Protocol and Statistical Analysis Plan as submitted in original NIH grant, as well as changes made prior to start of study.

Protocol. The proposed RCT will be a stratified random assignment of abandoned houses into full treatment, graffiti treatment, contact control, and no treatment arms matched within 4 sections of Philadelphia: north, south, west/southwest, and northwest. These sections of Philadelphia have clearly delineated roadway and water boundaries. Northeast Philadelphia is excluded because of the very limited number of abandoned buildings. The four sections of Philadelphia that will be involved in the study represent 90% the city's population. A significant portion of the City of Philadelphia will thus be touched by the proposed trial.

Abandoned house addresses will serve as the index locations of data collection for the trial and its outcomes. Outcomes will be surveyed around each abandoned house. Study arms (treatments and controls) will be concurrently exposed to the intervention, or not, within the same 6 month period, with the study following a parallel group trial design where each abandoned house receives only one treatment. Treatment or control status will be assigned to randomly selected houses within the same four sections of Philadelphia, i.e. matched by geographic section, to promote balance between study arms. As we have successfully done in the past, an urn or repeat randomization procedure will also further ensure balance between study arms.

Across these four sections of Philadelphia, a total of 320 abandoned houses will be randomly selected and screened for inclusion into the trial from a larger universe of approximately 40,000 vacant properties. A master list of abandoned houses will be compiled from the City of Philadelphia and US Postal Service records and will determine the universe of candidate abandoned houses available for random selection and enrollment. These 320 abandoned houses will each be a standard 2-3 story Philadelphia rowhome and will be clustered in groups of 3-5 houses (4 houses on average, called sites) on neighborhood blocks with at least 80% housing occupancy. Each group of houses will be either immediately contiguous or within 660 feet/1/8 mile (a standard metric of proximity in Philadelphia City ordinances) of its nearest-neighbor abandoned house. These parameters are in keeping with standard municipal practices for remediation of abandoned houses in Philadelphia. Thus, across all four Philadelphia sections there will be 320 abandoned houses in 80 sites; each arm of the RCT (full treatment, graffiti treatment, contact control, no treatment) will have 80 houses in 20 sites.

All 320 abandoned houses, across all four arms of the RCT, will also be screened for inclusion *as if they were all going to receive the full housing remediation treatment*. Of course, only 80 of these homes will be randomly assigned to the full treatment arm of the RCT, but as a necessary counterfactual, all homes will be screened for eligibility in this way. Only abandoned houses that the Philadelphia Housing Development Corporation (PHDC, www.phdchousing.org, see letter in Appendix) is authorized to remediate as per the City of Philadelphia's Office of Housing and Community Development (OHCD, www.phila.gov/ohcd, see letter in Appendix) will be eligible for inclusion in the RCT. The PHDC and OHCD already work closely together and this will be the exact same authorization procedure that PHDC uses in its day-to-day abandoned housing remediation program outside of the proposed trial. Houses authorized for remediation will: (1) be in violation of the Philadelphia Doors and Windows Ordinance and Section 306 of the Philadelphia Property Maintenance Code requiring owners of abandoned buildings to clean their facades and install working doors and windows in all building openings and (2) have been abandoned, as confirmed by a call by OHCD to the owner of record who is given 10 days to reply and offers no reply in said time; or (3) have been authorized for remediation by

the house owner themselves within the 10 day period (i.e., they want the free housing treatment). The vast majority of abandoned houses in Philadelphia that are randomly selected for inclusion in the trial will fall into one or more of these categories and be available for enrollment and random assignment. Houses that have already been remediated by the PHDC or other local or municipal agencies will not be eligible for enrollment. We expect based on our prior work that roughly 70% of eligible houses will be enrolled.

Full abandoned housing remediation RCT arm ("full treatment", n=80). Over a 6-month treatment period, the full abandoned housing remediation treatment will be performed on 80 of the abandoned houses randomly assigned to this RCT arm, followed by monthly maintenance and trash clean-up for the remainder of the post-treatment period. These remediations will done by the PHDC, a non-profit, community-based entity. Since 1964, the PHDC and its contractors have performed hundreds of housing remediations annually in the City of Philadelphia. The full abandoned housing remediation treatment will follow a standard protocol and include these activities: (1) Replacement of plywood boards or missing or broken doors and windows with new, standard, exterior, front entryway, wooden doors and standard, double-hung, wooden windows; (2) Removal or replacement of deteriorated structures on front building façade, such as eaves, downspouts, or gutters; (3) cleaning, new paint, and graffiti removal on building façade; (4) monthly maintenance of new doors and windows and clean building façade, including the subsequent abatement of new graffiti; and (5)monthly trash clean-up. New doors and windows and a newly cleaned building facade signal that a property is care for, prohibit easy entry, and are see-through thereby helping to reduce squatting, drug dens, and violence that proliferate when such behaviors are concealed from sight in abandoned buildings. Thus, in addition to a clean and cared for appearance, the dual-challenge of being seen more easily through glass windows (as opposed to, for instance, plywood coverings) and entering the openings of abandoned buildings through glass windows that make noise when shattered and leave a lasting, visual sign of forced entry, may prevent illegal substance abuse and violence.

Graffiti removal and trash clean-up RCT arm ("graffiti treatment", n=80). During the same 6-month period as the full treatment arm, a graffiti removal only housing remediation treatment will be performed on 80 of the abandoned houses randomly assigned to this RCT arm, followed by monthly maintenance and trash clean-up for the remainder of the post-treatment period. This will again be done by the PHDC. The graffiti treatment arm will follow a standard protocol and include these activities: (1) cleaning, new paint, and graffiti removal on building façade; (2) monthly maintenance of clean building façade, including the subsequent abatement of new graffiti; and (3) monthly trash clean-up. A motivation for inclusion of this study arm is isolation of the effects of the doors and windows replacement itself from the removal of graffiti and the cleaning of building facades. This study arm will also allow us to directly test whether graffiti remediation itself has an effect on substance abuse and violence outcomes. This is significant because graffiti removal is a very common and inexpensive practice in cities around the world that is being conducted with almost no scientific evidence-base. Whether the removal of graffiti actually affects negative outcomes like substance abuse or firearm violence (as many have speculated) remains an outstanding but largely unanswered research question with sparse evidence, especially from RCTs.

Trash clean-up only RCT arm ("contact control", n=80). During the same 6-month period as the full treatment arm, 80 abandoned houses will be randomly assigned to receive monthly trash clean-up only as a control condition of the proposed trial. This will be timed to match the treatment arms of the RCT and will be followed by monthly trash clean-up for the remainder of the posttreatment period. This trash clean-up only control will also be performed by the PHDC, follow the same standard protocols for

trash clean-up as in the treatment arms, and parallel the number of workers and the amount of time typically spent on trash clean-up at abandoned houses in the treatment arms. Uncontrolled trials fail to provide unbiased and reliable statistical inference regarding what would have happened to subjects if they had not received the test treatment. Our proposed use of a randomly assigned trash clean-up control group of abandoned houses will be akin to a "placebo" group in a clinical trial, that is it will be intended to eliminate observer bias, mimic the psychological benefit of offering active treatment, and allow isolated study of the nonpsychological benefits of treatment. The proposed trash clean-up control group will allow us to disentangle the psychological effects of abandoned housing remediation and the act of having workers present and in contact with surrounding residents (i.e. its function as a contact control) from the actual active ingredient of abandoned housing remediation, the physical changes to the buildings themselves.

No housing remediation, graffiti or trash clean-up RCT arm ("no treatment", n=80). As a second control arm of the proposed trial, we will also randomly assign a separate group of 80 abandoned houses to receive nothing, i.e. no new doors and windows, graffiti removal or trash clean-up. This control group of abandoned houses will be monitored over the same periods as the other 3 arms of the trial. Although "no treatment" controls fail to simulate the psychological effect of treatment, they are important when used in conjunction with controls that do simulate such psychological effects of treatment. Our use of a randomly assigned control group of abandoned houses to receive nothing is therefore intended to eliminate observer bias and other selection effects, when compared with the other arms of the trial.

Random assignment procedures. The random assignment of abandoned houses to 4 different trial arms will be done to balance known and unknown factors between treatment and control groups. Geographic sections of Philadelphia represent covariates necessary for the internal validity of the study and, as such, random assignment of abandoned houses will be performed independently within strata by geographic section of the city. This will keep the variability of lots within strata as small as possible and the between-strata variability as large as possible and will prevent imbalance with respect to important covariates related to geographic location (e.g., class, race, ethnicity, etc.). To avoid contamination between study arms or dilution of true effects we will also set geographic selection rules to prohibit any abandoned houses in our study from being within ¼ mile from each other. We have used this ¼ mile distance restriction successfully in past community-based RCTs.

As we've also successfully done in past community RCTs, an urn or repeat randomization will be used in advance to ensure balance in several key, baseline covariates. Urn or repeat randomization further reduces experimental bias and insures balance, over and above the balance that is obtained by standard random assignment alone. These key covariates, measured only in the baseline, pre-treatment period, and within a ¼ mile radius around each abandoned house enrolled in the trial, will be: (1) number of abandoned houses that were already remediated as part of normal city operations, outside of the RCT; (2) number of people below the poverty line; (3) number of college educated people; and (4) number of people unemployed. The repeat randomization will effectively iterate the random allocation process until balance is achieved between the 4 arms of the RCT in these key baseline covariates, by city section.

Once random assignments undergo acceptable quality assurance checks, the RCT's treatment and control arms will be cleared for implementation. A final, unalterable random assignment list will be locked in a database with the study's biostatistician to maintain blinding and prevent any tampering

until interim or final analyses need to be performed. A Manual of Procedures will document the entire process.

Blinding procedures. We will employ double blinding: i.e., our investigative team (except for the biostatistician and the PI) and field surveyors, our study participants completing surveys, and those reporting information to us from the field (such as the Philadelphia Police Department) will be blinded to the assignment of treatment or control to abandoned houses. This will help avoid biases created by subjective judgment in reporting, evaluation, data processing, and statistical analysis, as well as participant or field interviewer awareness of nearby abandoned houses that will or will not be remediated as part of the RCT (as opposed to just regular municipal processes). We will also determine whether the blinding has been seriously violated by asking both participants and investigators to guess the treatment assignment at the conclusion of the trial prior to unblinding. With this information the degree of unblinding and any biases it may have introduced can be directly assessed.

Observational metrics of substance abuse and firearm violence outcomes. Crime data will be collected from the Philadelphia Police Department every month in the year preceding the treatment, for the treatment period itself, and for 12 months following the treatment. Police data will include dates and address locations of narcotics possession, sales, and trafficking arrests, public drunkenness, firearm assaults, and other crimes. These arrest data have been validated as accurate. Address locations will be geographically coded ("geocoded") to points in space using geographic information systems (GIS) software. We will also use inverse-distance weighted (IDW) measures to calculate spatially interpolated estimates of the levels of crime at the point-in-space representing each abandoned house. We will also incorporate bandwidths (maximum distances) for our IDW measures as is standard practice. IDW measures will offer several important advantages over simply assigning subjects to solitary geographic polygons, such as census tracts or block groups. Analyses in which subjects are nested within solitary administrative geographic units (i.e., a single census tract or block group) can generate challenges, including the mis-estimation of effects. Oftentimes, the boundaries of these administrative geographic units have been determined for purposes other than the specific relationships under study and as such may be awkwardly shaped, poorly correspond to lived space, have edge-effects (i.e., a subject assigned to a tract but located on its border may be more influenced by their neighboring tract), or impose a neighborhood scale that is inappropriate for the subjects being studied. Our experience in Philadelphia with IDW measures shows that they are continuous and essentially boundary free, avoid aggregation effects, directly account for spillover effects and variability in neighboring areas, and can be quite reliably calculated.

Statistical Analysis Plan. Our primary analyses will be performed under the intent-to-treat (ITT) principle, i.e., pre-post changes to factors linked to abandoned houses will be analyzed according to the trial arms to which they were randomly allocated. Tests of group differences in pre- versus post-intervention accounting for longitudinal changes in continuous, ordinal, or binary outcomes will be made using spline-based, linear, log-linear or logistic regression models, as appropriate. Such models will include random effects for temporal and spatial correlations and fixed effects for treatment/control factors, time factors characterizing changes across pre- and postintervention periods, and interactions between the treatment/control factors and pre-post intervention temporal effects. Models will be fit using Proc Glimmix in SAS V9.2 based on the modeling procedures in Brown et al. as a special case of multiple-membership classification models (accounting for spatial clusters of nearby houses). Missing data weights based on inverse probability weighting will be used as a sensitivity analysis if missing data are significantly related to baseline factors.

Changes made prior to start of study. (1) Rather than the original planned 4 arms, the trial (as registered) had 3 arms (the graffiti/trash cleanup arm was merged to a single arm). (2) Police reported outcomes followed for 18 months pre/post, as registered.