CONCEPT PAPER
Pay for Success for Lead Poisoning Prevention

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This work investigates the potential of Pay for Success project in reducing the societal and government cost burden associated with lead poisoning.

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The Green & Healthy Homes Initiative (GHHI), founded in 1986, is a national 501(c)3 nonprofit organization that provides evidence-based direct services and technical assistance to create healthy, safe and energy efficient homes to improve health, economic and social outcomes for low-income families while reducing public and private healthcare costs.
Executive summary

It is possible to use a Pay for Success arrangement to fund or greatly reduce initial government investment in lead-poisoning prevention given the appropriate conditions.

The case for lead poisoning prevention is strong. Beyond preventing the poisoning of children, and beyond the practical reality that the burden of lead poisoning disproportionately affects minorities, the poor, and already-disadvantaged persons; beyond all this, preventing lead poisoning is an economic issue. This is an economic issue that the country cannot afford to inadequately address any longer.

There is no small number of challenges in addressing this issue of lead poisoning in children. Key issues include primary prevention rather than secondary prevention (which only occurs after screening and identification of an elevated blood lead level), paying for the actual cost of remediation,¹, a lack of general understanding of the lead hazard control programs, their direct cost-benefits, or broader social value; however, the large and mounting body of evidence indicates that we can and should, as a country, prevent the next child from being poisoned.

Understanding that the costs of lead remediation can be high, we set out to determine if there was a cost-effective way to address these challenges in our most vulnerable communities. To do so, we created a hypothetical test-case of remediating the 1,000 housing units most likely² to result in a lead-poisoned child in a jurisdiction, to maximize the impact of the program and continue at that scale for five years. We found that:

➢ It is entirely possible to create a program that uses future government cost-savings to fund interim controls for lead hazards on a large scale now.
➢ Each such program could cost USD 50 million over five years and generate hundreds of millions of dollars in savings to government over the following decades.
➢ The savings could incentivize the use of private capital with inflation-adjusted return rates commensurate with current market rates on other long-term government bonds.

¹ The estimated costs are in the tens to hundreds of billions of dollars for complete removal of hazards or hundreds of millions of dollars per year for interim controls. (President's Task Force on Environmental Health Risks and Safety Risks to Children 2000, 5)
² By using an algorithmic approach to target high-risk homes, similar on an article by Eric Potash. (Predictive Modeling for Public Health: Preventing Childhood Lead Poisoning 2015)
Even if the programs were not so clearly in the economic interest of the government, they would help offset the required investment in public health by communities. This would allow the government to prevent the poisoning of children at a substantial discount, likely pennies on the dollar even given relatively short repayment terms. Government should also consider the secondary economic benefits of such programs that include investment in the quality of low-income housing stock, improved community relations, the economic impacts of the jobs created through lead hazard control activities, as well as the plethora of other possibilities. These programs can become drivers of economic growth, sociopolitical mobility, and prevent the poisoning of this country’s vulnerable children in economically advantageous manners.
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Overview
Why we wrote this document and what we hope to accomplish.

The burden of lead poisoning is substantial and has direct costs to governments as well as society more broadly. This burden was largely imposed due to failings to see the long-term and systemic impacts of including lead in everything from gasoline, to industrial components, and even household paint. Lead poisoning has been linked to or causes health issues, diminished scores on standardized intelligence tests, as well as serious medical conditions including severely diminished mental capacity or impulse control that reinforced the link to higher crime and incarceration rates. These maladies can be prevented through the removal of hazards and the use of interim control measures. The societal burden of these programs far outweigh the costs of prevention, by orders of magnitude. Even the government cashable savings from prevention programs can be shown to be so substantive as to create an economic incentive for governments to undertake preventative measures now and on a large scale.

This document will walk through an initial investigation of the underlying economic argument for those programs and their implementation. We do not claim to have all the answers, but we do think that we have created a compelling economic case for finding a way to prevent children from being poisoned.
The burden of lead poisoning

The burden of lead poisoning weighs on vulnerable communities perpetuating socioeconomic stagnation through direct costs, opportunity costs, and diminished capability to contribute to society.

Lead poisoning in America is a travesty. It has disproportionately affected our vulnerable communities struggling to find healthy, safe, energy-efficient, and affordable homes. Lead poisoning is linked to or causes economic burden from:

- **Medical bills** – often paid for by the taxpayers directly due to the low-income status of affected parties;
- **Attention Deficit Hyperactive Disorder (ADHD)** – which, beyond the cost of medication and other treatment, is also linked to poor performance in schools, increased drop-out rates, decreased likelihood of college attendance, and decreased lifetime earning potential that act as economic and social detriments to society;
- **Life-long medical complications** – which raise the cost of medical care, support services, and other health-related expenses, often subsidized, if not outright funded by taxpayers;
- **Special education services** – that are provided by schools and funded through local property taxes as well as subsidies from federal, state, and local governments;
- **Crimes committed due to inhibited impulse control** – which have a direct cost to those committed against, as well as the resources required to respond, investigate, and otherwise police communities, the funding for which largely comes from state and local governments, again with subsidization and assistance from the federal government;
- **Incarceration rates** – which are linked to lead-poisoning and have substantial costs associated with the judicial process, the penal system, and a host of other costs absorbed by federal, state, and local governments and factor into racial issues and social unrest; as well as
- **Lower earning potential** – which is due to diminished intelligence quotients (IQs) on standardized tests that correlate to a lower life-time earning potential, lower taxes paid to governments, and lower socioeconomic mobility that perpetuates the cycle of vulnerable populations and prevents them from living in homes that won’t poison their children.
One study found that for each dollar spent on lead paint hazard control would return society between USD 17.00-221.00. Alone, the measurable societal costs of lead-poisoning prevention should justify major investments in programs that address the issue, but all of these costs directly affect governments and their ability to balance budgets. This makes lead poisoning incredibly expensive for governments and the taxpayers that support them. Additionally, these programs would overwhelmingly aim to help impoverished children living in communities where each and every possible lifeline matters.

Consider the severe burden of a particularly acute lead poisoning episode on an uninsured family of four teetering between public assistance and working their way into the middle-class. A single lead poisoning episode may require ongoing medical and care management support, and chelation if the elevated blood lead level is extremely high, most of which will be paid for by tax-payer supported insurance programs. Then factor in that the child will miss school days for ongoing care management, lessening the likelihood of good grades, graduation, scholarships, and future-earning potential. Additionally, the parents will miss work to attend their child’s appointments, and to take the time to identify safe housing and find the means by which to leave the property that has poisoned their child. They will likely be paid less as a result, and may potentially have the event contribute to losing their job or being passed over for promotions and raises. The lower earning potential and difficulty in finding safe, affordable alternatives means they have a lower chance of moving into housing that does not cause medical issues for their children and repeating that very same disadvantaging cycle. It could be the difference between that family progressing into the middle-class or needing expensive government assistance programs like Medicaid, SNAP, or the variety of others that cost governments and taxpayers dearly.

The burden of lead poisoning is substantial and there are no easy answers. Many affected parties do not own the homes they live in and are afraid to seek assistance in things as basic as ensuring that building or public safety codes are enforced in their apartments, if

(Gould 2009)
they are even aware that there are standards in place to protect them at all. Further, they could legitimately be dissuaded by either the potential for ineffective enforcement attempts, the costs of improvements being passed along to their families in the form of rental increases, or the possibility of other retaliatory steps being taken by the property owners that could see families losing their homes.

Even if the families own their own homes, many do not have the money to invest in improvements, leaving them to choose between necessities like food or clothing and the home they shelter in.
Complications with existing solutions

An overview of the most commonly cited challenges to preventing the poisoning of children in their own homes.

While the burden of lead poisoning is immense, there are also challenges with implementing solutions, which include:

- **Funding**: Allocating public funds likely means taking them from other critical programs, and tightening government budgets means less funding overall.

- **Accountability**: There should be accountability in the administering of programs so that funds for services are directly related to addressing lead hazards.

- **Efficiency**: Much like other primary prevention efforts, there is no way to know if the services actually prevented lead poisoning or if it was a matter of chance, since not every child living in a home with a lead hazard will be poisoned.

There is, however, no excuse for not working to solve these issues and that is what we have set out to do. GHHI has been an industry leader in aligning, braiding, and coordinating funding from various sources to keep lead poisoning prevention programs running, leveraging funds from the Department of Housing and Urban Development, the Environmental Protection Agency, the Department of Health and Human Services, the Department of Energy, and even private health-systems. We have identified that a collaborative approach can establish, scale, and work to continuously improve the delivery of services within and across jurisdictions. Coordinating interagency governmental actions is not an easy task, though there is already hope in this regard as legislation is under development to advance Pay for Success financing options for government projects across the country.
The promise of paying for success
An overview of the Pay for Success financing mechanism that may be able to raise the initial funding for a large-scale lead-poisoning prevention program.

Pay for Success is a new and promising financing solution for evidence-based programs. These arrangements can address many of the existing complications with implementing solutions to prevent the poisoning of children. Pay for Success can:

- **Raise funds**: Pay for Success allows private funding sources to initially pay for services, preventing government dilemmas in diverting funds from other programs.
- **Shift the burden of accountability**: Pay for Success programs only pay based on the impact that programs have, not the cost of running them.
- **Efficiency**: Pay for Success financing aligns economic incentives for efficient service delivery by basing program funding on the value created by running the program.

There is potential for innovative financing arrangements to raise desperately needed capital for social programs and even change the way that public-policy development occurs; however, an understanding of Pay for Success and other mechanisms is warranted. These more complicated financing arrangements do have added costs for developing the programs, coordinating between parties, and providing economic incentives for capital investments. Finally, there needs to be an end goal in mind – a way to institutionalize successful projects.

An added complication is that Pay for Success financing arrangements come in all shapes and sizes, ranging from attempts at standardization through ‘rate card’ approaches, to payments for meeting target metrics, to shared-savings arrangements, and even to more abstract approaches that seek to subsidize valuable social programs delivery costs because governments choose to invest in the public good.

**Pay for Success 101**

Pay for Success is a financing mechanism that offers a path forward for those shouldering the economic burden of public-health costs to implement or scale services and then measure associated cost savings. They also can transfer the upfront financial risk of funding
these services to outside investors. The basic PFS model is a partnership in which private parties fund services and then the party benefiting from the services repays the investment if and only if agreed-upon outcomes are met.

**The Pay for Success Model**

*Pay for Success Model leverages outside capital to fund services and capital is returned only if the program is successful.*

**Process**

1. Investors provide upfront capital for service delivery
2. Service Provider implements intervention for target population
3. Intervention results in a benefit to the Payer, usually cost savings
4. Payer repays Investors if and only if outcomes are verified, often by independent Evaluator
5. An intermediary may provide project and financial management services

An absolutely critical component of the Pay for Success financing mechanism is the commitment of the ultimate payer to share their savings with the investor. Typically, getting to this point requires the direct involvement of that party early in the project to develop potential economics. We are hoping to start engagement with governments across the country to discuss how this opportunity could benefit their local communities economically and socially.
Pay for Success in the context of preventing childhood lead poisoning

The programs leveraging Pay for Success financing arrangements are becoming more popular and inherently address many of the challenges:

- **Outside funding:** Programs can begin with commitment to participate and any payment are made out of measured savings generated by the programs. Governments will not need to allocate funds from elsewhere in their budgets to pay for achieved outcomes.

- **Accountability:** The payments made are not for the goods or services directly, but they are for a percentage of the economic value they generate, which removes any incentive for an organization to spend their funds on unnecessary services because they are not being paid for them – adding costs only reduces their own economic standing. Further, the programs are built with highly detailed budgets and projections, putting the service providers at risk for delivering their services at or below budget, again incentivizing fiscal responsibility.

- **Efficiency:** Programs are becoming more effective at targeting their interventions for preventative purposes with the advent of new technological advances in risk-factor modeling and machine learning. This increases the probability that a targeted home will actually prevent a case of lead poisoning by an order of magnitude. The programs that work and can continue in the future are those that prove their effectiveness, leaving only social investment programs that have a measurable return on investment for society.
Proof of Concept
An overview our demonstration model and how we plan further development.

Our work is at the stage of conceptual development. We want to actively challenge our assumptions, mechanics, and ensure that our model really represents the underlying reality that it's intended to. This section outlines our overall method for mechanics as well as the establishment of variables.

Method
To conduct our proof of concept demonstration, we composed a dynamic economic model and vetted the construction with industry experts. The model was created using an aggregation of established research, published mainly in scientific peer-reviewed journal articles. We looked at the expected outcomes of reductions of lead hazards. We aimed to determine what degree the cost of investing in preventing lead-poisoning could be offset, if not fully funded by a true Social Impact Bond, repaid using a Pay for Success financing mechanism.

We composed a modular economic model that included sections for:
- Baseline financial assumptions,
- Program design or operational assumptions,
- Baseline probabilities for the effectiveness of intervention targeting,
- Baseline probabilities for elevation of blood lead levels for the target population,
- Calculations for program enrollment and their expected blood lead levels,
- Program costs including estimated distributions for service needs,
- Possible medical savings,
- Possible nonmedical savings,
- Transaction costs possibilities, and
- A financial summary.

The following will be an overview of each of these areas and how they related to the overall model composition.
Baseline assumptions

We attempted to treat particular assumptions separately from others as they are within the control of the program designer. Others were inherently uncertain. We considered our baseline financial assumptions as inherently uncertain as they rely on macro-level issues that are beyond the scope of this project. Program design elements were treated as finite and more controllable. Another group of program elements were partially controllable but still contained inherently uncertain elements. In some cases a large-enough sample size should allow for statistical treatment of key variables. In others we treated variability as best tool to attempt to quantify the uncertain, while identifying the implications of outsized impacts on the project more qualitatively.

There were underlying financial assumptions that have substantive impacts on the overall project’s financial assessment. They included appropriate estimates of the long-term cost of risk-free capital, expected inflation rates, and real rate of increase for the cost of medical care, which has exceeded inflation in the past decades. These factors are inherently uncertain, especially given the time-frame. We assumed a 2.5 percent central tendency for these variables.4

Separately, program design variables are controllable. We used a hypothetical program design for our proof of concept design, consisting of enrolling 1,000 households per annum for five years. We calculated the expected savings over the expected life of an enrollee.5

Based on this program design, there were additional baseline assumptions that needed to be addressed. They included the attrition rate from the program, the number of children affected by the intervention who would not be poisoned, and the ability of the project to

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4 In our more advanced modeling exercises, we created a statistical distribution for these variables and let them vary annually across scenarios to approximate uncertainty. The possibility that inflation will go beyond this range is real and would have an outsized risk not only on our project, but the whole financial and economic system.
5 We used 70 years as an infant enrollee in the 5th year would reach 65 in our final year. We do take into consideration that each of the cost-savings areas have specific age ranges where the financial value can be captured so an increase of years does not include savings for age-inappropriate categories.
provide preventative services to those parties that would have been poisoned by some level of lead. These variables contained a controllable element, but were partially uncertain.

There will be an attrition rate from the project, which we considered to be representative of mortality rates and relocation beyond the United States, which we speculated for the target population would be in a range between 0.25 percent and 5.0 percent per annum with a most-likely rate of 2.0 percent.

Estimates for the number of children affected by the useful life of the intervention were speculative. By targeting a population with at least one child in the home, we could ensure a minimum of one child per home. We also expect that the project’s reach would extend beyond the immediate child to siblings, other children who visit the home, and even to future residents of the domicile. Due to the high degree of variability between locations, familial situations, and other factors, we expect that this variable would range from an average of 1.0 to 3.0 children per home with a central tendency of 1.87 children being affected in each targeted home. We expect this number would be substantially higher, though are seeking confirmation.

We then turned to a central question of preventative interventions: What is the efficacy with which we can target the interventions to prevent elevations in blood lead levels for children? To start we surveyed research, pulling data to calculate the likelihood that a child living in a home with a lead hazard would have an elevated blood lead level in a given year. Our results were highly variable, ranging from 0.09 percent to 19.05 percent.

Other factors, however, further complicated this estimate. General research in this area has used varying thresholds for blood lead levels ranging from less than 2 micrograms per deciliter to 10 micrograms per deciliter or even higher. Further, very interesting work

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6 The average number of children born per woman is estimated to be 1.87 (The U.S. Central Intelligence Agency 2016). This should be a lower-bound estimate as (a) we are targeting only domiciles with children, and (b) there will be multiple households benefiting from each remediated domicile’s useful life.

7 We used the numbers from the Gould article (Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control 2009) for internal consistency, however, there are other challenges with this approach.
coming out of research institutions has combined new sources of data with the use of algorithms that allow for more effective targeting of homes; though not currently adopted widely, these efforts show great promise.

Based on this ability to use data to target families more effectively and also working to prevent a new lower standard to reflect that no level of lead is safe, we would assert that the rate of intervention preventative effectiveness would be substantially higher than simply addressing homes with a lead hazard. We speculate that the range could be as wide as one in ten homes effectively being targeted for prevention of an elevated blood lead level in the following year to three in four or better.\(^8\)

**Program services**

GHHI has been a leader in healthy housing with direct service experience spanning decades. Lead-poisoning prevention programs can be highly scalable, using internally developed auditors, assessors, and educators for initial stages of work, while relying on a combination of internal staff and local sub-contractors to scale work to the remediation needs of the local housing stock. The costs of administering the program have been estimated using GHHI’s well established model as a direct service provider and technical assistance provider for programs across the United States. We consider these estimates to be substantially more precise and controllable than other variables in the model.

**Benefits of program**

The economic benefits of preventing children from being poisoned are substantial and have been well documented in research. We have attempted to aggregate some of those key findings but acknowledge that it is only a partial survey of the existing body of work. The basis for the project was largely the article “Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control” by Elise Gould.\(^9\) We additionally included research from other sources, information garnered in interviews

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8 We used 0 percent to 90 percent with a central tendency of 50 percent given that we do not know how to better estimate this variable at this point. Being overly precise here is unwise as it is a key variable for the project. A change of only a few percentage points changes the economic value by orders of magnitude. This has shown us that it is worth investing our time and resources in further developing this area on inquest.

9 (Gould 2009)
with industry experts or practitioners, as well as work with our own direct services program.

We have attempted to classify these elements by medical and nonmedical benefits, though within each classification, we were unable to approach the problem from a collectively exhaustive manner. Within each class, there was a breakdown by key factors that affect each area. These were:

- An appropriate age range for the benefits to be accrued in,
- A baseline elevated blood lead level that negatively affected the group,
- A baseline estimate for the costs to government entities for the disruption, and
- An expected savings rate for the population based on the prevention of household-lead hazards.

In most cases we deferred to the practical age-range for benefits, such as high-school enrollment. We started with the researched baselines for elevated blood-lead levels at which an affect was measured, but in some cases—especially for dated research relying on higher thresholds—we adopted the newer thresholds. We also deferred to researchers’ estimates for program costs, though updated them where publicly available information was relevant. We relied heavily on published research for expected cost-abatements. In all cases, we would appreciate any additional input on these areas that are available.

**Transaction costs**

While Pay for Success financing projects have many benefits, they also come with substantial transaction costs. These include the cost of capital in financing services through innovative funding sources; the time, effort, and added expense of setting up a project’s legal structure; as well as additional management layer for the Pay for Success project partners and underlying transaction.

Transaction costs can be prohibitive, but for large projects, they represent a substantially smaller component of the overall costs. For the hypothetical project design we investigated, they represent 10 percent or less of the total project costs. We estimate that the
total transaction costs will be in the range of USD 2.5-7.5 million dollars, inclusive of origina-
tion fees, evaluation design and implementation, as well as ongoing management of the Pay for Success project and transaction. The range is so widely varied due to the inherent uncertainty about the final project design, involvement of partners, and relationship to the broader public-health system.

Net economic impact
The net economic impact of the project was estimated as a simple arithmetic subtraction of the cost-savings generated in a given period, less the costs incurred in the period, each adjusted for their present value, finally totaling the net of present values for the stated period.

Key variables identified
We conducted a limited scenario analysis that we plan on developing further, especially as we continue to work with industry experts and practitioners. The fuller scenario analysis looks at pseudorandom variations within specified ranges for variables distributed based on established criteria. We then conduct the analysis through enough iterations where the output variables stabilize.

While at this point, we do not consider the financial outputs to be definitive, we do believe there were two benefits to this exercise. First, we were able to identify that there is a very good likelihood that an investment in childhood lead poisoning prevention will have a net economic benefit for governments, given our program’s constraints. Second, that there is a hierarchy of key variables which will determine the project’s feasibility.

The project’s financial outcome is substantially more sensitive to variations in the ability to effectively target enrollees for preventative services than it is to changes in the service-provider budgets. Likewise, relatively small variations in underlying rates of criminal activity have outsized impacts on the project’s financial returns given the comparatively low frequency of these events and low volume of program participants expected to be involved
with the program. Many others have been identified and are referenced in the key questions section later in the document.
The economics of prevention

An overview of the costs and benefits of preventing children from being poisoned by lead hazards in their own homes.

The beneficial economics of preventing children from being poisoned by lead hazards are very compelling. The costs of intervention programs are controllable and can be adjusted to meet the needs of the local community. The savings values that accompany the programs can be classified by medical and nonmedical costs; these costs are often shared by multiple parties.

Intervention costs

The program costs depend on the implementing service provider. They generally break down depending on the severity of the need for improvement in the local housing stock. We have analyzed multiple tiers of services in the following process:

- **Assessment**: An initial assessment is performed to ensure that there are lead hazards in the home. Referrals are made to other appropriate programs for social services, and a scope of work is developed for a project, where warranted.

- **Tier 1 services**: Services involving minor interventions are often the focus of the program. They may include education, actual remediation of high-risk hazard areas, minor repairs, painting, or provision of supplies to appropriately address risks.

- **Tier 2 services**: In addition to Tier 1 services, more involved services are sometimes needed. This tier of services typically requires expensive materials, such as for window replacement, or other capital intensive remediation that includes removal of some persistent hazards such as lead-painted windows.

For each of these tiers of service there are two components of our cost estimates (a) the average cost of services, when required and (b) the prevalence of service need in the underlying housing stock.

**Note on targeting and assumptions**

All project assumptions are based on improvements in targeting of services to ensure that services are delivered to households with the highest likelihood of a future elevated blood
lead level. This impacted our estimates and, in some cases, resulted in prevalence estimates that would be otherwise inappropriate. Any term described as ‘targeted’ indicates that this subpopulation is the high-risk pool of households statistically likely to result in future lead poisoning of a child.

Further, many of our estimates were based on the Maryland-based, direct-services program that GHHI has been offering for over a decade. These numbers would substantially change and need to be adjusted for a program tailored to different or multiple markets.

Assessment
We assumed that all targeted homes would require an assessment and it would have an average total program cost of roughly USD 1,000.00 and be inclusive of personnel time, resources, and overhead.

Low level interim controls
We assumed that these services would be required in roughly 70 percent of homes, with an additional total program cost of roughly USD 1,200.00 per household. This would cover an intensive lead cleaning, minor painting

High level interim controls
We assume that a higher level of services would be required in roughly 65 percent of homes having an additional total program cost of roughly USD 11,700.00 per household.

Abatement
We are not currently modeling the cost of a full lead abatement strategy but would be open to discussing one.
Program cost-savings

Program cost savings were developed based on a number of research articles currently in the public domain, as well as internal analysis of direct services operations and interviews with industry experts. We disaggregated costs into the following categories:

- **Medical expenses**: We aggregated estimates of cost-savings from medical conditions from prominent research publications falling into a number of categories, including a mutually exclusive ‘other reductions in total cost of care’.

- **Nonmedical expenses**: Nonmedical costs are non-collectively exhaustive as there is so much uncertainty around various issues. We did attempt to target some of the highest value cost savings streams. We did not include a few key categories that may turn out to have substantive economic value. They include changes in likelihood to receive benefits through Medicaid, SNAP, or unemployment programs. We are actively seeking research to include them in our work.

Estimates of cost were based on calculating a rate at which targeted parties would be afflicted by lead-poisoning in a given year and then estimating the distribution of affliction severity within the group.

**Affliction and severity rates**

In all cases, the method was to ascertain the probability that a party would be afflicted by a given elevated blood lead level, then to determine their level of affliction. This was done by creating a likely range of probabilities that a child living in a targeted home would have an elevated blood-level in a given year. Second, we established the likely distributions of the peak blood lead level for those parties to calculate the number of afflicted persons at a given severity level.¹⁰

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¹⁰ One substantial complication with this method has been the progress made on lead regulations. While most of the historical research has focused on regulated thresholds, those thresholds have changed. Additionally, new research has indicated that the greatest marginal impact on many of the health factors occurs at the lowest level of blood lead level elevation, with less severe poisonings having the largest marginal impact, while more severe poisoning has the largest aggregate impact. Simply, the first bit of lead does the most damage and, while every additional bit does less damage, they still keep making it worse, until the level is so severe as to cause systemic damage resulting in partial or complete organ failure.
The underlying research varied widely. The probability of affliction in any given year while living in a home with a lead hazard was calculated anywhere from 0.19 percent to 19.94 percent of children. The range is so wide as standards, methods, and other factors have changed over time and with different studies. With the advent of advanced targeting using data-analytics, there is a high probability that any program could improve on this range substantially and do a far better job of providing services that prevent lead-poisoning. Considering the influence of two factors (a) the expansion of blood-level sensitivity to any elevation, and (b) the use of targeting algorithms, we believe that it may be possible to deliver services as efficiently as 3 in 4 homes or more that would have resulted in any level of elevated blood lead. The distribution we would present as most-likely is as follows:

Exhibit 01

<table>
<thead>
<tr>
<th>Distribution of blood lead levels, percent of affected parties</th>
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<tbody>
<tr>
<td>Enrollment years by blood level category</td>
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<tr>
<td>70 micrograms per deciliter</td>
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<tr>
<td>45–70 micrograms per deciliter</td>
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<tr>
<td>20–45 micrograms per deciliter</td>
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<td>15–20 micrograms per deciliter</td>
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<td>10–15 micrograms per deciliter</td>
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<td>02-05 micrograms per deciliter</td>
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<tr>
<td>00-02 micrograms per deciliter</td>
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<tr>
<td>All levels</td>
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</tbody>
</table>

Determining the severity was an additional challenge as many of the severity distribution estimates are based on the same challenging aggregation of historical data as the affliction rates. We are still looking for updated research on this topic that covers blood levels and an estimate for the severity of estimate. In the current iteration of our model we are using statistically implied estimates for these distributions.

(Gould 2009)
Medical costs

With a focus on developing cost-savings estimates for medical systems, we addressed the immediate elevated blood lead level, attention deficit hyperactive disorder (ADHD) medical costs, and other reductions in total cost of care.

- **Elevated blood levels:** We looked at primarily the average cost of direct treatment of elevated blood lead levels across the weighted average of participants in a recent article. We modeled that between 9 and 75 percent of children in the targeted homes would be afflicted with some level of elevated blood level, while we only applied a cost to those with elevated levels above 10 micrograms per deciliter for consistency with the research. There would be some cost-savings associated with the excluded parties but we did not have an estimate for this group. We also limited the range to persons of 0 to 8 years of age for the cost-savings potential in a given year.

- **Attention deficit hyperactive disorder (ADHD):** Using a similar method, we used a more-likely-than-not distribution between the APA’s estimate of 5 percent and the CDC’s estimate that 11 percent of children in the U.S. have ADHD. We then included a 21.1 percent reduction in this rate and estimates for the average cost. Additionally, we limited the savings potential for this cost category to participants while aged between 5 and 19 years of age.

- **Total cost of care:** We also identified a recurring trend that persons afflicted with lead poisoning have life-long health implications attributed to the affliction. We attempted to capture this through a reduction in the average cost of care for this population over their lifetimes. We looked at the likelihood of an elevated blood lead level over 10 micrograms per deciliter and applied a 70 percent rate of prevention to account for elevated levels from non-paint hazards. We then used the average cost of care for a Medicaid participant and projected reductions in their total cost of care per annum in a range from 0 to 20 percent, with a median of 10 percent.

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12 (Gould 2009)
13 (Braun, et al. 2006)
14 (Gould 2009)
Nonmedical costs

We additionally looked to aggregate the nonmedical costs of lead-poisoning, focusing on those with the most conclusive research and substantive economic benefits. We do not consider this group collectively exhaustive, and are actively looking to include additional factors in the future as research becomes available. The primary costs we identified were:

- **Special education costs**: We considered that special education needs for parties aged 6 to 19 years would be substantial. There is indication in research that as many as 20 percent of those with blood lead level elevation above 25 micrograms per deciliter will have special education needs. We calculate that rate and estimate that a range between 55 and 85 percent, with a central tendency of 70 percent is more-likely-than-not a plausible reduction due to remediated hazards.\(^\text{15}\)

- **Criminal activity (direct cost)**: The direct cost of crimes committed was also included in our model. The research indicated\(^\text{16}\) a central tendency of 0.0195 percent likelihood of criminal activity in a year, with an average cost to society of USD 9,915.00. We estimate that reductions of, even only 3 percent of that likelihood would result in substantial savings within a population aged 16 to 60 years.

- **Incarceration (direct cost)**: The research\(^\text{17}\) indicated that the incarceration rate in the target population would reach 0.1 percent, with lead prevention resulting in a decrease of as much as 3 percent of this rate, leaving an expected 0.097 percent change of incarceration in a given year at an average cost of USD 28,893.00 per person per annum. This likely underestimates the impact of the interventions substantially as the incarceration rate among these vulnerable populations will likely be higher, with an indeterminate impact adjustment for additional factors.

- **Lifetime earning potential**: Research has linked lifetime earning potential to intelligence, using standard tests of intelligence quotients as a proxy-measure. Based on backing-out the stated rates in available research\(^\text{18}\), we determined that the most-likely central tendency was roughly USD 1,738.34 per IQ point per annum.

\(^{15}\) We acknowledge that there will be a base-rate not attributable to lead-poisoning by paint, though there will also likely be an increase in rates for those under the 25 micrograms per deciliter threshold, we do not know the magnitude of this group and have omitted the calculation.

\(^{16}\) We understand that this is subject to interpretation, measurement, and other variability so we are relying on the research estimate, though are open to discussion.

\(^{17}\) (Gould 2009)

\(^{18}\) (Salkever 1995)
Additional non-economic factors: We were unable to include but acknowledge there are additional benefits to society, many of which are not limited to regular events. There is no way to account for the opportunity-cost of previous spending to address these issues nor the possibility of a rare event occurring, such as the missed opportunity of someone inventing the next microwave, founding the next Google, or other such events. Considering the ongoing socioeconomic and closely related racial tensions, there is a case to be made that investments in low-income housing could alleviate some of the structural disadvantages of vulnerable populations.
Program economics summary

Our initial findings are that a program offering five successive cohorts of 1,000 highly targeted homes has the potential to generate over USD 51 million in surplus economic value over resort expected life of the population (70 years). A program like this has the potential to reduce the economic burden of funding lead poisoning prevention interventions by 70 percent, while the rest of the economic value would be retained in later years. There are still substantial number of aligning data that certainly would improve the validity of this analysis.

We project the cost savings potential of such a program is nearly USD 140 millions of dollars in nominal terms, which at the discount rate of 2.5 percent is worth nearly USD 80 million today. This does not include substantial other benefits such as increased socioeconomic mobility that will likely alleviate some of the economic burden on programs like Medicaid, SNAP, and unemployment insurance programs. Additionally, there are a number of programs where we used conservative estimates; we will continue to find better data sources that will likely indicate higher potential returns.

The program costs are one of the more well-known and better-controlled elements of the model as they are based off of highly regular historical program operations budgets. We estimate to be just shy of USD 50 million dollars, with an additional USD 5 million dollars allocated for indirect costs, for a total of roughly USD 55 million dollars.

Using conservative estimates for the cost savings potential, an investment in lead poisoning prevention for high risk children pays for itself by a program participant’s 27th year, while not including a number of substantial cashable savings sources. There is potential to use Pay for Success financing arrangements to offset a substantial component of capital intensive investment in programs seeking to offset the cost of running substantial healthy housing programs.

For a summary of the economic findings please see the appendix of economic exhibits.
Key decision for investor repayment

There are a number of ways in which a payment mechanism could work under a Pay for Success arrangement. Two such options include:

1. Constructing a project around actual measured savings from programs, which, while not impossible, could be complicated and extend the project’s payback period well into the future and raising the cost of capital for the project.

2. Constructing a project around proxy measures that are more readily measurable, such as blood-tests of the participants to ensure poisoning has not occurred, measuring performance on early standardized tests of intelligence, and using these as indirect measures that trigger government payments for the future income levels and other benefits attributed to the program as a result of extensive historical research.

In either case the key economic drivers of the program would be:

- **Affect rate**: The difference between (a) the probability of a child living in a home with a lead hazard would be poisoned in a given year and (b) the probability of a child living in a home that had a lead hazard which has not been remediated.

- **Number of affected children per dwelling**: During the useful life of a remediation, there may be multiple children receiving positive benefits from the original program participant. Siblings and subsequent residents of the abode may all be counted, effectively multiplying the effect of the program beyond the initial party.

- **Probability distribution of affect rate**: There is a wide range of effects from lead-poisoning that are tied to the severity of the poisoning, understanding these distribution effects will have a meaningful impact on the project.

The long run

One final note is that a project can be theorized with continuous enrollment and it would reach a point where the cost savings in the year exceed running that project, effectively creating an exit velocity where the program could self-fund with appropriate design and longevity. Depending on the key variables, this could happen as soon as year 15. While the capital requirements to reach that point would be in the hundreds of millions of dollars, it would effectively constitute the creation of a semi-independent entity that could
continually address the highest-risk lead hazards in the nation while generating an annual net-benefit to the funding government – effectively converting a cost-center into a strategic investment in the health of the nation’s most vulnerable populations.
Moving forward
An overview of the possible path to implement large-scale lead-poisoning prevention programs utilizing social innovation funding to capitalize the project.

The human, social, and economic case for preventing children from being poisoned by lead hazards in their own homes is compelling. To bring the work to fruition we will:
1. Verify our analysis to date by working with industry experts, practitioners, and researchers to improve our proof of concept by answering the key questions below;
2. Develop a working group of project partners interested in advancing this work, which will have the advantage of narrowing the focus and developing the potential projects;
3. Secure funding and support for the development of formal projects.

Key questions to get moving
The resolution of the following key questions would greatly enhance the conceptual development of a Pay for Success financed lead poisoning prevention program:
- What is the likelihood that a child living in a home with a lead-hazard will have an elevated blood lead level during a given year?
- What is the most likely distribution of elevated blood lead levels for children living in homes with lead hazards?
- How effectively can homes be targeted to prevent the elevation of blood lead levels for children through the use of business intelligence algorithms?
- What is the average reduction in the total cost of care for a Medicaid patient having been prevented from reaching different thresholds of blood lead level elevation?
- What is the reduction in criminality and associated societal costs for differing thresholds of blood lead level elevation?
- What is the base-rate and reduction in incarceration rates for persons with differing thresholds of blood lead level elevation?
- What is the reduction in intelligence quotient and associated societal costs due to differing levels of elevated blood lead content?
- What effect and societal costs as elevated blood lead levels have on various social safety net programs including Medicaid, SNAP, and unemployment insurance as well as others?
These key questions will help determine the most effective path forward for the development of social innovation funding to finance or offset the cost of preventing children from being poisoned by lead hazards their own homes. Please contact info@ghhi.org for information or to receive assistance.

**Working group formation**

Creating a collaborative group of parties working together to advance this issue is the only way to solve this public health problem. We are actively seeking participants to help by digging in and contributing time, effort, and expertise to solving this imperative issue. The working group should include:

- Researchers and other experts in the field who can assist in program development;
- Industry practitioners familiar with details of similar program development, scaling, or other operations; and
- Government representatives and other parties economically benefiting from the expansion of services.

If you are interested, please contact us at info@ghhi.org.

**Formal project development**

Once a sufficient case has been made, project partners should be selected to move forward to formal project development. The process will have the following criteria:

- An extensive program development effort would need to be led by a technical assistance provider that determines the feasibility of the project and conducted capacity building efforts as needed to ensure the program could effectively launch;
- The appropriate government entities would need to agree to pay for the successful outcomes the project generates;
- Investors and other funders would need to agree to provide capital; and
- All the parties would need to agree on terms.

The process could follow a model pioneered by other Pay for Success projects where:
- The technical assistance provider works with a number of sites to provide capacity building efforts while analyzing the feasibility of conducting local projects or including them in a larger effort;
- A selection committee would review the feasibility studies and determine which, if any, projects should advance;
- Appropriate projects would then advance to structuring formal transactions, potentially collectively structured, to finance large scale services; and
- Project would launch, and begin delivery of services using funding provided the name to compensate the initial funders parties.
Bibliography


Centers for Medicare & Medicaid Services. 2016. "Medicaid and Children’s Health Insurance Program (CHIP) Programs; Medicaid Managed Care, CHIP Delivered in Managed Care, and Revisions Related to Third Party Liability." Final Rule, Department of Health and Human Services, Washington.


Appendix A: Economic exhibits

This section provides an overview of summary economic findings from the proof of concept modeling exercise, to arrange for a personal demonstration or more information, please contact info@ghhi.org.

We consider the following numbers to be directionally correct and likely to be in the correct order of magnitude. It would be inappropriate at this state to establish any specific economic or financial systems around what is listed below.

Exhibits presented in text:
- Exhibit 01: Distribution of blood lead levels, percent of affected parties

Exhibit 02
Summary of cost savings generation

<table>
<thead>
<tr>
<th>Medical outcomes</th>
<th>Modeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated lead levels in blood</td>
<td>2,320,078.33</td>
</tr>
<tr>
<td>Total cost of care (excluding direct lead and ADHD meds)</td>
<td>31,495,395.42</td>
</tr>
<tr>
<td>ADHD</td>
<td>1,329,989.63</td>
</tr>
<tr>
<td>Total medical outcomes</td>
<td>35,145,463.38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nonmedical outcomes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Special education</td>
<td>326,018.21</td>
</tr>
<tr>
<td>Incarceration</td>
<td>9,303,040.36</td>
</tr>
<tr>
<td>Crimes committed - direct cost</td>
<td>79,712,041.99</td>
</tr>
<tr>
<td>Earning potential</td>
<td>203,817,159.23</td>
</tr>
<tr>
<td>Total nonmedical outcomes</td>
<td>293,158,259.80</td>
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</tbody>
</table>

Total cost savings 656,528,205.51

Discount factor 37.56

Present value

Net of present values 246,569,542.97
**Exhibit 03**

**Summary of program costs**

<table>
<thead>
<tr>
<th>Program cost summary</th>
<th>Modeled</th>
</tr>
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<tbody>
<tr>
<td>Direct costs</td>
<td>$(49,777,431.04)$</td>
</tr>
<tr>
<td>Indirect costs</td>
<td>$(5,608,502.53)$</td>
</tr>
<tr>
<td>Total program costs</td>
<td>$(55,385,933.57)$</td>
</tr>
<tr>
<td>Total transaction costs</td>
<td>$(5,553,859.34)$</td>
</tr>
</tbody>
</table>

**Exhibit 04**

**Summary of capital requirements**

<table>
<thead>
<tr>
<th>Total capital requirements</th>
<th>Modeled</th>
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<tbody>
<tr>
<td>Program costs</td>
<td>$(55,385,933.57)$</td>
</tr>
<tr>
<td>Transaction costs</td>
<td>$(5,553,859.34)$</td>
</tr>
<tr>
<td>Total capital requirements</td>
<td>$(60,939,792.90)$</td>
</tr>
</tbody>
</table>

**Exhibit 05**

**Summary table of project economics**

<table>
<thead>
<tr>
<th>Net project outcomes</th>
<th>Modeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical outcomes</td>
<td>$35,145,463.38$</td>
</tr>
<tr>
<td>Social outcomes</td>
<td>$293,158,259.80$</td>
</tr>
<tr>
<td>Total value created</td>
<td>$328,303,723.18$</td>
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<tr>
<td>Program costs</td>
<td>$(55,385,933.57)$</td>
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<tr>
<td>Transaction costs</td>
<td>$(5,553,859.34)$</td>
</tr>
<tr>
<td>Capital requirements</td>
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</tr>
<tr>
<td>Net economic benefit</td>
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<tr>
<td>Discount factor</td>
<td>0.25</td>
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<tr>
<td>Present value</td>
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<tr>
<td>Net of present values</td>
<td>$67,485,784.42$</td>
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<tr>
<td>Internal rate of return less inflation</td>
<td>2.71</td>
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