24.2

As with the energy savings, the environmental benefits will multiply annually. Table 11 includes the calculation of greenhouse gas reductions over a 20 year period. Clear-Win is expected to reduce emissions by 9,196 metric tons in that period. This is the equivalent of nearly 9.9 million Pounds of coal not being burned.

Section 6: ECONOMIC BENEFITS

Window replacement results in increased home values, better health through lead poisoning prevention, and enhanced energy efficiency. This section quantifies those benefits.

The impact of preschool blood lead on IQ, combined with research on how IQ is related to education attainment and lifetime earnings, has provided the basis for cost-benefit analyses of EPA regulations that eliminated leaded gasoline during the 1980s,[24] and a 1999 Department of Housing and Urban Development (HUD) rule on lead paint hazard reduction.[25] Research by Nevin (2008) on the costs and benefits of lead safe window replacement applied this same analytical framework to estimate the monetized health benefits of preventing preschool lead exposure, combined with an analysis of market benefits associated with lower energy bills and related increases in home value.[26] The economic benefits described in this section are based on Nevin (2008), applying the methodology from that study to the data generated by the Clear-Win program.

6.A. Health Benefit

The monetized health benefit of lead-safe window replacement reported in Nevin (2008) reflects the present value of higher earnings (in 2005 dollars) associated with avoided preschool lead exposure, based on the following:

- ***The present value of lifetime earnings*** associated with a one point increase in IQ consists of the indirect effects of increased educational achievement and workforce participation plus the direct effect of higher hourly earnings associated with higher IQ. Nevin (2008) updated estimates from Grosse (2002)[27], to calculate a present value of $16,809 (in 2005 dollars) for every one IQ point lost due to preschool lead exposure.
- ***IQ points lost per 1 mcg/dl increase in blood lead*** in Nevin (2008) were based on the Lanphear (2005)[28] analysis that showed an average of 0.52 IQ points lost for every one mcg/dl increase in blood lead from 2.5 to 10 mcg/dl. National blood lead data show that children in older housing units targeted for lead-safe window replacement are very likely to have blood lead between 2.5 and 10 mcg/dl.

The blood lead levels of young children are largely determined by the prevalence of lead dust hazards (percent of homes with lead in dust above hazard standards) and the severity of lead dust hazards (lead loading in dust per square foot). Nevin (2008) cited data showing the following relationship between preschool blood lead and windowsill dust lead loadings above the national windowsill hazard standard of 250 mcg/ft^2 (micrograms of lead per square foot):

- Children in homes with median sill dust lead loadings of 250-500 mcg/ft^2 have average blood lead that is 1.98 mcg/dl higher than children in units with sill dust lead loadings below 250 mcg/ft^2 (i.e., homes with no sill dust lead hazards);
- Children in units with sill loadings of 500-1000 mcg/ft^2 have average blood lead that is 2.44 mcg/dl higher than children in units with no sill dust hazards; and
- Children in units with sill loadings over 1000 mcg/ft^2 have average blood lead that is 4.33 mcg/dl higher than children in units with no sill dust hazards

Nevin (2008) calculated the weighted average monetized health benefit per resident child in homes with lead safe windows replacement, based on:

- The percent of homes with single-pane windows that have lead paint on interior window surfaces, by age of housing;
- The prevalence of lead dust hazards in housing units with and without lead paint on interior window surfaces, by age of housing;
- The average dust lead loading (hazard severity) in units with and without lead paint on interior window surfaces, by age of housing;
- The increase in average preschool blood lead associated with dust lead loadings;
- The average loss of IQ per 1 mcg/dl increase in blood lead; and
- The present value of lower lifetime earnings per IQ point lost.

This analysis showed lead safe window replacement yields weighted average health benefits per resident child ages 6-30 months, in 2005 dollars, of:

- $21,195 in housing built before 1940,
- $8,685 in 1940-1959 housing, and
- $2,219 in 1960-1977 housing.

The monetized health benefits of lead-safe window replacement are higher in pre-1940 housing than in 1940-1959 housing, and much higher than in 1960-1977 units, because pre-1940 homes with single-pane windows are much more likely to have lead paint on interior window surfaces, and much more likely to have severe lead dust hazards. Approximately 60% of 1940-1959 homes and 90% of 1960-1979 homes with single-pane windows do not have lead paint on interior window surfaces, and are therefore less likely to have lead dust hazards, thereby reducing the average monetized health benefit of lead safe window replacement in these homes.

The monetized health benefits of lead-safe window replacement are realized in housing units with very young children, because the developing brain is most vulnerable in the first three years of life. In the original paper, Nevin (2008) also calculated the weighted average benefit in any housing unit, based on the random probability of having resident children ages six to 30 months old. This average monetized benefit per housing unit (the weighted average for units with and without young children) is much lower than the benefit in units with very young resident children.

Nevin (2008) "assumes that new birth cohorts of young children are protected for a time horizon of 10 years", but subsequent research has shown that lead hazard reduction benefits last at least 12 years, with ongoing declines in lead dust loadings.[29] Therefore, a conservative estimate of monetized health benefits should now reflect the number of resident children ages 6 to 30 months likely to live in a home at any time during a 12 year period after lead safe window replacement.

As presented above, Nevin (2008) showed a conservative weighted average monetized benefit per resident child ages 6-30 months, in 2005 dollars, of $21,195 in housing built before 1940, $8,685 in 1940-1959 housing, and $2,219 in 1960-1977 housing. This benefit would be realized by all children ages 6-30 months residing in a housing unit during at least the first 12 years after lead safe window replacement. The monetized health benefit in 2005 dollars reflects the increase in lifetime earnings discounted at 3%, so increasing benefit estimates by 3% per year provides an updated health benefit estimate in 2010 dollars, for comparison with years when CLEAR-Win costs were incurred. This updated estimate shows lead safe window replacement yields weighted average health benefits per resident child ages 6-30 months, in 2010 dollars, of:

- $24,571 in housing built before 1940,
- $10,068 in 1940-1959 housing, and
- $2,572 in 1960-1977 housing.

The CLEAR-Win program performed lead safe window replacement in housing with 204 resident children under the age of six in pre-1940 units, 37 children under six in 1940-59 units, and 10 children under six in 1960-77 units. If one-third of these children were ages 6-30 months, then the monetized health benefit would be realized by a minimum of 68.0 children in pre-1940 housing, 12.3 children in 1940-59 units, and 3.3 children in 1960-77 units, based just on the resident population of children ages 6-30 months when windows were replaced. Evidence that lead safe window replacement continues to protect against lead dust hazards for at least 12 years, and possibly much longer, indicates that this benefit will also be realized by other young children as families move in future years. American Housing Survey data show that about 21% of households have lived in their current home for less than five years, 28% for five to ten years, and 16% for ten to 15 years. Therefore, over 12 years it is likely that at least one additional cohort of children ages 6-30 months will live in these units. The monetized health benefits would then be realized by 136 children in pre-1940 housing, 25 children in 1940-59 units, and 7 children in 1960-77 units over 12 years (roughly double the number of resident children ages 6 to 30 months when windows were replaced). These are the figures used in the calculation of health benefits.

It should be noted that the estimated health benefit is a conservative estimate, and perhaps a very conservative estimate, for three reasons:

1. The estimate is based on children in the age group of 6-30 months. Children ages 30 to 72 months would also benefit from avoided lead exposure.
2. The calculated monetized health benefits for children ages 6 to 30 months reflects only the lifetime earnings impact of preschool lead exposure, and does not include other costs associated with childhood lead poisoning such as visits to physicians and health care facilities, laboratory testing, home inspections, and follow up by health officials.
3. Childhood lead poisoning can also contribute to other health issues such as mental retardation and Attention Deficit Hyperactivity Disorder (ADHD). There is also a growing body of evidence linking preschool lead poisoning to crime and other impulsive behavior later in life. The benefits of reducing these outcomes have not been calculated in this report.

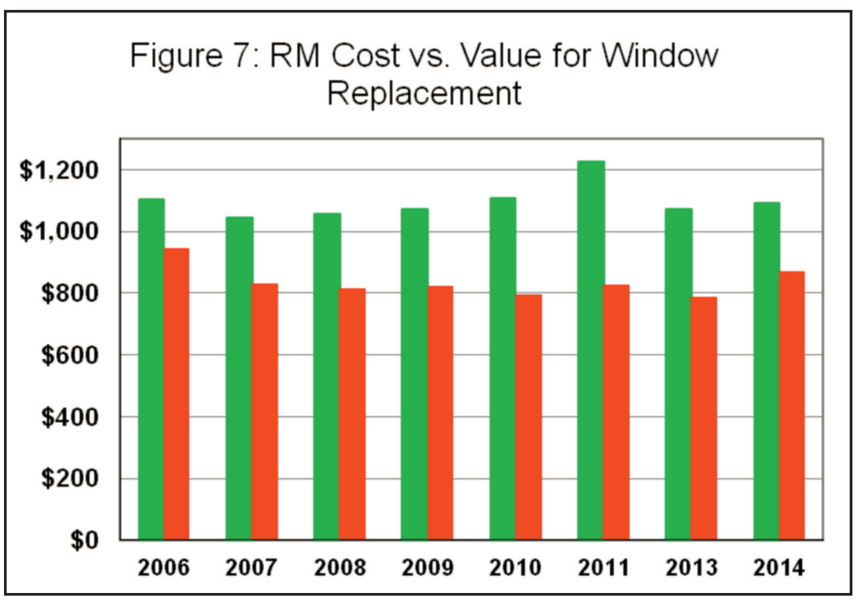
6.B. Market Benefit

Market benefit refers to the increase in property value that result from replacing old windows with energy efficient windows. Window replacement adds to the value of a home due to enhanced appearance, functionality, and anticipated (and ultimately realized) energy savings. The cost of window replacement has been well established in Clear-Win. In order to quantify the market benefit of the program, it is necessary to determine an appropriate increase in resale value that results from window replacement.

Remodeling Magazine (RM) performs annual "Cost vs. Value" reports.[30] The RM Cost vs. Value reports compare remodeling cost estimates for window replacement versus resale value estimates from realtor surveys. RM survey cost estimates for window replacement are based on detailed construction cost estimates from remodeling software, including labor, material, and other expenses, plus industry-standard overhead and profit. RM survey value estimates reflect estimates from realtors who were asked how much window replacement would add to the resale value of a "mid-priced house" sold one year after the remodeling project was completed.

Figure 7 shows there has been more variation over the past decade in the cost estimate per window than in the average resale value estimate per window. The cost estimate has varied from a low of $1,045 per window replaced in 2007 to a high of $1,223 in 2011. The survey-based resale value estimate per window was $942 in 2006 and $866 in 2014, but close to $800 per window in 2007 through 2013 (ranging from $829 in 2007 to $785 in 2013). Nevin (2008) used both the cost and value data from RM data to determine market benefits and net benefits.

The cost of window replacement in the survey data greatly exceed the cost experienced in Clear-Win. One of the most important findings from CLEAR-Win results in Peoria and Chicago is that a programmatic bulk purchase program, on the heels of DOEs WVP program, can substantially reduce the average cost per installed window: The average installed cost per window was just under $400, which is 62% lower than the lowest RM estimated retail cost per window since 2006 ($1,045 per window replaced in 2007).



The resale value of around $800/window provided by the RM data seems counter-intuitive with respect to the Clear-Win program. Clear-Win was intended for low income residents, and therefore specialized in low-income neighborhoods. The median home value for Chicago's Englewood neighborhood is $91,000, and similar for Peoria at $89,600.[31] These midpoint values are about one half the median home value in the U.S., $178,400. A value of $800/window for Clear-Win would imply an average 18% increase in market value of the homes in the program. This was judged to be improbable, and it was determined that the market benefit for replacement windows as listed by the RM data could not directly apply to the housing markets making up the Clear-Win program.

Other research on window replacement indicates that the increase in market value is consistent with an increase of $20 for every one dollar per year of energy savings, plus about $100 per window for appearance value.[32] The estimated average energy savings in Peoria and Chicago just from the reduction in thermal loss through glass was $9.87 per window, resulting in a minimum energy efficiency market value of $197 per window ($9.87 x 20). Adding $100 per window for appearance value would yield an overall minimum market value benefit of $297 per window. This estimate should be viewed as a lower bound because, as explained in Section 6.B., it does not reflect additional annual energy savings associated with reduced air infiltration and/or air-conditioning savings.

The RM value survey is based on estimates for a "mid-priced house." Based on this national survey, it is makes sense that the $800 benefit/window in the RM data represents the expected market benefit for the median house in the U.S. Since the median market value for a house in the Clear-Win neighborhoods is one-half the U.S. median value, it is reasonable to expect that the market benefit for window replacement would be proportional or about $400/window. At this level, the total market value benefit for Clear-Win is estimated at $3,098,800. As has been noted, part of the increased market value lies in the additional amount that buyers are willing to pay for future energy bill savings. Approximately one half of the market benefit, $1,529,974 (calculated in Section 5.b.) is, therefore, the embedded energy savings. Additional resale value, beyond the energy benefit, is estimated to be $1,568,826, or about $4100/building, an average 5% increase in estimated market value. The long term energy benefit is included as a component of the total market value benefit in the cost/benefit summary.

6.C. Cost/Benefit Summary

Table 12 summarizes the recorded costs and the long term benefits of lead safe window replacement by age of housing in the Clear-Win program. Costs are carried over from Section 4. Long term benefits include monetized health benefits, energy reduction benefits from Section 5, additional market value benefits, and income tax benefits from job creation (Section 7). The benefits are described as "long term" because: (1) the health benefits occur over the lifetime of the children who lived in the buildings as toddlers, and, (2) the energy benefit is based on the energy saved by replacement windows over the life of the windows, assumed to be 20 years.

Table 12: CLEARWin Long Term Benefits	
Installed Window Cost (A)	$ 3,071,841
Windows Replaced	7747
Long Term Energy Benefit	$ 1,529,974
Other Market (Resale)Value	$ 1,568,826
Total Market Value Benefit (B)	$ 3,098,800
Children Realizing Health Benefit:	
Children 6-30 months in Pre-1940 Housing	136
Children 6-30 months in 1940-59 Housing	25
Children 6-30 months in 1960's Housing	7
Pre-1940 Health Benefit ($24,571/child)	$ 3,341,656
1940-59 Health Benefit ($10,068/child)	$ 251,700
1960's Health Benefit ($2,572/child)	$ 18,004
Total Monetized Health Benefit [C]	$ 3,611,360
State Income Tax Return on Job Creation (D)	$ 51,128
Administrative Cost [E]	$ 380,000
Net Benefits [B+C+D-A-E]	$ 3,309,447

These data show the CLEAR-Win program should realize net benefits of over $3.3 million. Total benefits include:

- **Energy saving benefits of $1.5 million, and**
- **Additional market value benefits of $1.57 million, and**
- **Lead poisoning prevention health benefits of nearly $3.6 million, and**
- **Tax benefits of $51,000, and**
- **These benefits are well in excess of installed window costs of $3.1 million, and**
- **Local administrative costs of $0.4 million.**

Section 7: JOBS CREATED

Table 13 looks at the direct job creation that resulted from implementing the Clear-Win program. It includes job creation in three areas: 1) window manufacturing, 2) on-site installation and contracting, and, 3) local administration. Conversion from man-hours to full-time equivalent jobs (FTE) is based on 2000 hours/year, allowing 80 hours, or two weeks, for leave and holidays.

Table 13: Direct and Indirect Job Creation

		Peoria	Chicago	ClearWin Total
	Replacement Windows	2316	5431	7747
Window Manufacturing	Assembly hrs (1.333)	3,088	7,241	10,329
	R-5 additional hours (0.3125)	724	1,697	2,421
	Indirect labor hours (0.3)	695	1,629	2,324
	Total Manufacturing Hours	4,507	10,568	15,074
	FTE Jobs	2.25	5.28	7.54
	FTE Jobs/Program Year	1.13	2.64	3.77
	Generated State Income Tax (5%)	$ 4,024	$ 9,436	$ 13,459
On Site Installation and Contracting	Window Installation hrs (3.5)	8,106	19,009	27,115
	Additional hours	70	1,325	1,395
	Total Installation hours	8,176	20,334	28,509
	FTE Jobs	4.09	10.17	14.25
	FTE Jobs/Program Year	2.04	5.08	7.13
	Generated State Income Tax (5%)	$ 7,300	$ 18,155	$ 25,454
Local Administration	FTE Jobs	2.12	3.99	6.11
	FTE Jobs/Program Year	1.06	1.99	3.05
	Generated State Income Tax (5%)	$ 4,243	$ 7,971	$ 12,214
ClearWin Total	FTE Jobs	8.46	19.44	27.90
	FTE Jobs/Program Year	4.23	9.72	13.95
	Generated State Income Tax (5%)	$ 15,566	$ 35,562	$ 51,128

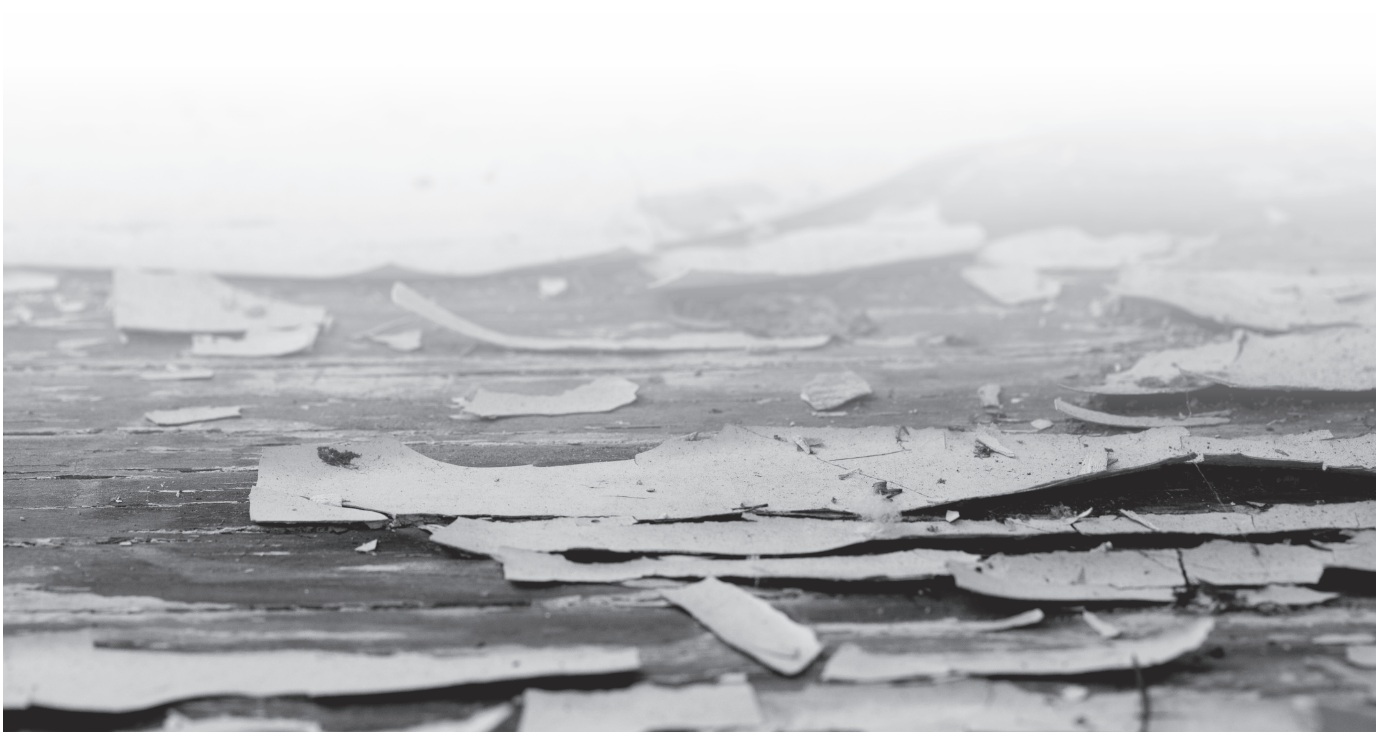
Staff at Armaclad Windows, provided the breakdown of hours for the manufacture of the R-5 windows used in the program. The assembly of the windows required 1.33 man-hours/window, with an additional 0.3125 man-hours/window for the upgrade to the triple-glazed, energy efficient configuration used in the program. An additional 0.3 man-hours/window is required to cover indirect labor (shipping, customer service, inventory control, etc.). Total labor for manufacturing was 1.95 man-hours/window, or 15,074 man-hours. This is the equivalent of 7.54 full time jobs for a year, or 3.77 full-time jobs each year of the two year Clear-Win program.

As stated previously, the installation cost was established on a flat fee. This was based on an anticipated mean labor estimate of 3.5 man-hours/window. This can be compared to the estimates found in popular construction cost and estimating handbooks for window installation - 2.8 man-hours/window (Homewyse), and 2.7 man-hours/window (RS Means). The 3.5 man-hours/window estimate is appropriate when considering the extra time required for the lead-safe approach mandated by Clear-Win, specifically dust containment setup and specialized cleaning. On this basis, window installation entailed a total of 27,115 man-hours. When the labor for the additional work that was tracked under Clear-Win (Section 2.G.) is considered, total man-hours by building contractors totaled 28,509 man-hours. This is the equivalent of 14.26 full time jobs for a year, or 7.13 full-time jobs each year of the two year Clear-Win program.

The funding for local administration was intended as compensation for staff salaries. The figures in Table 13 are based on the assumptions that 90% of local administrative funds were devoted to salary and benefits, and assuming a fully burdened annual rate of $56,000/employee. Based on these assumptions, an additional 6.11 full-time jobs were created, or 3.05 full-time jobs each year of the two-year program.

Totaling the three employment categories, it is estimated that Clear-Win created nearly 28 full time jobs over the course of the program, or nearly 14 full-time jobs each year of the two-year program. This is probably a conservative estimate. The estimate does not include any jobs created as a result of the increased economic activity of the program. Additionally, it does not include a consideration for central management at IDPH.

The State of Illinois has a 5% flat rate tax on income. Assuming a 40% benefits rate in all Clear-Win job categories (manufacturing, installation, and administration), a $50k fully burdened annual rate for manufacturing and installation jobs, and the $56k fully burdened rate for administration, an estimated $51,128 was returned in income taxes to state government as a result of Clear-Win. This is presented for each job category in Table 13, and the total included in the long term benefits in Table 12.



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