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Evaluating the Use of Public Surveillance Cameras for Crime Control and Prevention

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About the COPS Office

The Office of Community Oriented Policing Services (the COPS Office) is the component of the U.S. Department of Justice responsible for advancing the practice of community policing by the nation's state, local, and tribal law enforcement agencies through information and grant resources. The community policing philosophy promotes organizational strategies that support the systematic use of partnerships and problem-solving techniques to proactively address the immediate conditions that give rise to public safety issues such as crime, social disorder, and fear of crime. In its simplest form, community policing is about building relationships and solving problems.

The COPS Office awards grants to state, local, and tribal law enforcement agencies to hire and train community policing professionals, acquire and deploy cutting-edge crime-fighting technologies, and develop and test innovative policing strategies. The COPS Office funding also provides training and technical assistance to community members and local government leaders and all levels of law enforcement.

Since 1994, the COPS Office has invested more than $16 billion to add community policing officers to the nation's streets, enhance crime fighting technology, support crime prevention initiatives, and provide training and technical assistance to help advance community policing. More than 500,000 law enforcement personnel, community members, and government leaders have been trained through COPS Office-funded training organizations.

The COPS Office has produced more than 1,000 information products—and distributed more than 2 million publications—including Problem Oriented Policing Guides, Grant Owners Manuals, fact sheets, best practices, and curricula. And in 2010, the COPS Office participated in 45 law enforcement and public-safety conferences in 25 states in order to maximize the exposure and distribution of these knowledge products. More than 500 of those products, along with other products covering a wide area of community policing topics—from school and campus safety to gang violence—are currently available, at no cost, through its online Resource Information Center at www.cops.usdoj.gov. More than 2 million copies have been downloaded in FY2010 alone. The easy to navigate and up to date website is also the grant application portal, providing access to online application forms.

Executive Summary

Law enforcement agencies are continually seeking new technologies that hold promise for enhancing their public safety efforts. Among the latest generation of such public safety tools is the use of public surveillance cameras. The theory behind the utility of public surveillance systems for crime prevention purposes is that potential offenders will refrain from criminal activity if they know they are being watched and believe they are at greater risk of apprehension. Cameras may also increase perceptions of safety among law abiding citizens, encouraging them to use public spaces and serve as informal guardians and potential witnesses.[1] Advocates of cameras also theorize that their surveillance capabilities can enhance criminal justice system efficiency by alerting police of crimes and potentially dangerous situations as they occur and providing crucial information that can help police determine the safest way in which to respond.[2] Video footage documenting criminal activity and identifying perpetrators and witnesses may also aid in investigations and prosecutions, increasing police and prosecutorial efficiency, benefiting crime victims whose cases are able to be closed through the use of video evidence, and incapacitating a greater number of offenders from committing future crimes.[3]

The contributions to policing and public safety that surveillance cameras may yield perhaps explain why their use has expanded in recent years.[4] These investments of scarce public safety resources, however, are being made despite the fact that very few rigorous evaluations of public surveillance cameras have been conducted in the United States. Scant research exists documenting the decisions made to invest in public surveillance technology, its use, and the lessons learned by cities that have employed this technology. Importantly, no prior research has sought to explore the degree to which camera use is cost-beneficial—a critical inquiry in light of the economic challenges currently being experienced by jurisdictions across the country.

In response to this knowledge gap, The Urban Institute (UI) undertook a rigorous process and impact evaluation of the implementation and use of public surveillance cameras for crime control purposes in three U.S. cities: Baltimore, Maryland; Chicago, Illinois; and Washington, D.C. The results of the evaluation, funded by U.S. Department of Justice's Office of Community Oriented Policing Services (the COPS Office), illustrate the variety of ways in which cameras can be implemented and used by jurisdictions and suggest that these differences affect the degree to which cameras reduce crime. UI researchers structured this evaluation around the following research questions:

1. What were the decision-making processes behind public surveillance camera implementation and use in each of the three study sites?
2. To what degree did camera implementation coincide with a reduction in crime? To what degree was camera implementation associated with the diffusion of crime benefits and the displacement of crime to nearby areas?
3. What are the costs associated with camera implementation and use, including monitoring and maintenance expenditures?
4. How do the costs associated with public surveillance systems compare to the monetized societal benefits associated with crime reductions following camera implementation?

To answer these questions, UI evaluators:

1. Welsh, Brandon C., and David P. Farrington. 2002. "Crime Prevention Effects of Closed Circuit Television: A Systematic Review." *Home Office Research Study.* 252. London: UK Home Office, Research, Development and Statistics Directorate; Welsh, Brandon C., and David P. Farrington. 2004. "Surveillance for Crime Prevention in Public Space: Results and Policy Choices in Britain and America." *Criminology and Public Policy* 3(3): 497–526.

2. Goold, Benjamin J. 2004. *CCTV and Policing: Public Area Surveillance and Police Practices in Britain.* New York: Oxford University Press; Levesley, Tom, and Amanda Martin. 2005. "Police Attitudes to and Use of CCTV." *Home Office Online Report.* London: UK Home Office, Research, Development and Statistics Directorate.

3. Chainey, Spencer. 2000. "Optimizing Closed-Circuit Television Use." In *Crime Mapping Case Studies: Successes In the Field.* Vol. 2, ed. Nancy La Vigne and Julie Wartell, 91–100. Washington, D.C.: Police Executive Research Forum; Gill, Martin, and Martin Hemming. 2004. *"The Evaluation of CCTV in the London Borough of Lewsham: A Report."* Leceister: Perpetuity Research and Consultancy International; Ratcliffe, Jerry. 2006. *Video Surveillance of Public Places.* Washington, D.C.: U.S. Department of Justice, Office of Community Oriented Policing Services.

4. Gill, Martin. 2006. "CCTV: Is It Effective?" In *The Handbook of Security*, ed. Martin Gill, New York: Palgrave Macmillan, 2006: 438-461; Nestel, Thomas J. III, "Using Surveillance Camera Systems to Monitor Public Domains: Can Abuse Be Prevented?" Master's thesis, Naval Postgraduate School, Monterey, CA: 2006.

1. Collected and synthesized qualitative data on the ways in which cameras are employed to support patrol, investigations, tactical unit activities, and prosecutions;
2. Selected comparison areas for impact analysis purposes, matching each camera area on historical crime volume, geographic location, land use, and demographics of the surrounding area;
3. Collected pre- and post-intervention reported crime data from each site's police department to support impact and cost-benefit analyses;
4. Collected data on the costs associated with the surveillance technology and the monetized criminal justice system and victimization costs associated with crimes the cameras are intended to prevent; and
5. Analyzed the effectiveness and net cost/benefit of camera implementation and use.

Evaluation Findings

The process evaluation component of this study involved the synthesis of qualitative data obtained from interviews with 44 stakeholders representing the planners and public officials involved in each city's decisions to acquire and employ this technology, as well as the law enforcement officers, civilians, and other local criminal justice practitioners engaged in camera use. UI evaluators supplemented these interviews with the collection and review of documents related to public surveillance camera implementation, monitoring, and use. In addition, the UI research team conducted site visits to each jurisdiction, observing monitoring practices and use of cameras by line officers, detectives, and supervisors. Findings on the implementation and use of public surveillance systems varied significantly by study site. Baltimore virtually saturated its downtown area with cameras and employed around-the-clock monitoring of the live video footage. Chicago employed an extensive wireless network of cameras and enabled access to all sworn officers. Washington implemented the fewest cameras in specific high-crime areas while restricting live monitoring of cameras to a narrow set of actors and contexts in order to safeguard citizens' rights to privacy.

The process evaluation yielded critical contextual information with which to interpret results of the impact analysis. The impact analysis employed three categories of methods: (1) descriptive, time series, and Difference-in-Differences (DiD) analyses (employing comparison areas matched on historical crime, socio-economic factors, and land use) of pre- and post-intervention reported crimes in each camera area to detect the degree to which cameras had an impact on crime; (2) spatial analyses of potential displacement and diffusion effects in areas adjacent to the camera locations; and (3) a cost-benefit analysis of public surveillance cameras derived from data on the costs of camera installation, use, monitoring, and maintenance and on the societal costs of crimes that may have been prevented due to the intervention. Given the variations in camera implementation and use documented in the process evaluation, the impact analyses are site-specific and do not involve any pooling of data across cities. While this limits the generalizability of the findings, it is nonetheless justified due to the vastly different local contexts and technology use documented in this report. The findings from both the process and impact evaluation are detailed below.

Baltimore, Maryland

Baltimore implemented cameras in both its downtown area and in select neighborhoods identified as high-crime areas. The city's greatest investment in cameras was in the downtown business district. These cameras are present throughout the 50-block area and are monitored around-the-clock by a team of trained retired police officers, who are located at a centralized monitoring facility known as CitiWatch. Officers use the cameras for special events, routine patrol activities, and undercover investigations. The city later introduced cameras in several high-crime neighborhoods, although neither the degree of camera saturation nor monitoring level matched that of the downtown Baltimore area during the evaluation period.

Process Evaluation Highlights

Stakeholders associated with Baltimore's camera implementation and use largely viewed cameras favorably, indicating that they are an effective crime control tool when integrated into other law enforcement activities. They noted that while detractors of the technology argue that it simply displaces crime, such displacement

was anticipated and prevented. When the cameras were first deployed, commanders identified areas susceptible to crime displacement and placed patrol officers in those locations—a tactic that increased offender apprehension. In addition, stakeholders reported that camera use has recorded suspects in action and captured images of getaway vehicles. It has compelled witnesses to cooperate with police, even if they fear retribution, and it has also aided police in retrieving weapons used in the commission of crimes.

Despite these positive aspects of camera implementation and use, stakeholders reported limitations to the technology's usefulness. Prosecutors, for example, cited the "CSI effect" whereby juries assume that advanced forensic and technological evidence is present at all crime scenes and fail to deliver a guilty plea in the absence of camera footage. Further complications for investigators and prosecutors lie in the camera technology itself. The camera, when passive, pans on a pre-programmed tour, so it may not capture an entire criminal event as it transpires—if it captures anything at all. Even when an event is captured on camera, restricted visibility at night and in inclement weather, along with limitations in the resolution quality of the footage, can constrain the utility of the footage as evidence.

Baltimore's camera system has also generated unanticipated costs. Ongoing maintenance costs far exceeded the initial investment in surveillance technology and included repairing vandalized cameras. Early problems led officials to purchase cameras with vandal-resistant domes, cover electrical lines with metal bands, and lock electrical access conduits at additional cost. Such changes yielded new complications; for example, different generations of cameras run on disparate software systems that are not always compatible with each other or the monitoring equipment. These differences in camera types resulted in delays and additional costs associated with unifying the cameras under one system.

Impact Analysis Results

The results of the impact analysis of Baltimore's camera investment suggest that the costs Baltimore incurred in camera implementation, maintenance, and monitoring are beginning to pay off in reduced crime. Particularly in the downtown Baltimore area, which was the area within the city with the greatest concentration of cameras and the highest degree of monitoring, both property and violent crimes declined by large percentages in the months following camera implementation. As illustrated in Table 1, the average number of crimes per month prior to the identification of a significant structural break—or shift—in crime trends was significantly higher than the average number of monthly crimes following that shift. These significant differences were observed for total crime, violent crime, and both types of larceny crime categories—those occurring behind closed doors (in businesses, private homes, or other buildings) and those occurring out in the open. These reductions were identified without any signs of crime displacement to neighboring areas and with marginal evidence of a diffusion of benefits. Crime near the camera area but beyond the camera viewsheds (in the 1000-ft buffer surrounding the cameras) also declined during the post-implementation period.

*Table 1: Significant Changes in Crime, Downtown Baltimore**

Crime	Time from Installation	Pre-Shift Mean	Post-Shift Mean	%Change
Larceny Inside†	3 months	36.79	25.03	-31.97%
Larceny Outside†	11 months	41.47	27.13	-34.58%
Violent†	6 months	21.17	16.36	-22.72%
Total†	**4 months**	**119.05**	**89.47**	**-24.85%**
1000-ft Buffer	5 months	82.83	58.38	-29.52%

Source: The Urban Institute

*First set of cameras were installed in early May 2005; therefore, the intervention point was determined to be May 2005.

The downtown extension cameras were not included in this analysis.

†Significant at p<.05.

Impacts on crime in other Baltimore camera areas were mixed, with some areas demonstrating statistically significant drops in some types of crimes and one area yielding no measurable impact at all. In the Greenmount area, for example, results from the DiD analyses indicated a significant 15 percent decrease in all aggregated crime following camera installation, representing an average decrease of eight fewer incidents per month following camera implementation (see Table 2). This reduction in crime was not accompanied by displacement or a diffusion of benefits.

*Table 2: Significant Changes in Crime, Greenmount Area, Baltimore**

Crime Type	Area	Before	After	Change	Difference-in-Differences
All Crime	Treatment	64.00	50.76	-13.24	
	Comparison	40.42	35.39	-5.03	-8.22†

Source: The Urban Institute

*Camera installation occurred in early August 2005; therefore, the intervention point was determined to be August 2005.

†Significant at p<.05.

In the Tri-District area of Baltimore, results indicated a significant decline in total crime, with average monthly crime counts decreasing by nearly 35 percent — or roughly 12 fewer incidents per month—following camera installation. As shown in Table 3, robberies and inside larcenies also dropped by roughly two incidents per month. These reductions occurred in the absence of signs of displacement and only small evidence of diffusion that was not found to be statistically significant.

*Table 3: Significant Changes in Crime, Tri-District Area, Baltimore**

Crime Type	Area	Before	After	Change	Difference-in-Differences
All Crime	Treatment	37.61	29.12	-8.49	
	Comparison	32.53	36.38	+3.86	-12.35†
Larceny Inside	Treatment	3.39	1.54	-2.83	
	Comparison	1.97	1.65	-0.32	-1.54†
Robbery	Treatment	3.84	2.08	-1.77	
	Comparison	3.47	3.77	+0.30	-2.06†

Source: The Urban Institute

*Camera installation occurred in early March 2006; therefore, the intervention point was determined to be March 2006.

†Significant at p<.05.

Despite these promising findings in three of the four camera areas selected for this evaluation, the fourth area, North Avenue, demonstrated no crime reduction. Neither the pre- and post-comparisons of means nor the more rigorous Difference-in-Differences analyses revealed statistically significant changes in crime following camera implementation.

Cost-Benefit Analysis Results

The above findings create a strong case for the positive impact that Baltimore's public cameras have on crime reduction, with some signs of diffusion of benefits and no statistically significant evidence of displacement. Even accounting for the fact that no impacts on crime were identified in one of the four study sites, the results of the cost-benefit analysis of Baltimore's camera system indicate that Baltimore's monthly benefits from averted crime are greater than its monthly costs. Societal savings associated with crimes averted due to

the presence and use of cameras exceeded the costs of the system in the 29th month following implementation. This delay in net benefits is explained by the upfront loading of start-up costs such as for infrastructure, installation, and initial hardware and software acquisition.

While the value of crimes prevented through the use of public surveillance systems in terms of victimization costs averted is real and important to society, it often masks the degree to which an intervention is cost-beneficial from a governmental perspective. That is, government budgets do not benefit from averted crimes to victims. Analysts therefore conducted a second cost-benefit analysis excluding victimization costs. Doing so reduced the savings associated with surveillance cameras considerably: in Baltimore, the costs of the cameras were roughly equal to the benefits attributed to them (the camera system yielded $1.06 in benefits for every dollar spent on them).

Chicago, Illinois

At the time the evaluation began, Chicago had approximately 8,000 cameras in operation, of which 2,000 were operated by the Chicago Police Department (CPD) and represent the main focus of this evaluation.[5] Termed "PODs" for portable observation devices, the cameras are highly visible and are typically accompanied by both signage and blue flashing lights. Due to the wireless networking of Chicago's camera system, the city is unique in its ability to make live video feed accessible to as many authorized users as it chooses. In Chicago, this means that all sworn officers have the ability to monitor cameras from their desktop computers. While the camera system may be actively monitored at all times, the extent of monitoring varies by police district. Even in the districts that engage in the most proactive monitoring, relatively few individuals are dedicated monitors charged solely with the task of viewing live camera footage. However, within the Crime Prevention Information Center (CPIC) and the Office of Emergency Management and Communications (OEMC), live feeds from the camera network are integrated and shared. In each of these locations, monitors are able to view one or more screens with real-time footage from cameras located throughout the city. CPD sends a list of a dozen or so "POD missions" each day, which are identified as priorities for this monitoring function.

Process Evaluation Highlights

Among the many lessons learned from Chicago's experience with its public surveillance system, two particular lessons stand out. First, it is very important to include citizens in the planning stages of camera implementation and second, attorneys require specific training to use camera footage effectively in court. Those involved with the implementation and use of cameras in Chicago noted that gains could have been made earlier had planners more effectively incorporated the ideas and concerns of the mayor, law enforcement, and members of the community. Simple communication strategies, such as public hearings, community meetings, and efforts toward transparency in the initial planning stage would have streamlined the implementation process. Stakeholders also cited the need for more thorough and consistent training of both prosecutors and defense attorneys in the use of camera footage. While some attorneys have worked with the police department to learn more about the surveillance system, additional training in software use, system capabilities, and strategies for presenting video footage as evidence at trial would be useful for future cases.

Impact Analysis Results

Despite the lessons and limitations observed by stakeholders, many stakeholders expressed the view that cameras have a tangible crime control impact, a perception that was validated—albeit not consistently—by the results of the impact analysis. Two areas with high concentrations of cameras were employed for the impact analysis, one located in the Humboldt Park neighborhood and the other in the West Garfield Park neighborhood. As depicted in Table 4, the DiD analysis revealed a significant decrease in average monthly total crime counts in the Humboldt Park area following camera installation. In addition, the average monthly crime counts for drug-related and robbery offenses were reduced by nearly one-third, with drug crime

5. In addition to the police camera system, Chicago has both overt and covert cameras that are monitored primarily for homeland security purposes.

*Table 4: Significant Changes in Crime, Humboldt Park, Chicago**

Crime Type	Area	Before	After	Change	Difference-in-Differences
All Crime	Treatment	301.39	243.53	-57.86	
	Comparison	349.57	330.00	-19.57	-38.30†
Violent	Treatment	33.00	23.19	-9.81	
	Comparison	29.57	25.62	-3.95	-5.87†
Drug	Treatment	115.22	77.31	-37.91	
	Comparison	120.57	116.14	-4.43	-33.49†
Robbery	Treatment	11.52	8.53	-2.99	
	Comparison	11.43	11.61	+0.18	-3.17†
Weapons	Treatment	3.96	2.58	-1.37	
	Comparison	3.78	4.56	+0.77	-2.15†

Source: The Urban Institute

*First camera installation on July 31, 2003 and, therefore, intervention line inserted at August 2003.

†Significant at $p<.05$.

decreasing by more than 30 incidents and robbery by 3 incidents on average per month. While weapons-related crimes in the camera target area declined by more than half—or roughly two fewer incidents per month—this finding should be interpreted with caution given the low base rate of this crime category. However, the violent crime category also declined significantly by approximately one-fifth, with six fewer incidents on average per month following camera installation. In summary, the decrease in crime in the treatment area, which was significantly greater than that experienced by the comparison area, suggests that the Humboldt Park area cameras accomplished their desired crime control impact. This impact was achieved with no evidence of displacement but did seem to generate a diffusion of benefits, which were ultimately not found to be statistically significant either.

The second Chicago camera area evaluated, West Garfield Park, yielded little to report. When examining the mean change before and after camera installation using independent samples T-tests, only prostitution and robbery significantly changed, with prostitution increasing and robbery decreasing. However, these findings are not persuasive in the absence of a comparison area to control for other factors that may be influencing the crime rate. Employing DiD analyses for the two crime categories for which comparisons of means indicated a significant change, we found that both prostitution and robbery were no longer significant. Thus, the change in crime levels for both crime categories may be attributed to the fluctuation of crime in the area rather than as a result of the cameras themselves.

However, given the strong crime prevention impact that cameras had in Humboldt Park, we explored in more detail the differences between Humboldt Park and West Garfield Park that might explain why cameras had an impact in one area and not another. One possible explanation for the difference is that cameras were employed by law enforcement differently in the two sites. Yet, both areas are housed in the same police district with the same leadership, indicating that use of cameras was similar in the two areas. Perceptions of West Garfield Park residents, however, suggest differently; one community advocate shared that it is her perception, and that of her neighbors, that police do not watch the cameras in West Garfield Park. Another possible reason for the difference in impact between Humboldt Park and West Garfield Park is the concentration of cameras. The Humboldt Park area has a much higher concentration of cameras (approximately 53 per square mile) compared to West Garfield, at approximately 36 per square mile. This difference in camera saturation could have influenced the degree to which cameras were able to catch crimes in progress and thus officers to intervene, make arrests, and deter other potential offenders.

Cost-Benefit Analysis Results

In a story similar to Baltimore's, the results of the Chicago cost-benefit analysis suggest that the city's investment in cameras is well justified, despite the fact that significant reductions were only detected in one camera area. In fact, because crime reductions in the Humboldt Park area included costly violent crimes, the societal benefits of preventing those crimes were significant: for every dollar spent on cameras in both Humboldt Park and West Garfield Park areas, the crimes prevented in Humboldt Park alone yielded a societal savings of over four dollars. Even when excluding victimization costs from the analysis, the benefits of camera use in Chicago still outweighed the costs, at a ratio of $2.81 in benefits for every dollar spent on cameras. These results provide compelling support for the implementation and use of public surveillance cameras by the Chicago Police Department.

Washington, D.C.

The camera system that served as the focus of the Washington, D.C., component of this evaluation was designed to have a direct impact on crimes occurring in specific high-crime neighborhoods. In the interest of both transparency and enhancing their crime control impact, implementers chose to have all 73 of these neighborhood cameras clearly visible, with signs posted near the cameras to alert passersby that a camera was present and recording. In addition, the location of each camera is published on the Metropolitan Police Department's (MPD) website.

At the outset, District residents were very vocal and forthright in expressing their concerns that the neighborhood cameras would be subject to misuse and pose a threat to privacy rights. Camera implementers met this concern with transparency, public outreach, and the credibility established by the successful operation of the preceding homeland security camera system. The city council designed the guidelines regarding camera use based on input from the public and interest groups—including the ACLU and American Bar Association—that was solicited through a series of open hearings and through a Public Review published in the D.C. register. The regulations ensure that monitors only view public space, and prohibit viewing any flyers or handbills in order to protect the First Amendment rights of those holding and distributing them. In addition, monitors are prohibited from targeting cameras on subjects based on their race, gender, sexual orientation, disability, or other distinguishing characteristics. The regulations are often held up as a rare example of what a sound policy safeguarding camera use should look like.[6]

These regulations, however, severely limit the extent of active monitoring employed in D.C. Active monitoring can only take place in a single location, the control center that is employed to monitor cameras and other alert technology. Those engaged in active monitoring are all sworn personnel and they, along with other officers working in the control center monitoring room, must sign a statement acknowledging the rules regarding the privacy rights of those being monitored. Monitoring procedures require that a sworn MPD staff person at the rank of Lieutenant or higher be in the monitoring room at all times. This protocol was developed to minimize misuse of cameras by monitors and other MPD staff and to remind those viewing the footage to follow the guidelines set forth to protect citizens' privacy. Up to two staff persons serve as monitors on each shift. During a shift, one monitor will usually watch four to five cameras while the other works primarily with other crime-alert technology in the room.

This limited degree of active monitoring makes the ability to extract and use footage generated from passive monitoring for investigative purposes all the more critical. In D.C., camera footage is stored for 10 days unless needed for evidence or training purposes. As with active monitoring, historical footage may only be viewed if a sworn officer at the rank of Lieutenant or higher is present. To request footage to be kept as evidence, a detective must contact the command center and request the desired time span. A technician will then burn the video onto a DVD for the investigator to collect and the video is stored in the evidence room. If the camera is not connected to the network, the hard drive must be physically retrieved and brought to the command center in order to make a copy. The video is then put in the case file and officially marked as evidence. DVDs are encrypted and time-stamped to prevent tampering.

6. The Constitution Project. 2007. *Guidelines for Public Video Surveillance: A Guide to Protecting Communities and Preserving Civil Liberties.*

Process Evaluation Highlights

With the limited number of cameras in D.C., investigators reported that it is hit or miss in terms of whether a camera captures a crime. They do not typically have the ability to extract footage from multiple cameras in the area because it is unusual for more than one camera to exist in any given location. It was not surprising to learn from stakeholder interviews that while they viewed cameras as useful tools in solving crime, they underscored that cameras are not consistently useful. When the cameras do catch a crime or the circumstances surrounding the crime clearly, the footage is powerful and useful at all stages of investigation and prosecution. In this ideal situation, investigators have an easier time finding witnesses and achieving witness cooperation, which could significantly reduce investigation time. With clear video evidence, prosecutors who have used the footage noted that case preparation time was also reduced, due both to an increase in the likelihood of pleas and a lower level of effort required to make a powerful case to a jury should the case go to trial.

Regardless of these limitations, members of the police department touted the system's value as a crime deterrent, although some raised questions about the potential for cameras to simply displace crime to neighboring areas that do not have cameras. Overall, stakeholders noted that even if cameras are not having an impact on crime, they serve a purpose in raising community awareness and increasing perceptions of safety.

Impact Analysis Results

Cameras alone did not appear to have an impact on crime in D.C. Basic comparisons of means for crimes occurring before and after camera implementation found significant reductions in assault with a deadly weapon and violent crime, while larcenies increased significantly. None of these crime changes remained significant after controlling for competing effects that are not attributable to the cameras, through the introduction of a comparison area. Indeed, the control areas followed the same pattern of change for each of the crime categories (i.e., assault with a deadly weapon and violent crime declined, while larceny increased). This suggests that there were other factors contributing to crime reduction throughout the city and that while cameras may have had some impact they were not on their own a significant contributing factor to the crime decline. The absence of a significant impact on crime associated with D.C.'s camera system led us to forego the cost-benefit analysis component of the evaluation for this site.

Summary and Recommendations

This report's documentation of the implementation and use of public surveillance systems in three jurisdictions has yielded several useful findings. Of primary importance is the fact that public surveillance technology is viewed as a potentially useful tool for preventing crimes, aiding in arrests, and supporting investigations and prosecutions. While the technology and its applications are not without limitations, it is noteworthy that stakeholders across a wide array of vested interests were generally supportive of public video surveillance. These views were largely—but not consistently—supported by impact analyses. Analysis results indicate that cameras, when actively monitored, have a cost-beneficial impact on crime with no statistically significant evidence of displacement to neighboring areas. However, in some contexts and locations these crime reduction benefits are not realized.

Two possible explanations for the lack of the surveillance technology's impact on crime in certain study areas are that the cameras are not actively monitored on a routine basis and that the no-impact areas had relatively low concentrations of cameras with fewer overlapping viewsheds and thus a reduced ability to capture crimes in progress. These are critical factors that both current and future investors of surveillance technology should consider when expanding or implementing camera systems. In addition to these recommendations stemming from the impact analysis, stakeholders interviewed for the process evaluation component of this study recommended that perhaps the single greatest investment of time associated with a public surveillance system should occur during the planning and implementation phase, particularly in setting the groundwork for camera implementation. Stakeholders repeatedly emphasized the importance of community input through the convening of open public meetings, the invitation

of public comment, and the clear explication of the rationale behind camera placement decisions. Developing and disseminating written policies on the proscribed use and dissemination of footage, including planned restrictions and security measures, can go a long way toward building public support for a camera system. However, jurisdictions should carefully balance the advantages of implementing stringent guidelines on camera use, in order to safeguard against invasion of privacy, against the disadvantages of overly restrictive guidelines that may limit the ability to use cameras to their greatest capacity.

While laying the groundwork for camera investment, jurisdictions should give careful consideration to planning and procurement activities. Stakeholders across all three study sites underscored the fact that the cost of the cameras themselves is minimal compared to the costs of installation, maintenance, and monitoring. Jurisdictions investing in a public surveillance system should be prepared to do their own research rather than relying on the advice of vendors, as it is not in a vendor's interest to highlight in detail all the hidden costs associated with camera systems. Those planning for such an investment should also be aware of the fact that the technology is constantly evolving; each subsequent generation of cameras offers greater resolution and potentially more useful features. One caveat to this advice, however, is that jurisdictions should weigh the pros and cons of cameras that produce superior image quality; images captured with greater resolution create a greater burden on video storage capacity. Thus, a thoughtful camera investment strategy will procure the best affordable technology while building in plans for camera upgrades.

Stakeholders also advised jurisdictions to plan for a larger system than they initially intend to implement, as doing so will reduce the costs of expansion of the system in the long run. For example, the decision-makers behind camera implementation in Washington, D.C. purchased wireless-capable cameras even though they did not have the capacity to connect the cameras to a wireless system until several years later. Regardless of system size and the intended complexity of the final network, stakeholders recommended installing cameras incrementally in one or two areas. This type of piloting strategy enables implementers to work out details in camera placement, monitoring, and video retrieval prior to widespread implementation.

With regard to camera placement, jurisdictions should understand at the outset that even when locations are identified through the mapping of hot spots of criminal activity, the ultimate locations of cameras will be guided by infrastructure (including proximity to power sources), the camera technology employed, and characteristics of the natural and man-made environment. For example, wireless camera systems require consideration of the location of cameras and antennas in relation to trees, physical obstructions, and other cameras. In addition to camera placement decisions, camera movement decisions should be made with care. Based on the experiences of the three cities highlighted in this report, jurisdictions that intend to move cameras as hot spots shift locations should consider building in plans for the purchase of additional cameras in anticipation of resident opposition to the removal of cameras in their neighborhoods.

The stakeholders interviewed for this study also had rather strong opinions on how and when cameras should be monitored. Baltimore stakeholders in particular argued that the greatest impact from cameras can be yielded through actively monitoring areas and intervening in real time. Active monitoring is also useful for later investigative and prosecution purposes, as live monitors can zoom into a scene to capture important details that may not be captured through a pre-programmed camera tour. However, active monitoring requires significant resources and may also raise concerns among the public about how the cameras are being monitored. These experiences suggest that jurisdictions should carefully consider both the benefits and drawbacks of active monitoring.

Regardless of whether cameras are actively or passively monitored, stakeholders across all three study sites emphasized the importance of training. While most stakeholders indicated that on-the-job training for camera monitors was sufficient, they saw a need for training detectives and prosecutors on how best to employ camera footage in their investigations and case presentation. This training should include information on how to retrieve and use footage and the potential value of camera footage to their cases, as well as the limitations associated with video evidence and the fact that it typically enhances, rather than serves as a substitute for, witness testimony.

Finally, inasmuch as the promise of public surveillance cameras as a crime prevention and control tool is a powerful motivator for those investing in the technology, it is important to view it in the context of a larger community policing framework. Surveillance cameras alone are a not a silver bullet, but simply another crime control and investigative tool. That tool should be employed along with other policing strategies, such as community-oriented problem-solving strategies and intelligence-led policing. Further, it is important for jurisdictions to understand that public surveillance technology is only as good as the manner in which it is employed. If it is employed minimally or is not well-integrated into other policing functions, it is unlikely to yield a significant impact on crime.

Chapter 1. *Introduction*

Municipalities across the country are in a constant search for effective public safety interventions that will curb crime and improve the livability and economic well-being of their communities. This is particularly true among law enforcement agencies that embrace a community policing philosophy, which has become a key component of policing efforts in most mid- and large-sized law enforcement agencies across the United States.[7] While many believe that the adoption of community policing has led to more efficient and effective policing strategies,[8] law enforcement agencies continue to grapple with limited resources and are therefore interested in employing new tools that can enhance their community policing efforts. Among the latest waves of public safety tools is the use of public surveillance cameras, often referred to as Closed Circuit Television (CCTV).[9] While surveillance cameras are widely employed in the business sector to improve security,[10] until recently their use to monitor public spaces has been much less common in the United States, in part due to concerns about privacy and civil liberties.[11] Community policing, which embodies a combination of proactive crime prevention and community engagement with more traditional policing functions, may benefit from this technology because public surveillance cameras could enhance problem-solving strategies, aid in arrests and investigations, and ultimately increase potential offenders' perceptions that they will be both caught *and* prosecuted. Public surveillance systems may also have a secondary impact, serving to increase law abiding citizens' perceptions of safety and thus their presence in public spaces, which in turn may increase guardianship, improve police-community partnerships, and reduce crime.

The potential contributions to policing and public safety that public surveillance cameras may yield perhaps explain why the technology's use has expanded in recent years.[12] Unfortunately, these investments of scarce public safety resources are being made despite the fact that very few rigorous outcome evaluations of public surveillance cameras have been conducted in the United States. Scant research exists documenting the decisions behind public surveillance technology investment and use, and the lessons learned by cities that have employed this technology. Further, only one publication exists describing the use of public surveillance cameras in investigations and prosecutions.[13]

This evaluation aims to fill these research gaps by detailing: (1) the results of an in-depth qualitative data collection effort to examine and synthesize the experiences of cities—Baltimore, MD; Chicago, IL; and Washington, D.C.—that have invested heavily in public surveillance technology in recent years; (2) a rigorous analysis of crime data to determine the degree to which cameras significantly reduce and/or displace crime; and (3) the degree to which the camera investment is cost-beneficial. Designed primarily for law enforcement agencies and their municipal partners, this report begins with a review of previous findings of published public surveillance studies and describes the research methodology employed for the present study. We then present case studies from each of the three research

7. Skogan, Wesley. 2004. "Community Policing: Common Impediments to Success." In *Community Policing: The Past, Present, and Future*, ed. Lorie Fridell and Mary Ann Wycoff, 159–168. Washington, D.C.: Annie E. Casey Foundation and Police Executive Research Forum.

8. Fridell, Lorie, and Mary Ann Wycoff. "Community Policing: The Past, Present, and Future," (see note 7); Skogan, Wesley. 2006. "The Promise of Community Policing." In *Police Innovation: Contrasting Perspectives*, ed. David Weisburd and Anthony Braga, 27–44. New York and Cambridge: Cambridge University Press.

9. While CCTV is the most commonly used term for public surveillance systems, it has become antiquated given the introduction of new video recording technologies that are not closed-circuit. Hence, the term public surveillance is employed throughout this report to describe the use of cameras in public spaces.

10. Nieto, Marcus. 1997. "Public Video Surveillance: Is It an Effective Crime Prevention Tool?" CRB-97-005. Sacramento, CA: California Research Bureau; National Institute of Justice. 2003. "CCTV: Constant Cameras Track Violators." *NIJ Journal* 249: 16–23.

11. Gill "CCTV: Is It Effective?" (see note 4); See National Institute of Justice, "CCTV: Constant Cameras Track Violators," (see note 10).

12. Gill, "CCTV: Is It Effective," (see note 4); Nestel, "Using Surveillance" (see note 4).

13. King, Jennifer, Deidre K. Mulligan, and Steven Raphael. 2008. "CITRIS Report: The San Francisco Community Safety Camera Program," Berkeley, California: University of California Center for Information Technology Research in the Interest of Society.

sites, detailing the decisions behind camera investment, implementation, and use, and highlighting the role that public surveillance cameras play in supporting arrests, investigations, and prosecutions. Findings from the impact, spatial, and cost-benefit analysis pieces are discussed within the chapters for each of the three sites. The report concludes with a section devoted to the lessons learned by these jurisdictions, followed by recommendations to help inform both agencies that are currently investing in public surveillance systems for public safety purposes, as well as those that are contemplating doing so.

Chapter 2.
Overview of Public Surveillance Use

In order to understand the mechanisms by which public surveillance cameras may impact crime and disorder and to examine the relevant information that can help inform future public surveillance investments, it is necessary to review the literature on public surveillance technology in general, as well as its application to specific crime control measures. The following discussion describes public surveillance technology, the theories underpinning its use as a crime prevention tool, and the results of previous impact evaluations.

Public Surveillance Technology

Public surveillance systems are comprised of a network of cameras and components for monitoring, recording, and transmitting video images. New systems typically incorporate cameras with good image quality; the ability to pan, tilt, and zoom; and capabilities such as color recording and night vision.[14] Most cameras are pre-programmed to scan an area following a set pattern (referred to as a "tour") and can also be operated remotely by security personnel or automated computer surveillance programs to focus in on specific areas or activities of interest.[15] More sophisticated systems incorporate audio equipment or motion sensors that provide additional information about the monitored space,[16] including detecting gunshots or recognizing license plates.[17]

Careful placement of cameras in a public surveillance network is required to maximize effectiveness. Camera locations are often selected by examining crime patterns using Geographic Information Systems (GIS).[18] The identification of crime hotspots may be supplemented with input from police, other criminal justice stakeholders, and the public regarding areas where they believe surveillance can be most beneficial.[19] Once target areas have been identified, a determination must be made as to the desired number and exact locations of cameras. The coverage area of the camera network (the area that the cameras can collectively "see") is a function of the saturation and distribution of cameras and the range of visibility of each camera, commonly referred to as the viewshed.[20] A camera's range of visibility is determined by its technological abilities to pan, zoom, and focus but can be restricted by the lighting in the surrounding area or by obstructions blocking the camera's line of sight.[21]

Cameras are only one component of a public surveillance system—the arrangements for monitoring, recording, and responding to the video footage play an equally important role in the system's effectiveness in both the prevention and detection of crime. These factors vary widely depending on the purposes of the system and available resources. "Passive" camera systems rely upon the retrieval of previously recorded images, which are reviewed after-the-fact as needed, while "active" systems are monitored in real time, typically by police or private security personnel.[22]

14. Gill, Martin, and Angela Spriggs. 2005. "Assessing the Impact of CCTV." Home Office Research Study 292. www.homeoffice.gov.uk/rds/pdfs05/hors292.pdf. (Accessed January 18, 2007.); Goold, "*CCTV and Policing,*" (see note 2); Ratcliffe, "*Video Surveillance,*" (see note 3).

15. Ibid., 14; National Institute of Justice, "CCTV: Constant Cameras Track Violators," (see note 10); Ratcliffe, "Video Surveillance," (see note 3).

16. Goold, "CCTV and Policing," (see note 2); Ratcliffe, "Video Surveillance," (see note 3).

17. National Institute of Justice, "CCTV: Constant Cameras Track Violators," (see note 10); Surette, Ray. 2005. "The Thinking Eye: Pros and Cons of Second Generation CCTV Surveillance Systems." *Policing: An International Journal of Police Strategies and Management* 28(1): 152–173.

18. Chainey, Spencer. 2000. "Optimizing Closed-Circuit Television Use." In *Crime Mapping Case Studies: Successes In the Field,* Vol. 2, ed. Nancy La Vigne and Julie Wartell, 91–100. Washington, D.C.: Police Executive Research Forum.

19. Gill and Spriggs, "Assessing the Impact," (see note 14).; Nestel, "Using Surveillance Camera Systems," (see note 4); Ratcliffe, "Video Surveillance," (see note 3).

20. Chainey, "Optimizing," (see note 19); Gill and Spriggs, "Assessing the Impact," (see note 14).

21. Chainey, "Optimizing," (see note 19); Ratcliffe, "Video Surveillance," (see note 3).

22. Ratcliffe, "Video Surveillance," (see note 3).

The effectiveness of active monitoring depends on how frequently the images from each camera are displayed, the ratio of operators to video monitoring screens, and the training that operators receive on how to detect and respond to suspicious activity.[23] Typically passive and active systems are used in combination, as few jurisdictions have the resources to actively monitor all cameras continually.

Theories Supporting the Effectiveness of Public Surveillance Systems

The theory underlying the effectiveness of public surveillance technology as a crime control tool is based on the belief that, if potential offenders know they are being watched, they will refrain from criminal activity. This belief is consistent with rational choice theory, which posits that potential offenders make purposeful, rational (albeit bounded[24]) decisions to commit crimes after weighing the potential costs and benefits of the crime in question.[25] Practical applications of rational choice theory are typically embodied under the Situational Crime Prevention (SCP) rubric, which offers an array of means by which the cost-benefit ratio of offending opportunities can be altered, including the following: (1) increasing the risk of being apprehended; (2) increasing the effort involved in committing the crime; (3) decreasing the rewards of the crime; (4) increasing the shame and guilt expected to result from the crime or felt at the immediate moment of decision-making; and/or (5) reducing provocations that create criminal opportunities.[26]

Applying rational choice theory and SCP to public surveillance use, one would hypothesize that any impact of cameras on offenders' perceptions is likely to take the form of increasing the risk of apprehension.[27] However, to increase perceived risk, an offender must be aware of the presence of the camera(s) and thus be deterred from committing crime. Overt camera systems accomplish this by placing cameras in public view and coupling them with signage and/or flashing lights advertising their presence.[28] These systems often rely on media and publicity campaigns to communicate information to potential offenders.[29] Yet, even when potential offenders are aware that a camera system exists, they may not know the extent of the system's capacity. This imperfect knowledge about what the cameras can see may actually magnify their deterrent impact. As is evident with other crime prevention measures, such as "hot spot policing,"[30] cameras may prevent crime in areas beyond the immediate area of intervention, a phenomenon known as diffusion of benefits.[31]

Public surveillance systems may also have an impact on preventing crime by increasing perceptions of safety among legitimate users of the public areas monitored by cameras, thereby encouraging people to frequent places they may previously have been fearful of visiting.[32] As more people use these spaces for pro-social purposes, their presence may serve as a further deterrent to crime, providing natural surveillance as informal guardians and potential witnesses.[33]

23. Gill, "CCTV: Is It Effective?" (see note 4).

24. Rational choice theory acknowledges that an offender's decision-making processes may not be truly rational, in that they could be influenced by intoxication or drug addiction, low intelligence levels, and/or an inclination to discount the future costs of one's actions.

25. Cornish, Derek B., and Ronald V. Clarke. 2003. "Opportunities, Precipitators and Criminal Decisions: A Reply to Wortley's Critique of Situational Crime Prevention." In *Theory for Practice in Situational Crime Prevention Crime Prevention Studies,* Vol. 16, ed. Martha J. Smith and Derek B. Cornish, 41–96. Monsey, NY: Criminal Justice Press.

26. Clarke, Ronald V. 1997. "Introduction." In *Situational Crime Prevention: Successful Case Studies, 2nd edition*, ed. Ronald V. Clarke, 1–43. Monsey, NY: Criminal Justice Press; Cornish and Clarke, "Opportunities," (see note 25).

27. Ratcliffe, "Video Surveillance," (see note 3); Welsh and Farrington, "Surveillance for Crime Prevention," (see note 1).

28. Ratcliffe, "Video Surveillance," (see note 3).

29. Mazerolle, Lorraine, David Hurley, and Mitchell Chamlin. 2002. "Social Behavior in Public Space: An Analysis of Behavioral Adaptations to CCTV." *Security Journal* 15(3): 59-75; Ratcliffe, "Video Surveillance," (see note 3).

30. Weisburd, David, Laura A. Wyckoff, Justin Ready, et al. 2006. "Does Crime Just Move around the Corner? A Controlled Study of Spatial Displacement and Diffusion of Crime Control Benefits." *Criminology* 44: 549-591.

31. Clarke, Ronald, and David Weisburd. 1994. "Diffusion of Crime Control Benefits: Observations on the Reverse of Displacement." In *Crime Prevention Studies,* Vol. 2, ed. Ronald V. Clarke, 165–186. Monsey, NY: Criminal Justice Press; Gill, "CCTV: Is It Effective?" (see note 4); Gill and Spriggs, "Assessing the Impact," (see note 14); Ratcliffe, "Video Surveillance," (see note 3); Weisburd, Wycoff, Ready, et al., "Does Crime," (see note 30).

32. Gill, "CCTV: Is It Effective?" (see note 4); Ratcliffe, "Video Surveillance," (see note 3).

33. Welsh and Farrington, "Crime Prevention," (see note 1); Welsh and Farrington, "Surveillance," (see note 1).

Advocates of public camera use also theorize that its surveillance capabilities can enhance criminal justice system efficiency. Camera monitors can alert police of crimes and potentially dangerous situations as they occur, providing crucial information that can help police determine the safest, most effective response, including how many officers to deploy and how to respond on the scene.[34] Video footage documenting crimes that transpired and identifying perpetrators and witnesses may aid in investigations and prosecutions, increasing police and prosecutorial efficiency, benefiting victims of crimes whose cases are able to be closed through the use of video evidence, and incapacitating a greater number of offenders from committing future crimes.[35]

Public Surveillance Issues and Challenges

Despite the many potential benefits of camera systems, their introduction can also create political tensions in communities. Critics of public surveillance systems are typically most concerned by the potential threat to civil liberties that the technology presents. Some members of the public are concerned about government agencies conducting extensive and potentially inappropriate surveillance activities as well as individual civilian or sworn personnel misusing cameras, and many question the adequacy of public surveillance regulations and guidelines in preventing such misuse.[36] Others argue that cameras create a false sense of security, leading potential victims to let their guard down, thereby becoming "softer" targets.[37] This may in turn diminish citizen guardianship and natural surveillance, as people feel that there is less need for them to monitor public spaces if cameras are present.[38] Alternatively, some contend that a well-publicized camera system may actually increase people's fear and elicit other negative public responses by highlighting the crime problems in an area.[39] Another concern surrounding public surveillance use is the threat of crime displacement, whereby efforts to reduce opportunities for crime do not truly lower crime, but merely change where, when, or how it is committed.[40] [41] Thus, the introduction of cameras in one area or neighborhood could result in increased crime elsewhere.

Evaluations/Existing Research

The vast majority of public surveillance evaluations have been conducted in Europe, and particularly in the United Kingdom (UK), where use of the technology is most widespread. An early UK study by Chainey produced promising results based on camera use in two downtown areas: Street robbery was reduced in one of the two areas with no evidence of displacement, and a survey of residents and business owners nearby overwhelmingly reported increased feelings of safety in both areas following camera installation.[42] More recently, Gill and Spriggs' 2005 study of 14 separate UK public surveillance systems found evidence that cameras reduce fear of crime, but only 2 of the 14 sites showed statistically significant declines in crime that could be attributed to the presence of cameras. The

34. Goold, "CCTV and Policing," (see note 2); Levesley and Martin, "Police," (see note 2).

35. Chainey, "Optimizing," (see note 18); Gill and Hemming, "The Evaluation of CCTV," (see note 3); Ratcliffe, "Video Surveillance," (see note 3).

36. Gill, "CCTV: Is It Effective?" (see note 4); Nestel, "Using Surveillance," (see note 4); Painter, K. and N. Tilley, eds. 1999. *Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention.* Vol.10. Monsey, NY: Criminal Justice Press; Schlosberg, Mark, and Nicole A. Ozer. 2007. "Under the Watchful Eye: The Proliferation of Video Surveillance Systems in California." CA: American Civil Liberties Union of Northern California; Siegel, Loren, Robert A. Perry, and Margaret Hunt Gram. 2006. "Who's Watching? Video Camera Surveillance in New York City and the Need for Public Oversight." New York: New York Civil Liberties Union.

37. Welsh and Farrington, "Surveillance," (see note 1).

38. Surette, "The Thinking Eye," (see note 17).

39. Ratcliffe, "Video Surveillance," (see note 3).

40. Displacement may take the form of a change in the location, time, modus operandi, victim, or type of crime (Welsh and Farrington, "Surveillance," (see note 1); Surette, "The Thinking Eye," (see note 17); Gill and Spriggs, "Assessing the Impact," (see note 14); Barr, Robert, and Ken Pease. 1990. "Crime Placement, Displacement, and Deflection." *Crime and Justice* 12: 277–318).

41. Barr and Pease, "Crime Placement," (see note 40); Clarke, "Introduction," (see note 26); Clarke, Ronald V. 1992. "Situational Crime Prevention: Theory and Practice." *British Journal of Criminology* 20: 136–147; Cornish and Clarke, "Opportunities," 25 (see note 25); Cornish, Derek B., and Ronald V. Clarke. 1987. "Understanding Crime Displacement: An Application of Rational Choice Theory." *Criminology* 25(4): 933–47; Eck, John E. 1993. "The Threat of Crime Displacement." *Criminal Justice Abstracts* 25: 527–46; Gill and Spriggs, "Assessing the Impact," (see note 14); Weisburd, Wycoff, Ready, et al., "Does Crime," (see note 30).

42. Chainey, "Optimizing," (see note 18).

study also found evidence that public surveillance systems have different impacts on different types of crime.[43] For example, while thefts from and of vehicles declined, shoplifting and public order crimes rose significantly.

Welsh and Farrington (in 2002, 2004, and 2008) conducted a study of previous public surveillance evaluations worldwide, of which 41 were identified as having sufficient methodological rigor to be included in a formal meta-analysis.[44] Of these evaluations, 34 were carried out in the United Kingdom, four in the United States (U.S.), two in other European countries, and one in Canada. Overall, the authors found that cameras reduce crime to a small degree, although evaluations of public surveillance impact on downtown areas were mixed. About half of the downtown studies (n=22) found that public surveillance systems decreased crime in the monitored areas relative to the control areas, while the other studies found increases or no change in crime in monitored areas. Among the 20 studies with enough data to evaluate effect sizes, significant reductions of crime were found in UK settings, but no effect on crime was detected in other countries. These lackluster results may be a function of the low number of observations (with weekly averages as low as two crimes in some studies) or the short post-implementation periods employed (as little as three and one-half months)—both of which are methodological concerns that plague many other public surveillance impact analyses. Notably, the authors found just one U.S.-based study on camera use in city centers, which assessed the impact of three camera locations in Cincinnati (Ohio).[45] This evaluation found decreases in disorder-related calls for service during the post-intervention period[46] but no impact on reported crime. The only two other U.S. studies included in the meta-analysis, both of which assessed camera use in public housing complexes in New York City, had null or inconclusive results.[47]

A second meta-analysis, combined with an evaluation of two public surveillance locations in Los Angeles (California), echoes the mixed findings of Welsh and Farrington.[48] Of the 44 sites included in the meta-analysis (11 of which were of sites in the United States), almost 41 percent (18) showed a statistically significant decrease in crime, with the remainder demonstrating either a rise in crime or null results. The impact was slightly more positive for camera systems implemented specifically in commercial areas, where just under half (12) of 25 sites experienced a positive impact. By contrast, cameras placed in residential areas typically failed to reduce crime. Of the nine sites included in this category, the vast majority (7) had no significant impact, while a significant rise in crime was found in the remaining two sites. None of the 11 U.S. sites showed a significant decrease in crime in any category.

Three recent studies have taken a closer look at public surveillance use and impact in U.S. cities. In Los Angeles, neither crime nor arrest data changed significantly after the city's camera system was implemented.[49] In the other two cities, however, results were more mixed. Philadelphia's camera evaluation did find a significant reduction in crime within a month of camera installation at half of the camera locations.[50] Four of the eight sites included in the study experienced a statistically significant decrease in disorder incidents in the target areas and witnessed a reduction of crime in the buffer area, which researchers deemed a diffusion of the benefits associated with the camera installation. The evaluation does not address the question of why some camera sites had an impact on crime while others did not.

43. Gill and Spriggs, "Assessing the Impact," (see note 14).

44. Welsh and Farrington, "Crime Prevention," (see note 1); Welsh and Farrington, "Surveillance," (see note 1); Welsh, Brandon C., and David P. Farrington. 2008. "Effects of Closed Circuit Television Surveillance on Crime." The Campbell Collaboration Crime and Justice Coordinating Group.

45. Mazerolle, Hurley, and Chamlin, "Social Behavior," 22 (see note 29).

46. Welsh and Farrington's (2002, 2004) meta-analysis calculated a null effect for the same study.

47. Williamson, D., and McLafferty S. 2000. The effects of CCTV on crime in public housing: An application of GIS and spatial statistics. Paper presented at the American Society of Criminology meeting, November 15–19, San Francisco, California.; Musheno, M.C., J.P. Levine, D.J. Palumbo. 1978. Television surveillance and crime prevention: Evaluating an attempt to create defensible space in public housing. *Social Science Quarterly* 58: 647–656.

48. Cameron, Aundreia, Elke Kolodinski, Heather May, and Nicholas Williams. 2007. "*Measuring the Effects of Video Surveillance on Crime in Los Angeles*." CRB-08-007. Sacramento, CA: California Research Bureau.

49. Cameron, Kolodinski, May, et al., "Measuring the Effects," (see note 48).

50. Ratcliffe, Jerry, and Travis Taniguchi. 2008. "CCTV Camera Evaluation: The Crime Reduction Effect of Public CCTV Cameras in the City of Philadelphia, PA Installed during 2006." Philadelphia, PA: Temple University.

A more comprehensive study of San Francisco's public surveillance system found similarly mixed results.[51] The study examined 19 camera sites, each with multiple cameras, from 209 days before installation to 264 days afterward. In that period, there were no statistically significant changes in drug offenses, vandalism, prostitution, or violent crime. Property crime rates, however, declined significantly (23 percent) within 100 feet of the cameras with no signs of displacement to areas adjacent to but not within the viewsheds of the cameras. The effect was driven entirely by declines in larceny theft. Interviews with police, prosecutors, and public defenders established that footage was used for corroborating and exonerating suspects, corroborating witness testimony, and in some cases standing in for witnesses or giving otherwise uncooperative witnesses the courage to testify. The evaluation highlighted several key problems with the system, including poor image quality, inadequate inter-departmental communication, lack of a clear leader for the program, and misguided camera placement.

Prior evaluations have contributed greatly to our knowledge of how best to measure public surveillance technology's impact on both crime and possible displacement or diffusion effects. These evaluations, however, yielded mixed evidence of the impact of cameras on crime and disorder. Furthermore, a significant share of these studies raise methodological concerns, such as failure to include a comparison or displacement area in analyses; lack of independence from government agencies with a strong interest in the results; short follow-up or post-intervention periods; small sample sizes; insufficient saturation of cameras; and shortcomings in design and execution.[52] These problems with studies' evaluation designs may explain their inconsistent findings. Moreover, only one of these prior evaluations explores how cameras are used to support arrests of crimes in progress, investigations of crimes that took place in view of cameras, or prosecutions of such crimes. And, while a few publications explore issues associated with the considerations necessary for investing in and using public surveillance systems,[53] these publications do not provide guidance based on real-life experiences of police agencies in the United States. Nor does prior research examine the degree to which any favorable impact of public surveillance technology is cost beneficial—an important consideration for jurisdictions contemplating investing in or expanding public surveillance use. As described in the *Research and Design* section below, the present study addresses these issues comprehensively.

51. King, Mulligan, and Raphael, "CITRIS Report," (see note 14).

52. Ratcliffe, "Video Surveillance," (see note 3); Welsh and Farrington, "Surveillance," (see note 1).

53. See Ratcliffe 2006 for exception.

Chapter 3.
Research Design and Methods

The methodology employed in this evaluation combines the collection of both qualitative and quantitative data. The qualitative component is embodied in a process evaluation designed to document the installation and use of the public surveillance systems in three U.S. cities: Baltimore, MD; Chicago, IL; and Washington, D.C. Interviews with jurisdictional and law enforcement leaders, sworn officers, detectives, prosecutors, and civilian camera monitors, along with the review of policies, budgets, and other documents, form the backbone of the process evaluation. The impact evaluation relies on quantitative data on reported crimes, demographics, land use, camera installation locations and types, and cost data. UI researchers used these data to conduct both general and crime-specific time series and difference-in-differences analyses to examine the impact of public surveillance technology on crime. Researchers also employed detailed location-specific diffusion and displacement analyses to determine the degree to which crime was reduced, diffused, or shifted to nearby areas. Stemming from findings from the impact analysis, a cost-benefit analysis of camera use was conducted in two study sites, Baltimore and Chicago. The cost-benefit analysis explored whether the costs associated with public surveillance technology are proportionate to any reductions in crime and increased efficiencies in investigations that may be attributed to the intervention.

Process Evaluation

The process evaluation component of the present study is based upon qualitative data and is organized around the following research questions:

- Why do cities choose to invest in public surveillance technology for public surveillance purposes? What do they hope to gain from their investment?
- What factors play a role in decisions about the types of cameras that are purchased and how they are deployed and monitored?
- How is the public involved in decisions to invest in and use public surveillance cameras?
- How are cameras used to support real-time arrests, and how are they used for investigative purposes?
- What are the advantages and limitations to using public surveillance cameras for prosecution purposes?

Thus, the process measures collected during the course of this evaluation were guided by the types of information that would be most helpful to those cities that are considering investing in public surveillance technology, as well as those that are looking to improve or expand current public surveillance use.

These questions were explored through the collection of data from three distinct sources: (1) in-person or telephone interviews with stakeholders who were identified as having been involved in the public surveillance planning process, as well as those who are currently engaged in or affected by its operation and use; (2) identification and collection of technical and financial documentation of the surveillance camera acquisition and installation process, such as vendor contracts, training materials, and privacy policies; and (3) in-person observation of the monitoring of cameras at each of the study sites to document how the cameras are monitored, how alerts are issued and to whom, and how data are archived and retrieved for investigative purposes.

Table 3.1: Total Number of Interviews, by Type

Interview Type	Totals
Planners and City Officials	24
Crime Analysts/Technicians	4
Monitors	12
Investigators	9
Prosecutors	19
Total Interviews	**68**
Site Observations	**15**

Source: The Urban Institute

Stakeholders represented local law enforcement, prosecutors,[54] people involved in the planning of the public surveillance system, high-level city officials in both the police department and mayor's office, local elected officials, and representatives of citizen's groups. They were identified through initial contact with each site's police department and local government, and then additional stakeholders were identified through a "snowball" sampling approach, which involved asking interviewed stakeholders to provide names of others involved in the investment and use of cameras. In total, we conducted 68 stakeholder interviews across all three study sites (see Table 3.1 for details by type of interview). Specific questions were posed on the following topics: planning, acquisition, installation, monitoring, and policies and procedures (see Appendix A for detailed interview questions by type of respondent).

Impact Analysis

In addition to describing the various applications of public surveillance technology—whether for crime control or to assist with investigations—and the process of installing such a system, we tested whether cameras had an impact in reducing and/or displacing crime in and around the vicinity of the cameras. As previously discussed, through the lens of a rational choice perspective, and more specifically situational crime prevention, cameras may serve as a means of formal surveillance, thus increasing the presence of police. In turn, public surveillance technology increases the risk of apprehension in areas where cameras are being monitored by law enforcement, enabling them to intervene immediately. Cameras also increase the risk of detection by providing video footage that can aid investigative efforts and identification of perpetrators. Keeping these theoretical underpinnings in mind, we would anticipate that street crime of all types would likely be affected by the presence of cameras.

Study Area Selection

In each site, the impact analysis included crime incidents for all available crime categories provided by local law enforcement, which are defined in more detail in the site-specific sections below. The following tables of reported crime data obtained from BPD provide a general overview of the volume of crime in each of the sites included in our study leading up to the camera intervention dates for each site.

54. Local defense attorneys were also contacted, but the research team was unable to find willing participants to include in the study.

Table 3.2: Quarterly Crime Counts in Downtown Baltimore by Crime Type

	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2†	Q3	Q4
Aggravated Assault	22	25	30	16	17	21	18	22	21	17	26	21
Arson	0	0	0	0	0	0	0	0	0	0	0	0
Burglary	21	16	19	27	22	18	20	7	9	16	14	17
Larceny- Inside	72	59	70	66	112	118	100	84	113	124	98	81
Larceny- Outside	129	146	99	133	144	122	124	126	137	123	111	88
Murder	1	1	0	0	0	0	0	1	1	1	0	0
Motor Vehicle Theft	12	11	19	8	10	13	8	20	12	22	10	6
Rape	2	1	1	1	0	1	0	1	2	0	1	1
Robbery	22	34	30	33	18	37	31	25	20	19	46	15
Simple Assault	0	0	0	0	42	63	44	32	37	38	40	30
Total Crime*	**281**	**293**	**268**	**284**	**368**	**399**	**346**	**318**	**354**	**363**	**352**	**261**

Source: The Urban Institute

†Intervention date occurred during this quarter in May 2005.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.3: Quarterly Crime Counts in Greenmount, Baltimore, by Crime Type

	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Aggravated Assault	33	41	49	38	27	41	48	41	28	43	51	20
Arson	0	0	0	0	0	0	1	2	2	2	0	2
Burglary	35	26	31	31	21	20	28	33	16	19	33	18
Larceny- Inside	11	20	23	27	14	9	21	14	18	19	22	23
Larceny- Outside	38	50	39	52	47	55	66	40	30	28	42	24
Murder	2	1	3	3	0	2	2	1	2	1	2	1
Motor Vehicle Theft	12	12	17	11	17	13	20	18	14	12	15	16
Rape	1	0	0	1	0	2	0	1	1	0	0	0
Robbery	12	19	23	14	16	29	16	27	12	16	12	17
Simple Assault	0	0	0	0	50	59	41	35	35	38	47	31
Total Crime*	**144**	**169**	**185**	**177**	**192**	**230**	**245**	**212**	**158**	**178**	**225**	**156**

Source: The Urban Institute

†Intervention date occurred during this quarter in August 2005.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.4: Quarterly Crime Counts in North Avenue, Baltimore, by Crime Type

	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Aggravated Assault	28	51	48	31	32	45	32	33	28	64	52	39
Arson	0	0	0	0	0	0	0	0	0	1	0	1
Burglary	31	37	31	24	15	18	25	20	19	38	24	33
Larceny- Inside	12	23	15	11	10	11	16	18	4	13	20	16
Larceny- Outside	20	39	33	35	21	23	31	25	46	27	19	23
Murder	1	2	6	1	1	0	0	1	3	3	1	1
Motor Vehicle Theft	17	23	27	32	14	26	22	20	12	10	16	30
Rape	0	2	2	1	2	1	2	2	0	0	0	0
Robbery	19	28	14	20	16	10	26	36	24	30	20	22
Simple Assault	0	0	0	0	38	48	57	40	55	66	43	42
Total Crime*	**128**	**205**	**176**	**155**	**149**	**186**	**212**	**197**	**191**	**252**	**196**	**210**

Source: The Urban Institute

Note: Intervention date occurred in March 2006.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.5: Quarterly Crime Counts in Tri-District, Baltimore, by Crime Type

	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Aggravated Assault	24	34	28	21	19	36	34	20	18	31	33	12
Arson	0	0	0	0	0	0	1	1	0	1	1	0
Burglary	21	17	22	20	19	13	22	19	12	22	18	15
Larceny- Inside	12	10	11	11	14	12	9	11	6	13	12	7
Larceny- Outside	11	23	7	8	11	7	22	11	11	14	11	11
Murder	4	0	0	1	0	2	1	1	0	2	1	1
Motor Vehicle Theft	7	10	6	8	5	14	8	12	5	13	10	4
Rape	0	0	0	0	1	1	1	0	1	0	0	0
Robbery	17	23	11	16	10	4	15	6	9	7	7	19
Simple Assault	0	0	0	0	29	34	36	29	43	41	40	28
Total Crime*	**96**	**117**	**85**	**85**	**109**	**127**	**150**	**118**	**108**	**147**	**135**	**97**

Source: The Urban Institute

Note: Intervention date occurred in March 2006.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.6: Quarterly Crime Counts in Humboldt Park, Chicago, by Crime Type

	2002				2003			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Aggravated Assault	45	62	77	54	44	57	52	42
Arson	3	3	3	1	0	2	2	1
Burglary	13	17	12	18	8	27	25	27
Drug-related Offenses	438	390	363	276	262	243	493	212
Larceny	52	61	59	74	49	79	77	57
Murder	1	1	0	6	0	1	2	0
Motor Vehicle Theft	34	28	21	31	27	20	31	25
Problem Persons	2	2	1	3	2	3	5	5
Prostitution	0	0	0	0	0	0	0	2
Robbery	29	35	49	43	18	27	38	21
Sexual Assault	4	4	8	3	4	6	9	7
Simple Assault	134	207	188	151	140	201	192	180
Vandalism	51	73	71	66	48	68	63	68
Weapons Offenses	12	6	13	11	14	13	13	12
Total Crime*	**916**	**981**	**950**	**840**	**760**	**861**	**1099**	**722**

Source: The Urban Institute

†Intervention date occurred during this quarter in August 2003.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.7: Quarterly Crime Counts in West Garfield Park, Chicago, by Crime Type

	2002				2003			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Aggravated Assault	28	40	40	41	19	38	35	32
Arson	0	3	2	1	0	3	0	0
Burglary	14	20	10	13	7	13	15	10
Drug-related Offenses	137	138	143	127	110	100	114	82
Larceny	58	65	74	37	58	65	72	79
Murder	0	3	2	0	2	0	1	0
Motor Vehicle Theft	20	19	10	18	21	16	18	15
Problem Persons	3	2	1	5	3	3	0	1
Prostitution	12	9	8	7	12	11	6	15
Robbery	35	28	40	39	30	35	35	26
Sexual Assault	6	7	3	3	2	5	3	5
Simple Assault	101	131	106	122	130	145	141	107
Vandalism	43	35	43	39	18	35	33	38
Weapons Offenses	4	7	11	6	7	6	7	10
Total Crime*	**532**	**571**	**556**	**508**	**484**	**537**	**527**	**481**

Source: The Urban Institute

†Intervention date occurred during this quarter in August 2003.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.8: Quarterly Crime Counts in Individual Camera Area, D.C., by Crime Type

	2005				2006			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Assault with a Deadly Weapon	31	46	42	39	30	53	41	40
Arson	0	0	0	0	0	0	0	0
Burglary	15	21	19	13	23	21	22	12
Larceny	43	46	68	57	57	71	86	65
Murder	5	6	4	2	2	3	5	1
Motor Vehicle Theft	20	34	35	33	32	39	24	29
Robbery	32	28	45	38	49	56	47	33
Sexual Assault	3	4	5	4	1	8	4	5
Total Crime*	**149**	**185**	**218**	**186**	**194**	**251**	**229**	**185**

Source: The Urban Institute

†Intervention date occurred during this quarter in August and September 2006.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Table 3.9: Quarterly Crime Counts in Clustered Camera Area, D.C., by Crime Type

	2005				2006			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Assault with a Deadly Weapon	18	18	22	30	18	35	30	20
Arson	0	0	0	1	0	0	1	0
Burglary	14	15	14	7	12	13	14	12
Larceny	20	34	38	70	66	82	44	65
Murder	0	1	4	0	1	2	2	0
Motor Vehicle Theft	7	10	14	29	18	29	16	12
Robbery	8	13	11	25	18	18	27	12
Sexual Assault	1	2	2	0	1	1	1	0
Total Crime*	**68**	**93**	**105**	**162**	**134**	**180**	**135**	**121**

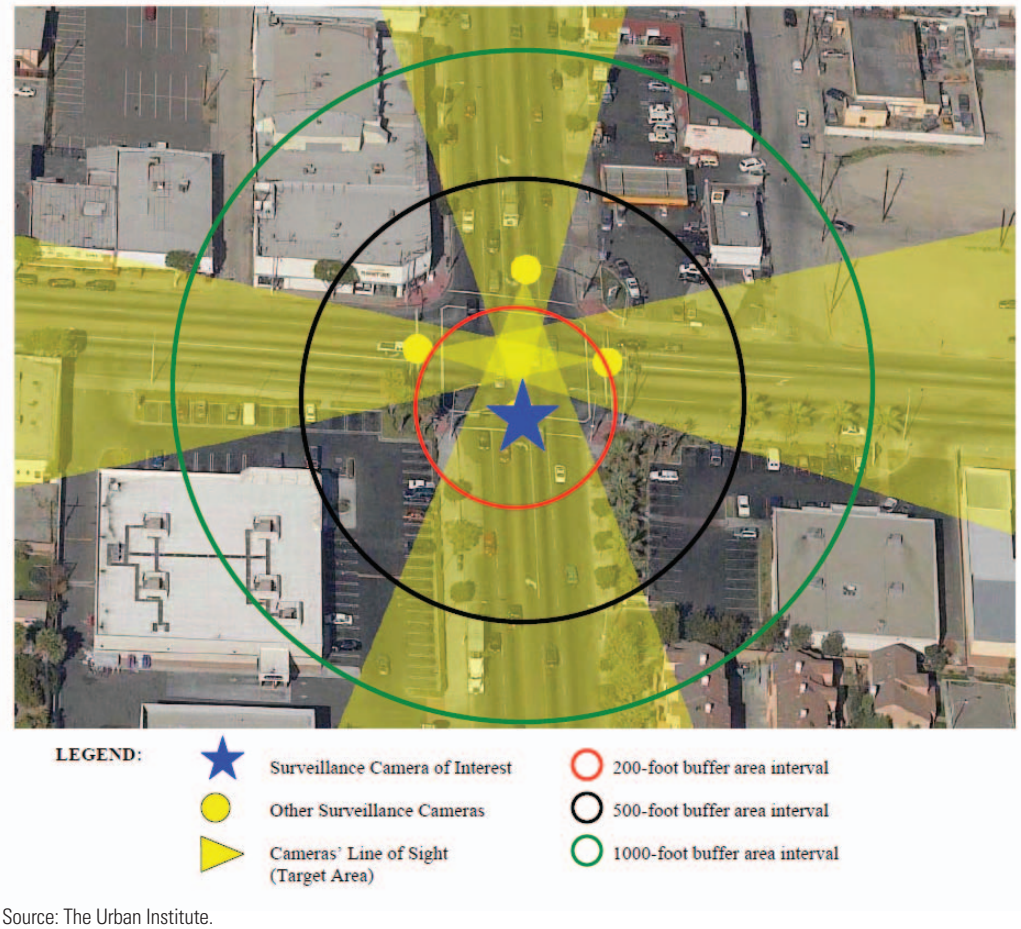
Source: The Urban Institute

†Intervention date occurred during this quarter in August 2005.

*The sum of the above crime types does not equal total crime. Total crime includes additional crime types that were not presented above.

Analyses were performed within four areas of each site: (1) the 200-ft target areas of the camera(s); (2) at buffer zones of 500 feet; (3) at buffer zones of 1000 feet; and, with the exception of downtown Baltimore,[55] (4) in matched comparison areas. UI researchers selected the size of the buffer zones based on conversations with various camera vendors, local law enforcement officers, and camera monitors about the typical camera's zooming ability. Two hundred feet represented the size of the viewshed (shown in Figure 3.1 using a red ring), or the distance that a camera is able to zoom and provide a clear image, which is an estimated size that varies based on the fact that each city block poses different challenges in terms of obstructions to the view of the camera, how the camera is installed, and the type of camera. Our analyses also explored the possibility that cameras produce a "halo effect," or diffusion of benefits to areas immediately adjacent to the camera target areas but beyond the cameras' viewsheds, as well as a displacement effect, with crime shifting to nearby areas that were not within camera viewsheds (see Figure 3.1). Therefore, we established 500-ft and 1000-ft buffers around each camera target area by drawing two concentric circles around the 200-ft buffer to look for diffusion and displacement effects (represented by the black 500-ft and green 1000-ft rings in Figure 3.1). Spatial displacement is defined here as occurring when any crime that is reduced by the presence of cameras in the target area simply shifts to nearby areas. Although both the 500-ft and 1000-ft zones had the potential for either diffusion or displacement, we hypothesized that if change were to occur outside the target area as a result of the cameras, diffusion would likely take place at 500 feet and displacement at 1000 feet. We therefore designated the 500-ft zone as the diffusion buffer and the 1000-ft zone as the displacement buffer, and we refer to each as such throughout this report. Figure 3.1 is an example (not drawn to scale) of how the buffers were drawn in each of the sites, using a single camera as an example. This method was employed in Washington, D.C., while in Chicago and Baltimore buffers were created around clusters of cameras due to the heavy concentration of cameras in the study areas of those two cities. For areas with clusters of cameras, a polygon was first drawn to encompass all cameras that were to be included in the analysis and then a 200-ft buffer was placed around the polygon to represent the target area or the distance that a camera is able to zoom in any direction and provide a clear image. Maps of the specific areas that were included in the study are provided in the case studies below.

55. Given the unique nature of Baltimore's downtown area and the historical crime trends that occurred there, we determined that it was not feasible to identify a similar geographic area of the city that did not have cameras.



Source: The Urban Institute.
Note: Map not drawn to scale.

Figure 3.1

Each comparison area was selected based on similarities in land use, historical crime rates, and socioeconomic measures to its corresponding target area (refer to Appendix B for detailed findings). A factor score was derived for each block group in the vicinity of the target area based on the block-level calculations for indicators of neighborhood disorder. The scale was constructed based on three factor loadings—concentrated disadvantage, immigrant concentration, and residential stability[56] — as well as on crime rates and patterns of land use. The first dimension, concentrated disadvantage, included percentages of residents who are below the poverty line, on public assistance, in female-headed families, unemployed, under age 18, and black. The immigrant concentration dimension included percentages of Latinos and foreign-born residents. The third dimension, residential stability, was calculated based on the percentage of residents who had lived in the same house since 1995 and the percentage of owner-occupied houses. Census data were obtained from 2000 at the block level to generate the calculations described above.[57] In addition, the comparison areas were each presented to local law enforcement to confirm that they were appropriately matched areas and to account for police activity that may be targeted in specific neighborhoods. When possible, the comparison area was kept within the same police patrol district in order to minimize variation between the control and target areas.

56. These measures are consistent with prior research on measures of social disorganization (Sampson, R.J., S. Raudenbush and F. Earls. 1997. Neighborhoods and violent crime: A multi-level study of collective efficacy. *Science* 277: 918–24.).

57. Although the Census data were more than five years old at the time at which the comparison areas were selected, it was the best available source of data to use for these purposes.

Analytic Approach

The statistical methods employed for the impact analyses were dependent upon site- specific characteristics and included t-tests, time series analyses, and difference-in-differences analyses. We began by comparing pre- and post-implementation means across various crime types, running independent-samples, and two-tailed t-tests on reported crime data to identify statistically significant changes in crime. We then introduced either a time series component (in the case of downtown Baltimore) employing structural break analyses or a matched comparison area employing Difference-in-Differences (DiD) analyses.

Time Series Analysis

In the case of downtown Baltimore, which had no viable comparison area, time series analyses were conducted on all crime types for which a significant change was detected in the previously conducted comparisons of means. Traditional time series analysis involves the introduction of a dummy variable indicating the specific date of the intervention. However, in the case of this evaluation, the timing of the intervention was uncertain and it was more appropriate to employ a time window surrounding the potential implementation dates. For example, the implementation of cameras was often preceded by an announcement of the intention to implement cameras, creating a potential impact prior to actual implementation. Another scenario is that the implementation of cameras was followed by training and the full integration of cameras into law enforcement activities, creating a lagged impact. In light of these issues, we employed structural break analysis, a well-documented econometric approach for evaluations of programs with inexact implementation dates.[58] Indeed, econometricians view this approach as more agnostic than traditional pre-post analyses with a specific implementation date, in that statistical significance runs the risk of being overstated under the latter approach.[59]

The analysis involved the construction of a time series of accumulated reported crime counts for each of several categories of criminal incidents (e.g., violent crime, larceny, motor vehicle theft) for all three areas—target, diffusion, and displacement zones—for each calendar month from January 2003 to April 2008. We then used structural break analysis to identify the optimal set of break points (i.e., changes in the mean level of a time series) in the outcome measures. Once significant breaks (at $p<.05$) were identified, we interpreted the dates of those breaks in the context of the evaluation's implementation period. By aligning the month and year of the break with the month and year of camera installation activities, we were able to determine the likelihood that crime declined as a result of the intervention and to assign an impact value to that decline.[60]

Difference-in-Differences Analyses

While structural break time series analysis has the benefit of analyzing the impact of interventions with inexact implementation dates, we chose a different approach for the other camera sites given our interest in employing comparison areas to control for intervening factors that could be influencing crime. Therefore, in the case of all camera site analyses except for downtown Baltimore (for which no suitable comparison site existed), UI researchers identified matched comparison sites and employed DiD analyses across main crime categories to determine the degree to which cameras had an impact on crime after accounting for any changes in the comparison sites. DiD compares net change in crime in the target area using a control area to subtract other changes occurring in a similar location over the same evaluation period. This assumes that these other changes were identical between the target and control areas.

58. Piehl, Anne M., Suzanne J. Cooper, Anthony A. Braga, and David M. Kennedy. 2003. "Testing for Structural Breaks in the Evaluation of Programs." *The Review of Economics and Statistics.* 85(3): 550–558.

59. Ibid., 49.

60. We applied the method for testing for multiple break points developed by Bai (Bai J. 1997a. *Estimating Multiple Breaks One at a Time. Econometric Theory,* 12: 315–352; Bai J. 1997b. Estimation of a Change Point in Multiple Regression Models, *Review of Economics and Statistics,* 79: 551–563.), performing the analysis using the R statistical language (R Development Core Team. 2008. *R: A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing: Vienna, Austria. ISBN: 3-900051-07-0. www.r-project.org.) and using the functions provided by the strucchange package (Zeileis, Achmin, Friedrich Leisch, Kurt Hornik, and Christian Kleiber. 2001. Strucchange: An R Package for Testing for Structural Change in Linear Regression Models. *Adaptive Information Systems and Modelling in Economics and Management Science*, 55.).

Spatial Analysis

Using the same four areas included in the impact analysis (i.e., target, comparison, diffusion, and displacement zones), we further explored the degree to which camera impact extended beyond the cameras' viewsheds into the two buffer areas. Theoretically, there would be no justification for examining displacement of crime if crime in the target area had not changed over time. Therefore, we only conducted spatial analyses in areas where crime changed significantly. Our spatial analyses included the production of density maps of crime concentrations and calculation of mean center before and after camera implementation and the use of the weighted displacement quotient (WDQ).

Density Maps

The kernel density maps were used to create visual depictions of crime concentrations in the areas covered by and surrounding the cameras. Maps were generated for all aggregated crime at two points in time (one year before and after the intervention). The mean center of crime was calculated within a half mile of the camera target area for the same two points in time; each mean is displayed accordingly on the density maps. These points show the geographic center of the concentration of crime in the selected area, in this case a half-mile radius around the cameras, and enable researchers to determine if there was a shift in the specific location of the center of crime within and around the target areas. A shift in the mean center would show that crime is moving and in this case, the cameras may be the source of displacement. Each density map was created using the same parameters to allow for examination across different time periods and between maps (maps, however, cannot be compared between study sites due to differences in crime concentrations). Only those incidents that occurred within a half-mile radius were included in the development of the densities in order to display only the concentrations of crime in the areas of interest.

Weighted Displacement Quotient (WDQ)

The WDQ measures changes in crime occurring in the target area (A), displacement or diffusion zone (B), and comparison area (C), using two points in time (pre- and post-implementation).[61] The displacement and diffusion zones employed in this analysis were created using two concentric circles that were drawn at 500 and 1000 feet from the camera target area. Given that the WDQ, as it was originally intended, only accounts for a single displacement or diffusion zone, we calculated two separate WDQs, one for the 500-ft buffer and another for the 1000-ft buffer, over the same time periods. The WDQ formula is provided below:

$$WDQ = \frac{B_{t1}/C_{t1} - B_{t0}/C_{t0}}{A_{t1}/C_{t1} - A_{t0}/C_{t0}}$$

Figure 3.2

where A_{t0} and A_{t1} are crime levels in the target area at times 0 and 1; B_{t0} and B_{t1} are crime levels in the diffusion or displacement zone at times 0 and 1; and C_{t0} and C_{t1} are crime levels in the control area at times 0 and 1.

The quotient is broken into two parts: (1) the *displacement measure*, which is the numerator shown in Figure 3.2, determines the change in crime in the displacement area relative to the change in crime in the control area over the same period; and (2) the *success measure*, which is the denominator in Figure 3.2, determines the success of the intervention, or the reduction in crime in the target area relative to the control area over the same period. The displacement measure is divided by the success measure to calculate the WDQ. First, the success measure is interpreted and a negative success measure confirms that there was in fact a decrease in crime in the target area and therefore displacement or diffusion effects may be occurring and further interpretation of the WDQ is needed. On the other hand, a positive value shows that crime increased in the target area and the WDQ should not be interpreted because displacement of crime would not theoretically be expected if crime did not decrease in the target area.

61. Bowers, Kate J. and S.D. Johnson. 2003. "Measuring the Geographical Displacement and Diffusion of Benefit Effects of Crime Prevention Activity." *Journal of Quantitative Criminology* 19: 275–301.

There are two general steps involved with interpretation of the overall WDQ value, determining if the value is positive or negative and whether it is greater or less than 1/-1. A positive WDQ indicates a diffusion of benefits to the specified displacement or diffusion area (B), which in this case is either the 500-ft or 1000-ft zone, suggesting that crime has also declined in the buffer area as a result of the intervention. A negative result would suggest displacement of crime, with crime in the specified zone increasing over the same time period. Values that are between 0 and 1/-1 indicate that the effect in the buffer zone is less than the effect that occurred in the target area. Values greater than 1 or less than -1 indicate that the effects on crime—positive and negative, respectively—in the buffer zone were greater than the effects in the target area. This method has no tests for significant change and therefore is used solely to complement the difference-in-differences analyses by suggesting whether diffusion and displacement may be occurring. Two distances, 500-ft and 1000-ft, were used to look for displacement or diffusion of benefits to determine how expansive the effects of the cameras were geographically and whether positive change becomes negative the further from the cameras.

Cost-Benefit Analysis

Cost-benefit analysis (CBA) is a useful tool for jurisdictions deciding amongst alternative technologies or procedures, as it supplies a common unit of analysis—dollars. Within a CBA framework, a jurisdiction is able to determine whether the type and amount of crime it currently experiences warrants investment in the technology or intervention designed to prevent it. This is achieved through the monetization of crime into dollars; by doing so, we can determine the cost of crimes, the cost of preventing crimes, and whether the cost of preventing crimes is less than the calculated cost of those crimes occurring.

Of the three cities in this study, only Baltimore and Chicago were included in the cost-benefit analysis.[62] The same structural break analysis and difference-in-differences modeling discussed in the impact analysis were employed for the CBA. However, instead of using crime counts as a variable, these counts were monetized before being placed in the model. Therefore, the discussion below refers to the methods used to arrive at the cost and benefit estimates rather than the modeling procedures.

Cost Collection

The crux of the costs related to employing a camera surveillance program fall within one of two categories: initial implementation costs and recurring costs. Cities should be cognizant of both costs as each can be substantial. Interviewed stakeholders in jurisdictions that had already instituted a camera program cautioned against making a commitment to such an endeavor before obtaining all of the cost information. Cities typically anticipate the startup costs to acquire and install cameras, but many jurisdictions underestimate the cost of maintaining the system, let alone the cost of monitoring and/or supervising the system if active monitoring is a part of the intended plans.

Information regarding the labor and non-labor costs of implementing and maintaining a surveillance camera network were gathered through interviews with key stakeholders in the city government and police departments, as well as through official budget records from Baltimore and Chicago. Where cost information was not available, costs reported in the extant literature were used in their stead.

For each of the two sites, similar—but not identical—cost collection procedures were implemented. Baltimore was provided with an annualized cost-collection instrument that requested information about camera model costs and number of cameras obtained, as well as costs of companion technology, such as data storage servers and view stations to access the recorded or real-time footage. Baltimore also provided information specific to the startup costs of camera implementation, including changes to the infrastructure to accommodate the electricity and networking needs of the system as well as any environmental modifications related to camera installation. In addition, recurring costs were also documented, such as the cost of rent and utilities, labor costs associated with the continued

62. The decision to focus on just two of the three study sites was driven by the limited resources available to dedicate to the cost benefit component of this evaluation. Baltimore and Chicago were selected due to their well-documented data on public surveillance system costs.

operation of the system, and the costs of maintaining the existing cameras and infrastructure repair. After receipt of the populated spreadsheet from Baltimore, which was accompanied by official city budgets as they pertain to the camera system, a follow-up meeting with stakeholders was held to review the provided information and seek clarification where needed.

While the cost spreadsheet was effective in documenting costs across time and within various categories, it proved cumbersome for Baltimore's stakeholders to complete. With this feedback in mind, a second collection instrument was designed for use by Chicago's stakeholders. Chicago received a cost collection form that was closer to a survey with respect to its style and presentation. Though different in appearance and ease of use, the Chicago instrument included all substantive areas and questions used in Baltimore's collection instrument. After reviewing the provided information, Chicago stakeholders were asked to respond to additional questions and provide clarification to reported figures where needed.

Estimating Benefits

The camera program's cost, when compared to the benefits it produces, if any, provide the framework necessary to decide whether it is cost-beneficial. A jurisdiction contemplating the implementation of a crime prevention policy or program can assess benefits in two ways. First, they can consider only the costs the jurisdiction incurs that it would not if a crime is prevented; these include the benefits from reductions in the use of law enforcement, court, and corrections resources used to investigate, prosecute, and supervise offenders whose crimes were prevented. Alternatively, they can take a more societal approach and consider the value of averted victimizations in addition to the criminal justice benefits identified above. By pursuing the latter approach, jurisdictions may find real benefits to preventing crimes where an analysis of saved criminal justice expenditures alone would not reveal these savings. The benefits in this study are evaluated using the latter approach—the savings in criminal justice costs and the savings in victimization costs from preventing crime. For each crime that is committed, there are associated costs that some entity—whether it is a person, a government, or an entire society—incurs. By calculating the total cost of crime for each offense, the calculated cost represents the benefits from employing that policy or program each time such an incident is prevented. This analysis implements a framework provided by Roman et al.,[63] an update of an approach first presented by Cohen.[64]

The estimated total cost of crime, represented by the formula below:

$$\text{Total Cost of Crime (T)} = C_i + V_i$$

Figure 3.3

has, as stated above, two main components: criminal justice costs (C) and costs to victims (V). Total cost of crime reflects the averted costs per month, which are then scaled by time (T), the number of months observed post-implementation. Criminal justice costs were calculated based on arrest (A);[65] pre-sentencing (P);[66] and incarceration (I),[67] adjusted for inflation over time. Pre-sentence costs consisted of pre-sentence detainment and adjudication; these were calculated on a per-minute basis for trial costs and an assumed mean sentence length of 40 hours for rape, 10 hours for larceny and stolen property offenses, and 20 hours for all other offenses. Following sentencing, the incarceration costs[68] were computed based on the probability of each type of sentence, the percentage of time served,

63. Roman, John K., Aaron Sundquist, and Carly R. Knight. 2008. *Cost-benefit analysis of reclaiming futures.* Washington, D.C.: The Urban Institute.

64. Cohen, Mark. 1998. The monetary value of saving a high risk youth. *Journal of Quantitative Criminology* 14: 5–33.

65. Aos, S., P. Phipps, R. Barnoski & R. Lieb. 2001. *The Comparative Costs and Benefits of Programs to Reduce Crime* (version 4.0). Olympia, Washington: Washington State Institute for Public Policy.

66. Roman, Sundquist, and Knight, "Cost-benefit," (see note 63).

67. Durose, M.R., and P.A. Langan. 2004. Felony sentences in state courts, 2002. Bureau of Justice Statistics Bulletin NCJ 1206916. Washington, D.C.: U.S. Department of Justice.; Stephan, J.J. 2004. *State prison expenditures, 2001.* (NCJ Publication No. 202949). Washington, D.C.: U.S. Department of Justice, Bureau of Justice Statistics.; Roman, John and Aaron Chalfin. 2006. *Does it pay to invest in reentry programs for jail inmates?* Washington, D.C.: The Urban Institute. www.urban.org/ReentryRoundtable/roman_chalfin.pdf.

68. These calculations were not adjusted for inflation because only the total expected cost of sentencing was provided by the authors. Therefore, the daily costs for prisons and jails could not be disentangled to allow for adjustment over time based on the year the costs were calculated.

and in which facility each type of offender would reside. State prison cost estimates utilized data provided by Stephan,[69] while jail cost estimates used figures provided by Roman and Chalfin.[70] Together, arrest, pre-sentencing and prosecution, and incarceration costs produce total criminal justice costs (C), as shown in Figure 3.4 below:

$$C = A_i + P_i + I_i$$

Figure 3.4

In calculating victim costs (V), as shown in Figure 3.5, we implemented the estimates provided by Roman,[71] in which jury awards were used as a proxy for both direct (D) and indirect (I) costs resulting from victimization. This approach accounts not only for the out-of-pocket expenses incurred by victims, but also for the pain, suffering, and fear that accompany any victimization.[72] Failing to consider these components when conducting a cost-benefit analysis risks undervaluing the costs to victims, thus underestimating benefits. The subscript *i* denotes that the total cost was calculated for each type of crime.

$$V = D_i + I_i$$

Figure 3.5

The costs attributed to the criminal justice system per offense are combined with victimization costs per offense to estimate the total cost of crime across several offense types (see Table 3.10). Estimates of the total costs to the criminal justice system for prostitution offenses were derived from Flynn et al.[73] Victim costs factor considerably into the total costs for several of the offense categories. Victim cost estimates used in this analysis are median cost estimates taken from Roman.[74]

Despite best efforts to quantify both victimization and criminal justice systems costs, inherent uncertainties exist with such estimations: the quantity of crime can be easily miscalculated due to under-reporting by victims, and some share of reported crimes are unfounded. In terms of calculating the actual dollar value associated with victimization, monetization requires placing a price tag on societal harm—factors such as pain, suffering, and fear—which vary based on the circumstances and have a high degree of inherent uncertainty. We therefore generated upperbound and lowerbound estimates using 95 percent confidence intervals around each parameter estimate (the average monthly cost) to control for the volatility in the benefits estimates (refer to Appendix F).

69. Stephan, "State prison," (see note 67).

70. Roman and Chalfin, "Does it pay," (see note 67).

71. Roman, John. 2009. "What is the price of crime? New estimates of the cost of criminal victimization." Doctoral Dissertation, University of Maryland.

72. Cohen, Mark. 1988. Pain, suffering, and jury awards: a study of the cost of crimes to victims. *Law and Society Review*. 22: 537–555.

73. Flynn, P. M., P. L. Kristiansen, J. V. Porto, and R. L. Hubbard. 1999. Costs and benefits of treatment for cocaine addiction in DATOS. *Drug and Alcohol Dependence*. 57(2): 167–174.

74. While Roman also reports mean cost estimates, using median costs appears to be the more desirable approach when conducting a cost-benefit analysis of police surveillance camera use in public places. In the context of jury awards, which is the source from which Roman arrives at his cost estimates, mean costs reflect the average jury award for a given crime. These awards can be heavily skewed, especially for serious violent crimes, and particularly for those that are sexual in nature. Median costs, on the other hand, reflect the typical award and are a more conservative estimate of any cost impact that cameras may be generating. As we have no basis to believe crimes committed in Baltimore and Chicago were particularly egregious as compared to the typical crime, we believe the median victim estimates are best-suited for this analysis; Roman, "What is the price of crime?" (see note 71).

Table 3.10: Cost of Crime, by Offense Type

	Total Cost of Crime				
Offense	Cost of Arrest[1]	Cost of Pre-Sentence and Adjudication[2]	Cost of Incarceration[3]	Victim Cost[4]	Total Cost
Murder/Non-negligent Homicide	$17,764	$15,990	$27,848	$1,375,335	$1,435,507
Rape/Sexual Assault	$17,764	$15,990	$10,994	$18,840	$62,159
Aggravated Assault	$17,764	$8,710	$6,502	$89,495	$121,042
Simple Assault	$17,764	$8,710	$5,127	$58,872	$89,043
Robbery	$17,764	$8,710	$7,236	$88,598	$120,878
Burglary	$3,627	$8,710	$1,484	$779	$13,171
Larceny/Theft	$2,675	$3,640	$888	$150	$7,353
Stolen Property Offenses	$2,675	$3,640	$888	$498	$7,701
Drug Offenses	$2,675	$8,710	$998	$38	$10,992
MV Theft	$2,675	$3,640	$1,254	$6,800	$14,369
Vandalism	$2,675	$3,640	$888	$212	$7,415
Arson	$17,764	$8,710	$5,188	$846	$31,078
Weapons	$17,764	$8,710	$5,127	$269	$30,440

Table created by the Urban Institute (2009). All dollars are calculated as 2009 dollars.

1. Aos, "The Comparative Costs," (see note 65).

2. Roman, John K., Jennifer Woodard, Adele V. Harrell, and Stacia Riggs. 1998. Relative Costs and Benefits of the Superior Court Drug Intervention Program. Washington, D.C.: The Urban Institute. www.urban.org/publications/407753.html.

3. Durose and Langan, "Felony sentence," (see note 67); Stephan, "State prison," (see note 67); Roman and Chalfin, "Does it pay," (see note 67).

4. Roman, "What is the price," (see note 71) – Median award.

In addition, all cost-benefit calculations were conducted two ways: including and excluding victimization benefits. While the former calculation acknowledges the averted societal costs associated with prevented crimes, the latter calculation provides a more relevant ratio from a local financing perspective, as any victimization cost savings that might be attributed to the camera system are not transferred to governments' budgets.

The methodology described above is repeated to some degree in the case study chapters that follow so that readers can interpret the impact and cost-benefit analysis findings in the context of the methods employed.

Chapter 4.
Baltimore, Maryland

In 2000, Martin O'Malley assumed the office of Mayor of the City of Baltimore with a pledge to bring a data-driven approach to addressing a variety of the city's challenges, chief among them the burgeoning crime rate. Indeed, Mayor O'Malley (now Governor of the State of Maryland), embraced technology and data and pledged to use both to improve the lives of residents and the economic vitality of the city. This led to the launching of CitiStat, which extended the CompStat model employed by police departments to the entire city, enforcing swift, data-driven action and accountability among the city's key decision-makers and their staff.[75]

On the heels of this successful model, which was credited with reductions in crime and cost savings,[76] O'Malley entered his second term as Mayor in 2004 seeking new technologies and innovations. On a trip to London he visited the Westminster area of the city, which was virtually saturated with surveillance cameras. He concluded that such a system could help combat the crime that had historically plagued his city. By the next year, the first elements of Baltimore's public surveillance system were in place. Using federal Homeland Security and Asset Forfeiture Funds, and with the support of the police department and the community, the Baltimore city government made a commitment to combating crime with technology.

Since its inception, the public surveillance program in Baltimore grew from a pilot project of a mere five cameras to over 500 cameras and a centralized control room enabling live monitoring 24 hours per day. While the use of cameras in Baltimore has had its skeptics, the commitment to the program by city stakeholders, and particularly the Mayor's Office, has ensured the continued existence and growth of their system. With the camera system in place, Baltimore continues to strive for perfection with new complementary technologies—such as gunshot-flash recognition and video analytics—in their sights to ensure a more efficient and effective crime-fighting tool.

Purpose of Camera Investment

Mayor O'Malley's trip to London in 2004 reinforced his belief that public surveillance technology could help both in crime prevention and crime-solving capacities. Shortly after returning, he sent a delegation of officers and city officials to London, as well as to Chicago, Illinois, and Jersey City, New Jersey, to thoroughly assess how this technology was employed.

These visits reassured the city stakeholders that cameras could be an effective complement to their crime-fighting strategy. The specific goal behind implementing public surveillance technology, however, was to target violent crime. In 2003, Baltimore experienced 11,183 violent crimes and 48,653 total crimes, ranking 7th overall in total violent crime in the United States and 28th in overall crime.[77] Public surveillance technology was viewed as a tool that could aid in the prevention, detection, and investigation of these crimes. Camera stakeholders embraced the theory that camera visibility would deter would-be offenders by increasing would-be offenders' perceptions that they are likely to be caught committing a crime if cameras are in the area. Indeed, stakeholders believed that cameras would act like a force multiplier, covering ground so that police could patrol other areas, supporting both local day-to-day police work as well as national homeland security purposes.

75. CitiStat. City of Baltimore, MD. 2004 Winner of the Innovations in American Government Award. www.innovations.harvard.edu/awards.html?id=3638.

76. Perez, Teresita and Reece Rushing. 2007. "The CitiStat Model: How Data-Driven Government Can Increase Efficiency & Effectiveness." Center for American Progress: Washington, D.C.

77. U.S. Department of Justice. Federal Bureau of Investigation. 2004. Crime in the United States, 2003: Uniform Crime Reports. Washington, D.C.: Government Printing Office. (Also available at www.fbi.gov/ucr/ucr.htm.)

Setting the Groundwork

While the Mayor was intimately involved in initiating the camera system, its actual implementation was a collective effort that brought together the police department, legal counsel, and community input. At the outset, implementers feared that the community would not embrace the camera program. Indeed, early on, residents expressed concerns that installing cameras could potentially infringe on privacy rights and that their presence could reduce property values. Open meetings and community gatherings prior to installation enabled the city to reassure residents that the cameras would be used judiciously and that their crime prevention impact could actually yield a positive effect on home values. These arguments helped win over those skeptical of the program, avoiding potential problems before they came to fruition. In addition, the city aimed to engage residents by establishing a Virtual Citizens on Patrol program, for which members of the community volunteer to be trained as camera monitors and assist in the effort.[78] Baltimore police also instituted a General Order on Electronic Surveillance Procedures governing police use of public surveillance technology. These efforts were effective in building the necessary level of buy-in of various city constituencies. With support and governance over the potential program in place, the next steps entailed obtaining estimates and securing financing for the project.

Planning and Procurement Process

The public surveillance system procurement process was launched with the release of a Request for Proposals (RFP) to prospective vendors, which occurred during the summer of 2004. The content of the RFP drew from knowledge obtained during visits to other cities in the United States, which helped guide decisions on the numbers and types of cameras in which to invest. The initial competitive bid winner was contracted to install cameras in Baltimore's downtown area. When cameras were expanded to neighborhood areas, the contract was awarded to another vendor who had a pre-existing agreement for other city projects. Initial financing was obtained through a $3 million Department of Homeland Security (DHS) grant, which covered the costs of purchasing the first set of 50 cameras in the downtown area, their installation, and a control room for their monitoring. The city has since used Asset Forfeiture Funds, money from the City's General Fund, Local Law Enforcement Block Grants, and Byrne Grants[79] to acquire additional cameras and to provide camera maintenance.

Due to rapid changes in camera technology, the city's camera investments evolved over time. The initial investment involved the procurement of five microwave cameras, which were quickly determined to be too expensive, difficult to use, and were ultimately abandoned in favor of newer technology. Portable Overt Digital Surveillance System (PODSS) cameras were the next version of cameras the city acquired. At the time they were considered cutting edge technology, but they quickly became outdated due to the fact that their stand-alone hard drives required technicians to physically remove and replace drives (often requiring the use of a bucket truck) in order to view footage.[80] In 2004, the city elected to purchase a combination of hardwired and wireless pan, tilt, zoom cameras that generally record in color during the day and in black and white in the evening. Each camera can store 30 days' worth of video, which is fed to a central hard drive for on-demand playback. This system utilizes an Internet Protocol (IP)-based platform allowing multiple users in multiple locations to have real-time access to all of the cameras connected to the network. This platform allows the police department to give specific people or agencies with access to the internet the ability to use the system and review camera footage by providing them with the proper credentials, such as a user name and password. In order to protect the integrity of the images and videos in terms of chain of custody, alteration, and non-release into the public, the city encrypts all images and videos in the system, which requires appropriate software to decrypt and view them.

78. The Virtual Citizens on Patrol program has since been disbanded due to lack of citizen interest in monitoring.

79. Local Law Enforcement Block Grants are funded by the Bureau of Justice Assistance, U.S. Department of Justice, to support local-level responses to reduce crime and improve public safety.

80. These cameras, while still in use today to a limited degree, are being phased out in preference for CCTV cameras.

Camera Specifications, Placement, and Visibility

Baltimore decision-makers were adamant about the visibility of cameras to the public, ensuring that all cameras were overt and had flashing lights and a sign advertising their presence. They believed that the prominent placement of cameras would reassure the community that the city was doing everything in its power to address the crime problem.

Keeping their goal of reducing crime (and targeting violent crime specifically) in mind, the Baltimore Police Department (BPD) placed the cameras in specific areas with the largest number of reported crimes (based on incident and arrest reports and input from district commanders). The areas under consideration for cameras had a disproportionate number of shootings, murders, assaults, and narcotics calls for service. After determining which areas needed cameras, the city conducted a block-by-block evaluation of each, assessing the feasibility of installing a camera based on access to the infrastructure and other physical environment impediments. In many cases, light poles had to be erected and trees needed to be trimmed.[81]

Since the cameras are attached to light poles and buildings in neighborhoods, they technically have the ability to see within residences. The BPD has taken necessary precautions to prohibit misuse by placing permanent black boxes within the image of such private areas to restrict viewing by users. In addition, monitors are obligated to follow the user guidelines set forth in the General Order which outlines the types of acceptable viewing and strictly prohibits recording private areas. Also, the technology allows supervisors to see who is watching each camera at any given time. These are important precautions from a civil liberties perspective and thus represent best practice in public surveillance camera usage (refer to The Constitution Project, 2007).

Once the cameras were in place, the viewshed, or visible window, for each was assessed and the camera tour patterns were set accordingly. A camera that is not being operated by a user is pre-programmed to follow a pattern that, for example, pans from left to right and zooms to areas of interest and those with high foot traffic. The cameras are set to follow this pattern and record the images 24 hours per day, or until they are taken control of by a monitor for real-time viewing. Once the monitor has finished viewing the cameras, the cameras are set back to their pre-programmed tour. Monitors reported that people on the streets became attuned to the locations of the cameras and what they thought the cameras could see, thus pushing would-be offenders out of the view of the cameras. Some commanders reported using this to their advantage by anticipating the locations where offenders would move beyond the camera's sight and assigning officers to those areas to apprehend them.

Camera Use and Monitoring

Once cameras were brought online, integrating them into the network to facilitate real-time monitoring was a priority in order to ensure that the cameras were actively monitored. Active monitoring began simultaneously with the launch of the cameras. The integrated system was designed to enable all authorized users (who are provided with login names and passwords) to access the system. These users include monitors, investigators, and command staff from the BPD. Baltimore employs two camera monitoring strategies. On the district level, each district that has cameras develops its own schedule for active monitoring (typically 20 hours of active and 4 hours of passive monitoring each day). By contrast, at the centralized CitiWatch control room, cameras in the designated downtown CitiWatch area are actively monitored around the clock.[82]

A variety of BPD staff are hired to monitor the cameras, including retired police officers, light-duty officers, and officers specifically assigned to monitoring duty. Active or retired monitors are ideally suited for such a position because of their training as patrol officers. This previous experience working in the neighborhoods has taught them where the major crime locations are, who are the persistent offenders, and how to identify subtle movements such

81. It is possible that the increased natural surveillance created by the tree trimming and greater illumination had an effect on crime in addition to the cameras; since camera erection occurred concurrent to these changes, it is not possible to disentangle the independent effect of these changes.

82. In 2009, CitiWatch became responsible for monitoring all of Baltimore's cameras. Cameras are now monitored based on crime trends and world and local events. Geography is not the only reason to view a camera at any given time.

as those associated with a drug transaction. While a civilian could be trained in some of these areas, supervisors noted that it is no substitute for the experience acquired after years on the job, which could explain why formal training of monitors is minimal and varies greatly by district. Each monitor is given a manual that outlines what activities are and are not acceptable while monitoring and details criminal background check and drug testing requirements. Most of the preparation of monitors, however, occurs during on-the-job training with some guidance from veteran monitors. In the absence of formal training, monitors employ a variety of techniques based upon their own preferred methods.

In the past two years, Baltimore has taken considerable steps to become more centralized in its monitoring, stressing that the active monitoring of cameras is a critical component to the successful use of cameras. The City has also developed and implemented a training program to further advance the skills of their camera monitors. Indeed, many stakeholders believe that without active monitoring, the city would be wasting its time and money on a public surveillance system.

Active Monitoring and Real-Time Arrests

Active monitoring consists of authorized users, such as retired police, watching and manipulating the view of a camera and radioing patrol officers to alert them of suspicious activities or crimes in progress. Active monitoring can occur at a district or centralized monitoring station.

The monitoring stations in the control rooms typically include dual-screen computer systems that are equipped with joysticks and camera system software. With large clusters of cameras in close proximity to each other in Baltimore, monitors are able to follow activity from one viewshed to the next virtually seamlessly. However, there are a few "dead zones," such as alleyways and areas with heavy foliage, where some offenders, such as drug dealers, intentionally engage in transactions in order to avoid being captured on camera.

During active monitoring, monitors are trained to identify both perpetrators in the act of committing a crime and persons engaging in suspicious behavior that might lead to a crime. When monitors observe a crime in progress, they contact patrol officers using police radios, relaying vital information including the suspect description (and potentially the vehicle description) and the direction of his or her escape from the scene. In addition, the cameras have been helpful in giving police support until backup can arrive.

One example of camera use to disrupt crimes-in-progress was the successful interruption of an attempted rape that was caught when a monitor observed a suspicious male lurking around a park. The monitor observed the man hide and then spring on a female who was walking alone, forcibly dragging her at knife-point into the nearby park, at which time the monitor radioed police in the area. The perpetrator fled when local police began arriving, but the monitor was able to track his movements, describing his attire and reporting his locations until he was apprehended.

Another noteworthy example of the impact of active monitoring was when monitors identified four males brandishing weapons in a downtown area late at night. BPD was dispatched by the monitors and as they were approaching the scene, the men fled in various directions and stashed their weapons. Monitors were able to direct police both to the locations of the perpetrators and the guns, and the footage then served as concrete evidence for their conviction.

While geared toward violent crime initially, monitors have found that the most common crimes observed by active monitoring are narcotics activities. The cameras have also been used in sting operations, during which undercover officers stage a purchase of drugs in sight of the cameras, hoping to secure a conviction with visual proof of the defendant committing a crime.

Active monitoring has also led to improvements in arrest and booking procedures that help support prosecution. One monitor observed that after arrest, suspects often claim that they are not the person on the video and, absent a clear facial recording, such individuals are released. This led the monitor to suggest that all suspects who are apprehended through the use of video be brought to the police station to be photographed in the clothes they were wearing at the time of the offense. This change in procedure has made the difference between securing a charge and releasing a perpetrator.

Active monitoring also enables monitors to become familiar with areas that experience heightened levels of criminal activity and with the individuals who are committing crimes. One monitor reported that after monitoring for a time, "you see the same faces day in and day out." Knowing the neighborhood and the daily routines of its citizens assists monitors in controlling and reducing crime. This, when coupled with the enhanced trust the police department hopes to forge with the neighborhood by showing its commitment to reducing crime and increasing safety, underscores the department's commitment to community policing.

In addition to the role of monitors, many patrol officers have embraced cameras, integrating them into their jobs. This is particularly true for the BPD bike patrol officers, who have incorporated the control center into their typical routine. For example, some of these officers use the control center to observe areas of interest, working with monitors to zoom in on suspects, and then hitting the street to make arrests. This technique is quite useful to officers because their physical presence typically disperses illegal activity, whereas the cameras enable them to view activities without detection, increasing their ability to make real-time arrests.

Passive Monitoring, Storage, and Use

In contrast to active monitoring, passive monitoring is employed for investigative, prosecution, and training purposes. For passive monitoring, the cameras can be set to view a single location or follow a viewing pattern, or "tour." The "single" setting positions a camera to record a single frame and can be changed over time to direct the viewshed toward an area of interest. The "pattern" setting programs the camera to repeatedly pan a geographic area, recording the same series of frames over time. Whether monitored passively or actively by live monitors, the video footage that is produced by cameras is often viewed after the fact to support police officers' problem solving activities, to aid in investigations and prosecutions, and to enhance training exercises.

In the city's weekly CompStat meetings, during which BPD leadership convenes precinct commanders to review crime data and maps in order to identify emerging crime trends and hot spots, commanders are asked whether there were cameras near the incidents of interest, whether the video footage was reviewed, and if any information derived from that footage might inform investigation and suppression efforts. This integration of the public surveillance system into CompStat has proved useful in highlighting district deficiencies in need of attention; footage of particular incidents, such as street robberies, is used to review the types of crimes occurring in each of the districts, underscoring the need for taking swift and directed action.

For investigative purposes, monitors or investigators review the video associated with a crime event in order to identify perpetrators as well as witnesses who may have been present when the incident took place but who are reluctant to share their knowledge with the police voluntarily. This type of evidence has been helpful to investigators in soliciting witness cooperation, which is often difficult to obtain given mistrust of police and a street norm of no "snitching" (with a threat of retribution if one does). Indeed, detectives report that the most useful aspect of public surveillance technology is using the footage as a tool in identifying witnesses who refuse to step forward and in separating truthful reports from those based on false allegations. Often when a detective suggests that they will be reviewing the video footage to corroborate a complainant's story, the complainant decides to drop the charges. In addition, video footage of unidentified individuals wanted for questioning or arrest has been played during roll call. Often officers know perpetrators or witnesses from their daily patrols and interactions and are able to alert the appropriate unit when they next encounter them on their beat. Video footage has also proved fruitful in obtaining vehicle descriptions and recovering discarded weapons after the commission of a crime.

Although there are many positive aspects of video footage, investigators noted frustration that in many instances the camera may only catch a small piece of the puzzle. Since most of the cameras cannot be constantly monitored, they are programmed to follow a set panning tour and therefore may only catch the beginning or end of the incident. For example, the investigator can see the suspects arriving at the scene, but as the camera moves to the right and away from the suspects, the incident occurs on the left and outside of the viewshed, and by the time the camera pans back, the incident is over. Investigators struggle with piecing together the footage retrospectively to provide the most complete picture possible. However, even small pieces of evidence can be useful, such as a distinctive

article of clothing. Videos of such items have been instrumental in demonstrating that a suspect was at the scene of the crime because they can aid in identification.

On the prosecutorial side, many of the same uses of camera footage from investigations are employed. In determining whether to take a case, prosecutors often review camera footage to discern whether the video can substantiate the charges; in many cases, the charges have been dismissed when it could not. Validating testimony of witnesses, both for the prosecution and the defense, has also been a valuable use of camera footage. Prosecutors believe that cameras provide an unbiased account of what happened, which is well received by jurors, because the camera cannot lie or forget incidents as time passes. In addition, having camera footage gives leverage to prosecutors in negotiating guilty pleas: a defense attorney viewing a video of a clearly identifiable client committing a crime has little recourse besides negotiating a plea.

Camera footage alone, however, does not make and seal a case; investigators and prosecutors describe it as one of many tools in their toolbox. It cannot replace traditional police work in tracking down leads, speaking with informants, or interviewing witnesses and suspects. Camera footage cannot be shown to a jury without supporting witness testimony or other physical evidence. However, it is often very persuasive, and on average prosecutors report that its integration into court room use has only marginally increased the time it takes for case preparation (adding approximately 10-30 minutes more time when using the camera footage).

In addition to routine policing, investigative, and prosecutorial functions, video footage has been used innovatively in the training and review of officers' apprehension and arrest tactics. If the technique used by the officer left him or her vulnerable or appeared overly aggressive, the video would be used to discuss the situation and how to be better prepared for a similar situation in the future.

Stakeholder Perceptions of Camera Effectiveness

Stakeholders for the Baltimore public surveillance system identified two elements as most critical in the successful use of cameras: (1) users at all levels need to buy into the technology; and (2) monitors must use the cameras proactively. If these two elements are not in place, it is unlikely there will be a significant and enduring impact on crime. Monitors, officers, commanders, investigators, and prosecutors all need to be willing to use the cameras and the video footage they produce creatively.

Police believe that cameras act as a deterrent and, while there are mixed feelings about whether or not displacement occurs as a result of the cameras, many feel that Baltimore is reaching such a point of camera saturation, that there are very few places left to which criminals can displace. Officers believe that the expansiveness of the cameras' lines of sight enable them to more intensely patrol the few areas that fall outside of camera surveillance, yielding reductions in crime there as well.

Officers also encourage looking beyond the numbers in assessing the camera program's success. The city is forging a bond with the community and they will go to whatever lengths necessary, including adopting the most advanced technologies to promote public safety. In the same vein, Baltimore soon plans to integrate this system with other helpful systems—such as working with sensor technologies to detect gunshots. When a gun is fired, the camera would pan to the source and record the scene. In addition, Baltimore has been working to incorporate the cameras into a crime mapping program to make it easier to track suspects across cameras. These strategies, along with the development of innovative approaches in utilizing CompStat, represent some of the many ways in which Baltimore is striving to develop new technologies and use existing ones in new ways to enhance public safety and the communities' perception of it.

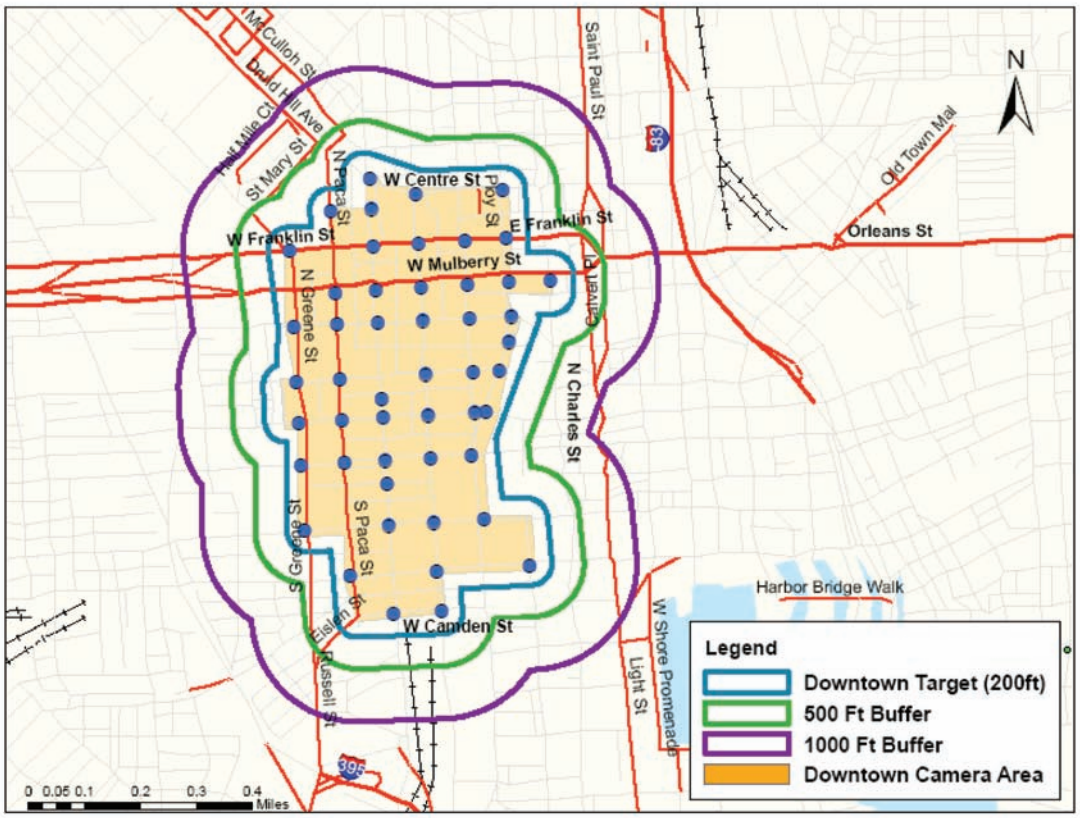
Many camera stakeholders also believe that the presence of the cameras makes citizens feel safer. Whereas initially, residents were resistant in accepting cameras in their communities, today the police report that residents in areas without cameras are lobbying to get them. Currently, there are so many requests for cameras that the police department does not have enough funding available to place them in all of the desired areas. One officer noted that the

presence of cameras indicates that the police have a stake in residents' safety, which makes community members feel more empowered to do their part in keeping the community safe, such as reporting crimes.

Camera Impact Analysis

In the City of Baltimore, UI researchers selected four areas for the impact evaluation component of the study: Downtown area, Greenmount area, North Avenue area, and Tri-District area. The BPD provided camera locations and installation dates for all cameras installed throughout the city in 2005 and 2006. Using those locations, UI researchers drew a polygon around each cluster of cameras and expanded the "treatment area" to be within 200 feet of that polygon. Each target area contained a cluster of approximately 30 or more cameras, which were typically located within a neighborhood that also contained a central commercial strip. For more details regarding the selection of the study area, refer to the *Research Design and Methods* section.

The BPD provided crime-related data for the period of January 2003 through April 2008 for the entire City of Baltimore. Our analyses examined seven crime categories: all crime, violent crime, inside larceny (thefts occurring inside businesses), outside larceny (thefts occurring in open spaces), motor vehicle theft, burglary, and robbery. Rare-event crime categories, such as arson, were not included in the analyses due to their low base rate. Within each of the four areas, we tested for statistically significant changes in average monthly crime counts within: (1) the target area of the camera; (2) buffer zones of 500 feet; (3) buffer zones of 1000 feet; and (4) a matched comparison



Note: No comparison site available for the Downtown Baltimore Area.
Source: The Urban Institute.

Figure 4.1: Map of Downtown Baltimore, Treatment and Buffer Areas

area selected due to similarities in land use, historical crime rates, and socio-economic measures to the target area, with the exception of Downtown. A description of each site in Baltimore, and the crime trends and analytic results in these areas are presented below.

Downtown Baltimore Area

The Downtown Baltimore area includes more than 50 city blocks and ranges from Center Street to Camden Street and from Greene Street to Cathedral Street (see Figure 4.1), with a camera in nearly every intersection. This area differs from the rest of the Baltimore camera sites in that it is the largest portion of the city covered by cameras and is primarily a commercial area, comprised of businesses, financial institutions, and retail services. More than 50 cameras were installed to blanket the hub of the city in May 2005, all of which are included in this study. The area closest to the pier, referred to as the Downtown Extension, was not included in the evaluation because the cameras there were not installed until September 2007.

Given the unique nature of the Downtown Baltimore area and the historical crime trends that occurred there, we determined that it was not feasible to identify a similar geographic area of the city that did not have cameras for comparison purposes.[83]

Crime Trends Before and After Camera Installation

On average, larceny was the most common crime occurring in the Downtown Baltimore area, representing more than half (65 percent) of the total number of crimes committed each month. Outside larcenies accounted for approximately ten more incidents per month than larcenies occurring inside businesses and other enclosed spaces. The majority of crime in Downtown Baltimore falls into the property crime category accounting for approximately 80 percent of the total crime in the area (see Table 4.1). Nearly one-fifth (17 percent) of reported incidents was violent in nature.

Table 4.1: Quarterly Crime Counts in Downtown Baltimore by Crime Type and Area

	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2†	Q3	Q4
Property Crime												
Treatment	234	232	207	234	288	271	252	237	271	285	233	192
Comparison	-	-	-	-	-	-	-	-	-	-	-	-
Violent Crime												
Treatment	47	61	61	50	35	59	49	49	44	37	73	37
Comparison	-	-	-	-	-	-	-	-	-	-	-	-
Total Crime*												
Treatment	281	293	268	284	368	399	346	318	354	363	352	261
Comparison	-	-	-	-	-	-	-	-	-	-	-	-

Source: The Urban Institute

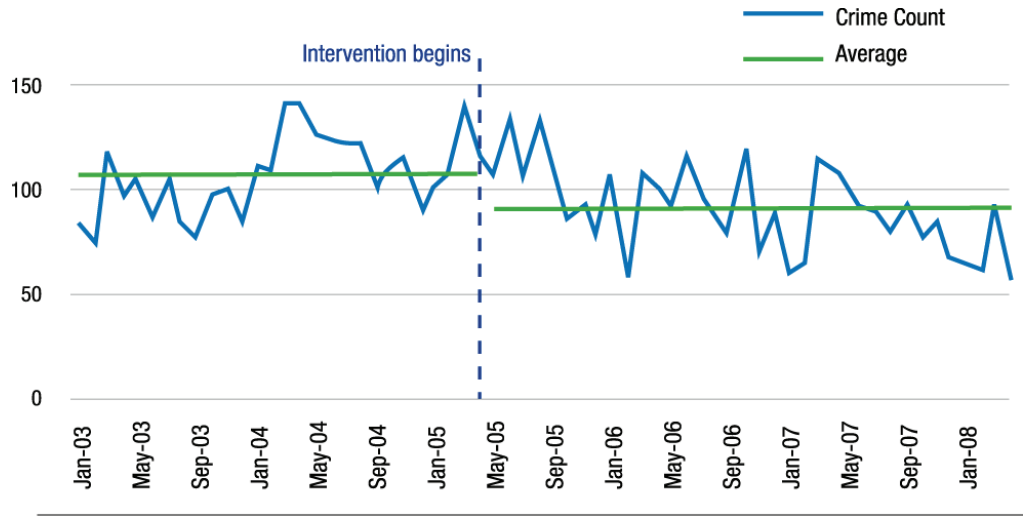
†Intervention date occurred during this quarter in May 2005.

*The sum of property and violent crime does not equal total crime. Total crime includes additional crime types that were not included in either of those crime categories, such as other sex offenses and common assault.

Note: Violent crime included the following offenses: murder, rape, robbery, and aggravated assault. Property crime included the following offenses: burglary, larceny, motor vehicle theft, and arson. Downtown Baltimore area did not have a control area.

Prior to the installation of cameras in 2003 and 2004, crime was following a seasonal pattern, with summer months having the highest frequency of crimes and winter months the lowest. As shown in Figure 4.2, crime in 2004 was much higher than in 2003 for similar months. The Downtown Baltimore area experienced one of its highest peaks in in March 2005, totaling nearly one and a half times the average number of incidents. After camera installation, the monthly average of crime dropped by more than ten incidents per month. Figure 4.2 shows that this drop does

83. Southeast of the camera area was the only potential comparison location that included major commercial land use, but because cameras were installed in 2007 as part of the Downtown Extension, we were unable to conduct testing that required the use of a control group.



Note: The intervention line displayed above for Downtown Baltimore corresponds with May 2005.

Source: The Urban Institute.

Figure 4.2. Crime Trend in Downtown Baltimore, 2003–2008

not appear until approximately three months following camera deployment. By the beginning of 2008, this decrease stabilizes, with the frequency in March 2008 totaling nearly 30 incidents less than in March 2007 and the frequency in April 2008 being half of the number of incidents in April 2007.

Statistical Analysis Results

Our analytic approach for the Downtown Baltimore area differed from that of other Baltimore camera areas included in the study due to the fact that no suitable comparison area exists for the Downtown Baltimore area, given its unique land use, demographics, and historical crime rates. Without a means to introduce a comparison area, we were unable to employ *Difference-in-Differences* analyses. Instead, analysts conducted a form of *Time Series Analysis* known as *Structural Break Analysis* to ascertain when crime significantly declined and what crime types were impacted by the cameras. With structural break analysis, a precise intervention date is not necessary because the method tests for the optimal set of break points in the series of monthly crime data and then aligns those with camera installation activities. This method was viewed as desirable due to the period of time it typically takes for new interventions to be fully implemented by law enforcement staff. In the case of public surveillance systems, for example, while the implementation of cameras may not be incremental, the training of monitors and integration of camera use into policing practices likely is.

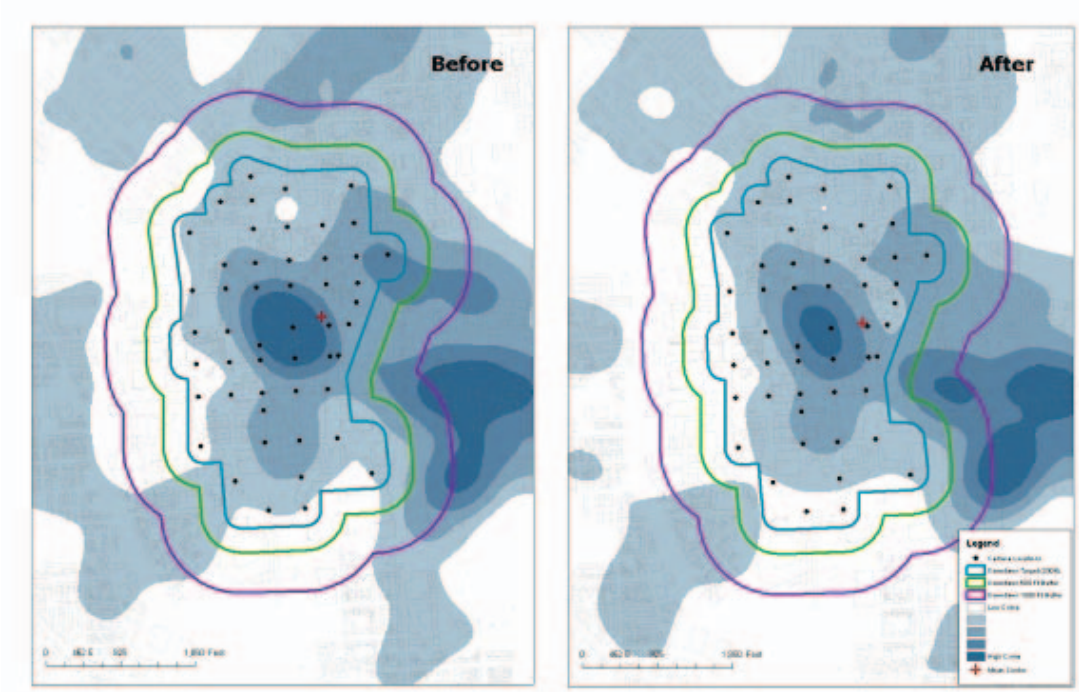
*Table 4.2: Significant Changes in Crime, Downtown Baltimore**

Crime	Time from Installation	Pre-Shift Mean	Post-Shift Mean	%Change
Larceny Inside†	3 months	36.79	25.03	-31.97%
Larceny Outside†	11 months	41.47	27.13	-34.58%
Violent†	6 months	21.17	16.36	-22.72%
Total†	**4 months**	**119.05**	**89.47**	**-24.85%**
1000-ft Buffer†	5 months	82.83	58.38	-29.52%

Source: The Urban Institute

*First set of cameras were installed in early May 2005; therefore, the intervention point was determined to be May 2005. The downtown extension cameras were not included in this analysis.

†Significant at p<.05.



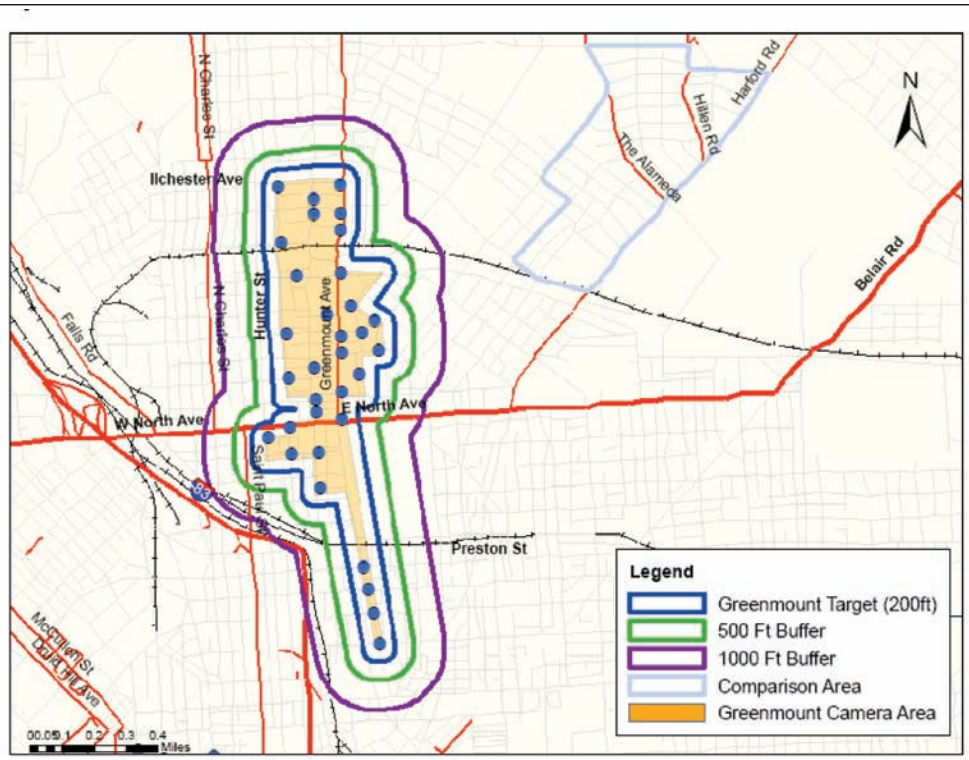
Note: The parameters used to generate the maps were kept consistent between each map above to allow for visual comparison between the two time periods.
Source: The Urban Institute.

Figure 4.3: Change in Density and Mean Center of Crime: Downtown Baltimore

Results of the structural break analysis spanning from January 2003 through April 2008 revealed a significant decline in total crime, violent crime, and both inside and outside larcenies in the Downtown Baltimore area following camera installation. These reductions occurred along with evidence of diffusion of benefits at the 1000-ft buffer for total crime, and no significant evidence of displacement into surrounding areas. However, these significant changes in crime occurred at different points in the evaluation period, with outside larceny declining nearly a year after installation. Therefore, the positive result for outside larceny is difficult to attribute to the cameras in the absence of a documented change in the manner in which BPD employed cameras for crime control and prevention purposes.

As depicted in Table 4.2, the average monthly crime counts for total crime, violent crime, and inside larcenies occurring in the Downtown Baltimore area declined within the six months following camera installation. Notably, all crime in camera target areas within the downtown area declined by nearly 25 percent—or roughly 30 fewer incidents per month—beginning in the fourth month following camera installation, which is consistent with initial observations depicted in Table 4.2. This time lag of four months is consistent with interviews with BPD staff indicating that most of the training of monitors and patrol officers occurred following the May 2005 camera installation and that by the fall of 2005 the cameras were being used proactively by both parties. Significant declines in crime counts were also observed for violent crimes and inside larcenies, which include auto break-ins. More specifically, these findings indicate that camera use resulted in an average of five fewer violent incidents per month and 12 fewer inside larcenies per month.

One noteworthy factor regarding the time series results is that there was also a significant break prior to camera installation at the end of 2003. This shift in crime may indicate that crime was unusually high in 2004 and may have naturally dropped over time due to regression to the mean. On the other hand, if crime was unusually low in 2003 due to police activity or other circumstances, this may have suppressed the magnitude of the camera impact. Overall, following camera installation at the fourth month break, the mean number of incidents was approximately five fewer per month than the average in 2003.



Note: Cameras included in the map were installed in August 2008.

Source: The Urban Institute.

Figure 4.4: Map of Greenmount Area, Baltimore: Treatment, Comparison, and Buffer Areas

Diffusion and Displacement

Our analyses also explored the possibility that cameras produced a "halo effect," or diffusion of benefits in areas immediately adjacent to the camera target areas but beyond the cameras' viewsheds (see Figure 4.1). We defined areas of potential diffusion by creating 500-ft and 1000-ft buffers around the camera target areas. We also sought to identify signs of spatial displacement, whereby any crime that is reduced by the presence of cameras simply shifts to nearby areas. These same areas that were used to look for signs of diffusion were also tested for spatial displacement effects. Although both zones had the potential for either diffusion or displacement, we hypothesized that if change were to occur, diffusion would likely take place at 500 feet and displacement at 1000 feet. Our time series analyses found no evidence of displacement or diffusion of benefits in the 500-ft buffer area (see Table 4.2). However, in the case of total aggregated crime we did observe a significant decrease in incidents within 1000 feet of the cameras. In the absence of a comparison zone, however, we cannot determine whether the decline in all crime in the 1000-ft buffer zone is a result of diffusion of benefits or reflects the introduction of several cameras in September 2007.[84]

For descriptive purposes, density maps were created to depict the geographic movement of crime within the treatment area. The previous analytic techniques required artificial boundaries to be drawn as shown in Figure 4.3. This did not allow us to determine if crime was moving to new areas within the target area or outside of the camera's viewshed, rather than being prevented altogether.

In Figure 4.3, the deepest colored areas represent the areas with the most crime. The center of the downtown camera area has the most crime and compared to before cameras were placed, the hot spot of crime has diminished and covers a smaller portion of the city. The second hot spot located just East of the target area is the location of the downtown extension camera deployment and as you can see, that area is a prime candidate with high crime

84. The Weighted Displacement Quotient (WDQ) employed with the other camera areas could not be calculated for downtown CitiWatch area due to its lack of a comparison area.

spanning several city blocks. Due North of that area is another higher crime area where the higher level of crime completely vanished following deployment of public surveillance. The mean center shifted very slightly between the two time periods, with a shift of less than one city block. This finding suggests that although crime is diminishing in the area, it is not geographically shifting; in other words, the cameras are not displacing crime and rather the reduction is real.

Greenmount Area

The Greenmount camera area is found along Greenmount Avenue, northeast of the Baltimore city center. This area includes approximately 30 cameras placed in intersections along Greenmount Avenue and within two blocks east and west of that thoroughfare. The area extends from Ilchester Avenue to East Federal Street and from Hunter Street to Homewood Avenue. In addition to the general cluster of cameras (see Figure 4.4), four cameras were located just south of Preston Street along Greenmount Avenue. Unlike the downtown area, Greenmount is a residential location that is flanked by commercial strips along the northern and western edges. North Avenue, which runs through the target area from east to west, is also a mix of residential and commercial land. A major interstate (I-83) is located along the southwest portion of the site, but only slightly enters the outer most buffer zone.

Selecting matched comparison areas in Baltimore was particularly difficult given that most of the areas that are high in crime, have high levels of socio-economic disadvantage, and have a mix of commercial and residential land use are also locations where cameras are deployed. In addition to these challenges, we needed to ensure that control sites were several blocks distant from both the target areas and other locations in the city that contained cameras. Given all these parameters, the comparison area that most closely matched Greenmount was located east and slightly north of the camera area (see Figure 4.4). The majority of the area is residential, with retail businesses along the eastern border (Harford Road), on the southern side, and scattered throughout the area. Directly across from the site on the eastern side was a large high school and recreational park.

Crime Trends Before and After Camera Installation

The top three types of crime occurring in the Greenmount area during the evaluation period were violent crime, outside larceny, and burglary, respectively. Violent crime accounted for approximately 38 percent of total reported crime each month (see Table 4.3). Another fifth of the incidents in the area were outside larcenies.

Table 4.3: Quarterly Crime Counts in Greenmount, by Crime Type and Area

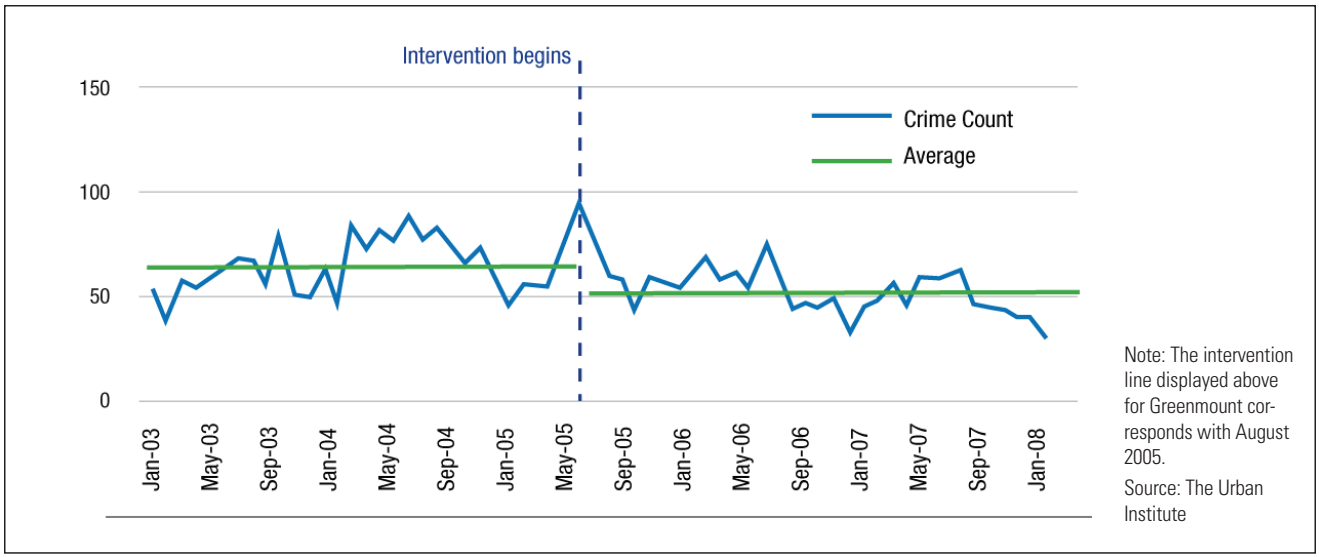
	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Property Crime												
Treatment	96	108	110	121	99	97	136	107	80	80	112	83
Comparison	43	65	69	62	77	67	58	66	62	61	45	34
Violent Crime												
Treatment	48	61	75	56	43	74	66	70	43	60	65	38
Comparison	30	39	48	30	44	48	41	30	34	29	28	26
Total Crime*												
Treatment	144	169	185	177	192	230	245	212	158	178	225	156
Comparison	73	104	117	92	162	158	148	124	117	129	102	88

Source: The Urban Institute

†Intervention date occurred during this quarter in August 2005.

*The sum of property and violent crime does not equal total crime. Total crime includes additional crime types that were not included in either of those crime categories, such as other sex offenses and common assault.

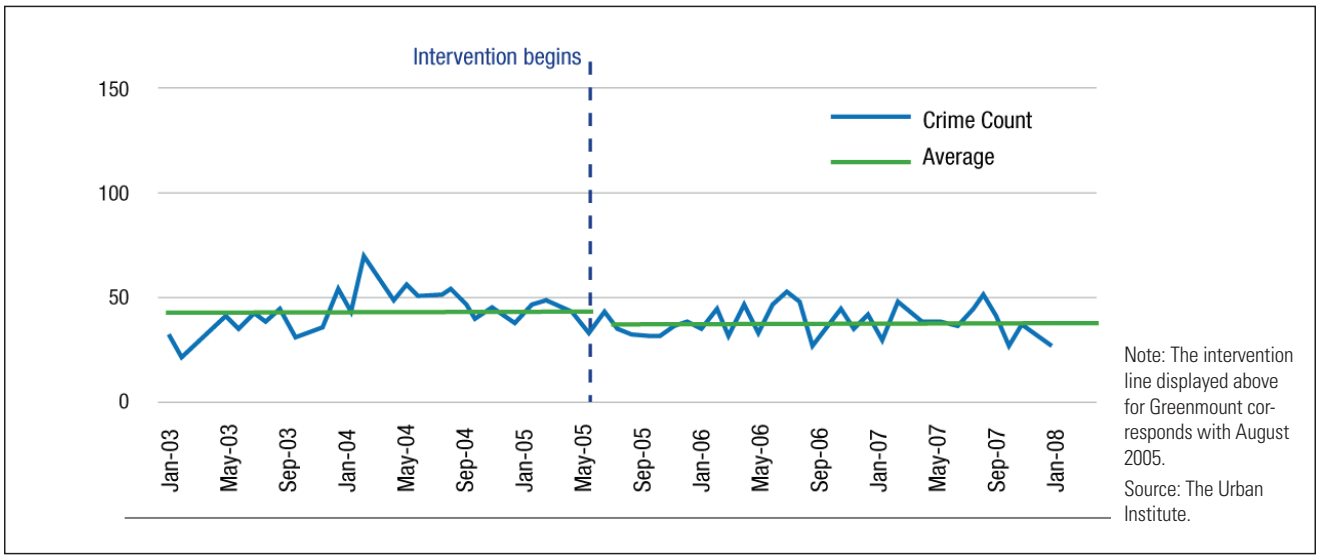
Note: Violent crime included the following offenses: murder, rape, robbery, and aggravated assault. Property crime included the following offenses: burglary, larceny, motor vehicle theft, and arson.



Note: The intervention line displayed above for Greenmount corresponds with August 2005.

Source: The Urban Institute

Figure 4.5: Crime Trend in Greenmount Area, Baltimore, 2003–2008



Note: The intervention line displayed above for Greenmount corresponds with August 2005.

Source: The Urban Institute.

Figure 4.6: Crime Trend in Comparison Area for Greenmount, Baltimore, 2003–2008

In Greenmount, the highest peaks in crime occurred in the summer months of June, July, and August each year, with February typically having the fewest number of crime incidents. As shown in Figure 4.5, there are several periods in the series where there is minimal fluctuation in crime. For example, between the months of March and October in 2004, the number of incidents per month was consistently in the high seventies and eighties. Following the intervention in August 2005, which occurred directly after the largest spike in the series, reported crime dropped over time and reached its lowest levels in early 2008. Crime patterns in the comparison area followed a similar trend up through the time of camera implementation (see Figure 4.6). However, post-implementation Greenmount experienced a 20 percent reduction in crime after camera installation while the comparison area experienced no discernable reductions in crime. Table 4.3 shows the quarterly crime trends for Greenmount and its comparison area for the periods leading up to—and the six months following—camera installation.

Statistical Analysis Results

We first explored changes in monthly crime means before and after camera installation by employing independent samples T-tests, using a pre-intervention period of January 2003 through July 2005 and a post-intervention period of August 2005 through April 2008.[85] The analyses revealed that total crime, outside larceny, motor vehicle theft, and robbery all significantly declined at $p<.05$. Inside larceny followed close behind and would have represented a statistically significant reduction of 22 percent had we loosened our cut off to $p < .10$. To further investigate these findings, we introduced a nearby comparison area as a means for controlling for other factors that may be influencing the crime rate. Employing difference-in-differences (DiD) analyses to ascertain what portion of the Greenmount crime decline could be attributed to the public surveillance system, the means were compared with changes in crime in the comparison site. Because the comparison area was chosen for its similarity to the treatment area on a variety of factors, it offers a reasonable counterfactual of what would have occurred without the camera deployment.

*Table 4.4: Significant Changes in Crime, Greenmount Area, Baltimore**

Crime Type	Area	Before	After	Change	Difference-in-Differences
All Crime	Treatment	64.00	50.76	-13.24	
	Comparison	40.42	35.39	-5.03	-8.22†

Source: The Urban Institute

*Camera installation occurred in early August 2005; therefore, the intervention point was determined to be August 2005.

†Significant at $p<.05$.

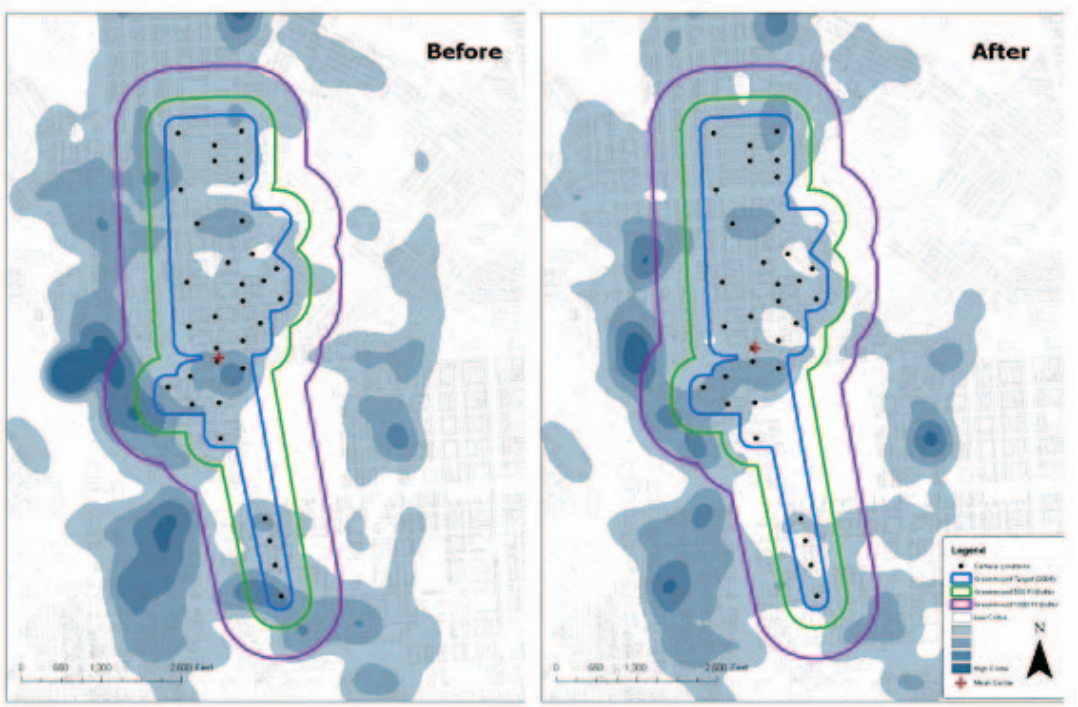
Results from the DiD analyses indicate a significant decline in all aggregated crime in the Greenmount area of Baltimore following camera installation. Evidence of a significant decline by more than 20 percent was found for total crime in Greenmount representing an average decline of 8 fewer incidents per month following camera implementation (see Table 4.4).

Diffusion and Displacement

While the crime declines detected through both T-tests and DiD analyses are promising, they do not tell the entire story, in that crime may have either displaced to adjacent areas or declined in areas not directly covered by camera surveillance. As a first test of displacement and diffusion, we produced the following kernel density maps depicting the movement of crime before and after cameras were implemented in Greenmount. The level of crime was displayed on a spectrum of blue with the deeper colors indicating higher crime compared to other levels in the area. The lighter blue and white represent the lowest levels of crime within a half mile of the Greenmount camera area. These maps show the concentration of crime on the southern portion of the target area, where four cameras are located, decreasing after camera installation, with the high crime spots in the northern and most southern camera areas reducing to lower levels of crime. The small hot spot near the mean center also diminished, and overall there is more white space in the target area showing that crime is declining. The size of the high-crime area that diminished on the western border and was partially contained by the 1000-ft buffer was cut in half in terms of its size. The mean center shifted approximately a half block north following deployment of public surveillance cameras and represents an overall very small amount of movement of crime; thus the bulk of crime was not displaced. These maps, while entirely descriptive in nature, nonetheless suggest a diffusion of benefits with little signs of displacement.

In order to increase the rigor in testing for diffusion and displacement, we employed two additional analytic methods, the Weighted Displacement Quotient (WDQ) and DiD analysis. The statistics generated by the WDQ produce a "success measure" to determine if there is an impact in the target area and if so, the WDQ generates estimates indicating the degree to which crime was displaced in the immediate vicinity of the target areas and into either of the buffers. A positive impact in the target area is represented by a negative value for the success measure, meaning crime was reduced in the camera area. An overall WDQ that is less than one and positive is interpreted as showing signs of diffusion of benefits that are less than the direct effects of the intervention in the target area. Negative

85. The intervention date was set to August 2005, the date on which the cameras were initially installed in the neighborhood.



Note: The parameters used to generate the maps were kept consistent between each map above to allow for visual comparison between the two time periods.
Source: The Urban Institute.

Figure 4.7: Change in Density and Mean Center of Crime: Greenmount Area, Baltimore

WDQ results represent displacement effects. These quotients were calculated over varying lengths of time pre- and post-implementation and by crime type. We chose to use three lengths of time (i.e., 12, 18, and 24 months pre- and post- camera installation) for each crime category that was found to be significant in the DiD analyses above.

Table 4.5: Weighted Displacement Quotient Results, Greenmount Area, Baltimore

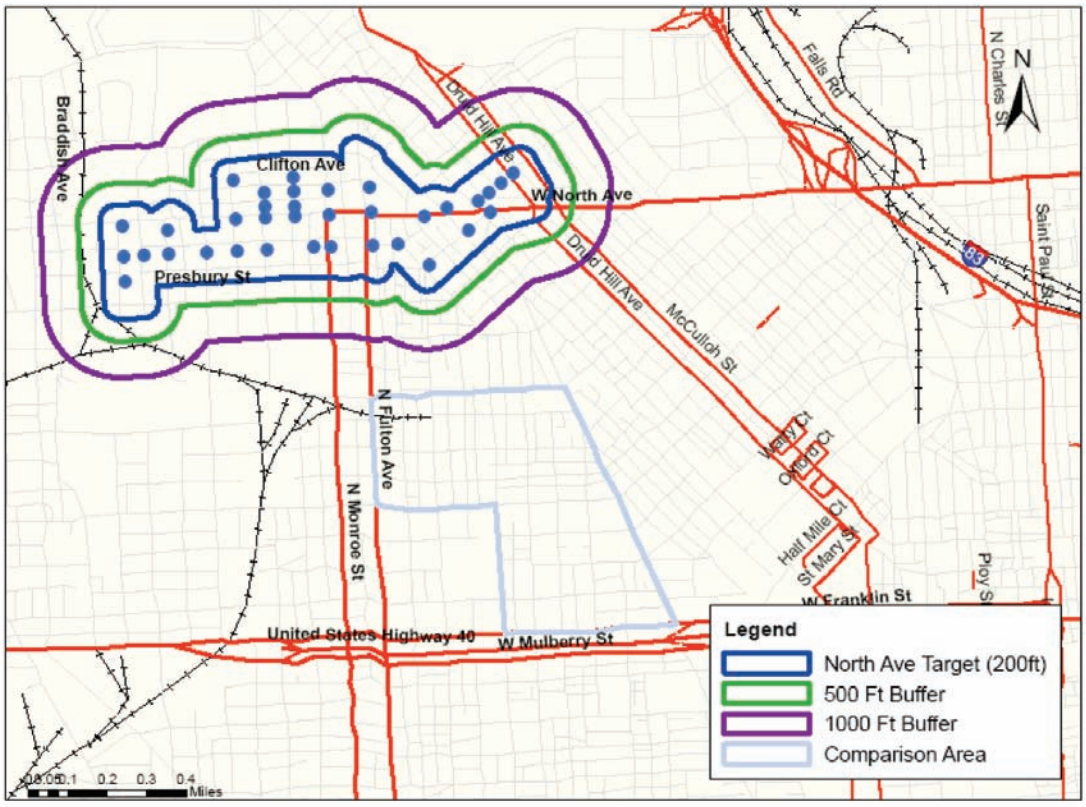
					WDQ	
Pre/post length	**Type of crime**	**t_0**	**t_1**	**Success measure**	**500'**	**1000'**
12 mo.	All	08/2004-07/2005	08/2005-07/2006	0.11	-	-
18 mo.	All	02/2004-07/2005	08/2005-01/2007	0.01	-	-
24 mo.	All	08/2003-07/2005	08/2005-07/2007	-0.07	0.88	0.01

Source: The Urban Institute

*Camera installation occurred in early August 2005; therefore, the intervention point was determined to be August 2005.

As illustrated in Table 4.5, WDQ results confirmed the DiD evidence of success for total crime in the target area, with the success measure showing positive change after 24 months of implementation (-0.07).[86] A diffusion of benefits was also evident in both of the 500 and 1000 feet buffers (0.88 and 0.01, respectively). In summary, total crime was reduced both in the Greenmount target area following 24 months of installation as well as in areas as far as 1000 feet from the target area. The impact in the 500- and 1000-ft buffers was not as extensive as that in the target area and there were no signs of displacement in either zone.

86. Success measures at 12 months and 18 months were positive, indicating no change in the target area during those time periods. When the success measure is positive, the WDQ results are no longer relevant because we do not theoretically expect crime to be displaced if there was no significant change in the target area.



Note: Cameras included in the map were installed in August 2008.
Source: The Urban Institute

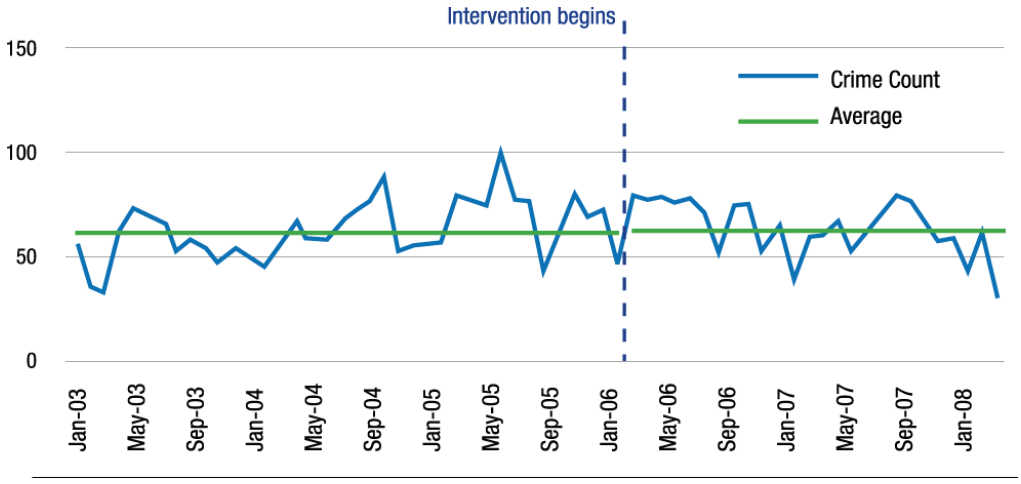
Figure 4.8: Map of North Avenue Area, Baltimore: Treatment, Comparison, and Buffer Areas

The DiD results mirrored the findings generated from WDQ in terms of a decline in crime in the buffer areas, but these declines were not found to be statistically significant at $p < .05$. While the DiD analysis confirms the absence of displacement associated with camera implementation, the evidence of diffusion of benefits is tenuous at best.

North Avenue Area

The North Avenue area is located northwest of Downtown Baltimore. It contains more than 30 cameras along the North Avenue (Route 1) strip (see Figure 4.8). This site is primarily residential, with small pockets of commercial areas consisting mainly of restaurants and a few retail establishments. It is sandwiched between several schools, including Coppin State University, and contains a large park. Given that North Avenue is one of the major routes in the area several public transportation stops are located throughout the area, including both bus stops and train stations within and in the direct vicinity of the target area.

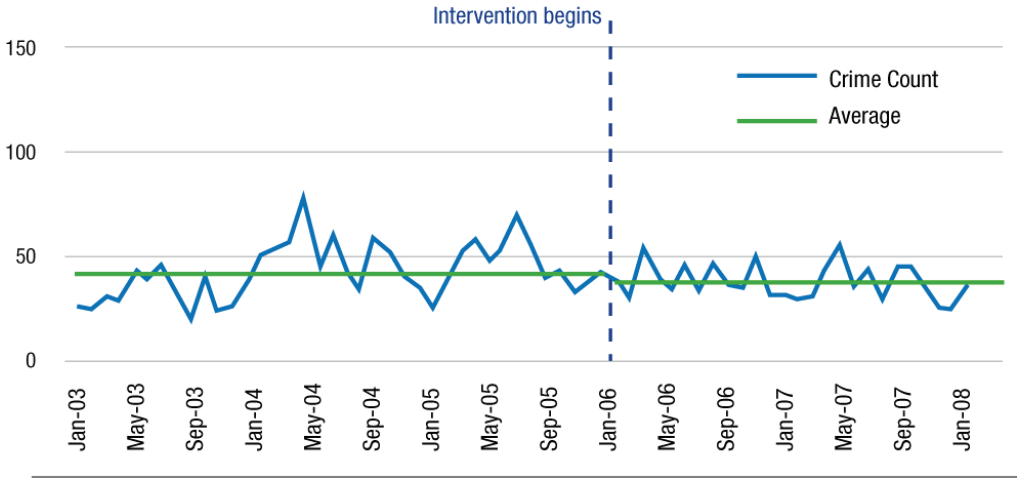
The comparison area for North Avenue extends from Lauren Street to West Franklin Street, and from North Fulton Avenue to North Fremont Avenue (see Figure 4.8). It is located just south of the target area. It is a residential area with an abundance of churches and schools and includes Lafayette Square. This area is bordered by major thoroughfares on all sides, including the continuation of Route 1 on the western side and Route 40 on the southern border. The large Harlem Park school and recreational area was not included in the analyses, with the boundaries intentionally drawn outside of that property.



Note: The intervention line displayed above in the target area for North Avenue corresponds with March 2006.

Source: The Urban Institute.

Figure 4.9: Crime Trend in North Avenue Area, Baltimore, 2003–2008



Note: The intervention line displayed above in the target area for North Avenue corresponds with March 2006.

Source: The Urban Institute.

Figure 4.10: Crime Trend in Comparison Area for North Avenue Area, Baltimore, 2003–2008

Crime Trends Before and After Camera Installation

The top reported crimes in the North Avenue area during the evaluation period were violent crime, burglary, and robbery. Combined, these three crime types accounted for nearly 70 percent of the reported incidents each month. As shown in Figure 4.10, crime levels were relatively constant over time, both before and following the intervention, with the exception of June 2005—eight months prior to camera installation—during which the area experienced the highest volume of crime—nearly double the monthly average for the area. Table 4.6 shows the quarterly crime trends for North Avenue and its comparison area for the periods leading up to camera installation. As shown in Figure 4.9, following camera implementation in March 2006, the overall average number of crimes per month increased slightly but not meaningfully. Indeed, crime trends in the comparison area were similar to that in the North Avenue area, declining slightly shortly after cameras were installed in North Avenue (see Figure 4.10).

Table 4.6: Quarterly Crime Counts in North Avenue, by Crime Type and Area

	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Property Crime												
Treatment	80	122	106	102	60	78	94	83	81	89	79	103
Comparison	63	66	63	58	66	85	62	81	38	68	91	50
Violent Crime												
Treatment	48	83	70	53	51	56	60	72	55	97	73	62
Comparison	26	49	41	39	35	54	38	39	36	42	50	39
Total Crime*												
Treatment	128	205	176	155	149	186	212	197	191	252	196	210
Comparison	89	115	104	97	145	181	141	154	103	160	179	120

Source: The Urban Institute

Note: Intervention date occurred in March 2006.

*The sum of property and violent crime does not equal total crime. Total crime includes additional crime types that were not included in either of those crime categories, such as other sex offenses and common assault.

Note: Violent crime included the following offenses: murder, rape, robbery, and aggravated assault. Property crime included the following offenses: burglary, larceny, motor vehicle theft, and arson.

Statistical Analysis Results

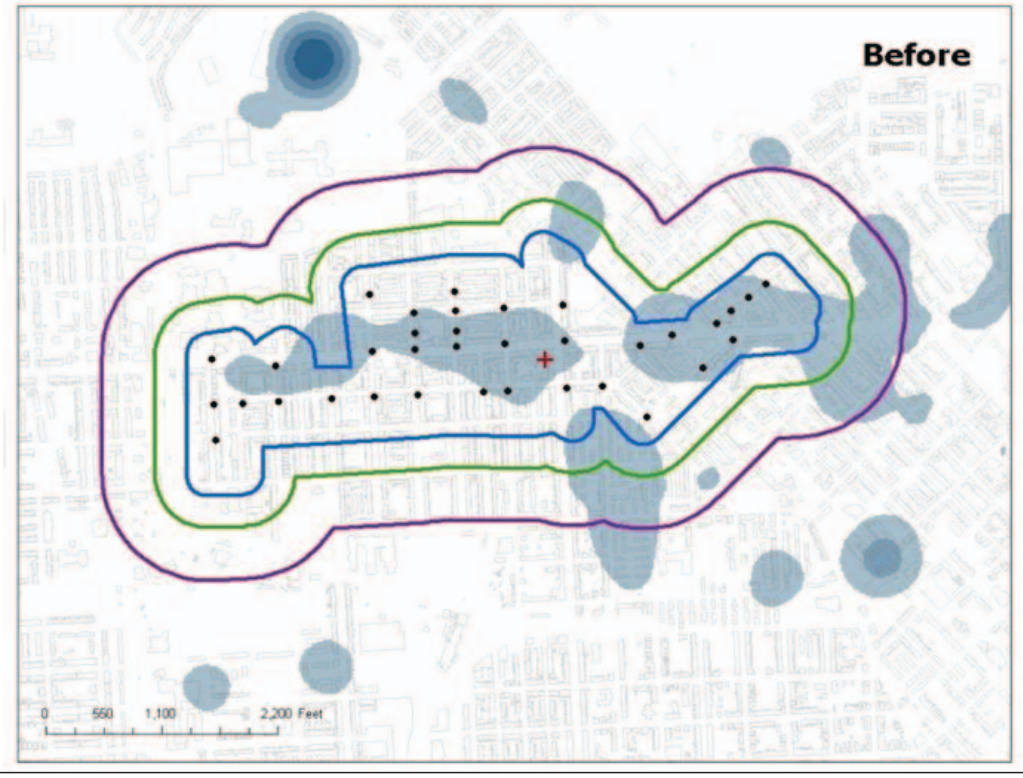
Kernel density maps were generated to visualize if crime was moving within the camera target area regardless of whether it was significantly reduced. The shades of blue represent the amount of crime, with darker shades indicating higher levels crime (see Figure 4.11). The densest area of crime that was located in the center and Eastern side of the target area and the main areas with the highest amount of crime are located outside of the target area prior to installation of the public surveillance system. Following the intervention, crime appears to have increased in the area with the white space between the two large areas of crime experiencing a higher level of crime. A hot spot is beginning to develop near one of the cameras in the Eastern portion of the target area. However, the mean center barely shifted between the two time periods, showing that the bulk of the crime remained in the same area and was not displaced to an area beyond the cameras. These findings may represent an increased detection of crime, thus should be interpreted in conjunction with the more rigorous impact and spatial analysis results.

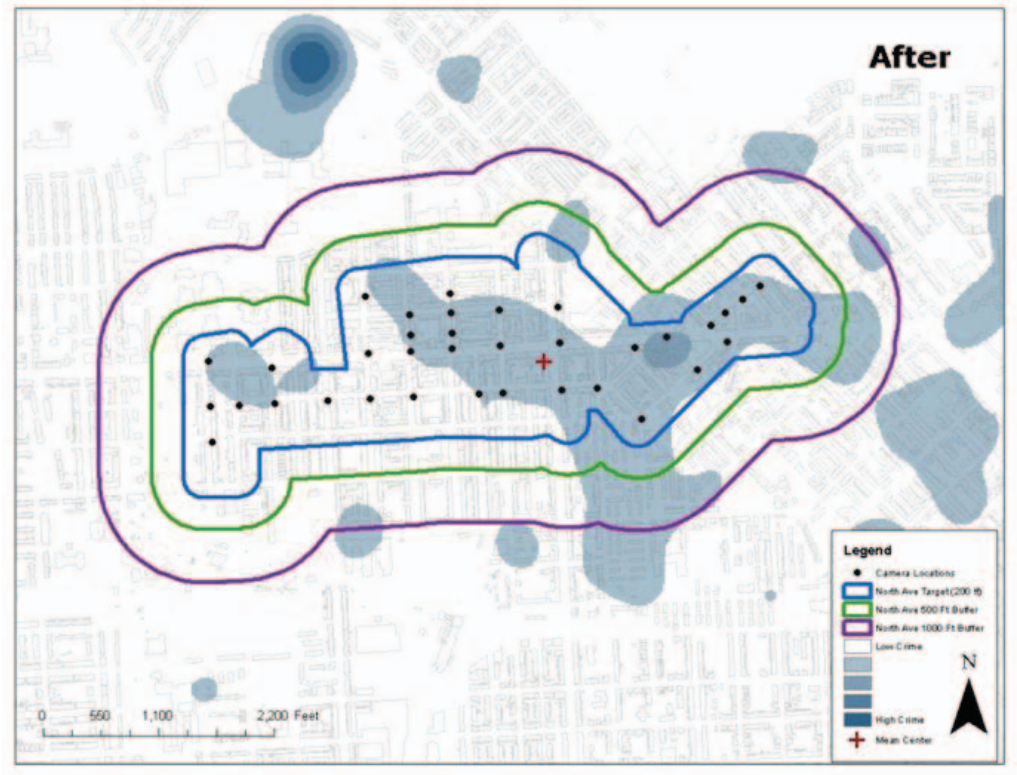
When examining changes in monthly means across a variety of crime types before and after camera installation using independent samples T-tests, no significant changes in any of the crime categories were detected, including total aggregated crime. We then conducted additional analyses employing a comparison area to control for other factors that may be influencing the crime rate. The DiD analysis[87] confirmed the T-test findings of no significant changes in the North Avenue area over the evaluation period (refer to Appendix E for detailed findings). Given that absence of a reduction of crime in the treatment area, we did not conduct tests for diffusion of benefits or displacement in the North Avenue area.

Tri-District Area

The Tri-District camera area is located west of downtown Baltimore and south of the North Avenue site, extending from Lemmon Street to Wilkens Avenue and from Furrow Street to South Norris Street, with South Fulton Avenue and South Monroe Street dividing the area through the middle (see Figure 4.12). The area is residential with several restaurants, churches, and small retail businesses on the western side and others interspersed throughout. The housing in the area is mainly row house style, with a strip of homes lining the edges of each city block. Just south of the area is a large public garden and recreational space. Tri-District represents the smallest camera area geographically and contains slightly less than 30 cameras.

87. The timeframe employed for DiD was identical to that employed for T-test: January 2003 through April 2008 with an intervention date set to March 2006.

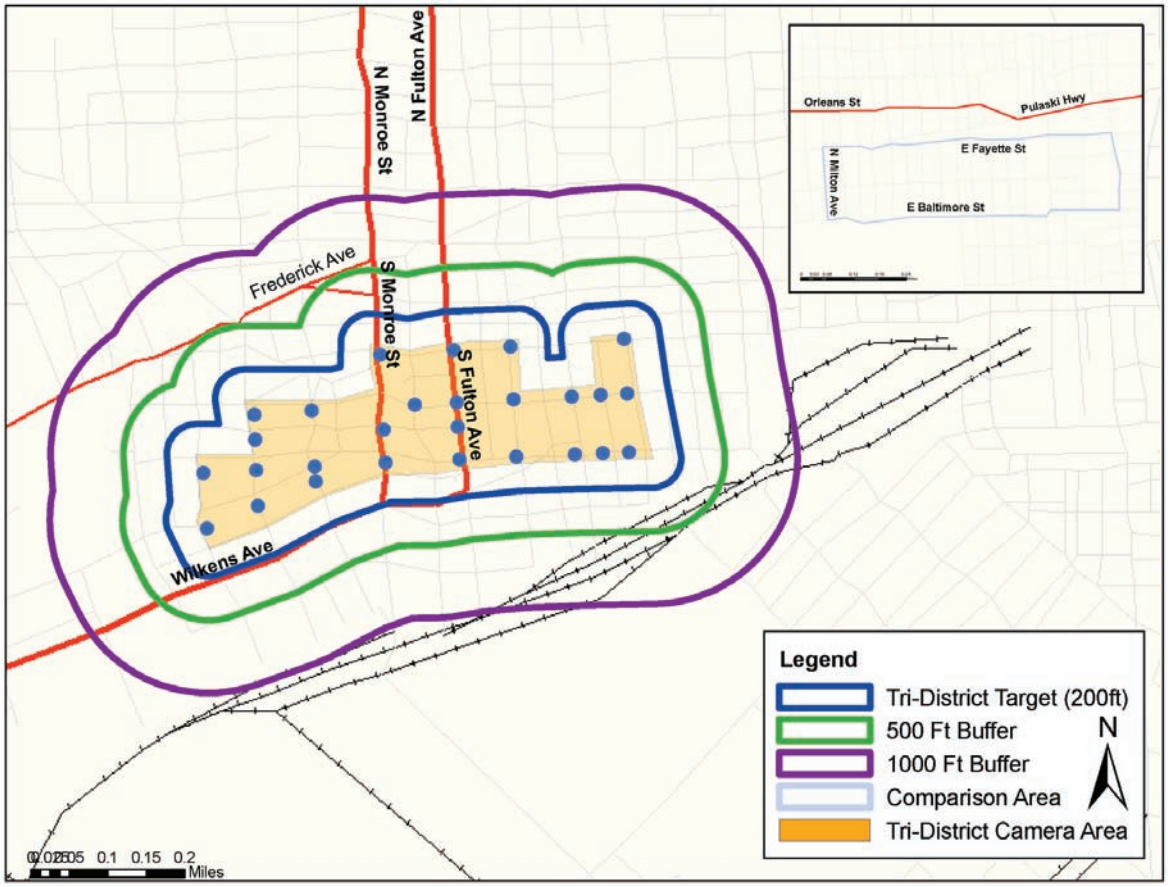




Note: The parameters used to generate the maps were kept consistent between each map above to allow for visual comparison between the two time periods.

Source: The Urban Institute.

Figure 4.11: Change in Density and Mean Center of Crime, North Avenue Area, Baltimore



Note: Cameras included in the map were installed in August 2008.
Source: The Urban Institute.

Figure 4.12: Map of Tri-District Area, Baltimore: Treatment, Comparison, and Buffer Areas

There were limited options for identifying areas that were similar to the Tri-District camera area for comparison purposes, leading us to select a location on the far eastern side of the city just beyond two other camera areas that were not used in the study (see Figure 4.12). This site contains primarily residential area with scattered businesses, such as restaurants and retail stores. The geographic area consists of approximately 30 blocks from East Fayette Street to East Baltimore Street and from North Milton Avenue to North Highland Avenue. Although the blocks are smaller in this area, there are more homes within each block than the target area; however, the homes share the same row house style that is found in Tri-District.

Crime Trends Before and After Camera Installation

The frequency of crime in the Tri-District area was relatively low compared to the other Baltimore camera sites. On average, there were a total of 30 reported crime incidents per month over the evaluation period. In the months preceding camera installation, violent crime accounted for roughly one third (35 percent) of the crime each month, followed by burglary, outside larceny, and robbery, respectively. Crime in the comparison area was similarly distributed, with violent crime representing 29 percent of the total, on average. However, as illustrated in Table 4.7, in both the treatment and control areas, crime trends were extremely volatile in the months leading up to camera installation. The average number of monthly incidents dropped nearly 25 percent following camera installation in March 2006, approximately a year after the downtown and Greenmount area cameras were deployed.

Table 4.7: Quarterly Crime Counts in Tri-District, by Crime Type and Area

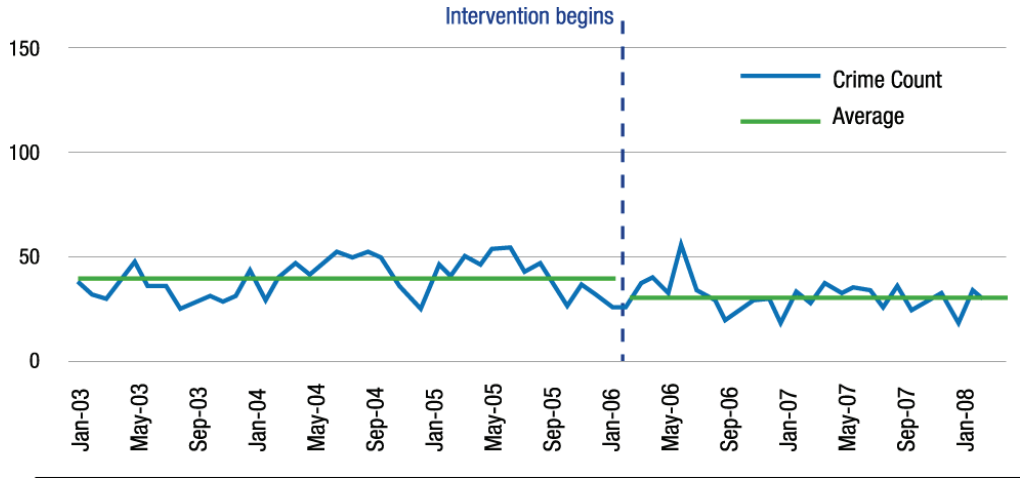
	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Property Crime												
Treatment	51	60	46	47	49	46	62	54	34	63	52	37
Comparison	55	107	69	53	56	62	61	40	33	51	39	41
Violent Crime												
Treatment	45	57	39	38	30	43	51	27	28	40	41	32
Comparison	32	41	43	24	19	27	23	31	16	29	29	29
Total Crime*												
Treatment	96	117	85	85	109	127	150	118	108	147	135	97
Comparison	87	148	112	77	95	115	106	88	72	103	89	86

Source: The Urban Institute

Note: Intervention date occurred in March 2006.

*The sum of property and violent crime does not equal total crime. Total crime includes additional crime types that were not included in either of those crime categories, such as other sex offenses and common assault.

Note: Violent crime included the following offenses: murder, rape, robbery, and aggravated assault. Property crime included the following offenses: burglary, larceny, motor vehicle theft, and arson.

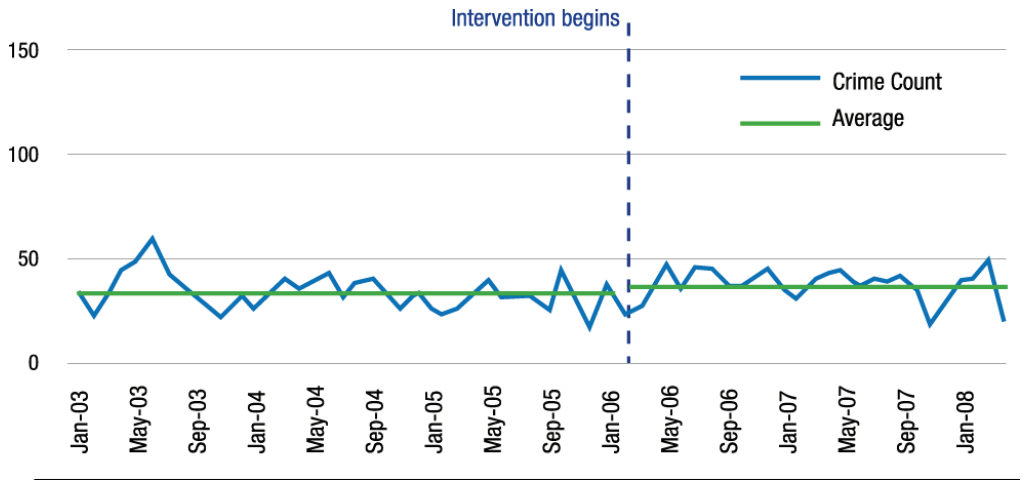


Note: The intervention line displayed above for Tri-District target area corresponds with March 2006.

Source: The Urban Institute.

Figure 4.13: Crime Trend in Tri-District Area, Baltimore, 2003–2008

As shown in Figure 4.13, crime was the highest during the summer months and followed a consistent pattern of climbing through the spring, reaching its highest point in the summer, and then slowly declining back down to its lowest levels in the winter. In June 2006, the area experienced its highest crime spike, but then steadily declined. By 2007, the volume of crime each month was nearly half of that experienced in the same month in 2004. However, in the comparison area, crime increased starting in 2006 and the average remained higher through 2007 (see Figure 4.14).



Note: The intervention line displayed above for Tri-District target area corresponds with March 2006.

Source: The Urban Institute.

Figure 4.14: Crime Trend in Comparison Area for Tri-District, Baltimore, 2003–2008

Statistical Analysis Results

The mean change in crime before and after camera installation was first assessed using independent samples T-tests, which indicated that total crime, inside larcenies, motor vehicle thefts, and robberies significantly declined. If the p-value was relaxed to $p < .10$, violent crime would also become significant, as it declined by nearly 16 percent.

*Table 4.8: Significant Changes in Crime, Tri-District Area, Baltimore**

Crime Type	Area	Before	After	Change	Difference-in-Differences
All Crime	Treatment	37.61	29.12	-8.49	
	Comparison	32.53	36.38	+3.86	-12.35†
Larceny Inside	Treatment	3.39	1.54	-2.83	
	Comparison	1.97	1.65	-0.32	-1.54†
Robbery	Treatment	3.84	2.08	-1.77	
	Comparison	3.47	3.77	+0.30	-2.06†

Source: The Urban Institute

*Camera installation occurred in early March 2006; therefore, the intervention point was determined to be March 2006.

†Significant at p<.05.

To further investigate these findings, we introduced the comparison area as a means of controlling for other factors that may be influencing the crime rate. As with the other sites, the timeframe that was included in the analyses was January 2003 through April 2008. Here, the intervention date was set to March 2006, the date in which the Tri-District surveillance system was in place. DiD analyses were employed to determine which of the crime categories were being influenced by the camera system (see Appendix E for detailed findings). Results indicate a significant decline in total crime, with average monthly crime counts declining by nearly 25 percent—or roughly 12 fewer incidents per month—following camera installation. The size of this decrease appears to be driven by the increase in the comparison. Specifically, these findings indicate that not only did crime decline in the treatment area, but what could have been an increase in crime, given the rise in the comparison area, was also prevented. As shown in Table 4.8, significant declines were also observed for inside larcenies, with an average of nearly two fewer inside larcenies per month following camera installation. Robberies also dropped by roughly two incidents per month. However, caution should be exercised in interpreting these findings, given the low monthly averages per crime type.

Diffusion and Displacement

Viewing crime declines in the treatment area without employing measures to detect displacement and diffusion may generate misleading findings about the impact of cameras in the area. We therefore conducted spatial analyses, examining the movement of crime in and around the target area through the creation of heat or kernel density maps. In addition, we calculated WDQ statistics to examine change in the target area in relation to that in the two buffer regions. Finally, the significant findings from the impact analysis above were included in more rigorous DiD testing to introduce another measure of geographic displacement of crime at both 500 and 1000 feet from the cameras.

In Figure 4.15, the Tri-District area is displayed before and after camera installation. The deepest colors represent the highest crime areas and the lighter shades the areas experiencing the least amount of crime. Overall the camera area experienced a reduction in crime following deployment of public surveillance technology. The amount of white space (low to no crime) covers nearly half of the area, where prior to installation the area was blanketed with a higher amount of crime. The hot spot north of the target area was greatly reduced, with crime declining to some of the lowest levels for the area, and the high-crime area along the eastern border also diminished. While crime was being reduced, it was not being displaced, with the mean center in virtually the same place before and after camera installation.

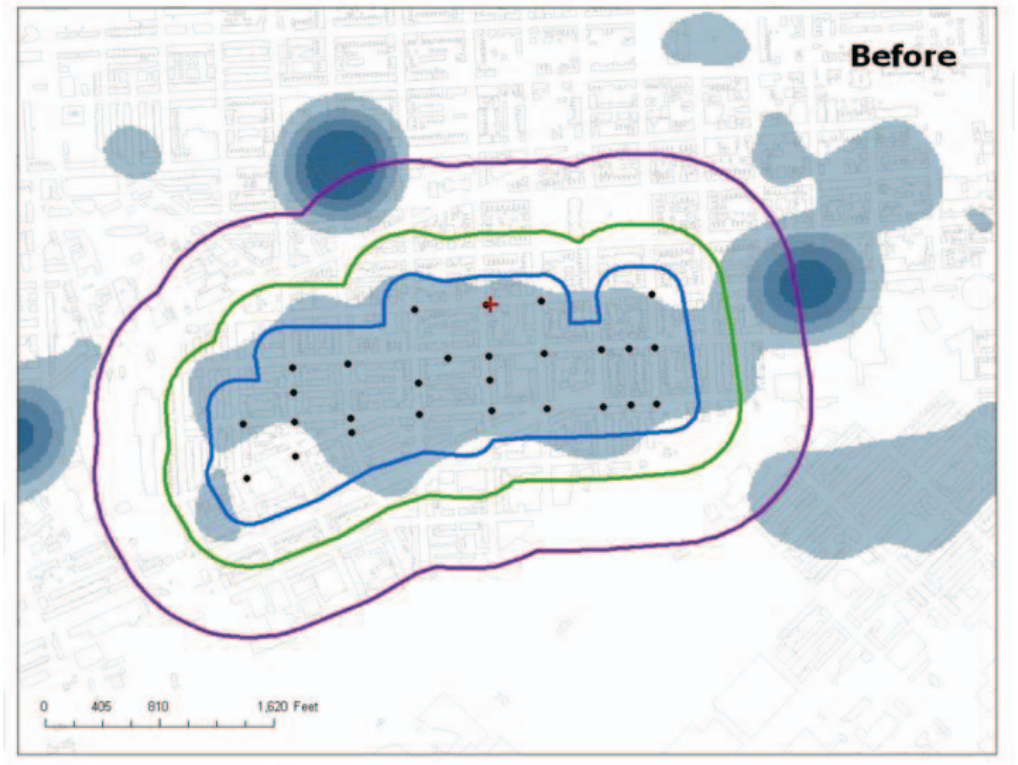
As previously discussed, the WDQ indicates whether there is change in the target area and the two buffer zones in relation to the comparison area. The success measure for all three crime categories was negative for each period of time, confirming the significant decline discussed above in the DiD results (see Table 4.9). With negative outcomes for each success measure across all crime types, we further investigated the degree to which crime increased or declined in either the 500-ft buffer or the 1000-ft buffer areas. Across the board, the WDQ indicated a decrease in crime, or diffusion of benefits from the cameras, that reached 500 feet. All of the WDQs were positive and less than one in Table 4.9, indicating that the crime reduction in buffer areas was not as great as it was in the target area. For total crime, the positive numbers over time indicated the decline continued into the 1000 foot region as well. On the other hand, there was evidence that inside larceny and robbery were displaced into the nearby area at 1000 feet within the first year (-1.19 and -0.76, respectively) to year and a half (-0.71 and -0.40, respectively) after the intervention.

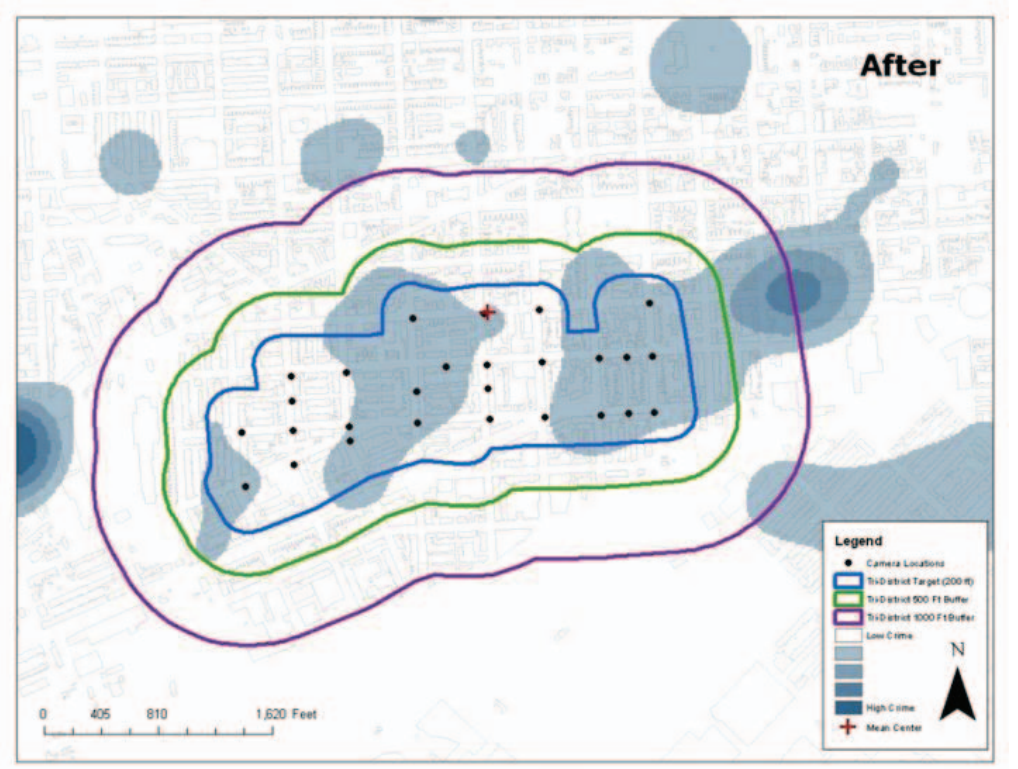
Table 4.9: Weighted Displacement Quotient Results, Tri-District Area, Baltimore

					WDQ	
Pre/post length	**Type of crime**	**t_0**	**t_1**	**Success measure**	**500'**	**1000'**
12 mo.	All	08/2004-07/2005	08/2005-07/2006	-0.51	0.59	0.50
	Inside Larc.			-0.66	0.94	-1.19
	Robbery			-0.14	0.18	-0.76
18 mo.	All	02/2004-07/2005	08/2005-01/2007	-0.53	0.44	0.52
	Inside Larc.			-0.61	0.76	-0.71
	Robbery			-0.14	0.03	-0.40
24 mo.	All	08/2003-07/2005	08/2005-07/2007	-0.50	0.39	0.50
	Inside Larc.			-0.93	0.53	-0.13
	Robbery			-0.28	0.23	0.14

Source: The Urban Institute

*Camera installation occurred in early March 2006; therefore, the intervention point was determined to be March 2006.





Note: The parameters used to generate the maps were kept consistent between each map above to allow for visual comparison between the two time periods.

Source: The Urban Institute.

Figure 4.15: Change in Density and Mean Center of Crime, Tri-District Area, Baltimore

*Table 4.10: Significant Changes in Crime, Tri-District Buffer Area, Baltimore**

Crime Type	Area	Before	After	Change	Difference-in-Differences
All Crime	500-ft Buffer	21.92	20.62	-1.31	-5.16
	1000-ft Buffer	28.82	26.04	-2.78	-6.64†

Source: The Urban Institute

*Camera installation occurred in early March 2006; therefore, the intervention point was determined to be March 2006.

†Significant at p<.05.

Because the WDQ does not test for statistically significant changes, the results are best interpreted in conjunction with the DiD results. Given this approach (see Table 4.10), there was no clear evidence of diffusion of benefits or displacement for inside larcenies or robbery in either the 500- or 1000-ft buffers. These findings are consistent with WDQ results. However, total crime declined significantly in the 1000-ft buffer area, with nearly a 10 percent reduction over all.

Cost-Benefit Analysis

The above findings create a strong case for the positive impact that Baltimore's cameras have on crime, with some signs of diffusion of benefits and no statistically significant evidence of displacement. While these results are promising, they are associated with a technology that is relatively costly to implement and maintain. We therefore set out to conduct a cost-benefit analysis to determine the degree to which the societal benefits of cameras outweigh the costs. The strategy for calculating the site-level costs follows the general framework outlined in the *Research Design and Methods* section, whereby the costs are broadly defined as either start-up costs associated with the initial deployment of the cameras or costs associated with the daily use and maintenance of the surveillance system. As noted in Table 4.11, the latter category encompasses labor costs for active monitoring and reactive camera footage review, non-labor costs including equipment and rental space, and maintenance costs for both cameras and equipment. Stakeholders in Baltimore report that these costs were initially paid for using grant funds, and were later supplemented with resources generated from asset forfeitures and other grants.

Table 4.11: Baltimore Camera Costs

Type of Cost	Cost ($)
Initial Start-Up	5,479,000
Maintenance	775,000
Personnel	1,693,000
Non-Labor	111,000
Total	**$8,058,000**

Source: Baltimore Mayor's Office on Criminal Justice. Costs compiled by Urban Institute staff by type and across years.

Note: Costs incurred from inception to April 2008. Amounts are in 2009 dollars.

Costs

The total costs associated with Baltimore's surveillance camera initiative as of April 2008 are estimated at $8.1 million. Of that amount, the majority of the money was spent during the planning and implementations stages—collectively representing the start-up costs—while subsequent costs represent a relatively small share of the total. However, because Baltimore's implementation of the camera system into neighborhoods was staggered over time, not all of these "initial-costs" were incurred simultaneously. For example, Baltimore purchased cameras for its Downtown area starting in 2004, yet it did not bring cameras into its Tri-District area until 2006. Nevertheless, the costs associated with bringing both neighborhoods' cameras online are captured in the initial start-up costs category.

Initial start-up costs reflect the cost of purchasing cameras as well as the capital investments in the complementary equipment and technology needed to view camera footage and facilitate the transfer of data from the camera to the terminal. This equipment and technology includes fiber cables, specialized software to encrypt and decrypt the transmission for view, the view-station terminals from which footage can be seen real-time and historic recordings can be reviewed, and initial data storage servers where footage can be retained over time. These costs also reflect the expense associated with installing and implementing the system, including installing poles in the ground from which cameras could be mounted; mounting cameras to poles, buildings, and other structures, and cutting away tree branches that would otherwise obstruct the cameras' views.

Stakeholders were unable to quantify with specificity the labor hours spent during the planning stages of camera investment, which was a clear limitation of this analysis. During interviews, stakeholders described making trips to other sites, including the United Kingdom, to observe their surveillance camera projects; reviewing proposals from potential vendors; determining the locations for each of the cameras; and engaging in other related activities. While the costs associated with this planning period are not included in our estimate of initial start-up costs, they likely represent a non-trivial amount, of which jurisdictions considering the implementation of a camera system should be mindful.

After purchase and implementation of cameras, ongoing costs related to maintenance, labor, and other non-labor costs continue to be incurred. Maintenance costs are associated with cleaning, fixing, and replacing camera hardware, including the electrical wiring to power the camera and the wired and wireless transmission components necessary to view the camera footage on site or from a camera terminal. The costs related to personnel are encompassed in the loaded salaries of camera monitors and those of their supervisors overseeing the camera operation. These labor costs include sworn members of the BPD, non-sworn employees of the police department, and individuals contracted to operate the cameras. Non-labor costs include expenses related to the hardware, software, and wiring necessary for the cameras and their monitoring to be fully operational, as well as rent, electricity, and other costs associated with housing the system.

Benefits

As outlined in the *Research Design and Methods* section, benefits are derived by ascertaining the societal cost of crime for each of several distinct crime categories. Criminal justice costs reflect the cost the system incurs when responding to and investigating a crime, the arrest and prosecution of an individual, jail costs pending case disposition, and incarceration and other forms of punishment and supervision if found guilty. Additionally, victim costs are calculated using estimates of the direct and indirect costs of victimization across categories. Using criminal justice and victim cost estimates by Cohen[88] and Roman,[89] we calculated the cost of a single incident for each of eight crime types in Baltimore: arson, burglary, larceny inside, larceny outside, robbery, and violent crime. The latter crime type is an aggregate of multiple offenses, consisting of murder and non-negligent homicide, sexual assault offenses, and both aggravated and simple assault offenses.

After determining the costs of each crime, we used these estimates to calculate the benefits. By comparing the outcomes of the treatment and comparison areas both before and after camera implementation, we were able to

88. Cohen, "The monetary value," (see note 64).

89. Roman, "What is the price," (see note 71).

determine what crime categories, if any, experienced a significant decline in the treatment area. For each crime that is prevented, the value of the cost of that crime is added to the benefits of the surveillance camera initiative. To this point, determining the number of crimes averted by surveillance camera use largely mirrors the work detailed in the impact analysis described above. The difference between the impact analysis and the cost-benefit analysis lies in the unit of analysis. The impact analysis used crime counts as its unit of analysis and therefore reported on the difference in the number of crimes between the treatment and control groups. By contrast, the cost-benefit analysis scales counts by their cost *before* running the DiD analyses, generating outcomes of the difference in the costs the treatment area incurred versus the costs the comparison area incurred. The cost-benefit analysis also differs from the impact analysis in that we identified both point and bounded estimates of potential benefits, with a range of an upper and lower bound estimate sandwiching a point estimate of potential cost savings. This conservative approach takes into account the fact that the costs of monitoring cameras are uniformly distributed across all crime types rather than according to the frequency with which they occur and the degree to which they are reduced as a result of camera surveillance.

As referenced in the *Research Design and Methods* section of this report, of the four target areas analyzed in Baltimore, Downtown Baltimore estimates were derived using structural break analysis employing costs due to the lack of a suitable comparison area, while Tri-District, Greenmount, and North Avenue were all subjected to a DiD model in order to identify any statistically significant changes in crime costs. For each of the crime categories excluding violent crime, statistically significant findings in the impact analysis will be mirrored in the cost-benefit analysis. For these crimes, there is no additional variation introduced when monetizing crime counts. In essence, the value of a given crime serves as a constant, whereby one could monetize individual crimes before introducing them into the model or monetize them afterwards and arrive at the same conclusion. However, monetizing crimes allows policymakers to make apples-to-apples comparisons among crime prevention strategies—and their calculated benefit—against their associated costs. Thus, for individual crime categories, the cost-benefit is merely another way to present the same information.

Violent crime, however, must have its crime counts monetized before analysis due to the fact that the category represents an aggregation of several crimes: murder, non-negligent homicide, sexual assault offenses, and simple and aggravated assault. Each of these crimes has a calculated cost value that is different from the others. However, in the impact analysis a change in any given crime within the violent crime category would be treated equally. For example, let's assume the treatment area experienced four fewer violent crimes after comparing crime before and after camera implementation. When examining the comparison area, it showed three fewer violent crimes; however, the outcome was not statistically significant. In this context, the DiD analysis compares change in counts and cannot conclude with reasonable certainty that treatment is different from the comparison. If the violent crime category consisted of only one crime type, like aggravated assaults, monetizing the crime counts would not change the DiD results.

Nevertheless, because there are several crime types within the violent crime category, it matters which crimes are changing in our above example. If the treatment area's change in violent crime was four fewer murders (valued at approximately $1.4 million each) and the comparison area's change was three fewer simple assaults (valued at approximately $89 thousand each), the difference between the treatment and comparison group changes. The impact analysis would be essentially comparing four crimes to three crimes while the cost-benefit analysis is comparing $5,600,000 (the value of four averted homicides) in the treatment area to $267,000 (the value of three averted simple assaults) in the comparison area. Therefore, the below discussion will present the monetized form of the statistically significant crime categories as observed in the impact evaluation. It will also present statistically significant monetized violent crime categories that may have become significant due to the change from crime counts to crime values.

Table 4.12: Downtown Baltimore Structural Break Results with Benefit Estimates

	Estimated Benefit per Month		
Offense	Target Area	500-ft Buffer	1000-ft Buffer
Larceny Inside	-$86,449.22*	-	-
Larceny Outside	-$84,316.85*	-	-

Source: The Urban Institute.

* Significant at the 0.05 level and included in the cost-benefit estimation.

The next neighborhood we examined was the Tri-District area (see Appendix F). Following the same approach employed with the Downtown Baltimore, we note the results of the *Camera Impact Analysis* section, indicating statistically significant changes in inside larcenies and robberies (refer to Appendix E for more detailed findings). Table 4.13 provides the monetized form of the changes in crime for each of these crime categories by month (see Appendix F). It is important to remember that Downtown Baltimore's changes in crime and therefore the monetization of these changes were calculated and then analyzed using structural break analysis because no comparable area could be identified for the Downtown Baltimore. Comparable areas were identified for the Tri-District, Greenmount, and North Avenue, thus enabling the use of a DiD model. Comparable areas were identified for the Tri-District, Greenmount, and North Avenue, thus enabling the use of a DiD model.

Table 4.13: Baltimore Tri-District Difference-in-Differences Results with Benefit Estimates

	Estimated Benefit per Month		
Offense	Target Area	500-ft Buffer	1000-ft Buffer
Larceny Inside	-$11,176.85*	-	-
Robbery	-$223,323.31*	-	-

Source: The Urban Institute.

* Significant at the 0.05 level and included in the cost-benefit estimation.

When we turn to Greenmount and North Avenue, we find that there were no crime categories in either target area that suggest a statistically significant reduction in monetized crime when using a comparison area. While both areas reveal a statistically significant change in monetized crime in the 500-ft buffer areas, we cannot attribute that reduction to public surveillance cameras, as no such reduction was detected in the target area (refer to Appendix F for more detailed findings).

To calculate the total benefits we observed in the Downtown and Tri-District, we aggregate the significant offense types. Examining Table 4.14, we observe approximately $390,000 in benefits due to averted crimes in the Downtown Baltimore and Tri-District. The cost-benefit literature frequently reports the benefit-to-cost ratio—the total benefits divided by the total costs—enabling us to estimate the amount of benefits received, if any, for every dollar spent on costs. To determine if it was cost-effective to implement the Baltimore camera system, we took the total costs incurred across all of the neighborhoods regardless if there was any significant change in reported crime, as these costs are incurred regardless of any statistically significant reductions in crime. Thus, the benefits of the particular offense categories in the Downtown Baltimore and Tri-District alone, when aggregated, must offset the surveillance camera costs in these two neighborhoods as well as in the Greenmount and North Avenue areas.

Table 4.14: Significant Values of Averted Crime per Month, by Location and Crime Category, Baltimore

Location	Offense	Target	500-ft Buffer	1000-ft Buffer
Downtown	Larceny Inside	-$86,449.22		
	Larceny Outside	-$84,316.85	-	-
Tri-District	Larceny Inside	-$11,176.85	-	-
	Robbery	-$223,323.31	-	-

Source: The Urban Institute.

As discussed above, Baltimore's total costs were approximately $8.06 million over 36 months, approximating $224,000 per month. Thus, to break-even, the monthly benefits would need to exceed $224,000 in order to yield a cost-beneficial finding for surveillance camera implementation. As of the end of the observation period, we estimate that Baltimore experienced approximately $12 million in benefits from averted crime over the course of the intervention (approximately $334,000 per month). Dividing $334,000 by $224,000 results in a benefit-to-cost ratio of approximately $1.49. In other words, every dollar spent on camera implementation yielded more than $1.50 in savings society experienced in averted public safety and criminal justice expenditures and in prevented harms to victims.

These results suggest that Baltimore's camera system is both effective and cost-beneficial. An intervention can be effective (reduces or prevents crime) but not cost-beneficial (the benefits exceed costs), and the converse is also true. However, in Baltimore's case, the camera system is attaining its stated goal and doing it in such a manner that justifies its expense.

While the value of crimes prevented through the use of public surveillance systems in terms of victimization costs averted is real and important to society, it often masks the degree to which an intervention is cost-beneficial from a governmental perspective. That is, government budgets do not benefit from averted crimes to victims. Analysts therefore conducted a second cost-benefit analysis excluding victimization costs. Doing so reduced the savings associated with surveillance cameras considerably. In Baltimore the costs of the cameras were roughly equal to the benefits attributed to them (the camera system yielded $1.06 in benefits for every dollar spent on them, representing a reduction in average monthly savings from $334,000 per month to $237,000). In conferring with Baltimore stakeholders, however, it is possible that the benefits relative to costs may be even greater than quantified in this evaluation. The city has renegotiated many of its contracts, particularly those that affect the non-labor costs, resulting in significant reductions in camera maintenance costs. These reductions were not included in the benefit-to-cost estimates, as they fell outside of this study's observation period. In the event that the costs are reduced and benefits remain the same, the program becomes even more cost-effective.

Challenges and Lessons Learned

Baltimore stakeholders believe that the city's public surveillance system prevents crime and also helps solve crimes that would not have otherwise been closed because the suspect would not have been identified, a witness would not have been willing to come forward, or the weapon used to commit the crime would not have been recovered. Camera use, both proactively and reactively, has recorded suspects in action and captured images of getaway vehicles. It has compelled witnesses to cooperate with police, even if they fear retribution, and it has also led police to retrieve weapons used in the commission of a crime, even when a perpetrator discards it prior to apprehension. However, there have also been challenges along the way.

Prosecutors, for example, cited the "CSI effect" whereby juries assume that advanced forensic and technological evidence is present at all crime scenes and fail to deliver a guilty plea in the absence of camera footage. Prosecutors have also experienced problems with officers describing drug transactions while testifying. Their experience makes it clear to them that drugs and money exchanged hands, but to a lay juror, the video does not make this apparent. Further complications for investigators and prosecutors lie in the camera technology itself. The camera, when passive, pans on its pre-programmed tour, so it may not capture an entire criminal event as it transpires, if it captures anything at all. Even when an event is captured on camera, visibility during the night or in inclement weather and limitations in the resolution of the footage can restrict the utility of the footage as evidence. Some investigators are frustrated that the cameras' night capabilities are not as clear and sharp as during the day. This deficiency impacts the investigations of crimes that occur after dark, which might benefit from video footage if only it were of better quality. Perhaps this explains why, while some investigators employ camera footage on a regular basis to assist in investigations, others are a bit disillusioned with what they feel is often a false promise of additional evidence. Instead, these investigators consider reviewing camera footage to be merely one more step in the list of activities associated with investigating a crime.

The camera system has also generated unanticipated costs. Indeed, the cameras alone, at several thousand dollars apiece, turned out to be the least costly component of the system when compared with the implementation and the on-going infrastructure and maintenance costs required to keep the cameras and system operational. During the installation phase, for example, it was discovered that many poles were not constructed to run electricity and those that were tended to have complications; for example, the light poles that only turn on at night had to be reconfigured to draw power all day instead of only at night. Beyond the initial installation costs, the fees associated with electricity and servicing cameras were much larger than initially anticipated. Baltimore soon learned that having a camera moving all day (either via active monitoring or passive pattern rotation) overheats the motor fairly quickly, resulting in the need for frequent servicing. Repairing vandalized cameras was another unplanned expense: cameras have been shot at, spray painted, and electrical lines have been cut. These early problems led to the subsequent purchase of cameras with vandal-resistant domes, the covering of electrical lines with metal bands, and the locking of electrical access conduits. Such ongoing changes in and additions to cameras yielded a new complication, in that different generations of cameras run on disparate software systems that are not always compatible with each other or the monitoring equipment, resulting in delays and additional costs to unify all of them.

To some degree, the unforeseen changes in technology and unanticipated costs in installation and maintenance would not have altered the way in which Baltimore invested in its surveillance technology. However, these experiences did yield some important lessons learned, particularly regarding interactions with vendors. Stakeholders underscored the importance of identifying hidden costs when negotiating with vendors, especially when agreeing upon a maintenance contract. Vendors may downplay the costs associated with installing cameras, removing impediments, providing electricity to poles, monitoring cameras, and archiving video footage. For example, the Baltimore Fiscal Year 2009 budget for camera maintenance and repair for the 480 cameras in its system is approximately $600,000, substantially lower than when they signed their first vendor contracts.

While budgeting considerations for installation, operation, and maintenance of the system are essential for any jurisdiction contemplating a camera program, stakeholders in Baltimore have offered a number of other recommendations that have been born out of the Baltimore experience. First, a jurisdiction should assess and build an infrastructure capable of handling its current needs, but also have a three- to four-year plan for growth that the system could still support. Second, putting money into top-of-the-line cameras can pay off, but an adopting city should not dedicate funds for high-tech cameras at the expense of the equally important technology necessary for transmitting and relaying the video and software that decrypts and displays it. The counter argument is that higher quality cameras have the ability to alleviate some of the reasons investigators and prosecutors cited for not being able to use footage that has captured a crime, such as granular appearance or insufficient lighting.

Third, when deciding to implement a system, a city need not saturate the entire jurisdiction with cameras at the outset. It may be more prudent to select one or two areas to pilot the system and expand as surveillance needs and budgets allow.

Chapter 5.
Chicago, Illinois

"When criminals are being watched, they alter their behavior."[90] This was the belief of Terry Hilliard, who as Superintendent of the Chicago Police Department (CPD) in 2003, launched a technologically advanced crime-fighting effort termed "Operation Disruption." The cornerstone of this initiative was the use of 30 portable Police Observation Devices (PODs)—cameras that were placed in neighborhoods with the highest incidence of violent crime and narcotics activity. These cameras were controlled by nearby officers, who operated them via a portable terminal in their patrol cars, allowing for real-time viewing and rapid response whenever the cameras revealed criminal activity. Chicago's public surveillance program quickly grew, advancing well beyond the handful of portable cameras to an integrated network of cameras that have become a benchmark for public surveillance in the United States. The city operates more than 8,000 cameras, including police, transit, and public school cameras, and the vast majority of them can be accessed by the city's Office of Emergency Management and Communications (OEMC).[91] To amass such a large network of cameras, Chicago leveraged federal and state funds and committed its own resources to support this multi-million dollar program that most stakeholders believe effectively deters crime, aids investigations, and secures guilty verdicts.

Purpose of Camera Investment

In the early 2000s, Chicago police were already tackling violent crime, narcotics, and gang activity through a variety of measures, but both Superintendent Hilliard and Mayor Richard M. Daley were interested in adopting new technologies and strategies in an effort to do more. Representatives from the City of Chicago visited cities throughout the United States as well as others abroad, including London, collecting lessons learned and identifying the most efficient ways to use public surveillance technology. After more than a year of review and fiscal planning, the city had identified the grants and other funds from federal, state, and local entities that would fund the camera program. Their goal was to implement a crime prevention and investigative tool that would enhance their capability to "see" as well as increase a sense of law enforcement presence in the community. They envisioned an integrated system that combined resources across city agencies to develop a collaborative approach to crime prevention, crime control, and emergency management activities.

Setting the Groundwork

The Police Department's Information Services Division and Office of Legal Affairs were key entities in implementing the public surveillance system. While no community groups were actively involved in the early planning stages, the Legal Affairs division did review and address any pre-existing public surveillance laws instituted in other jurisdictions. These laws primarily address privacy concerns, including the requirement that any person serving as a camera monitor must successfully complete training on First and Fourth Amendment rights.

90. "Operation Disruption Aims to Shut Down Gangs, Reduce Violence." City of Chicago Press Release. http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?contentOID=536891619&contenTypeName=COC_EDITORIAL&topChannelName=HomePage&blockName=Content.

91. The focus of this project is the Chicago Police Department crime cameras, not those cameras operated by the Chicago OEMC, which encompass emergency response more broadly beyond policing than the crime cameras do. In addition, Chicago Public School cameras can only be accessed by OEMC when permission is granted.

Shortly after implementation of the camera system, the city began to formalize the process for soliciting community input and concerns. Public input was solicited through each ward's Alderman,[92] who represented the neighborhood's collective sentiments regarding the camera program at city council meetings. Initially, community meetings were held because residents did not want cameras, believing they would reduce property values in their neighborhoods. Not long after camera implementation, however, the focus of community meetings shifted, with residents protesting cameras being removed from their neighborhoods. In fact, the implementers of the camera system had initially envisioned that individual cameras would be moved often in response to shifting flare ups of crime hot spots. Community opposition to camera removal, however, minimized such camera movement. Later, Aldermen were given the option of using their own city funds to purchase cameras for their communities; these cameras were then linked to the larger camera network for monitoring.

Planning and Procurement Process

In order to invest in this surveillance technology, the city issued a competitive Request for Proposals (RFP) to prospective vendors for supplying, implementing, and maintaining the public surveillance system. The initial RFP was a massive undertaking because the city viewed this project not simply as an additional policing tool, but as a large-scale capital investment project; besides camera installation, the winning vendor would need to create an infrastructure that could maintain such a system and allow for its growth over time. Indeed, the system was implemented in phases, all of which had their own round of RFPs, responding to changes in camera technology and networking capabilities in order to stay current with rapidly developing technology.

All of CPD's purchased cameras have pan-tilt-zoom (PTZ) abilities, enabling them to rotate nearly 360 degrees. These cameras can be operated in real-time by camera monitors or can be set to record using pre-set touring programs. The CPD cameras, however, do not incorporate motion or gunshot detection; original plans called for the incorporation of gunshot detection technology into the camera system, but further evaluation of Chicago's urban landscape revealed the environment was not suitable for gunshot detection sensors.

Camera Specifications, Placement, and Visibility

At full implementation, Chicago currently boasts over 8,000 public surveillance cameras, approximately 2,000 of which are operated by the CPD and represent the main focus of this evaluation.[93] All PODs operated by CPD are overt, with a combination of signage and/or blue flashing lights. Camera visibility is intended to reflect transparency to the public as well as to deter would-be criminals from engaging in illegal activity. Community members registered some initial objections to the lights, fearing that the prominence of cameras would lower property values. This, among other reasons, prompted the removal of lights from some cameras and the omission of lights from the last phase of cameras that was implemented. Nonetheless, the vast majority of cameras include flashing blue lights.

The locations of the cameras were guided by an assessment of both crime and the environment. Because the envisioned purpose of the system was to deter crime and aid in the arrest of perpetrators committing crimes in progress, police districts were first rated based on violent crime and arrest data, with the areas in most need of support and crime reduction receiving cameras. These placement decisions, however, were also influenced by the nature of the physical environment, in that many of the existing poles in the high-crime areas were too short, could not sustain the camera weight, or did not meet the electrical requirements necessary for camera functioning. In addition, the wireless component of the system restricted the full array of camera placement options because line-of-sight must be obtained not only for an individual camera's feed to be viewable, but also to relay other cameras' visual information for which that camera is acting as a hub. These factors led to some compromises in the exact placement of cameras as they related to crime hot spots. Nonetheless, the saturation of cameras was great enough to virtually blanket identified hotspot areas.

92. In Chicago, elected officials to the city council are called Aldermen.

93. In addition to the police camera system, Chicago has both overt and covert cameras that are monitored primarily for homeland security purposes.

Camera Use and Monitoring

Due to the wireless networking of Chicago's camera system, the city is unique in its ability to make live video feed accessible to as many authorized users as it chooses. In Chicago, this means that all sworn officers have the ability to monitor cameras from their desktop computers. While the camera system has the ability to be actively monitored 24 hours per day, 7 days per week, the extent of monitoring varies by police district. Even in the districts that engage in the most proactive monitoring, relatively few individuals are dedicated monitors charged solely with the job of viewing live camera footage.

Active Monitoring and Real-Time Arrests

Chicago's camera system operates via a complex web of components and stations. The system's networking component is the means by which video from individual CPD police officer work stations, district monitoring stations, the Crime Prevention Information Center (CPIC), and the Office of Emergency Management and Communications (OEMC) is integrated and shared. In each of these locations, monitors are able to view multiple screens with real-time footage from cameras located throughout the city. Monitors look for suspicious activity, which may indicate a crime is about to be committed, as well as for crimes-in-progress, for which the monitors relay information to responding officers. Active monitoring is also employed in calls for service and sting operations. For example, prior to an officer arriving on scene, a monitor viewing the events can radio pertinent details, such as the number of suspects and their descriptions, the presence of weapons, and the safest approach route. In addition, active monitoring can be used to protect the safety of undercover officers: sting operations can be staged to ensure coverage by a camera in order for a monitor to gauge officer safety and radio for back up if needed. When not being actively monitored, cameras are programmed to record passively, following a pre-set touring sequence (described under *Passive Monitoring* below).

On the district level, each district station has computer workspaces that are capable of active monitoring. Typically, districts assign one sworn officer to take on the role of active camera monitoring, but this is usually one among several other job responsibilities, so constant monitoring is not common. In addition, district monitors are often granted significant latitude in the manner in which they monitor, although they tend to focus on violence, drug activity, and gang activity. In the case of a crime flare-up or a specific investigative operation, however, monitors may be asked to view certain cameras with greater intensity. Monitors have also discovered that misdemeanor offenses, such as drinking, littering, and panhandling, are often captured by the cameras. Responding to all of these incidents is infeasible, as it would prevent officers from responding to more serious crimes as they arise. Monitors therefore must use their own discretion in determining which incidents require a police response.

These district cameras are complemented by those housed in CPIC, located within the CPD. Created in April 2007 CPIC serves as the intelligence hub for the police department, centralizing multiple law enforcement agency activities in a single location in an effort to serve multiple crime prevention and crime control functions. This unit contains 10 dual-screen stations for various agencies to use, including: the CPD, analysts from the Federal Bureau of Investigations (FBI), detectives from the suburban police department, the State Police, the Cook County Sheriff, the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), and the Coast Guard, as well as others. While analysts have the ability to do live monitoring at CPIC, most of their activity involves retroactively viewing archived footage for use in investigations and prosecutions.

The efforts of both CPD district camera monitors and CPIC are enhanced by the full-time, dedicated camera monitors housed at OEMC, which serves as a hub for the emergency cameras and contains two essential operations centers. The main control center for the emergency cameras is housed in a 16,000 square-ft room, including workstations for fire, police, and other emergency response as well as the 911 system. Although the crime cameras were not currently a part of this operations floor at the time of our data collection efforts, more recently OEMC integrated the cameras with the emergency response system to enable operators receiving calls and dispatching response units to access cameras near the incident. With this ability, dispatchers can assess the needs and dangers of the situation, providing better information to responding units.

The Operations Center, also under the umbrella of OEMC, contains monitoring stations specifically geared for the PODs, and as mentioned above, this center runs on a full-time monitoring schedule. Each monitor is equipped with a four-screen station that provides access to all camera systems operated by OEMC and the ability to view other private cameras upon approval. The room also contains a 28-ft monitoring wall which displays live POD footage as well as an electronic board of missions. These missions, referred to as POD missions, are directives for monitoring staff to observe high-priority locations and are detailed with specifics on time, date, location, crime type, and persons of interest. Superiors are authorized to submit POD missions to be placed on the screen. Also included in the Operations Center are two trained monitors who specialize in crime detection and analysis of body language, and whose main responsibility is to monitor locations for suspicious behavior.

With multiple players utilizing the camera systems simultaneously, it is quite likely that the same incident will be viewed in more than one monitoring station. Therefore, OEMC established a chain of command to alleviate disruption during a high-priority event. The bulk of the cameras rest within OEMC control, but if, for example, a police district is monitoring an incident on a set of those cameras, they are able to request control. Monitors are able to see the other agency manipulating the camera from their own station and noted that the chain of command is a very fluid process.

Passive Monitoring, Storage, and Use in Investigations and Prosecutions

Beyond active monitoring, the camera system is employed for a variety of crime control, prevention, and investigative purposes. These efforts are aided by the fact that, following camera system implementation, the arrest report form was modified to include a box that responding officers can check to indicate whether the suspected crime occurred within the vicinity of a camera. Officers are thus able to later review area cameras to determine whether the incident in question may have been captured on a camera. This also enables the mapping of incidents in relation to camera locations, integrating cameras into all manner of police operations. For example, cameras are used with the CPD's CompStat program, enabling officers to learn more about persistent localized crime problems and develop problem solving strategies to respond to them through extraction of camera footage.

Passive monitoring is most commonly employed to aid in investigations and prosecutions. Investigators identify whether cameras may have been present at the scene of a crime and can request that camera recordings be copied onto a DVD, which become a part of the case file. Investigators view historical footage to identify perpetrators, witnesses, cars, and weapons, as well as to document how crimes transpired. They have also employed cameras more proactively in order to identify witnesses for serious violent crimes. For example, in a creative use of a sting operation, an undercover officer stages a drug transaction in the known view of a camera in order to capture the images of buyers on video. The primary purpose of the operation is not to arrest the drug buyers but to encourage their cooperation as witnesses to serious crimes that recently transpired in the area as a tradeoff.

There are two caveats to the utility of cameras for investigations. The first is the limitations associated with what is captured on a camera that is running a standard pre-programmed tour. One way to adapt to that limitation, however, is to do what one Chicago police investigator did, which is to request an alteration to the camera tour based on her observation about where street narcotics activities were occurring. The second caveat is that archives of camera footage are only maintained for a specified period of time before being overwritten; if the camera is connected wirelessly to the system, it is able to record 15 day's worth of footage before overwriting takes place. However, if the camera is merely recording to a localized hard drive, it is only able to record for three days before being overwritten. This has led responding officers to inquire immediately whether a nearby camera might yield relevant information on a crime incident in order to prevent the loss of potentially useful information.

Prosecutors have also used the camera system to support their work, reporting that camera footage can be a persuasive tool in the courtroom. For security purposes, existing footage is protected via encryption so that it can only be viewed on computers installed with the necessary proprietary software. In the past, this created difficulties for prosecutors attempting to introduce camera footage as evidence. In order to make this evidence available to the defense, a security-enhanced laptop was made available for defense counsel to view the footage, as well as giving the judge and jurors the ability to view the recording in the courtroom. The Chicago Police Department now incorporates the

security decryption software within the DVD copies it makes available to prosecutors, thus removing the security obstacles mentioned above.

Employing this evidence on the front-end of a prosecution case, prosecutors report that cameras can make the crucial difference between charging or not charging a case. This is particularly true for cases in which the victim or witness might lack credibility if the case were to go to trial. For example, in some cases the victim might have been the initial aggressor; camera footage helps to bring such situations to light. Footage has also helped dismiss unfounded complaints and charges, allowing prosecutors to pursue cases with merit. In fact, prosecutors contend that the mere existence of camera evidence has already provided welcome results, believing that securing a plea agreement is virtually guaranteed if the prosecution possesses video footage.

From a defense attorney's perspective, if recorded video footage exists of the defendant committing a crime, a plea agreement is often sought. However, this decision is contingent upon the clarity and substance of the video: if defense counsel can make the argument that the video does not clearly show it is the defendant committing the crime, the evidence loses its value. It should be noted that video does not always support the prosecution: some defense attorneys have successfully employed camera footage to demonstrate that the perpetrator is someone other than the defendant.

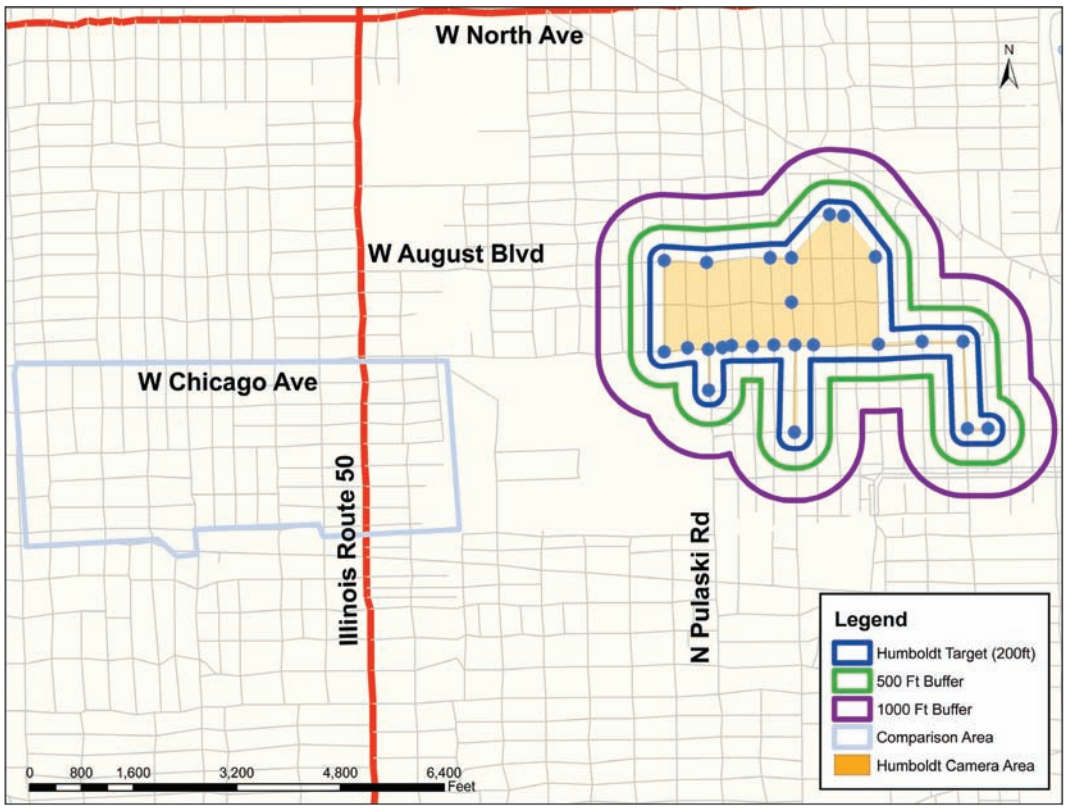
Other cases involving camera footage evidence go to trial because the defense believes the footage is not clear enough to satisfy the reasonable doubt standard or because the difference between pleading and being found guilty at trial in terms of sentence length is not drastic enough for the defendant to forego his or her day in court. At the trial stage, many cases hinge on witness credibility and who the jury believes is telling the truth, and prosecutors believe that judges and juries alike appear to put great stock in unbiased, visual evidence that camera recordings offer. Footage has been used both to refute a defendant's alibi (e.g., when the defendant is viewed at the scene) as well as to strengthen the prosecution's witness testimonies. Despite it being a welcome and helpful tool, prosecutors maintain that video alone is almost never enough to secure a guilty verdict in the courtroom. Witness testimony remains the most crucial component of the prosecution's case; it can be corroborated by the video, but it is usually not replaced by it.

Camera Impact Analysis

In the City of Chicago, two areas were selected by UI researchers for the impact analysis aspect of the study: the Humboldt Park area and the West Garfield Park area. As previously discussed, Chicago has blanketed the city with more than 8,000 cameras of which the Chicago Police Department manages approximately 25 percent. Our evaluation efforts focused on a small fraction of the police-operated cameras in District 11. Camera locations and installation dates were provided by CPD for all police cameras installed throughout the city from 2003 through 2007. In addition, nearly 60 months of crime-related data throughout the City of Chicago were obtained from CPD, spanning from September 2001 through July 2006.

For evaluation purposes, UI researchers followed the same methods employed in Baltimore and drew a polygon around two clusters of cameras and then expanded the "treatment area" to be within 200 feet of that polygon of cameras. The first cluster of cameras was mainly located in the Humboldt Park area of Chicago and the second in the West Garfield Park area.[94] Together, the Chicago analysis included approximately 30 cameras and the impact that resulted from their deployment. Our analyses examined 16 crime categories: (1) all crime, (2) violent crime, (3) aggravated assault, (4) arson, (5) simple assault, (6) burglary, (7) drugs, (8) larceny, (9) motor vehicle theft, (10) murder, (11) problem persons (public disorder, intoxication, nuisances), (12) prostitution, (13) robbery, (14) sexual assault, (15) vandalism, and (16) weapons. The crime categories of arson and murder were excluded from the analyses as stand-alone crimes due to their extremely low base rates. A violent crime category was created to alleviate part of this problem, which clustered a few categories that had low frequencies together with others that are typically included in this category and had monthly counts that were sufficiently high to support the impact

94. For more details regarding the selection of the study area, refer to the Research Design and Methods section.



Source: The Urban Institute

Figure 5.1: Map of Humboldt Park Camera Area, Chicago

analysis. Within each of the two treatment areas, we looked for significant changes in average monthly crime counts within: (1) the target area of the camera; (2) buffer zone of 500 feet; (3) buffer zone of 1000 feet; and (4) a matched comparison area selected due to similarities in land use, historical crime rates, and socio-economic measures to the target area. A description of crime trends and impact evaluation results for each site in Chicago is presented below.

Humboldt Park Area

The boundaries for the Humboldt Park[95] area were selected to include a cluster of cameras within Chicago that were part of the initial wave of installation, but did not have additional cameras located within 1000 feet of that area during the remainder of the intervention period. Once this cluster was identified, a 200-ft buffer around the cameras falling along the outer boundary of the cluster was drawn to define the treatment area. As shown in Figure 5.1, this shape follows street blocks, which results in the appearance of Gerrymandering, but was intended to simply align with the street network. The target area is bounded by West Thomas Street to West Ohio Street and North Karlov Avenue to North Christiana Avenue. This area is encompassed by the 11th police district in Chicago, where much of the police effort focuses on narcotics. The majority of the target area is comprised of residential property, with a mix of single family homes, townhouses, and small, multi-family apartments. The neighborhoods within this area are densely populated, with very little space between housing units. One of the major commercial strips, Chicago Avenue, dissects the area through the center and offers a variety of businesses and services, from markets and restaurants to health centers and churches.

95. Given that the majority of the target area and surrounding buffers were included in the neighborhood of Humboldt Park, we refer to this area as Humboldt Park throughout this analysis.

In contrast to how the treatment area was identified, the comparison area is defined by Census Block Group boundaries, with the selection of the specific groups that were included being based on similarities to the target area in land use, historical crime rates, and socio-economic measures. The comparison area is split between the neighborhoods of West Garfield Park and South Austin, and extends from West Chicago Avenue to West Kinzie Street and North Central Avenue to North Kilpatrick Avenue. Although this location is in a neighboring police district (15th), one of their priorities for the area is also narcotics. This area is mainly residential and included the continuation of the same commercial strip from the target area following along the Northern border of the site, West Chicago Avenue. The density of homes in this area is a bit more variable than in the treatment area, with the amount of spacing between the residential units differing drastically from block to block. However, the housing type is similar to that of the treatment area, although there is a greater presence of single family homes with larger lot sizes.

Crime Trends Before and After Camera Installation

Given the fact that camera use became more prominent in the city over time, the data include a 60-month time period spanning from September 2001 through July 2006, which was evenly distributed before and after the first camera was installed in the target area. On average, drug-related offenses were the most common in the Humboldt Park area, with one-third (35 percent) of the total number of crimes committed each month being drug-related. Violent crime accounted for approximately 30 incidents (10 percent) per month. Vandalism was a close third, with nearly 8 percent of reported incidents each month attributed to destruction of property. The comparison area experienced a similar crime pattern, with drugs and violent crime driving the crime rate in the selected neighborhoods (see Table 5.1).

Table 5.1: Quarterly Crime Counts in Humboldt Park, by Crime

	2002				2003			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Property Crime								
Treatment	153	182	166	190	132	196	198	178
Comparison	194	238	238	199	191	207	242	170
Violent Crime								
Treatment	79	102	134	106	66	91	101	70
Comparison	80	99	111	82	74	80	94	66
Total Crime*								
Treatment	916	981	950	840	760	861	1099	722
Comparison	1013	1145	1131	980	926	1030	1074	1027

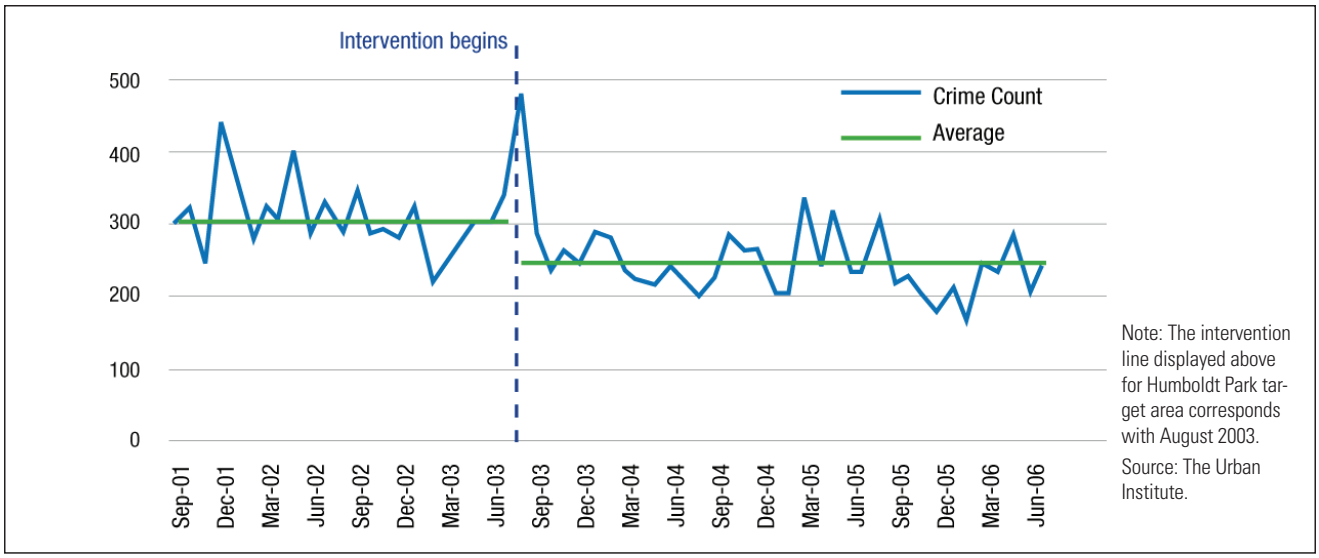
Source: The Urban Institute

†Intervention date occurred during this quarter in August 2003.

*The sum of property and violent crime does not equal total crime. Total crime includes additional crime types that were not included in either of those crime categories, such as drug-related and weapons offenses.

Note: Violent crime included the following offenses: murder, sexual assault, robbery, and aggravated assault. Property crime included the following offenses: burglary, larceny, motor vehicle theft, arson, and vandalism.

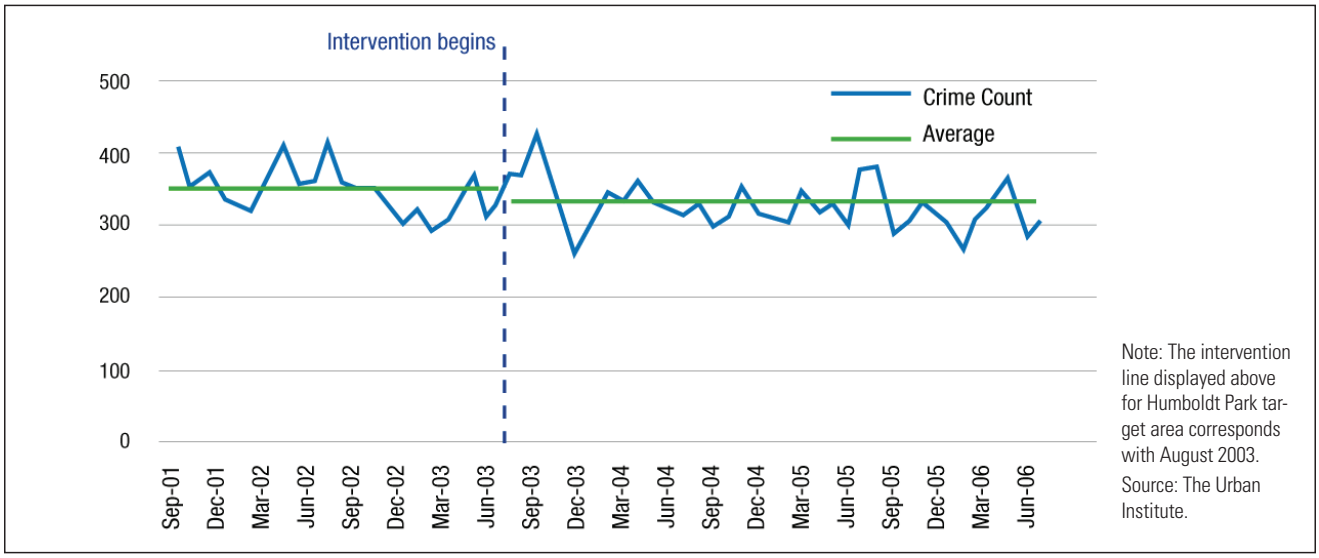
Prior to the installation of cameras, there were two peak periods for crime, one in December 2001 and the other in May 2002. Crime was relatively stable over the next year, with a large decline in crime in February 2003. In the month of August 2003, the area experienced a brief spike in crime, with nearly 500 reported incidents in a single month. Immediately following that month, however, the crime rate in the Humboldt Park area declined and remained lower than pre-intervention months, decreasing by one-fifth (20 percent). As illustrated in Figure 5.2, the difference in monthly crime counts in comparison to the same month in previous years became more pronounced over time. Even among post-implementation months that represented the highest crime counts for the year, those counts were much lower than those experienced in the same months during the pre-implementation period.



Note: The intervention line displayed above for Humboldt Park target area corresponds with August 2003.

Source: The Urban Institute.

Figure 5.2: Crime Trend in Humboldt Park Area, Chicago, 2001–2006



Note: The intervention line displayed above for Humboldt Park target area corresponds with August 2003.

Source: The Urban Institute.

Figure 5.3: Crime Trend in the Comparison Area for Humboldt Park, Chicago, 2001–2006

Statistical Analysis Results

UI analysts used a tiered approach to assess the degree to which cameras had an impact on crime. First, we compared pre- and post-implementation means using independent samples T-tests to determine whether there was change in crime following camera installation. The T-test results indicated that crime significantly changed for five crime categories and the combined category representing all aggregated crime. The categories that declined after deployment of the cameras were burglary, drug, robbery, violent, and weapons-related crime. In order to ascertain what portion of this decline could be linked to the camera installation, the crime categories experiencing significant changes were compared with changes in crime in the comparison area employing DiD analysis (refer to Appendix E for detailed findings). Because the comparison area was chosen for its similarity with the treatment area, it offers a reasonable counterfactual of what would have occurred without the installation of cameras. In fact, in the comparison area, crime declined by approximately 20 incidents per month. These findings indicate that the overall effect

of camera use in the treatment area resulted in a reduction of nearly 12 percent—or roughly 38 fewer incidents per month—when controlling for change in the crime rate in the comparison area.

As depicted in Table 5.2, the DiD analysis revealed a significant decrease in average monthly total crime counts in the Humboldt Park area following camera installation. In addition, the average monthly crime counts for drug-related and robbery offenses were reduced by nearly one-third, with drugs decreasing by more than 30 incidents and robbery by 3 incidents on average. While weapons-related crimes in the camera target area declined by more than half—or roughly two fewer incidents per month—this finding should be interpreted with caution given the low base rate of this crime category. However, the violent crime category also declined significantly by approximately one-fifth, with six fewer incidents on average per month following camera installation. In summary, the decrease in crime in the treatment area, which was significantly greater than that experienced by the comparison area, shows that the Humboldt Park area cameras achieved their desired crime control impact.

*Table 5.2: Significant Changes in Crime, Humboldt Park, Chicago**

Crime Type	Area	Before	After	Change	Difference-in-differences
All Crime	Treatment	301.39	243.53	-57.86	
	Comparison	349.57	330.00	-19.57	-38.30†
Violent	Treatment	33.00	23.19	-9.81	
	Comparison	29.57	25.62	-3.95	-5.87†
Drug	Treatment	115.22	77.31	-37.91	
	Comparison	120.57	116.14	-4.43	-33.49†
Robbery	Treatment	11.52	8.53	-2.99	
	Comparison	11.43	11.61	+0.18	-3.17†
Weapons	Treatment	3.96	2.58	-1.37	
	Comparison	3.78	4.56	+0.77	-2.15†

Source: The Urban Institute

*First camera installation on July 31, 2003 and, therefore, intervention line inserted at August 2003.

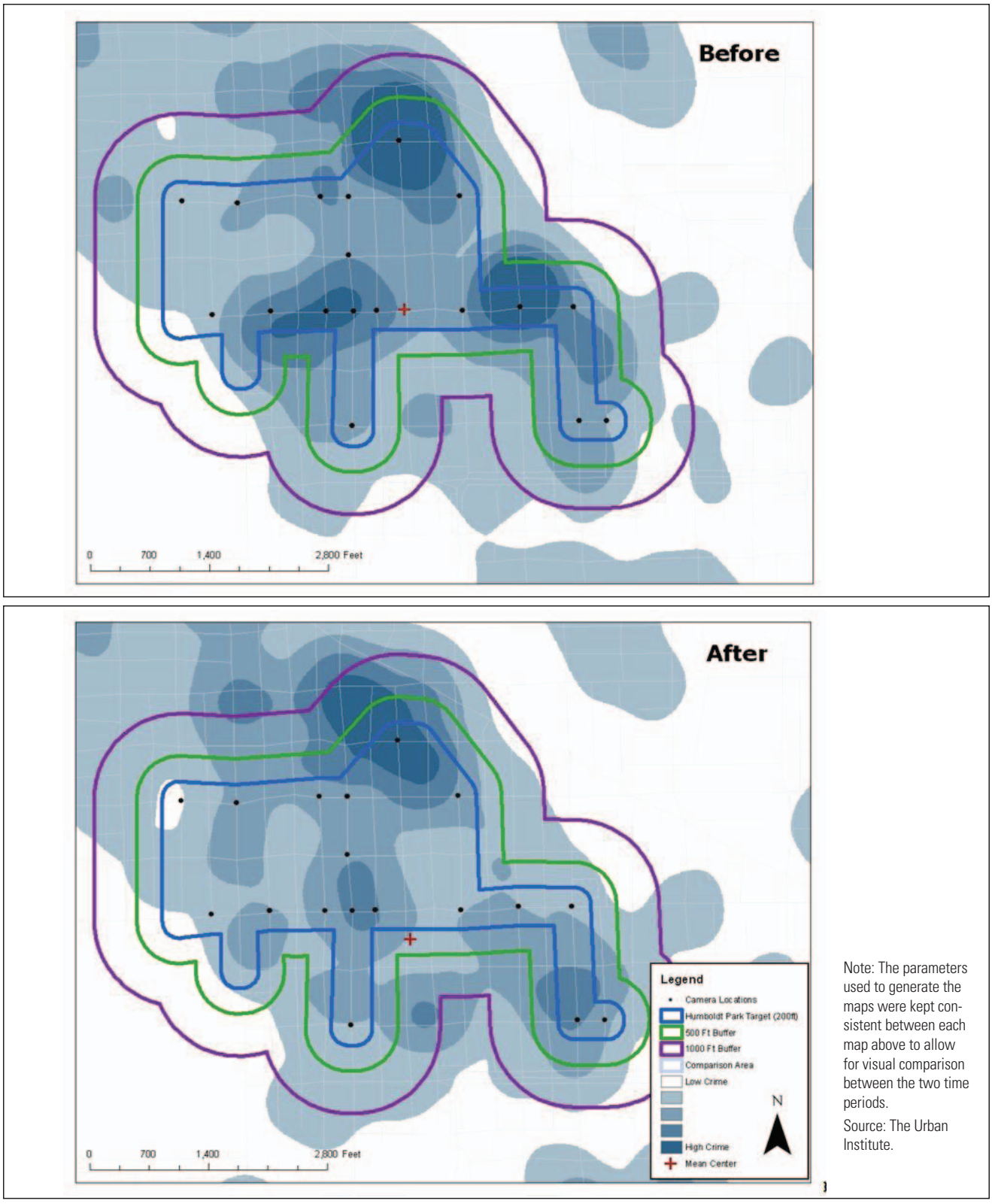
†Significant at $p<.05$.

Diffusion and Displacement

While the impact of cameras on crime in the Humboldt Park area was found to be significant, it was equally important to explore whether the reduced crime simply moved to adjacent areas rather than declining. We also were interested in exploring the possibility of a halo effect or "diffusion of benefits" in areas immediately adjacent to the camera target areas but beyond the camera viewsheds. We therefore identified likely diffusion and displacement areas, with the former being in the 500-ft buffer immediately adjacent to the camera area but beyond the cameras' viewsheds and the latter being in a buffer area 1000 feet around the camera target area. While theoretically we expected the 500-ft buffer to be the likely candidate for diffusion and the 1000-ft buffer a more likely displacement area, our analyses enabled the exploration of both diffusion and displacement effects in both buffer areas. These analyses consisted of density maps of crime locations before and after camera installation, the calculation of WDQ statistics for each crime type, and the use of DiD analysis.

Density Maps

The following kernel density maps (Figure 5.4) depict the concentration crime within a one-mile radius of the Humboldt Park camera area from pre- to post-implementation periods. The level of crime was displayed on a spectrum of blue with the deeper colors representing higher crime concentrations and the lighter blue and white represent the lowest levels of crime within one mile of the Humboldt camera area. These maps show crime most



Note: The parameters used to generate the maps were kept consistent between each map above to allow for visual comparison between the two time periods.

Source: The Urban Institute.

Figure 5.4: Change in Density of Crime, Humboldt Park Area, Chicago

densely concentrated in three areas, but the entire target area covered with higher levels of crime than the surrounding area. All three hot spots experienced change following camera installation with the two southern most spots disappearing and mirroring the level of crime in the rest of the area and the northern hot spot dropping two levels in the spectrum of crime. Overall, the shades of blue across the area became lighter following camera deployment showing a reduction in crime for the majority of Humboldt Park. The mean center moved south approximately half a city block and into the buffer area. Whether this shows displacement of crime is further investigated below in the more rigorous spatial analysis.

WDQ and DiD Analyses

The statistics generated by the WDQ include a success measure to determine if crime declined in the target area and if so, an estimate indicating whether crime was displaced into either of the buffers. These quotients were calculated over varying lengths of time pre- and post-implementation and by crime type. We examined three lengths of time—12, 18, and 24 months pre- and post-camera installation—for each crime category that was found to be significant in the DiD analyses above.

As illustrated in Table 5.3, WDQ results confirmed the previously reported DiD evidence of success in the target area. Each success measure had a negative value for all crime types presented and for each evaluation period, indicating that crime decreased in the target area compared to the control area. For all aggregated crime, some of the benefit in the target area spanned both 500 and 1000 feet buffers in the first 12 months. However, over time, the benefit was confined to the 500-ft buffer and by 18 months post-implementation, crime increased in the 1000-ft buffer. In addition, the WDQ results indicate that violent crime reduced in the target and buffer areas for all three time periods.

Table 5.3: Weighted Displacement Quotient Results - Humboldt Park Area, Chicago

					WDQ	
Pre/post length	**Type of crime**	**t_0**	**t_1**	**Success measure**	**500'**	**1000'**
12 mo.	All	08/2002-07/2003	08/2003-07/2004	-0.10	0.08	0.54
	Drug			-0.11	-0.07	0.79
	Robbery			-0.31	-0.13	0.49
	Violent			-0.26	0.05	0.48
	Weapon			-0.63	0.20	-0.05
18 mo.	All	02/2002-07/2003	08/2003-01/2005	-0.10	0.35	-0.17
	Drug			-0.24	0.52	-0.18
	Robbery			-0.35	-0.13	0.29
	Violent			-0.24	0.12	0.33
	Weapon			-0.44	0.41	0.49
24 mo.	All	08/2001-07/2003	08/2003-07/2005	-0.11	0.21	-0.32
	Drug			-0.27	0.33	-0.31
	Robbery			-0.26	-0.07	0.10
	Violent			-0.21	0.16	0.12
	Weapon			-0.51	0.50	0.75

Source: The Urban Institute

*First camera installation on July 31, 2003 and, therefore, intervention line inserted at August 2003.

Drug-related offenses followed a slightly different pattern. Although the WDQ indicated success in the first 12 months in the target area, there was an initial increase in drug-related crime at 500 feet. This initial sign of displacement is not detectable at 18 months post-implementation and rather signs of diffusion were found and continued after 24 months post-implementation. At 1000 feet, this pattern is somewhat reversed. At 12 months post-implementation the WDQ indicates a diffusion of benefits at 1000 feet, but after 18 to 24 months of the cameras being in place, this area experiences some signs of displacement. These findings may be the result of targeted police efforts beyond the cameras, with an increase representing an increase in law enforcement's detection of narcotics transactions.

In the case of robberies, the WDQ results revealed that although robberies declined in the target area, they increased within 500 feet throughout the 24-month post-intervention period. However, these potential displacement effects did not extend as far as 1000 feet. In fact, the outer buffer experienced a diffusion of benefits during that same time period. These findings should be viewed with caution, however, as the frequency of robbery in the area is extremely low. In fact, the frequencies for weapons offenses were even lower, rendering the use of WDQ futile.

In summary, WDQ generally indicated signs of diffusion with a few instances of displacement. However, while WDQ is a method that is increasingly employed in spatial analyses of crime,[96] the method itself does not yield definitive findings due to the lack of any measures of statistical significant. We are therefore more confident in findings generated from DiD. When applying DiD to buffer areas, any increases or decreases observed following camera installation were not found to be statistically significant following camera installation. It is therefore prudent to conclude that whilst cameras had an impact on crime in their intended sphere of influence, no compelling evidence exists to indicate either a diffusion of benefits or the displacement of crime to adjacent areas.

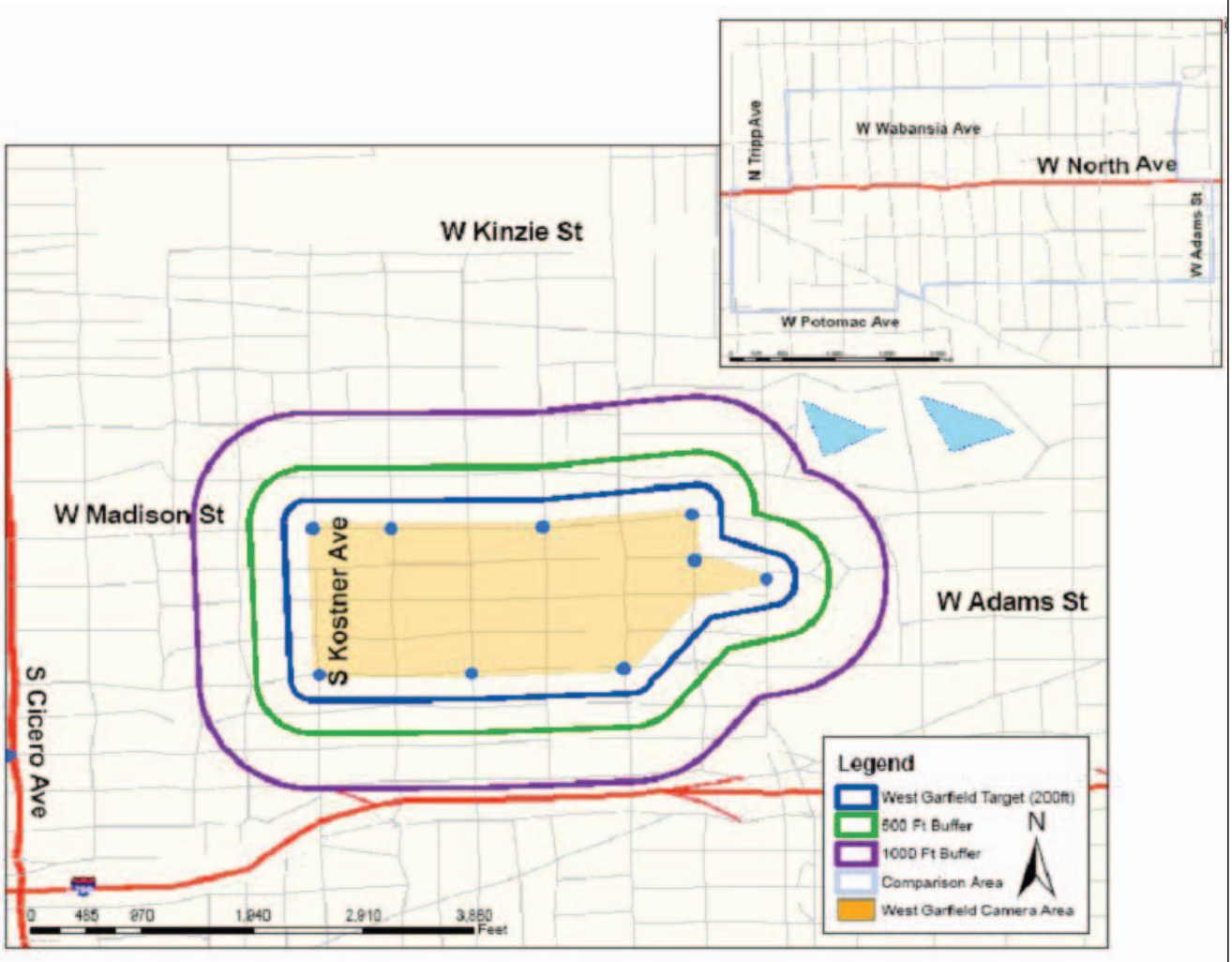
West Garfield Park Area

The second area included in the analysis for Chicago, West Garfield Park,[97] is located between West Madison Street to West Jackson Boulevard, from South Kostner Avenue to South Hamlin Boulevard. Within this area is a cluster of nine cameras that were all part of the initial wave of installation in August 2003. Following the same method that was used in the other impact evaluation sites, a polygon was drawn around the cameras and then a 200-ft buffer surrounding that area was created to designate the "treatment area." As shown in Figure 5.5, the lines do not exactly follow the city blocks, but were designed to capture the full viewshed of each camera within the 200-ft zone. West Garfield Park is located in the 11th Police District of Chicago, where police heavily focus on narcotics offenses. In comparison to the Humboldt Park site discussed above, the lots are larger and the area overall is less densely populated with structures. This area is mainly residential with West Madison Street, located on the Northern border, being the primary commercial corridor in the area. This commercial strip is not densely populated with businesses; many of the storefronts have bars covering their windows or are boarded up. The type of housing in this neighborhood is quite similar to Humboldt Park, with a dense mix of single family homes, townhouses, and small, multi-family apartments.

The comparison area is defined by Census Block Group boundaries, with the selection of block groups based upon similarities to the target area in land use, historical crime rates, and socio-economic measures. The comparison area is split between the neighborhoods of West Garfield Park and South Austin, and extends from West Bloomingdale Avenue to West Kamerling Avenue and North Kildare Avenue to North Homan Avenue. This area is mainly residential with two commercial strips, West North Avenue and West Grand Avenue (see Figure 5.5). Similar housing is found in this area compared to the target area, with an abundance of single and multi-family homes characterized by row homes mixed together with smaller, detached structures. This area is located in the 25th Police District, where much of the police efforts are focused on narcotics along with gang activity.

96. Cahill, Meagan, Samantha S. Lowry, and P. Mitchell Downey. 2010. "Moving' Out: Crime Displacement and HUD's HOPE VI Initiative." Washington, D.C.: The Urban Institute.; Costanza, S. E., Ronald Helms, Shamir Ratansi, John C. Kilburn Jr., and John E. Harmon. 2010. *"Boom to Bust or Bust to Boom? Following the Effects of Weed and Seed Zoning in New Britain, Connecticut, from 1995 to 2000"*. Police Quarterly, March, Vol. 13 Issue 1, 49–72.

97. Given that the majority of the target area and surrounding buffers were included in the neighborhood of West Garfield Park, we refer to this area as West Garfield Park throughout this analysis.



Source: The Urban Institute

Figure 5.5: Map of West Garfield Park Camera Area, Baltimore

Crime Trends Before and After Camera Installation

Over the course of the evaluation period, crime did not greatly fluctuate in the West Garfield Park area, which experienced an average of approximately 190 incidents per month. As illustrated in Table 5.4, in the two years leading up to camera installation, crime in both West Garfield and its comparison area was relatively stable, and both sites had roughly equal percentages of violent crime (13.8 percent on average for the treatment area versus 11.6 percent for the comparison area). Figure 5.6 shows that over time crime increased 18 months following camera installation. Crime initially declined following camera deployment, with December 2003 marking the lowest monthly average over the evaluation period. Beginning in 2005, the average monthly crime rate increased and for nearly every month through June 2006 crime counts were above the post-installation average. The driving force behind this average was violent crime, which accounted for nearly one-third of the incidents in the area, and another quarter of the monthly average is due to drug-related offenses.

Table 5.4: Quarterly Crime Counts in West Garfield Park, by Crime Type and Area

	2002				2003			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Property Crime								
Treatment	135	142	139	108	104	132	138	142
Comparison	229	262	336	299	221	274	421	245
Violent Crime								
Treatment	69	78	85	83	53	78	74	63
Comparison	61	76	110	74	63	86	58	72
Total Crime*								
Treatment	532	571	556	508	484	537	527	481
Comparison	507	625	775	617	562	721	771	606

Source: The Urban Institute

†Intervention date occurred during this quarter in August 2003.

*The sum of property and violent crime does not equal total crime. Total crime includes additional crime types that were not included in either of those crime categories, such as drug-related offenses.

Note: Violent crime included the following offenses: murder, sexual assault, robbery, and aggravated assault. Property crime included the following offenses: burglary, larceny, motor vehicle theft, arson, and vandalism.

Statistical Analysis Results

The first component of the West Garfield Park impact analysis involved a simple comparison of means between the pre-implementation period, from September 2001 through July 2003 (preceding the August 2003 camera installation date) and the post-intervention period, spanning August 2003 through July 2006. When examining the mean change before and after camera installation using independent samples T-tests, we found that only prostitution and robbery significantly changed, with prostitution increasing and robbery decreasing. Inside larcenies followed close behind and would have been significantly reduced if a more liberal confidence threshold ($p < .10$) had been employed, with an estimated 22 percent change. However, these findings are not persuasive in the absence of a comparison area to control for other factors that may be influencing the crime rate. Employing DiD analyses for the two crime categories for which comparisons of means indicated a significant change, we found that both prostitution and robbery were no longer significant (refer to Appendix E for detailed findings). Thus, the change in crime for both crime categories may be attributable to the fluctuation of crime in the area rather than as a result of the cameras themselves.

However, given the strong crime prevention impact that cameras had in Humboldt Park, we explored in more detail the differences between Humboldt Park and West Garfield Park that might explain why cameras had an impact in one area and not another. One possible explanation for the difference is that cameras were employed by law

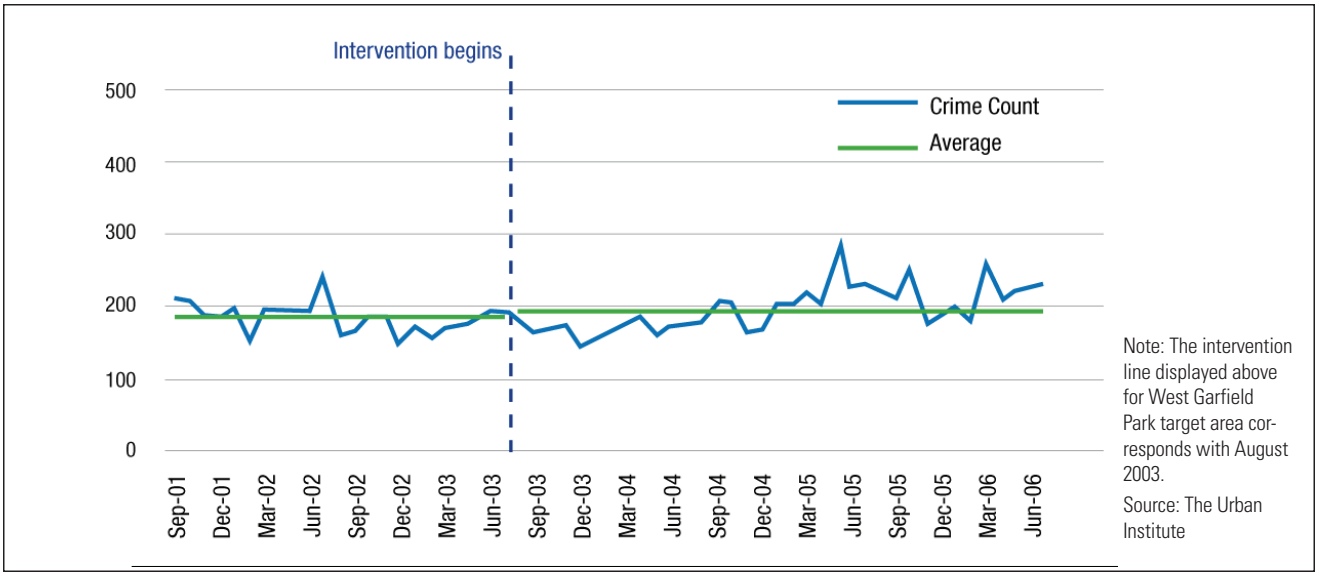


Figure 5.6: Crime Trend in West Garfield Park, Chicago, 2001–2006

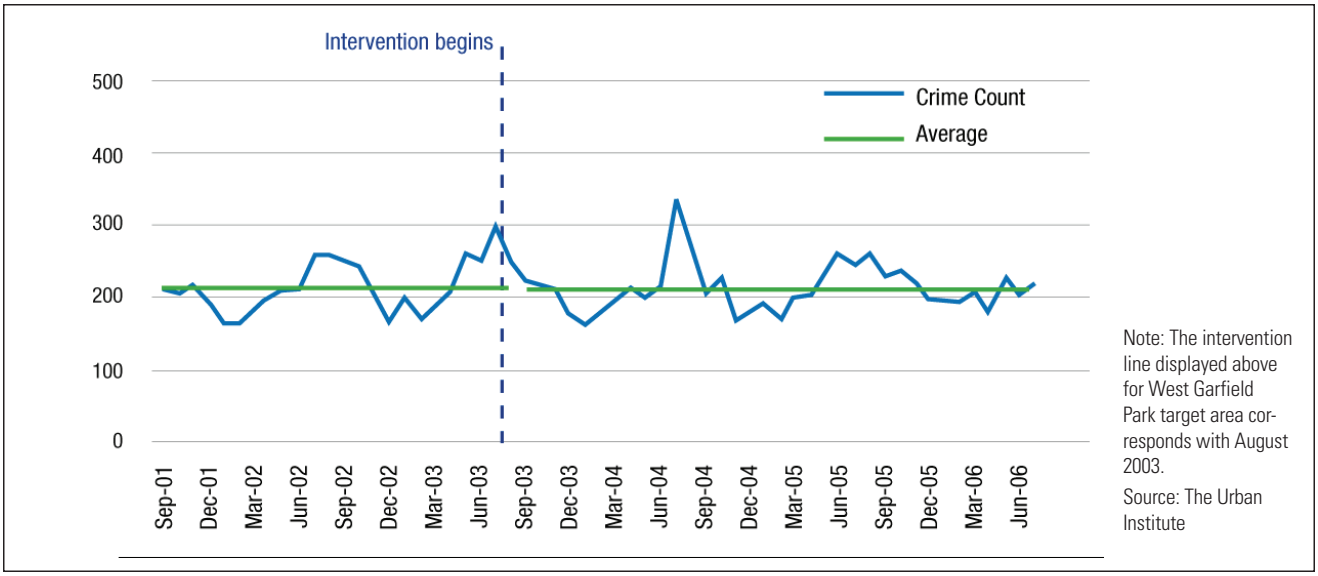
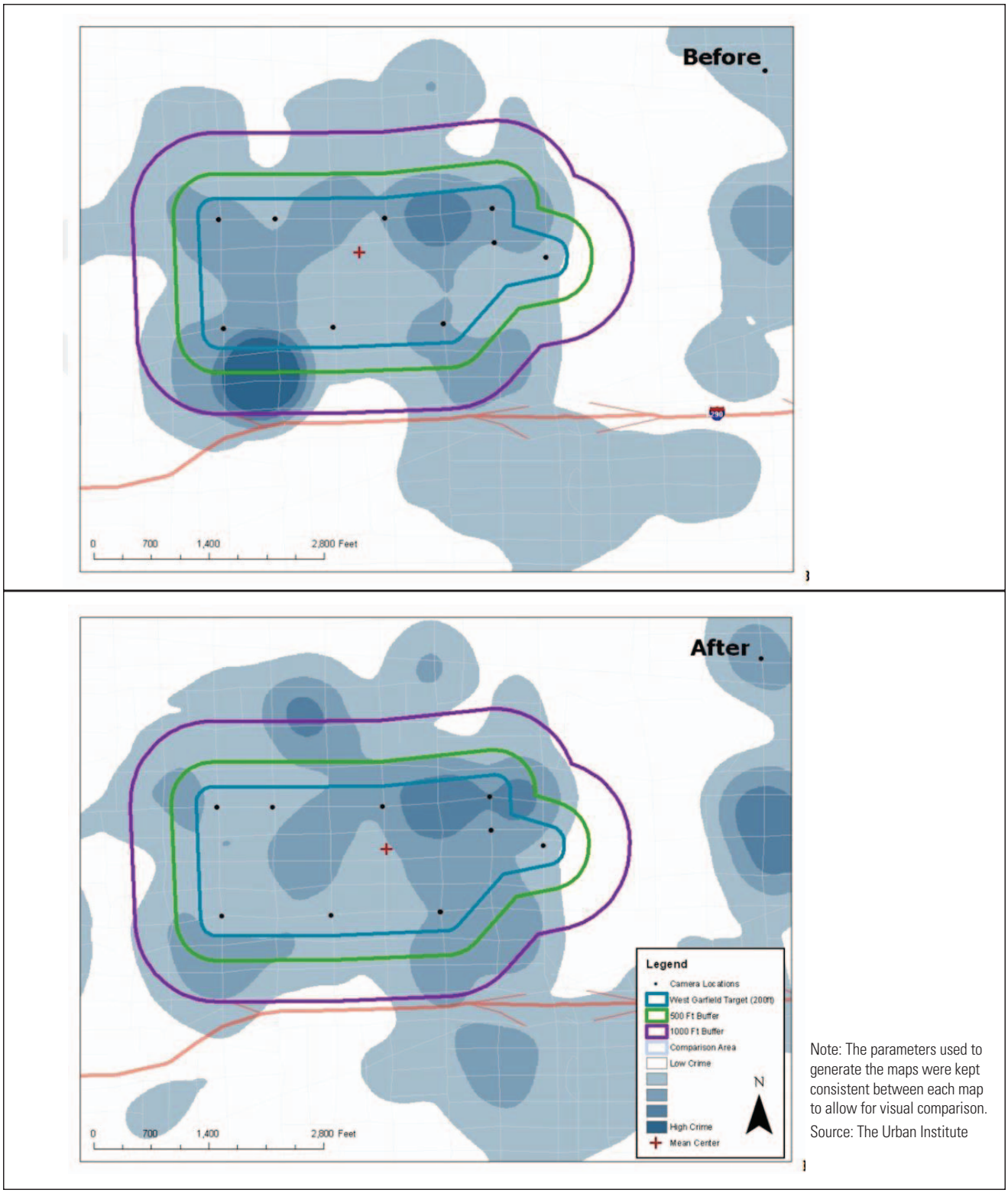


Figure 5.7: Crime Trend in Comparison Area for West Garfield Park, Chicago, 2001–2006

enforcement differently in the two sites. However, both areas are housed in the same police district with the same leadership, suggesting that use of cameras is similar in the two areas. Perceptions of West Garfield Park residents, however, suggest differently; one community advocate shared that it is her opinion and that of her neighbors that police do not watch the cameras in West Garfield Park.[98] Another possible reason for the difference in impact between Humboldt Park and West Garfield Park is the concentration of cameras. The Humboldt Park area has a much higher concentration of cameras (approximately 53 per square mile) compared to West Garfield, at approximately 36 per square mile. This difference in camera saturation could have an impact on the degree to which cameras are able to catch crimes in progress and thus officers to intervene, make arrests, and deter other potential offenders.

98. Email communication between Nancy La Vigne and Lola Chen, August 30, 2010.



Note: The parameters used to generate the maps were kept consistent between each map to allow for visual comparison.
Source: The Urban Institute

Figure 5.8: Change in Density and Mean Center of Crime, West Garfield Park Area, Chicago

Diffusion and Displacement

Given that the DiD results revealed that crime did not significantly change in the target area, we did not test for diffusion or displacement effects. Theoretically, we would not expect crime to be reduced or moved to nearby areas given that crime in the target area did not change. However, for general descriptive purposes the kernel density maps depicted in Figure 5.8 show that crime is moving between the pre- and post-intervention periods. Crime shifted from the Western portion of the area to the Eastern side, but the two highest crime areas were decreased. The large hot spot on the Southern border was completely removed from that area. The mean center shifted very slightly to the Southeast by half of a city block. This shows that crime is moving to the areas that are now a darker shade of blue along the Southeast side of the camera area, suggesting but not confirming that a marginal degree of spatial displacement occurred.

Cost-Benefit Analysis

Given the impact analysis results indicating significant reductions in crime in one area and no reductions in the other, a cost-benefit analysis is particularly critical in understanding the degree that such inconsistent impacts are worth the city's investment of resources. The following are the results of an analysis of Chicago's costs of camera implementation, monitoring, and maintenance, along with the quantification of dollar savings associated with crimes prevented in the Humboldt Park area.

Table 5.5: Chicago Camera Costs

Type of Cost	Cost ($)
Initial Start-Up	1,431,000
Maintenance	1,713,000
Personnel	3,341,000
Non-Labor	361,000
Total	**$6,846,000**

Source: Chicago Police Department. Costs compiled by Urban Institute staff by type and across years. Costs incurred from Inception to August 2006.

Costs

To compare—the total costs associated with Baltimore's surveillance camera initiative as of August 2006 were $6.8 million. Unlike Baltimore, the majority of Chicago's costs were related to personnel. Initial start-up (including camera purchases), maintenance, and non-labor costs represent the remaining 50 percent of Chicago's costs.[99] Stakeholders in Chicago provided the number of full time employees (FTEs) working with the camera surveillance system on a monthly basis and the number of hours these individuals work on it. Two main types of individuals work with CPD's camera system: officers who engage in the monitoring, and supervisors who oversee the monitoring. Because we were unable to obtain the fully-loaded wage rate for these individuals, we instead employed the average wage rate for a patrol officer and a sergeant[100] in Chicago as proxies for monitors and supervisors, respectively. Chicago contacts were also unable to provide historical data for their camera maintenance costs. To account for these costs, the per camera maintenance costs derived in Baltimore were used as a proxy for Chicago costs. While imperfect, we believe that if anything, this proxy overestimates the costs of Chicago's cameras, generating a more conservative estimate of the degree to which cameras are cost-beneficial.[101]

99. The large difference between the initial costs and overall cost estimates documented in Baltimore as compared to Chicago is attributed to the fact that the Baltimore camera costs represented four neighborhoods as opposed to two neighborhoods in Chicago.

100. Based on Bureau of Labor Statistics data for 2009.

101. Because Chicago's system was created earlier and is much larger than Baltimore's, it is likely that Chicago has become more efficient in its maintenance activities and thus more effective in containing its maintenance costs over time.

Finally, non-labor costs accounted for the remainder of Chicago's expenses on the cameras associated with the study areas. These costs typically include monitoring terminals, software, and other complementary equipment and wiring, along with facility costs. However, the non-labor costs referenced in Table 5.5 do not include facility costs due to the fact that in Chicago the facilities in which the terminals are installed serve multiple purposes. Interviews with stakeholders indicate that were Chicago to not have a camera surveillance system, the city would still employ the same buildings of the same sizes, and those spaces would not have been used for other department activities. Thus, because the opportunity cost for using monitoring space is zero, cost estimates for the facilities that house the monitoring terminals are not included in the analysis. Indeed, the vast majority of monitoring occurs via individual law enforcement officers' desktop computers. Although these terminals and other equipment incur some electrical and other costs that would not have been incurred but for the camera surveillance system, we believe these costs to be nominal and therefore have been similarly excluded.

Benefits

The process for estimating the cost of crime in Chicago mirrors the one employed for the Baltimore analysis described earlier in this report. With the exception of the violent crime category, the non-aggregated crime categories were scaled up when monetized, as the conversion from counts to dollars does not introduce any additional variation. The violent crime category, however, required the disaggregation of violent crime by type in order to ensure an accurate quantification of potential savings. We therefore explored whether violent crime becomes a category that changes significantly when monetized.

Table 5.6: Chicago Humboldt Park Difference-in-Differences Results with Benefit Estimates

	Estimated Benefit per Month		
Offense	Target Area	500-ft Buffer	1000-ft Buffer
Drug	-$368,072.73*	-$1,739.04	$174,663.98
Robbery	-$383,218.31*	-$5,547.09	-$78,541.69
Weapon	-$65,328.50*	-$38,748.60	-$44,557.16

Source: The Urban Institute.

* Significant at the 0.05 level and included in the cost-benefit estimation.

Note: As previously mentioned in the impact section, weapons-related offenses were rare for this area causing the N to be quite low. Given that monetization of these offenses greatly increases the weight of each offense, this category was included in the analysis, which is consistent with the DiD findings in the impact analysis section.

As described in the *Camera Impact Analysis* section, in Chicago's Humboldt Park, three of the ten offense categories had statistically significant changes between pre- and post-intervention areas when compared to the comparison area. As Table 5.6 depicts, these offenses were drug, robbery, and weapons crimes. For those offenses that had a significant result in the target area, we examined the results in the 500-ft area and 1000-ft areas in order to quantify potential costs or benefits associated with the diffusion or displacement of crime. However, there were no statistically significant changes in these areas for those crime categories. In Chicago's West Garfield Park, none of the crime categories had statistically significant changes, even after conducting a re-analysis of violent crime in its monetized form (refer to Appendix F for detailed findings). Thus, we cannot calculate any benefits—positive or negative—to using cameras in this neighborhood. However, when calculating the benefit-to-cost ratio of Chicago's camera investment, the costs associated with operating the camera system in West Garfield Park are nonetheless included, rendering a conservative estimate of the degree to which Chicago's cameras are cost-beneficial. Indeed, during interviews, Chicago stakeholders providing cost information could not differentiate costs associated with the Humboldt Park cameras from those associated with the West Garfield Park cameras, justifying the decision to include costs for both camera areas, despite the fact that benefits were only experienced in Humboldt Park.

To calculate the total benefits, we aggregated the significant offense types, in this case the benefits observed in Humboldt Park, for drug, robbery, and weapons crimes (see Table 5.7). Chicago's costs were approximately $6.8 million over 36 months, approximating $190,000 per month. To calculate the benefit-to-cost ratio, we divided the total benefits by the total costs. Using this technique, we are able to estimate the amount of benefits received, if any, for every dollar spent on costs. Thus, to break even, the monthly benefits would need to be at least $190,000 and would have to exceed that figure for there to be a cost-beneficial finding for surveillance camera implementation. Chicago's estimated monthly savings—its benefits—from increased public safety and improved criminal justice responses as well as prevented harms to victims, is approximately $815,000. Dividing $815,000 by $190,000 results in a benefit-to-cost ratio of approximately $4.30. In other words, for every dollar spent on cameras in both Humboldt Park and West Garfield Park areas, the crimes prevented in Humboldt Park alone yielded a societal savings of over $4.00. Even when excluding victimization costs from the analysis, the public safety system benefits of camera use in Chicago still outweigh the costs, at a ratio of $2.81 in benefits for every dollar spent on cameras (representing a reduction in average monthly savings from $815,000 per month to $533,000 per month). Our results, in summary, provide compelling support for the implementation and use of public surveillance cameras by the Chicago Police Department.

Table 5.7: Significant Values of Averted Crime per Month, by Location and Crime Category, Chicago

Location	Offense	Target	500-ft Buffer	1000-ft Buffer
Humboldt Park				
	Drug	-$368,072.73	-	-
	Robbery	-$383,218.31	-	-
	Weapon	-$65,328.50	-	-

Source: The Urban Institute.

Challenges and Lessons Learned

While cameras are viewed by the vast majority of Chicago stakeholders as a useful tool for law enforcement and prosecution, several unanticipated challenges and costs were encountered both before and after implementation, many of which can help inform other jurisdictions' efforts to invest in and use cameras effectively. These experiences can be summarized into technological challenges, limitations in use and effectiveness, and lessons learned.

Technological Challenges

One of the greatest initial challenges in Chicago's camera investment efforts was the development of a fiber infrastructure, which delayed installation and increased the cost from initial estimates. Nevertheless, this choice is not without its benefits; the infrastructure enables the simultaneous viewing of cameras from as many locations as CPD desires. In fact, the utility of the investment in the fiber network is illustrated by the challenges experienced early on with the stand-alone cameras. The hard drives for these cameras required manual replacement in order to avoid their being overwritten. The replacement of hard drives increased technician costs well above original estimates and required an abundance of hard drives so that they could be replaced on an ongoing basis.

The newer wireless cameras were not without problems, however. In order to maintain a feed to a central view station, the antennae on wireless cameras require an unobstructed line of sight to each other. As such, the cameras needed to be built on extremely high structures. In many cases the most convenient structure was a building, which often required the consent of private businesses. In addition, if an area was over-saturated with cameras, the video cannot stream back to the central viewing station due to insufficient bandwidth.

Maintenance costs, while anticipated, where higher than expected for both types of cameras. Not only did the cameras require routine maintenance, but adverse weather, traffic accidents involving the structure to which cameras are affixed, and vandalism to the cameras required their being serviced more often than originally anticipated.

Limitations

Perhaps the greatest limitation to cameras cited by those engaged in their use was image quality. In the event that a camera clearly captured a crime completely and was crisp enough to identify the offender, victim, and/or witnesses, it was quite literally viewed by investigators as the next best thing to a "smoking gun," resulting in a prompt arrest and nearly certain conviction. However, this is rarely the case. Both investigators and prosecutors lamented the fact that video quality is often poor, rendering the identification of suspects and witnesses difficult and making a less than persuasive case in trials.

Even when footage is clear enough for use in the courtroom, prosecutors referenced the "CSI effect" as hampering their cases. Their belief is that jurors, having been influenced by unrealistic forensic science television programs, expect more sophisticated camera footage than can possibly be produced given current technology and resource limitations. And, in the absence of camera footage, jurors may interpret the lack of such evidence as casting doubt about the guilt of a defendant.

Lessons Learned

Among the many lessons learned from Chicago's experiences, three rise to the top: the importance of including citizens in the planning stages of camera implementation; the need for more training of attorneys in the use of camera footage in court; and the judicious integration of cameras with other new crime control technologies.

Those involved with the implementation and use of cameras in Chicago noted that earlier gains could have been made had planners more effectively incorporated the ideas and concerns of the mayor, law enforcement, and members of the community. When cameras were placed in neighborhoods, many citizens and community groups were upset for a variety of reasons; however, once law enforcement and city representatives worked with them, these issues were resolved. This suggests that simple solutions, such as public hearings, community meetings, and efforts toward transparency on the front end will prove dividends at the back end. Creating an operational and effective public surveillance system is a large undertaking, and it should be made with all members jointly committed to its success.

More thorough and consistent training of both prosecutors and defense attorneys in the use of the public surveillance system is another suggestion that emerged from Chicago's camera stakeholders. Attorneys could benefit from guidance in how to effectively incorporate this technology into a case. While some prosecutors have worked with the police department in getting an overview of the system, additional training in software use, system capabilities, and strategies for presenting this evidence at trial would be useful for future cases.

A final lesson learned is to approach the integration of cameras with other technologies with discretion. While gunshot detection devices and video analytics may be among the newest and hottest crime-fighting tools, practitioners cautioned against becoming overly enamored with the promise of these technologies prior to gaining a complete understanding of their costs and limitations. Careful decisions need to be made, weighing the costs of these tools against their capabilities, and including the consideration of how long they will yield benefit before they become obsolete due to ongoing advancements in technology.

Chapter 6.
Washington, District of Columbia

As the nation's capital, Washington, D.C., is naturally a vulnerable homeland security target. As such, the city was an early adopter of public surveillance technology for national security purposes, installing several cameras in 2002 that are employed for special events. Washington's investment in cameras for crime reduction purposes occurred more recently, prompted by the occurrence of 14 slayings in the first 11 days of July 2006. Then-Chief Charles Ramsey, a national leader in law enforcement known for his support of community policing and proactive crime control efforts, partnered with then-Mayor Anthony Williams to declare a "crime emergency." The crime emergency afforded Chief Ramsey extraordinary latitude to assign police officers to overtime shifts, put desk officers on the street, impose a curfew, and implement broad new initiatives that could bypass normal contractual vetting processes. Among the strategies implemented during this crime emergency was the planned installation of public surveillance cameras in neighborhoods identified as crime hot spots based on the number of violent crimes.

Purpose of Camera Investment

At the time of the crime emergency, in the summer of 2006, D.C. already had the benefit of lessons learned from the installation and use of the Department of Homeland Security-funded surveillance cameras installed four years earlier to enhance security during special events, such as economic summits, protests, and presidential inaugurations. These cameras, however, were installed near federal buildings, national monuments, and other high-risk targets and are not typically employed when such events are not in progress. The initial goal of the camera system proposed by the Washington Metropolitan Police Department (MPD) in 2006 was to create a surveillance network that would have a direct impact on crimes occurring in specific city neighborhoods. Thus, they sought to implement cameras in neighborhoods with high volumes of violent crime in order to reduce street crime quickly and improve neighborhood safety. Together with an immediate impact from being able to catch a criminal in the act, the cameras were also intended to reduce crime by recording evidence for later use in investigations and prosecutions.

Setting the Groundwork

The crime emergency of 2006 afforded Chief Ramsey the opportunity to fulfill his long-held wish of implementing a camera system under the control of the police department. A proposal to fund such a system had been submitted earlier that year, but it failed to garner the necessary support from the city council. The crime emergency, however, enabled Chief Ramsey to persuade the city council to dedicate a large share of funds from the Crime Emergency Act budget to the camera effort, while also circumventing typically lengthy procurement procedures. In addition, concerns about the wave of violent crime helped increase support for the camera initiative among both the police and the public.

The city's police department and mayor's office were the most active entities engaged in setting the groundwork for the implementation of the public surveillance system. These efforts were aided by the Office of the General Counsel, which evaluated the legality of a public surveillance system, assessed obstacles, and addressed concerns about governmental intrusion in public spaces. According to police staff involved in the camera implementation, while some city council members initially did not support the camera system due to concerns that the cameras would be an intrusion or would be misused, many local residents demonstrated support for camera installation. With city funding and widespread buy-in from city constituencies, MPD secured the necessary support for the rapid procurement and installation of the neighborhood camera system.

Planning and Procurement Process

In the early stages of planning in 2006, MPD staff examined public surveillance systems in other cities, including Baltimore and Chicago, to learn what technology and regulations were in use. Staff conducted an expedited review of available technology and determined that the most desirable system would be composed of: (1) wireless cameras[102] with pan, tilt, and zoom features capable of providing quality images both during the day and at night; (2) all-weather bulletproof casings for the cameras; and (3) a network allowing for images to be downloaded remotely. The city issued a public procurement for this envisioned system, and two companies formally bid for the contract. The company that was selected met the technical specifications and was already providing services to other agencies in the city. Importantly, it was also the only vendor willing to guarantee that cameras housed in vandal-proof cases would not be too heavy for the poles specified by the city for mounting. Cost was less important than technical specifications in the bidding process, as the city council had ample funds through the Crime Emergency Act and the Mayor advocated allocating this money for camera implementation.

Given the perceived urgency of the crime problem and the latitude afforded to decision-makers based on the Crime Emergency Act, the entire planning and bidding process, including some initial camera installations, was completed in just 38 days. This ambitious timeline necessitated some compromises along the way. Since the vendor did not have the necessary quantity of cameras on hand, cameras were delivered and installed as the vendor produced them. By September 2006, the first wave of 48 cameras had been installed in the city. A second phase of installation starting in June 2007 added 25 more cameras to the system, bringing the total to 73.

Despite the speed with which the cameras were installed, great care was taken to develop rules and regulations surrounding camera use. Strict regulations were intended to both prevent system abuse and be responsive to concerns of those members of the community who voiced skepticism about the degree to which privacy would be protected. While there was a great demand for cameras from the community, their installation remained contentious because the cameras were to be placed in residential neighborhoods. Those involved in camera implementation met this challenge through transparency, public outreach, and the credibility established by the successful operation of the preexisting homeland security camera system. The city council passed the guidelines for camera use after receiving input from the public and a number of interest groups, including the ACLU and American Bar Association, during a series of open hearings and through a Public Review published in the D.C. register. The regulations specify that camera monitors only view public space, may not focus on any flyers or handbills (to protect First Amendment rights), and may not focus on individuals based on their race, gender, sexual orientation, disability, or other distinguishing characteristics.

Camera Specifications, Placement, and Visibility

In keeping with the spirit of transparency embodied in the city's camera use guidelines, implementers chose to make all of the 73 cameras in the first two implementation phases as visible as possible, with signs posted near the cameras to alert passersby that a camera is present and recording. In addition, the general locations of public surveillance cameras are published on MPD's website. The cameras themselves are housed in large marked boxes with the police logo stamped on the side. Many cameras are further identified by a small flashing blue light.

Camera placement was determined based on the input from a variety of stakeholders. MPD's crime analysts created violent crime density maps to identify hot spots and suggest camera placements within a 3- to 4-block radius of those areas. District commanders, with input from neighborhood councils and citizens, also offered suggestions regarding the optimal placement of cameras in their districts. The city council member from each district then reviewed the proposed camera placement(s) and had to approve the location(s). Information and technology (IT) staff from the police department then visited the potential sites with the vendor to assess location feasibility based on

102. While the cameras that were implemented in D.C. had wireless capabilities, the camera system itself was not initially wireless, as no wireless network existed at the time of implementation and none could be built within the restricted timeframe. Images were recorded on a 10-day loop to a DVR in the camera itself. Now that a wireless network has been established, many, though not all, of the cameras transmit footage to the command center.

infrastructure requirements. Infrastructure considerations included appropriate mounting areas, a good line of sight for wireless connections, an adequate camera viewshed, and access to a power source. Placement recommendations were then compiled into a memorandum sent to the Chief of Police, who made final placement decisions.

This careful multi-tiered process, involving all relevant stakeholders, may explain why few cameras have been moved from their original placements. Indeed, it is much more common for the city to install new cameras than to move existing cameras. However, due to limited resources, camera installation has not kept pace with community demands.

Camera Use and Monitoring

While cameras were implemented in D.C. neighborhoods as early as August 2006, active monitoring did not begin until the fall of 2007, at which point Chief Ramsey's successor, Chief Cathy Lanier, had already taken over leadership of the department. The extent of active monitoring of these cameras, however, is limited: only those cameras currently connected to the wireless network that feeds into the command center can be actively monitored. While that amounts to approximately 23 video feeds that are piped into the command center, only 16 feeds can be observed at any given time. When not undergoing active monitoring, the cameras follow a tour set by IT personnel and a detective at the time of installation. The following sections describe the active and passive monitoring activities employed by MPD and its partners.

Active Monitoring and Real-Time Arrests

Active monitoring only takes place in a single location—the control center that is employed to monitor cameras and other alert technology, such as ShotSpoter.[103] Those engaged in active monitoring are all sworn personnel, and they, along with other officers working in the control center room, must sign a statement acknowledging the rules protecting the privacy rights of those being monitored. Monitoring procedures require that a sworn MPD staff person at the rank of Lieutenant or higher be present in the monitoring room at all times. This protocol was developed to alleviate any concerns regarding misuse of the system by monitors or other MPD staff and to remind those viewing the footage to follow the guidelines set forth to protect citizens' privacy. Up to two staff persons serve as monitors on each shift. During a typical shift, one monitor watches four to five cameras while the other works primarily with other crime-alert technology in the room, such as ShotSpotter. In some cases, patrol officers and investigators coordinate with camera monitors to record planned activities, but this synchronization is not common. Monitors are not provided with instructions regarding what to watch and can only be requested to watch specific cameras by prior approval. If the monitors observe suspicious or criminal activity, they call the nearest responder and speak to him or her on a tactical channel or contact officers in the field by email.

The city does not have technology to mask areas of the camera's view and instead relies on officers following the strict monitoring regulations. If any misuse is suspected, it is reported through established internal affairs procedures. Command staff initially took part in a detailed training process with the expectation that they would convey the policies and procedures covered in that training to those who are assigned to monitoring duties. Monitors are required to review the written policies and sign a document indicating they understand and will comply with them. After signing the appropriate paperwork, monitors receive primarily on-the-job training on how to use cameras.

Other technology in the control room includes ShotSpotter, CAD, 911 and 311 call indicators, Amber Alert, and the police radio. If any of these crime alert systems raises an alarm, monitors can type in the address of the incident and determine whether there is a camera in the vicinity. The camera locations, including those that are not actively monitored, are programmed into Google Earth,[104] which enables monitors to quickly determine whether an incident occurred near a camera.

103. ShotSpotter is a network of audio sensors placed throughout the city that registers the sound of gunshots and alerts the central monitoring center. The system approximates the location of the incident by comparing the strength of the sound detected by different sensors.

104. Google Earth is a mapping software application that can be programmed with the location of CCTV cameras and other sensors, such as ShotSpotter. By entering the address of a crime or incident into Google Earth, command center staff can quickly ascertain whether it occurred near a camera, even if that camera is not on the network.

Passive Monitoring, Storage, and Use in Investigations and Prosecutions

Camera footage is stored for 10 days unless needed for evidence or training purposes.[105] As with active monitoring, historical footage may only be viewed if a sworn officer at the rank of Lieutenant or higher is present. To request that footage be kept as evidence, a detective must contact the command center and indicate the desired time span. A technician then burns the video onto a DVD that is stored in the evidence room until the investigator retrieves it. If the camera is not connected to the network, the hard drive must be physically retrieved and brought to the command center in order to make a copy. The video is then included in the case file and officially marked as evidence. DVDs are encrypted and time-stamped to prevent tampering.

If a crime occurs near a camera, investigators will request and review the footage to determine whether the cameras recorded any activity. If the crime itself was not captured, investigators may still be able to use surrounding details to corroborate witness statements or identify possible witnesses. Given the limited number of cameras in D.C., investigators have found that many crimes are not recorded by cameras. Additionally, they are rarely able to observe footage from multiple cameras in the area because it is unusual for more than one camera to be present in any given location. Camera footage is rarely enough to execute a warrant on its own and therefore is typically used in conjunction with other evidence, such as witness statements. For example, witnesses identified through review of camera footage can provide valuable information about an article of clothing worn by the perpetrator, such as a red baseball cap; investigators can search for that cap during the execution of a search warrant.

Prosecutors use the camera in similar capacities, gleaning information from the video on the victim, witness, and perpetrator, such as body language, interactions with others, and any weapon possession in the time surrounding the incident. However, they report that poor-quality images reduce the cameras' utility in court. In court, video evidence is used in conjunction with a representative from MPD, who testifies to the authenticity and accuracy of the footage. Prosecutors expressed that, with the increased use of camera footage in the courtroom, it has almost become a necessity—that, without video evidence, judges and jurors essentially assume the crime did not occur. Given the difficulties posed by the quality of video evidence, prosecutors suggested that it is necessary to think "outside the box" when using the footage, as creativity may allow for even the tiniest piece of evidence to be recovered. However, such creativity is left to individuals, as no formal public surveillance training is offered to investigators or prosecutors. Both groups expressed an interest in learning more about the technology, and prosecutors reported a desire for more guidance on using camera footage as evidence in a trial.

Internal Assessment of Cameras

Those involved in the use of public surveillance in Washington viewed cameras as useful tools in solving crimes, but they underscored that cameras are not *consistently* useful. When the cameras do clearly record a crime or the circumstances surrounding the crime, the footage is powerful and valuable at all stages of investigation and prosecution. In this ideal situation, investigators can more easily locate witnesses and encourage their cooperation, which could significantly reduce investigation time. Prosecutors who have used the footage noted that clear video evidence also reduces case preparation time due both to an increase in the likelihood of pleas and a lower level of effort needed to make a powerful case to a jury, should the case go to trial.

However, both prosecutors and investigators expressed frustration that cameras may record a crime but that the footage of the crime may be of too poor quality to be useful, or that the cameras may be located in the right area but not have captured any useful footage due to the use of the pre-programmed tour function. In addition, they noted that some cameras simply do not work at all. Despite these limitations, those investigators and prosecutors who have used the public surveillance system indicated that the benefits of cameras far outweigh their weaknesses. They noted that these benefits could be further enhanced with upgraded technology that affords the ability to zoom in on details of crime events while retaining image quality.

105. For cameras connected to the network, footage is stored on a hard drive in the command center; for all other cameras, footage is stored on the hard drive of the camera itself and must be manually retrieved.

Members of the police department also touted the system's value as a crime deterrent, though some raised questions about the potential for cameras to simply displace crime to neighboring areas in which no cameras are present. They noted that, even if cameras do not impact crime, they serve a valuable purpose in raising community awareness and increasing perceptions of safety.

Camera Impact Analysis

Decision-makers in Washington, D.C. deployed cameras in high-crime neighborhoods throughout the city beginning in August and September 2006. However, their placement of cameras was much more dispersed compared to the other two evaluation sites associated with this study, with very few locations in which more than two cameras were located in close proximity, and an even smaller number of areas for which camera viewsheds overlapped with one another. Given the low level of camera saturation in D.C., UI researchers employed two different site selection methods to determine the degree to which D.C.'s cameras had an impact on crime. The first method focused on the individual placement of cameras throughout the city, aggregating incidents across all these individual camera target areas for analysis purposes. Overall, 84 camera locations[106] were included using this first method, which will be referred to as the "individual camera analysis" in the remainder of this section. The second site selection method, referred to as the "camera cluster analysis," involved identifying the one area in the city, Mount Vernon Square, where cameras were clustered together and had overlapping viewsheds. For this analysis, researchers drew a polygon around an area encompassing two neighboring clusters of a total of 13 cameras. MPD supplied 50 months of reported crime data for analysis purposes, spanning from January 2005 through February 2009 and covering the entire city.

D.C. impact analyses examined ten crime categories: (1) all crime, (2) violent crime, (3) assault with a deadly weapon, (4) arson, (5) burglary, (6) larceny, (7) murder, (8) motor vehicle theft, (9) robbery, and (10) sexual assault. Rare-event crime categories, such as arson and murder, were excluded from the analyses as individual categories, but were included in an aggregated violent crime category. Within each of the two analysis areas, researchers identified statistically significant changes in average monthly crime counts in: (1) the target area of the camera/cluster; (2) a buffer zone of 500 feet; (3) a buffer zone of 1000 feet; and (4) a matched comparison area selected due to similarities in land use, historical crime rates, and socio-economic measures to the target area. A description of impact evaluation results for both the individual and clustered approach, along with a description of the crime trends in the targeted areas are presented below.

Individual Camera Analysis Area

The camera locations employed for the individual camera analysis were located in each of the seven police districts, with the Third District having the most cameras and the Second District having the least. The Third, First, Fifth and Seventh Districts each had approximately one-fifth of the MPD cameras (ordered by camera count from highest to lowest). Researchers plotted each camera based on geographic coordinates provided by MPD and then drew 200-ft buffers around each location to designate the "treatment area." The land use associated with each camera area varies from neighborhoods to commercial and business settings. The Third District is primarily residential and located near the center of the city, containing nearly 60 percent of the foreign embassies. The First District is just South of the Third and serves as the political center for D.C. and includes national landmarks such as the U.S. Capital and the White House. The Sixth and Seventh Districts are located mainly in the Southeast portion of D.C., with cameras in these areas predominantly located in public housing projects. The Fifth District is located in the Northeast quadrant of the city and also contains a number of landmarks, including the National Arboretum. The Second District, located in the Northwest quadrant of D.C. and the largest district in the area, includes several high-income residential communities, such as Georgetown, and is the home to one-third of the foreign embassies, the National Zoo, and the National Cathedral. The Fourth District, covering the upper Northwest and Northeast quadrants, contains a mix of businesses and low-density residential areas, including the Walter Reed Army Medical Center.

106. The number of camera locations changed over time due to maintenance issues and cameras that were moved to new areas.

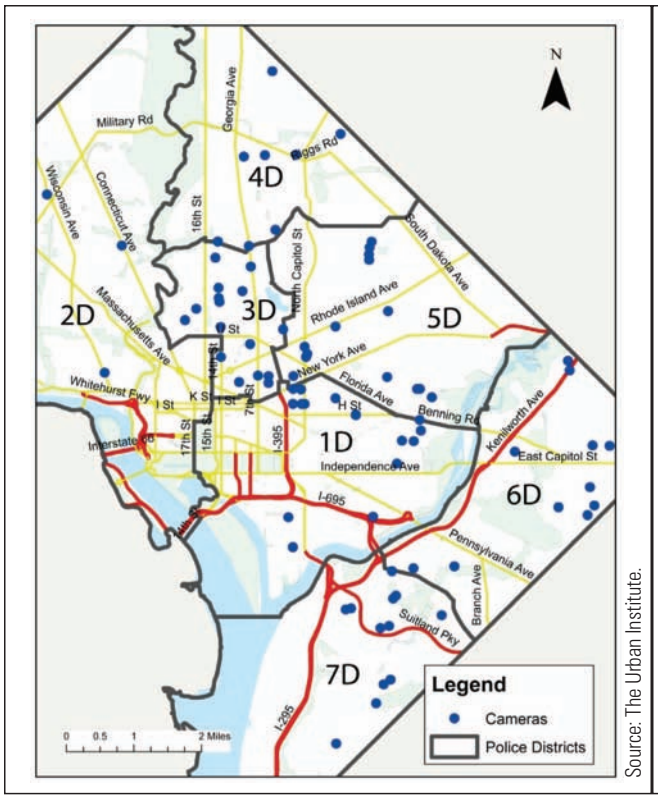


Figure 6.1: Map of the District of Columbia, by Police District

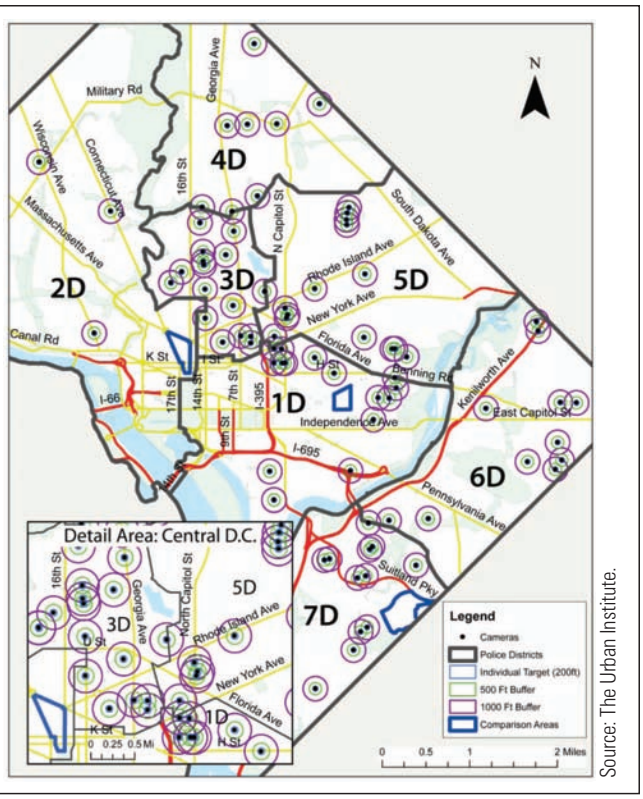


Figure 6.2: Map of the District of Columbia Area, Individual Cameras

In order to ensure a sufficient match on demographic and land use characteristics, the comparison area for the individual cameras was defined by Census Block Group boundaries, drawing upon census data and MPD crime data aggregated to the census block group level. The comparison area was a close match to the treatment area in terms of crime and additional emphasis was placed on selecting areas that contained similar housing types, people, and commercial areas. Given that each census block group selected for inclusion in the comparison area contained different levels of crime, UI researchers accounted for such a difference by juxtaposing areas where violent crime was lower, with areas where larcenies were more frequent. Given that cameras were placed in the most violent areas of the city, it was difficult to find comparison areas with similar violent crime rates. This deficit in violent crime was offset by having more larcenies in some areas, making the overall number of incidents in the area less than one percent different than the camera area.

Crime Trends Before and After Camera Installation

On average, the areas within 200 feet of the cameras experienced approximately 70 incidents per month. Larceny accounted for one-third (35 percent) of this monthly average, followed by violent crime (21 percent) and robberies (20 percent), with each averaging nearly one-fifth of the incidents per month. In the comparison area, the overall numbers of crimes were similar, with an average of 69 per month. The composition of those crimes differed, however, with violent crime representing 20 percent of the total, larcenies 31 percent, and robberies 20 percent (see Table 6.1).

Table 6.1: Quarterly Crime Counts in Individual Camera Area, by Crime Type and Area

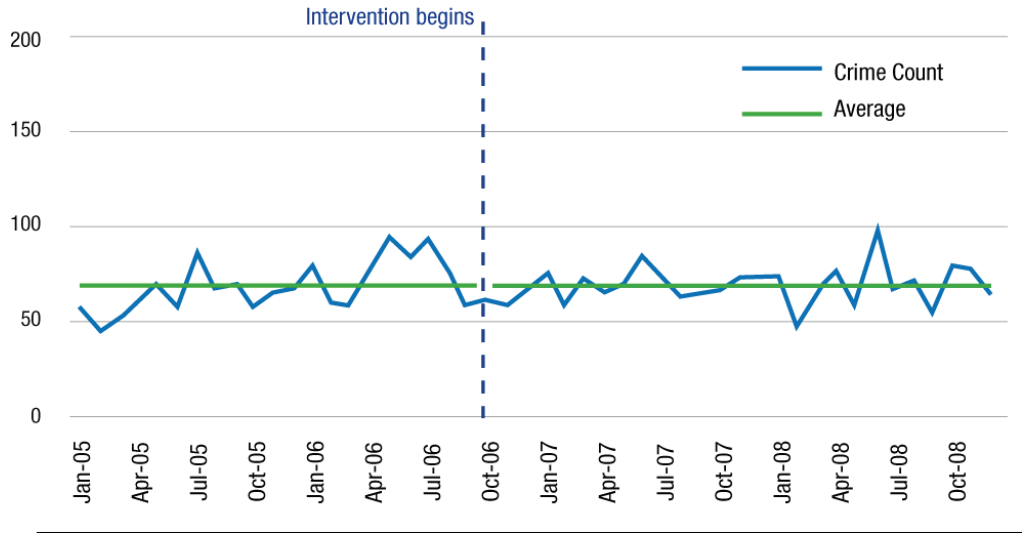
	2005				2006			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Property Crime								
Treatment	78	101	122	103	112	131	132	106
Comparison	180	175	171	176	121	168	150	139
Violent Crime								
Treatment	71	84	96	83	82	120	97	79
Comparison	37	40	39	42	27	58	41	37
Total Crime								
Treatment	149	185	218	186	194	251	229	185
Comparison	217	215	210	218	148	226	191	176

Source: The Urban Institute

†Intervention date occurred during this quarter in August and September 2006.

Note: Violent crime included the following offenses: murder, sexual assault, robbery, and assault with a deadly weapon. Property crime included the following offenses: burglary, larceny, motor vehicle theft, and arson.

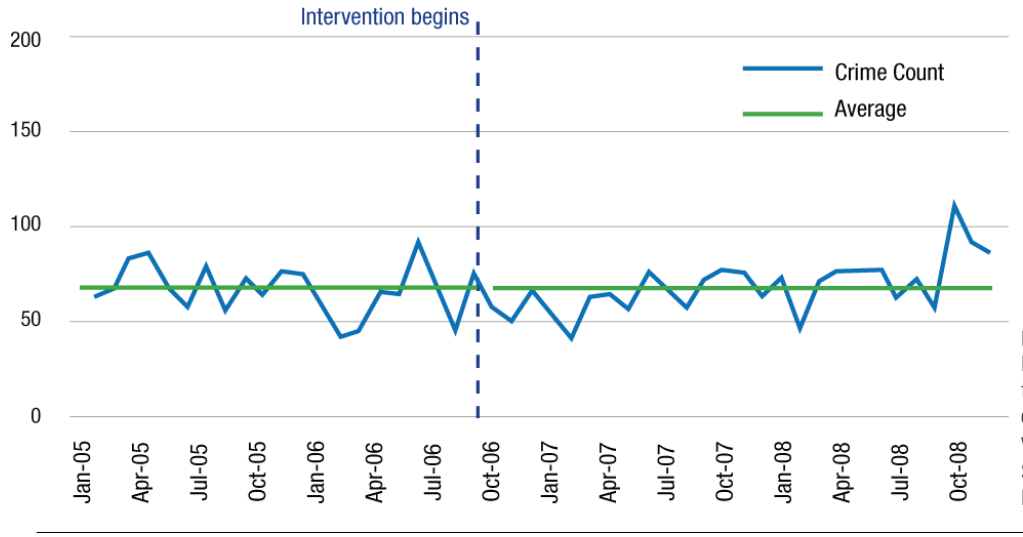
As described at the beginning of this chapter, crime was on the rise in the summer of 2006. In response to this increase, city administrators installed cameras in August and September of the same year. Figure 6.3 indicates that during this period the average number of monthly crimes in the individual camera area declined by 10 percent following camera deployment. However, the summer months of 2007 and 2008 continued to have the highest number of incidents, matching pre-implementation levels.



Note: The intervention line displayed above for the individual cameras corresponds with October 2006.

Source: The Urban Institute.

Figure 6.3: Crime Trend in Individual Cameras Area, D.C., 2005–2008



Note: The intervention line displayed above for the individual cameras corresponds with October 2006.

Source: The Urban Institute.

Figure 6.4: Crime Trend in Comparison Area for Individual Cameras, D.C., 2005–2008

The comparison area followed a similar pattern of crime as the target area. The summer of 2006 experienced an above average number of crimes, with more than 90 crimes occurring in June, and then in 2007 and through most of 2008 crime returned to levels similar to that prior to the summer of 2006 (see Figure 6.4).

Statistical Analysis Results

The initial step associated with the D.C. impact analysis was to conduct a comparison of reported crime means before and after camera installation occurred using independent samples T-tests. Incidents were pooled across each individual camera target area and then divided by crime type, with the intervention date set for October 2006.[107]

For the individual camera analysis area, assault with a deadly weapon, larceny, and violent crime each changed significantly, with larcenies increasing and the other two crime categories decreasing. To add a layer of rigor by controlling for competing effects that are not attributable to the cameras, analysts then introduced a comparison area to control for other factors that may be influencing the crime rate. Each of the crime categories that presented significant changes using the T-test above were included in the difference-in-differences analyses and were found to no longer be significant at $p < .05$ (see Appendix E for detailed findings). The control areas followed the same pattern of change for each of the crime categories (i.e., ADW, larceny, and violent crime), which led us to believe that there may be other factors influencing crime, but cameras were not the biggest contributor to the change in these areas.

Diffusion and Displacement

Given that the impact results yielded no significant changes in crime for the individual camera area, analysts did not explore potential diffusion or displacement effects. Theoretically, if crime was not reduced in the target area, effects beyond that area would not be expected.

107. The evaluation period spanned from January 2005 through February 2009. The intervention point was set to October 2006 given that cameras were installed throughout August and September 2006, with camera activation and calibration following the installation date for some cameras. An intervention date of September 2006 was also tested and the results did not vary; therefore, UI researchers determined that the best approach was to assess the impact once the majority of the cameras were fully operational.

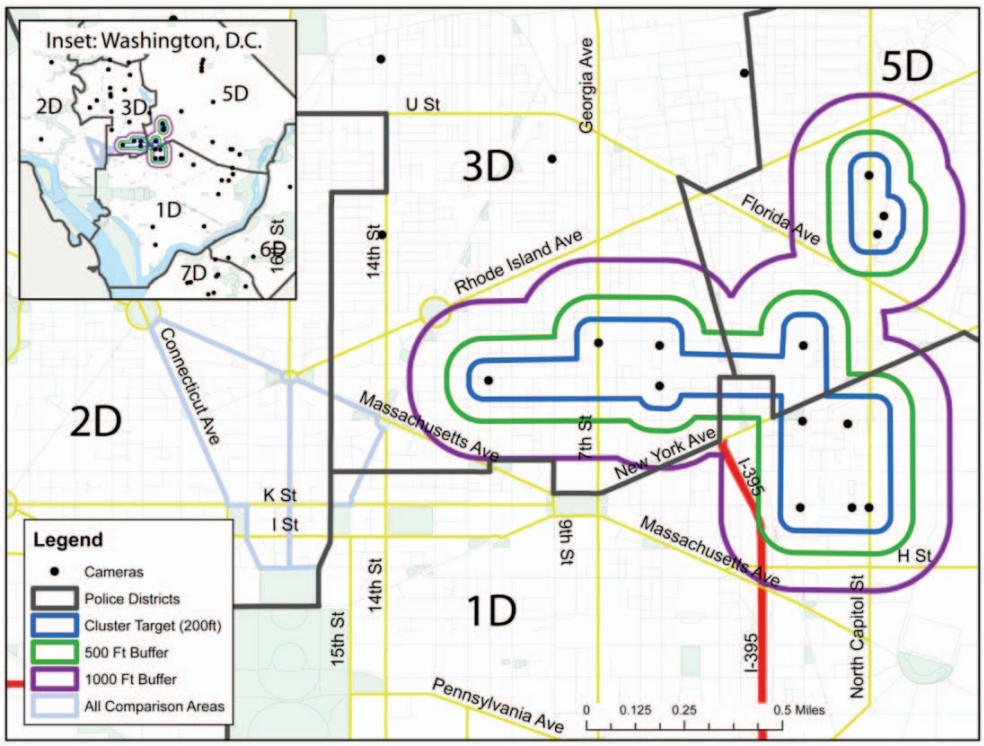
Camera Cluster Analysis Area

The second site selection method, referred to as the "camera cluster analysis," involved the identification of an area representing a cluster of cameras with overlapping viewsheds. This cluster had to be far enough away from other individual cameras to prevent those cameras from being in the buffer areas and conflicting with the analysis. To do this, analysts identified two small neighboring clusters, with a total of 13 cameras, located at the intersection of the Third, Fifth, and First Districts (see Figure 6.5). This area, located in the Mount Vernon Square neighborhood, has a mix of commercial and residential space, with some of the cameras located in primarily residential neighborhoods and others in places with a higher density of businesses and restaurants. However, the three cameras that are located in the Fifth District along Lincoln Street and North Capitol Street are in a densely populated residential area. These cameras were pooled with the rest of the cluster because the potential effect of the cameras overlap, with the buffers merging along one side (see Figure 6.5).

For the clustered camera area, two census block groups were identified for use as the comparison area. As shown in Figure 6.5, the comparison area was located just west of the target area along Massachusetts and Connecticut Avenues. A similar method as was used for the individual camera area was employed here in selecting the comparison area, with crime and socioeconomic indicators serving as the guide for choosing a matched area. Details regarding the similarities between treatment and comparison areas can be found in Appendix B.

Crime Trends Before and After Camera Installation

Over the evaluation period, violent crime (33 percent) and larceny (42 percent) were the two most frequent crimes in the aggregated camera cluster area, accounting for 75 percent of the monthly incidents. Violent crime in the comparison area was much lower than in the camera cluster area, but larcenies were much higher, making the overall crime rate similar in both areas (see Table 6.2).



Source: The Urban Institute.

Figure 6.5: Map of the Cluster Camera Area, D.C.

Table 6.2: Quarterly Crime Counts in Cluster Camera Area, by Crime Type and Area

	2005				2006			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3†	Q4
Property Crime								
Treatment	41	59	66	107	96	124	75	89
Comparison	107	98	104	115	103	127	105	82
Violent Crime								
Treatment	27	34	39	55	38	56	60	32
Comparison	10	10	21	17	5	16	16	17
Total Crime								
Treatment	68	93	105	162	134	180	135	121
Comparison	117	108	125	132	108	143	121	99

Source: The Urban Institute

†Intervention date occurred during this quarter in August and September 2006.

Note: Violent crime included the following offenses: murder, sexual assault, robbery, and assault with a deadly weapon. Property crime included the following offenses: burglary, larceny, motor vehicle theft, and arson.

Figure 6.6 shows that the overall crime trend for the cluster of 13 cameras remained unchanged following camera installation. As cameras were put in place and for only a few months after installation, crime was relatively constant. The overall trend in crime prior to the intervention showed that crime was climbing each year. However, post-implementation crime continued to decline each year with the monthly average in 2008 being 22 percent less than 2006 and 13 percent less than 2007. When comparing crime month-to-month between the years presented, the pattern of crime by month was not as consistent as was found in other cities. In other words, a seasonal trend was not found in the camera cluster area with the general ebb and flow of crime differing each year. For example, in 2006 and 2008, spikes in crime occurred in the winter months with another period of high crime in the summer months. However, crime did not follow a similar pattern in 2007, with the highest crime for the year in March, April, and May, and then not again until August. The average number of crimes for the other summer months was nearly half of what they were the year before.

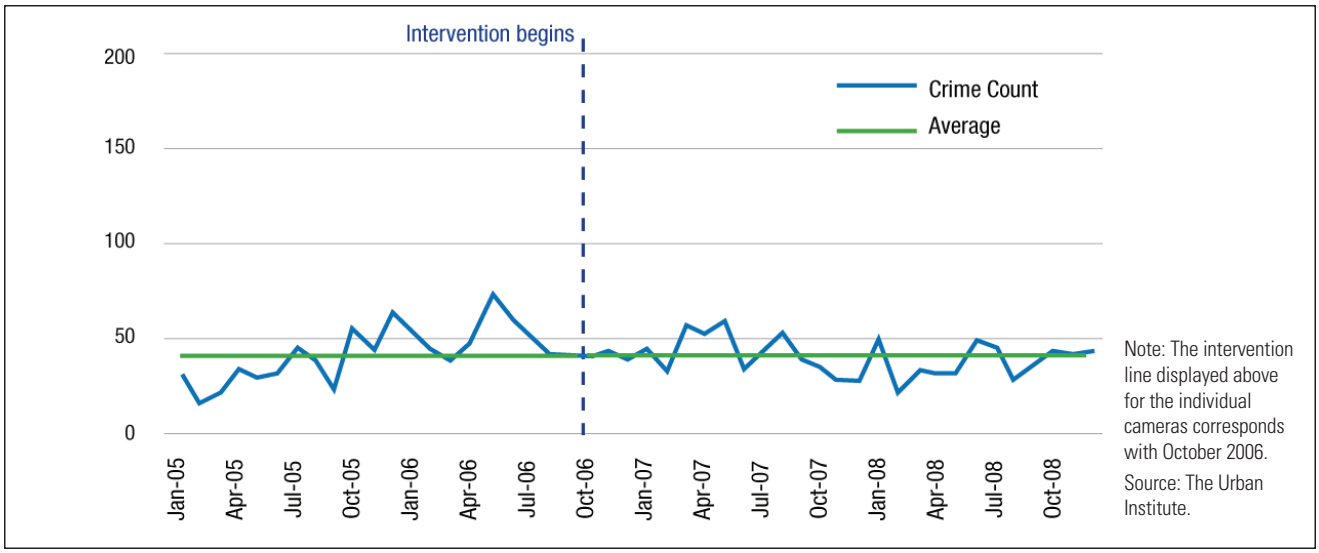


Figure 6.6: Crime Trend for Clustered Cameras, D.C., 2005–2008

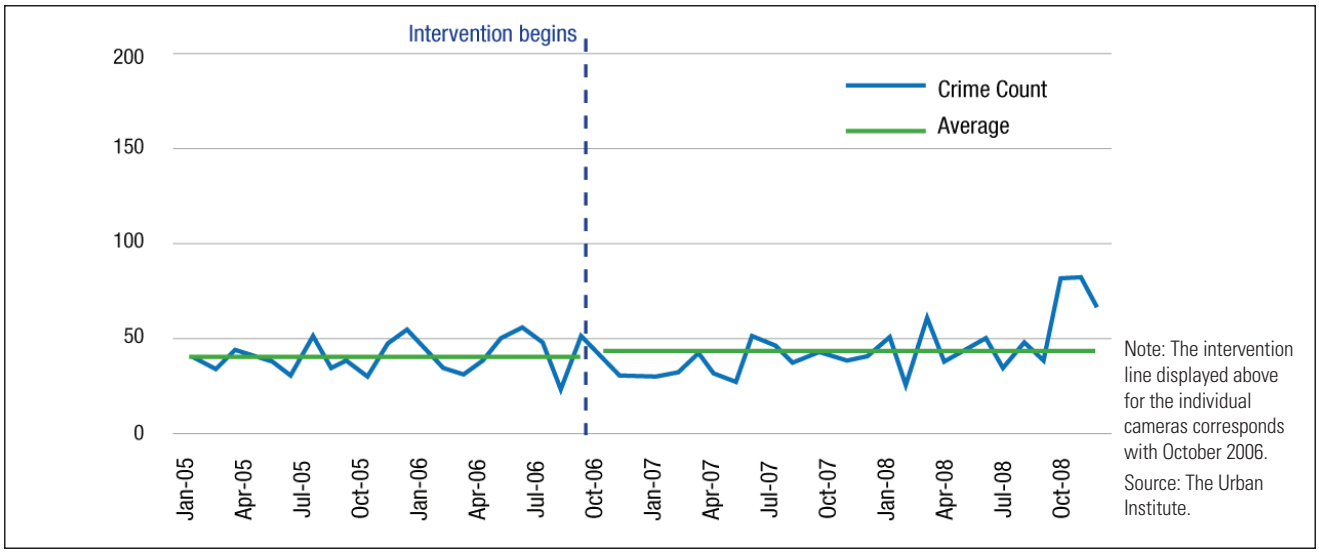


Figure 6.7: Crime Trend for the Comparison Area of the Clustered Cameras, D.C., 2005–2008

The comparison area experienced an average of 41 incidents per month, which is similar to the camera cluster area, which had an average number of 42 incidents per month. As shown in Figure 6.7, crime in the comparison area followed the same trend as that in the target area, with peaks in both the summer and winter months. Over time, the comparison area followed a similar pattern as the treatment area, remaining relatively stable but then deviating from the treatment area trend by increasing dramatically at the end of 2008.

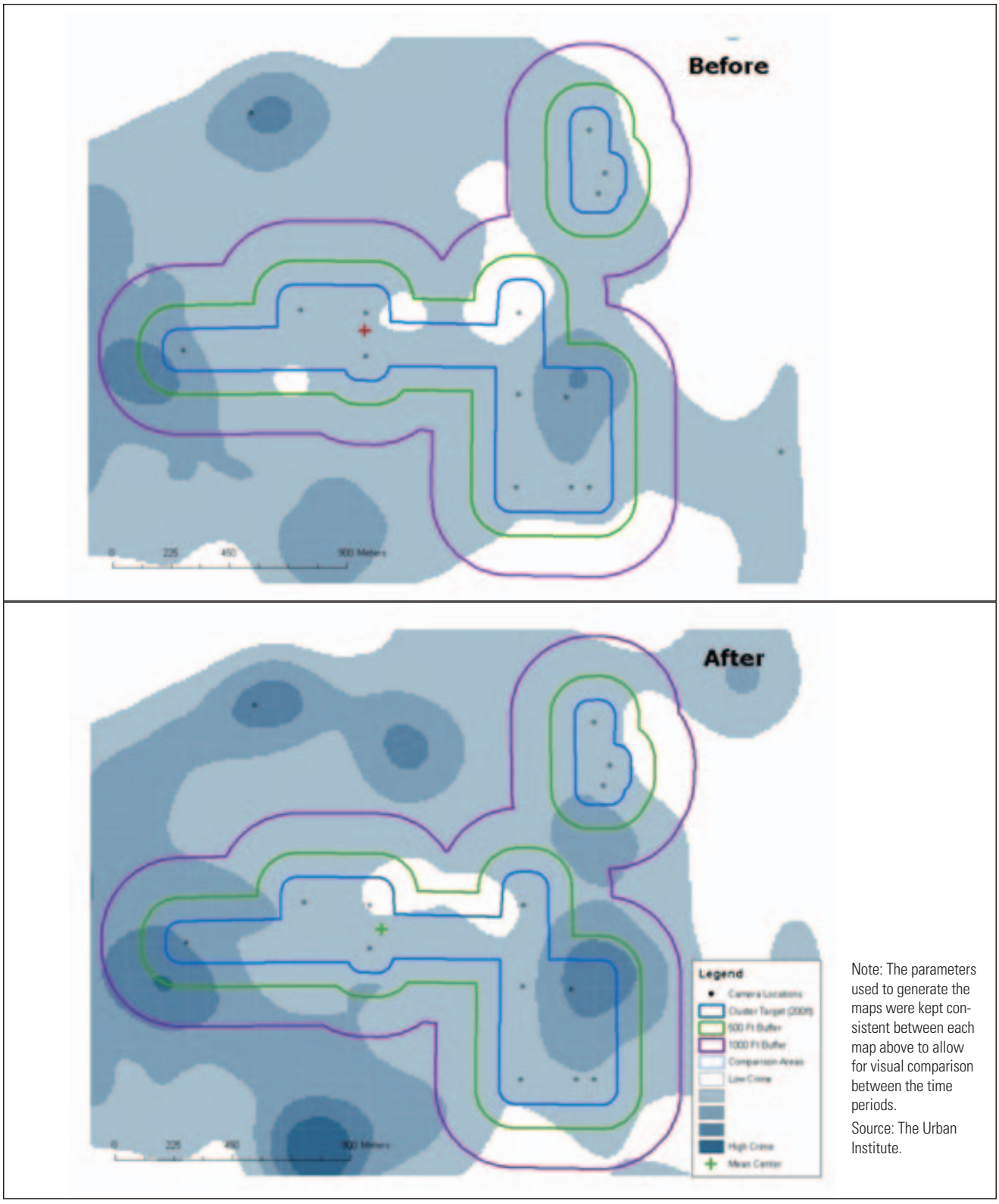
Statistical Analysis Results

T-tests employed with the cluster areas described above revealed that assault with a deadly weapon and burglary were significantly reduced. We then employed DiD analysis to determine if the significant reduction held up once a matched comparison area was introduced to control for competing effects. The DiD revealed that there were no significant declines for the cluster of cameras due to the fact that crime in the comparison area also declined during the post-intervention period (see Appendix E for detailed findings). This suggests that factors other than public surveillance cameras were at play in reducing crime in the camera areas as well as places similar to them in terms of historical crime, demographics, and land use.

Diffusion and Displacement

For descriptive purposes, density maps were created to depict the geographic movement of crime within the treatment area. The previous analytic techniques required artificial boundaries to be drawn, as shown in Figure 6.8. This did not allow us to determine if crime was moving to new areas within the target area or outside of the camera's viewshed, rather than being prevented altogether. The maps were generated one year before and after cameras were installed to compare the amount of crime. As shown in Figure 6.8, the entire camera area was experiencing a high level of crime, with the most crime occurring in the southeast portion and along the western border. Overall, the majority of the area was unchanged. Both hot spots grew following camera deployment and a third is developing below the northern pocket of cameras. The level of crime south of the target area has greatly increased with a large hot spot now formed. The mean center shifted slightly southeast by approximately a half of a city block.

Given that the impact results yielded no significant changes in crime for the camera cluster area, analysts did not explore potential diffusion or displacement effects. Theoretically, if crime was not reduced in the target area, effects beyond that area would not be expected.



Note: The parameters used to generate the maps were kept consistent between each map above to allow for visual comparison between the time periods.

Source: The Urban Institute.

Figure 6.6: Change in Density of Crime: Cluster Camera Area, D.C.

Challenges and Lessons Learned

While stakeholders consistently cited the value of the city's public surveillance system, they listed numerous challenges and limitations. Chief among them is the limited ability to use the cameras for active monitoring. While they acknowledged that severe restrictions on active camera use do protect the system from misuse and may foster trust in the community, they also limit the technology from yielding the greatest potential crime control impact. Passive monitoring was perceived as being useful for investigations and prosecutions, but its utility is hampered by technical limitations. For example, because the video cannot be zoomed in after-the-fact without distorting the image, the footage is often too granular to make positive identifications. Cameras are also sensitive to changes in weather and lighting and they do not always maintain a continuous flow of coverage. Though higher quality cameras were universally supported, decision-makers observed that there is a tradeoff between camera quality and the demands on storage space that higher resolution cameras impose. As the current storage period is only ten days, few people would advocate for shortening that period in exchange for greater quality. In addition, the limited number of cameras does not allow for full coverage of the city and limits the areas in which the cameras can record.

Prosecutors and investigators have found ways to work around these technical limitations, however, and maintain that the images they retrieve are powerful and reliable. The limited use of camera footage in court cases, however, precludes the ability to determine empirically the degree to which cameras are helpful in solving and prosecuting cases. In the interests of increasing camera footage use, both prosecutors and investigators have learned to inquire about footage immediately upon learning of an incident, to ensure that it is preserved before being overwritten. They also recommended employing a second-by-second viewing strategy to take in small details of behavior and the chronology of the incident. With this strategy, even images of poor quality that don't allow for concrete identifications can provide useful information for a case.

D.C. stakeholders' experiences with the public surveillance system have also generated important lessons for other agencies considering investing in this technology. During the planning process, stakeholders recommended building a wireless backbone to support all of the cameras on the same network; developing policies for every aspect of camera use; and budgeting for maintenance. The initial investment in a wireless network can greatly simplify the monitoring and reviewing process, as it centralizes footage collection and storage. Similarly, writing comprehensive policies and setting aside maintenance money can prevent later complications and unanticipated costs that could compromise the utility and cost effectiveness of the system. When purchasing cameras, both stakeholders and users in D.C. strongly advocate investing in the best possible equipment. A poor quality camera, which produces consistently low quality images, is worthless if the images are not clear enough to use in either investigations or prosecutions. After installation, camera users suggested devoting time exclusively to training officers and investigators how to best use the cameras as an investigatory tool and get the most information out of an image, even when the image is of poor quality.

Chapter 7. Summary and Recommendations

This report's documentation of the implementation and use of public surveillance systems in three jurisdictions has yielded several useful findings. Of primary importance is the fact that public surveillance technology is viewed as a potentially useful tool for preventing crimes, aiding in arrests, and supporting investigations and prosecutions. While the technology and its applications are not without limitations, it is noteworthy that stakeholders across a wide array of vested interests were generally supportive of public video surveillance. These views were largely—but not consistently—supported by impact analyses. Analysis results indicate that cameras, when actively monitored, have a cost-beneficial impact on crime with no statistically significant evidence of displacement to neighboring areas. However, in some contexts and locations these crime reduction benefits are not realized.

Two possible explanations for the lack of the surveillance technology's impact on crime in certain study areas are that the cameras are not actively monitored on a routine basis and that the no-impact areas had relatively low concentrations of cameras with fewer overlapping viewsheds and thus a reduced ability to capture crimes in progress. These are critical factors that both current and future investors of surveillance technology should consider when expanding or implementing camera systems. In addition to these recommendations stemming from the impact analysis, stakeholders interviewed for the process evaluation component of this study recommended that perhaps the single greatest investment of time associated with a public surveillance system should occur during the planning and implementation phase, particularly in setting the groundwork for camera implementation. Stakeholders repeatedly emphasized the importance of community input through the convening of open public meetings, the invitation of public comment, and the clear explication of the rationale behind camera placement decisions. Developing and disseminating written policies on the proscribed use and dissemination of footage, including planned restrictions and security measures, can go a long way toward building public support for a camera system. However, jurisdictions should carefully balance the advantages of implementing stringent guidelines on camera use, in order to safeguard against invasion of privacy, against the disadvantages of overly restrictive guidelines that may limit the ability to use cameras to their greatest capacity.

While laying the groundwork for camera investment, jurisdictions should give careful consideration to planning and procurement activities. Stakeholders across all three study sites underscored the fact that the cost of the cameras themselves is minimal compared to the costs of installation, maintenance, and monitoring. Jurisdictions investing in a public surveillance system should be prepared to do their own research rather than relying on the advice of vendors, as it is not in a vendor's interest to highlight in detail all the hidden costs associated with camera systems. Those planning for such an investment should also be aware of the fact that the technology is constantly evolving; each subsequent generation of cameras offers greater resolution and potentially more useful features. One caveat to this advice, however, is that jurisdictions should weigh the pros and cons of cameras that produce superior image quality; images captured with greater resolution create a greater burden on video storage capacity. Thus, a thoughtful camera investment strategy will procure the best affordable technology while building in plans for camera upgrades.

Stakeholders also advised jurisdictions to plan for a larger system than they initially intend to implement, as doing so will reduce the costs of expansion of the system in the long run. For example, the decision-makers behind camera implementation in Washington, D.C. purchased wireless-capable cameras even though they did not have the capacity to connect the cameras to a wireless system until several years later. Regardless of system size and the intended complexity of the final network, stakeholders recommended installing cameras incrementally in one or two areas. This type of piloting strategy enables implementers to work out details in camera placement, monitoring, and video retrieval prior to widespread implementation.

With regard to camera placement, jurisdictions should understand at the outset that even when locations are identified through the mapping of hot spots of criminal activity, the ultimate locations of cameras will be guided by infrastructure (including proximity to power sources), the camera technology employed, and characteristics of the natural and man-made environment. For example, wireless camera systems require consideration of the location of cameras and antennas in relation to trees, physical obstructions, and other cameras. In addition to camera placement decisions, camera movement decisions should be made with care. Based on the experiences of the three cities highlighted in this report, jurisdictions that intend to move cameras as hot spots shift locations should consider building in plans for the purchase of additional cameras in anticipation of resident opposition to the removal of cameras in their neighborhoods.

The stakeholders interviewed for this study also had rather strong opinions on how and when cameras should be monitored. Baltimore stakeholders in particular argued that the greatest impact from cameras can be yielded through actively monitoring areas and intervening in real time. Active monitoring is also useful for later investigative and prosecution purposes, as live monitors can zoom into a scene to capture important details that may not be captured through a pre-programmed camera tour. However, active monitoring requires significant resources and may also raise concerns among the public about how the cameras are being monitored. These experiences suggest that jurisdictions should carefully consider the benefits and drawbacks of active monitoring.

Regardless of whether cameras are actively or passively monitored, stakeholders across all three study sites emphasized the importance of training. While most stakeholders indicated that on-the-job training for camera monitors was sufficient, they saw a need for training detectives and prosecutors on how best to employ camera footage in their investigations and case presentation. This training should include information on how to retrieve and use footage, the potential value of camera footage to their cases, and the limitations associated with video evidence and the fact that it typically enhances, rather than serves as a substitute for, witness testimony.

Finally, inasmuch as the promise of public surveillance cameras as a crime prevention and control tool is a powerful motivator for those investing in the technology, it is important to view it in the context of a larger community policing framework. Surveillance cameras alone are a not a silver bullet, but simply another crime control and investigative tool. That tool should be employed along with other policing strategies, such as community-oriented problem-solving strategies and intelligence-led policing. Further, it is important for jurisdictions to understand that public surveillance technology is only as good as the manner in which it is employed. If it is employed minimally or is not well-integrated into other policing functions, it is unlikely to yield a significant impact on crime.

Appendix A.
Sample Interview Protocols

A-1. Protocol for Stakeholder Interview:

Respondent Information

1. Job title:

_____

2. Brief description of job:

_____

_____

3. Were you involved in the initial decision to implement CCTV?

☐ Yes ☐ No

3.1 If yes, who were the key decision-makers?

_____

_____

3.2 If yes, why were they interested in implementing CCTV?

_____

_____

3.3 If yes, were your views on the reasons for CCTV investment the same as other key decision-makers?

☐ Yes ☐ No

3.3.1. If yes, how so?

_____

_____

3.3.2. If no, how did they vary?

_____

_____

Planning

4. Why were you interested in using CCTV?

5. What were your reasons for wanting CCTV? (e.g., safety, crime prevention)

6. What were you hoping to gain through the use of CCTV?

7. Who was involved in the decision to use CCTV technology?

8. Did the community have input in the planning process?

   ☐ Yes ☐ No

   8.1 If yes, which groups? What were their roles? (Describe the process/type of input)

   8.2 If no, why not?

9. What type of planning took place before any purchases were made?

   9.1. How long did this process take?

10. Did you consult any other cities using CCTV during your planning process?

    ☐ Yes ☐ No

10.1 If yes, which ones? Why? Was the information useful?

11. Did you consult any publications or written literature on CCTV?

12. What was your initial expectation for hardware costs and operational costs of using CCTV? Where did these estimates come from?

13. How did you begin to identify or raise funds for CCTV use?

14. Was legal counsel consulted during the implementation of CCTV?

☐ Yes ☐ No

14.1 If yes, what was discussed?

14.2 If no, why not?

15. Was legal counsel involved in the development of policy?

☐ Yes ☐ No

15.1 If yes, how so?

15.2 If no, why not?

16. What challenges did you face during the planning stage? (e.g., financial, logistical, community concerns)

16.1 How were those challenges overcome?

16.2 How long did it take to overcome these challenges?

17. (If installed already) When was the first set of cameras installed?

17.1 Have there been any discussions about adding/moving cameras?

☐ Yes ☐ No

17.1.1 If yes, please describe:

17.2 Have any of the cameras been moved?

☐ Yes ☐ No

17.2.1 If yes, why?

Acquisition

18. What process was used to choose a camera vendor (or vendors)?

19. Why was this vendor(s) selected?

20. What funding mechanisms were tapped for camera purchases? (e.g., private, public, partnership)

21. Who was involved in the acquisition/funding process? (e.g., city council, community groups)

22. What types of cameras (i.e., fixed, pan & zoom, active, passive) were purchased and why?

23. Who was involved in the purchasing decisions?

24. How many cameras were purchased? Which agency did the purchasing?

25. Are the cameras intended for overt, semi-covert, or covert use? Or a combination?

☐ Overt ☐ Semi-covert ☐ Covert

Explain:

26. What challenges are you aware of that occurred during the acquisition stage of the process?

26.1 How were those challenges overcome? How long did they take to overcome?

Installation

27. How many cameras were installed?

_____

28. Where are cameras installed?

_____

_____

29. How were camera locations selected?

_____

_____

30. What physical aspects of the location(s) were considered? (e.g., lighting, buildings, aesthetics, environmental concerns)

_____

_____

31. Do you have signage and/or flashing lights "advertising" the cameras?

☐ Yes ☐ No

31.1 If yes, please describe:

_____

_____

Monitoring

32. Are cameras being actively or passively monitored?

☐ Actively ☐ Passively ☐ Combination

Explain:

_____

_____

33. If cameras are actively monitored, is there constant supervision for the operation?

☐ Yes ☐ No

33.1 If no, why not:

_____

_____

34. If cameras are actively monitored, are they monitored 24-hours a day?

☐ Yes ☐ No

34.1 If no, why not:

35. Are all cameras linked to a central control room or are there cameras that operate independently of the system?

36. Who is responsible for monitoring cameras? (i.e., which agencies?)

36.1 Do they undergo any formal training?

☐ Yes ☐ No

36.2 If yes, please describe:

36.3 If yes, is the training documented?

36.4 If they do not undergo formal training, why not?

37. If the cameras are monitored by police do they use sworn or civilian personnel?

38. What types of incidents are reported?

39. To whom do the monitors report incidents (e.g., crime, tampering) to?

40. What is the protocol for reporting incidents?

41. To what medium is camera footage recorded (i.e., tape, digital)?

42. Who has access to the recorded images?

43. How long is camera footage saved? Where is it stored?

Policies/Procedures

44. Were any legal or civil rights considered prior to CCTV implementation?

☐ Yes ☐ No

44.1 If yes, please describe:

45. Did camera installation result in any civil liberties or other challenges being raised?

☐ Yes ☐ No

45.1 If yes, please describe:

45.2 If yes, were they by organized groups, community groups, individuals?

45.3 If yes, how were the civil liberty challenges addressed?

46. Are there established/written operation CCTV guidelines or policies?

☐ Yes ☐ No

46.1 If yes, please describe:

46.2 If no, why not?

47. Are there any written policies to prevent the misuse of CCTV images/footage?

☐ Yes ☐ No

47.1 If yes, please describe:

47.2 If no, why not?

48. Who has access to these guidelines and are they publicly available?

49. What is the policy for the release of CCTV images?

50. Are there any state or local laws regulating CCTV operation?

☐ Yes ☐ No

50.1 If yes, please describe:

51. Have any complaints been lodged regarding the agency's use of CCTV?

☐ Yes ☐ No

51.1 If yes, please describe:

_____

_____

52. Have there been any violations of the agency's CCTV policy?

☐ Yes ☐ No

52.1 If yes, please describe:

_____

_____

53. Has anyone been disciplined for misuse of CCTV?

☐ Yes ☐ No

53.1 If yes, please describe:

_____

_____

54. Have any studies (internally or externally) been conducted to evaluate your agencies' use of CCTV?

☐ Yes ☐ No

54.1 If yes, by who and what were the findings?

_____

_____

Other

55. Do you believe CCTVs have had an impact on crime?

☐ Yes ☐ No

55.1 If yes, how so and for what types of crime?

_____

_____

56. Do you believe CCTV images have been used successfully in investigations?

☐ Yes ☐ No

56.1 If yes, please describe:

_____

_____

57. Do you believe CCTV images have been used successfully in prosecutions?

☐ Yes ☐ No

57.1 If yes, please describe:

A-2. Protocol for Interviews with Monitoring Room Staff

1. What did you do for work prior to becoming a CCTV monitor?

2. Have you had any prior:

2.1 Law enforcement experience?

☐ Yes ☐ No

2.2 Private security experience?

☐ Yes ☐ No

2.3 Relevant job experience?

☐ Yes ☐ No

Please describe

3. How long have you been working as a CCTV monitor?

4. How did you find out about this job?

5. Do you work the same hours every day or do you rotate shifts?

6. Do different shifts have different numbers of monitors on duty?

7. What sort of training have you had to become a CCTV monitor?

8. Who conducted this training?

9. What is your daily schedule for monitoring the CCTVs? (e.g., breaks, shift changes)

10. What sort of incidents are you looking for?

11. Who do you report these incidents to?

12. How do you keep track of the time when incidents occur for later review?

13. How is the tape archived?

14. How is the tape later retrieved for review?

A-3. Protocol for Interviews with Investigators

1. Have you used CCTV in criminal investigations?

   ☐ Yes ☐ No

   1.1 If yes, please explain:

   _____

   _____

   1.2 If no, why not? (If no, end survey)

   _____

   _____

2. Have your job responsibilities changed in relation to CCTV use?

   ☐ Yes ☐ No

   2.1 If yes, please describe?

   _____

   _____

3. Have you received any formal training on using CCTV to support investigations?

   ☐ Yes ☐ No

   3.1 If yes, what was the content of that training? How long was the training? Where did it take place? Who conducted it?

   _____

   _____

   3.2 If no, what training would have been useful?

   _____

   _____

4. What are the advantages of CCTV evidence in supporting investigations?

   _____

   _____

5. What are the disadvantages of CCTV evidence in supporting investigations?

   _____

   _____

6. How do you become aware if a case has CCTV evidence?

_____

_____

6.1 Does the incident reporting form have a check box for CCTV?

☐ Yes ☐ No

7. Do you know the locations of the CCTV cameras and the areas they cover?

☐ Yes ☐ No

7.1 If no, who would you ask to find out?

_____

_____

8. If you suspected that images recorded by a CCTV camera might assist in a criminal investigation, how would you request the images?

_____

_____

9. How is CCTV evidence extracted and documented? What is the chain of custody?

_____

_____

10. Who would review the CCTV images to determine if they possess video that could assist a criminal investigation?

_____

_____

11. What challenges have you encountered in using CCTV evidence?

_____

_____

12. How many hours did you typically work to investigate crimes before CCTV?

12.1 Violent crimes?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

12.2 Property crimes?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

12.3 Drug offenses?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

12.4 Other misdemeanors?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

13. Has CCTV use changed the amount of hours you spend on a case (cases that involve CCTV evidence)?

☐ Yes ☐ No

13.1 Violent crimes?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

13.2 Property crimes?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

13.3 Drug offenses?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

13.4 Other misdemeanors?

☐ less than 1 hour ☐ 1 to 3 hours ☐ 4 to 10 hours ☐ 11 to 24 hours

14. Has CCTV changed how you investigate a case?

☐ Yes ☐ No

14.1 If yes, how so?

_____

_____

14.2 In no, why not?

_____

_____

15. How is CCTV used in conjunction with other evidence to support an investigation?

_____

_____

16. When putting a case together for prosecution (warrant), is CCTV evidence alone enough? (Enough alone, Useable only in conjunction with other evidence, Depends on case)

Explain:

_____

_____

17. Has CCTV reduced the number of cases that are returned from the prosecutor's office?

☐ Yes ☐ No

17.1. Please explain:

18. How useful is CCTV evidence for:

18.1 Investigations?

18.2 Interviews?

18.3 Interrogations?

19. What suggestions or lessons would you want to share with other detectives looking to use CCTV evidence?

20. Are there any other comments you would like to make about your experiences with using CCTV?

21. Do you know any investigators who have used CCTV images during a criminal investigation? (If yes, who?)

Appendix B. *Study Areas, Socioeconomic Indicators*

Table B-1. Socioeconomic Factors, Downtown, Baltimore

	Area	
	Tx	**Control**
Area (sq. miles)	0.35	–
Residential population	3,530	–
% population under 18	4.6%	–
% foreign-born	10.9%	–
% population Black	49.1%	–
% population Latino	1.1%	–
% owner occupied housing	3.8%	–
% female-headed families	2.8%	–
% unemployed	4.2%	–
% households receiving public assistance	5.1%	–
% population below poverty line	38.7%	–
Crime rate for 2004 (per 1,000 people)	405.4	–

Source: The Urban Institute, U.S. Census Bureau, 2000.

Table B-2. Socioeconomic Factors, Greenmount, Baltimore

	Area	
	Tx	**Control**
Area (sq. miles)	0.39	0.29
Residential population	8,003	7,321
% population under 18	25.3%	30.9%
% foreign-born	3.1%	2.0%
% population Black	84.4%	96.2%
% population Latino	1.6%	1.0%
% owner occupied housing	25.7%	56.1%
% female-headed families	18.2%	21.3%
% unemployed	7.8%	9.8%
% households receiving public assistance	14.4%	10.3%
% population below poverty line	37.0%	23.7%
Crime rate for 2004 (per 1,000 people)	**109.8**	**80.9**

Source: The Urban Institute, U.S. Census Bureau, 2000.

Table B-3. Socioeconomic Factors, North Avenue, Baltimore

	Area	
	Tx	**Control**
Area (sq. miles)	0.30	0.29
Residential population	4,845	5,944
% population under 18	31.3%	31.8%
% foreign-born	1.0%	0.6%
% population Black	96.5%	98.4%
% population Latino	0.4%	0.4%
% owner occupied housing	41.0%	26.6%
% female-headed families	20.3%	23.0%
% unemployed	7.3%	7.8%
% households receiving public assistance	11.0%	12.5%
% population below poverty line	32.2%	37.3%
Crime rate for 2004 (per 1,000 people)	**153.6**	**104.5**

Source: The Urban Institute, U.S. Census Bureau, 2000.

Table B-4. Socioeconomic Factors, Tri-District, Baltimore

	Area	
	Tx	**Control**
Area (sq. miles)	0.15	0.12
Residential population	4,368	3,925
% population under 18	30.4%	30.6%
% foreign-born	3.1%	8.3%
% population Black	50.5%	45.8%
% population Latino	0.8%	4.6%
% owner occupied housing	43.7%	54.3%
% female-headed families	16.5%	18.4%
% unemployed	8.4%	5.2%
% households receiving public assistance	11.3%	11.1%
% population below poverty line	40.3%	26.3%
Crime rate for 2004 (per 1,000 people)	**115.4**	**102.9**

Source: The Urban Institute, U.S. Census Bureau, 2000.

Table B-5. Socioeconomic Factors, Humboldt Park, Chicago

	Area	
	Tx	**Control**
Area (sq. miles)	0.34	0.54
Residential population	9,370	11,524
% population under 18	37.2%	37.6%
% foreign-born	4.2%	0.8%
% population Black	85.6%	96.7%
% population Latino	11.2%	2.0%
% owner occupied housing	40.1%	42.5%
% female-headed families	25.7%	24.5%
% unemployed	14.3%	14.0%
% households receiving public assistance	15.4%	16.5%
% population below poverty line	35.7%	29.9%
Crime rate for 2002 (per 1,000 people)	**393.5**	**370.4**

Source: The Urban Institute, U.S. Census Bureau, 2000.

Table B-6. Socioeconomic Factors, West Garfield Park, Chicago

	Area	
	Tx	**Control**
Area (sq. miles)	0.25	0.55
Residential population	6,307	11,833
% population under 18	37.6%	37.6%
% foreign-born	0.7%	35.1%
% population Black	98.6%	13.9%
% population Latino	0.5%	84.0%
% owner occupied housing	30.8%	34.6%
% female-headed families	26.0%	18.4%
% unemployed	13.2%	5.0%
% households receiving public assistance	22.4%	16.7%
% population below poverty line	39.8%	31.1%
Crime rate for 2002 (per 1,000 people)	**343.6**	**213.3**

Source: The Urban Institute, U.S. Census Bureau, 2000.

Note: Identification of a control area for this site was difficult to find given the limited number of high crime areas in the city that did not already have cameras. In order to capture a similar level of crime, a control area was selected based on the indicators combined above.

Table B-7. Socioeconomic Factors, Cluster Cameras, D.C.

	Area	
	Tx	**Control**
Area (sq. miles)	0.25	0.19
Residential population	2,434	966
% population under 18	29.5%	6.0%
% foreign-born	10.8%	31.0%
% population Black	79.6%	17.9%
% population Latino	9.5%	12.6%
% owner occupied housing	24.1%	26.5%
% female-headed families	21.4%	–
% unemployed	10.3%	–
% households receiving public assistance	9.0%	–
% population below poverty line	24.7%	26.0%
Crime rate for 2005 (per 1,000 people)	**256.3**	**679.1**

Source: The Urban Institute, U.S. Census Bureau, 2000.

Note: Given that some of these indicators could not be calculated for the comparison area, the control area was primarily matched on crime and land use.

Appendix C. Analytic Approach

This section explains how UI analysts conducted the structural break analysis in more detail. In the case of downtown Baltimore, which had no viable comparison area, time series analyses were conducted on all crime types for which a significant change was detected in the previously conducted comparisons of means. Given that the timing of the intervention was uncertain, we employed structural break analysis, a well-documented econometric approach for evaluations of programs with inexact implementation dates.[1] Indeed, econometricians view this approach as more agnostic than traditional pre-post analyses with a specific implementation date in that statistical significance runs the risk of being overstated under the latter approach.[2]

To prepare the reported crime data, we generated monthly crime counts by the area of interest (i.e., target area and two buffer areas) and then weighted those counts to account for monthly variation over the evaluation period. Calendar months are not uniform in length, so we adjusted each monthly observation by multiplying the counts by a weight (W) such that:

(C.1) $$W = \left(\frac{365}{12}\right)\left(\frac{1}{d_m}\right)$$

where dm is equal to the number of days in the particular month. In this manner, we adjusted for the fact that February is shorter than March and that, due to the leap year, February was longer in certain years.

The analysis proceeded in several steps. For each site, we selected a window (i.e., a range of months) within which to test for structural breaks. In each site, the window began with the third monthly observation in our time series data and extended through the end of the time series. For information on the specific dates included in the series, refer to the site specific chapter and Research Design and Methods section. Next, because our modeling framework presupposed stationary time series,[3] we applied a Dickey Fuller test to test each time series for a unit root. In a series for which we were unable to reject the existence of a unit root, we followed Zeileis et al.[4] and used a simple error correction model in order to obtain a stationary series.[5] The error correction model was first estimated by obtaining residuals from the equation

(C.2) $$e_t = c_t - \alpha$$

where ct is the crime count and α is the long-run equilibrium value.[6] These residuals were then used to calculate the co-integration equation, estimated as

(C.3) $$\Delta c_t = Be_{t-1} + u_t$$

1. Piehl et al., "Testing." (see note 58).
2. Ibid., 106
3. A stationary time series is a time series which is not trending and does not display random walk tendencies.
4. Zeileis et al., "Strucchange," (see note 60).
5. Utilizing an error correction model allowed us to capture both long- and short-term dynamics. The co-integrating function captured the long-term relationships between level variables as well as the short-run relationship between the difference of the variables.
6. If we detected significant seasonality in a time series, we also included seasonal dummy variables in this regression.

where Δc_t refers to the month-to-month change in crime counts (i.e., the first difference) and e_{t-1} refers to the residuals calculated in Equation C.2.

Finally, we modeled each time series, or its co-integration function (Δct estimated from Equation C.3), to identify the date and magnitude of the optimal number of structural breaks found in the time series. Formally, we estimated the model that minimizes the residual sum of squares for the equation as:

$$Y = x_i^T B_j + u_i \qquad (i = {}_{j}i_{-1} + 1, \ldots i_j = 1 \ldots, m + 1) \tag{C.4}$$

where the time series (Y) is composed of m + 1 segments, each with a stable vector of coefficients B, j is a segment index, and u_i is a stochastic error term. We used the Bayesian Information Criterion (BIC), a goodness-of-fit measure, to identify the optimal number of break points.[7]

We retained and reported only statistically significant ($p < 0.05$) break points. In reporting our findings, where appropriate, we reversed the transformations performed to remove nonstationarity and seasonality from the time series so that the magnitude of the break points was presented in the units of the original time series (i.e., counts of criminal incidents).

7. Where only one break point was estimated from Equation C.4, we also independently estimated the break point associated with the maximum F statistic from a Chow test with a null hypothesis of no change in parameters. If the Chow test suggested the same break point as Equation C.4, we retained the one-break-point solution.

Appendix D.
Detailed Maps of Cameras in Baltimore, Maryland

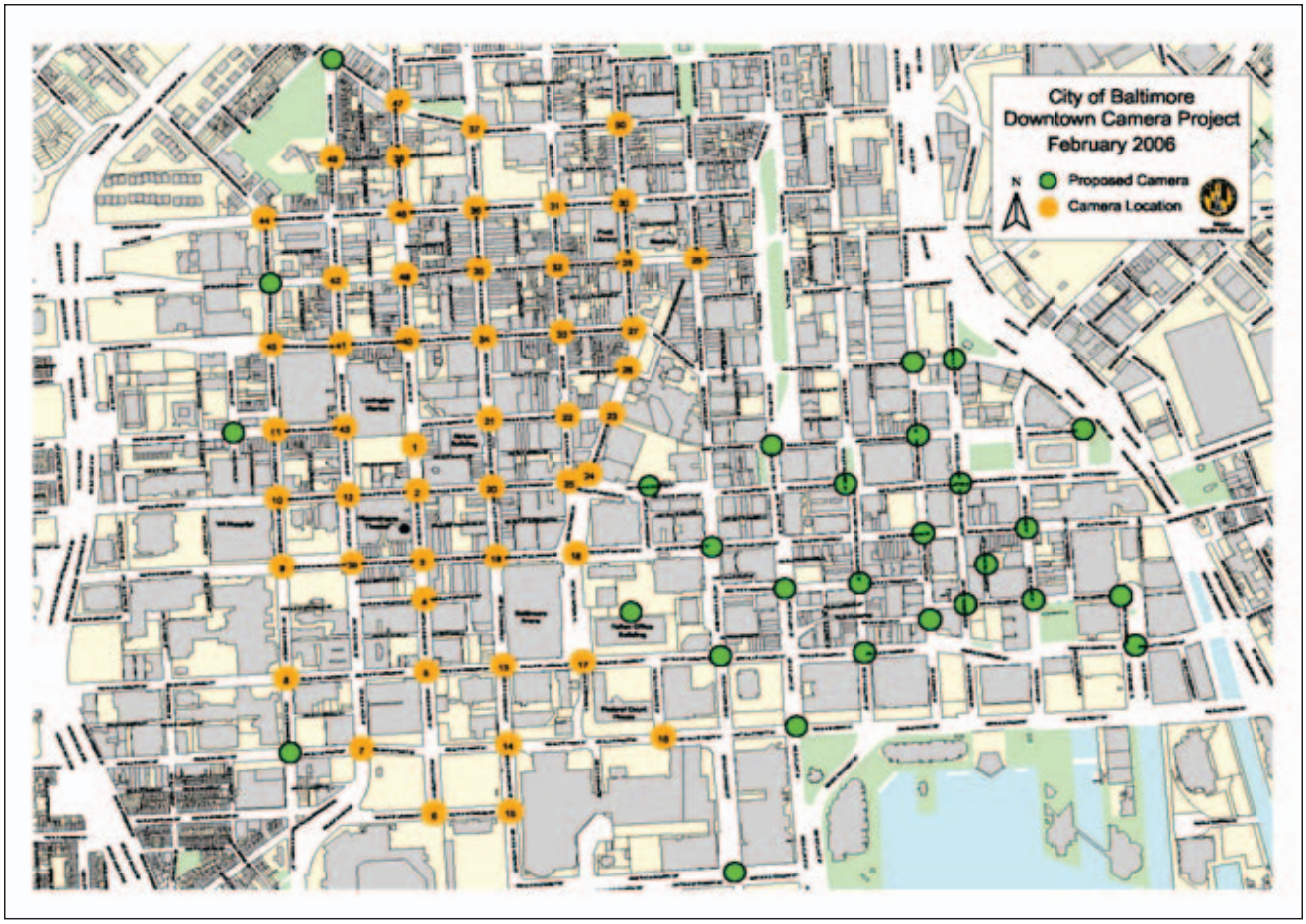


Figure D-1: Map of Downtown CitiWatch Camera Area, Baltimore

Source: Baltimore Police Department, City of Baltimore Mayor's Office.

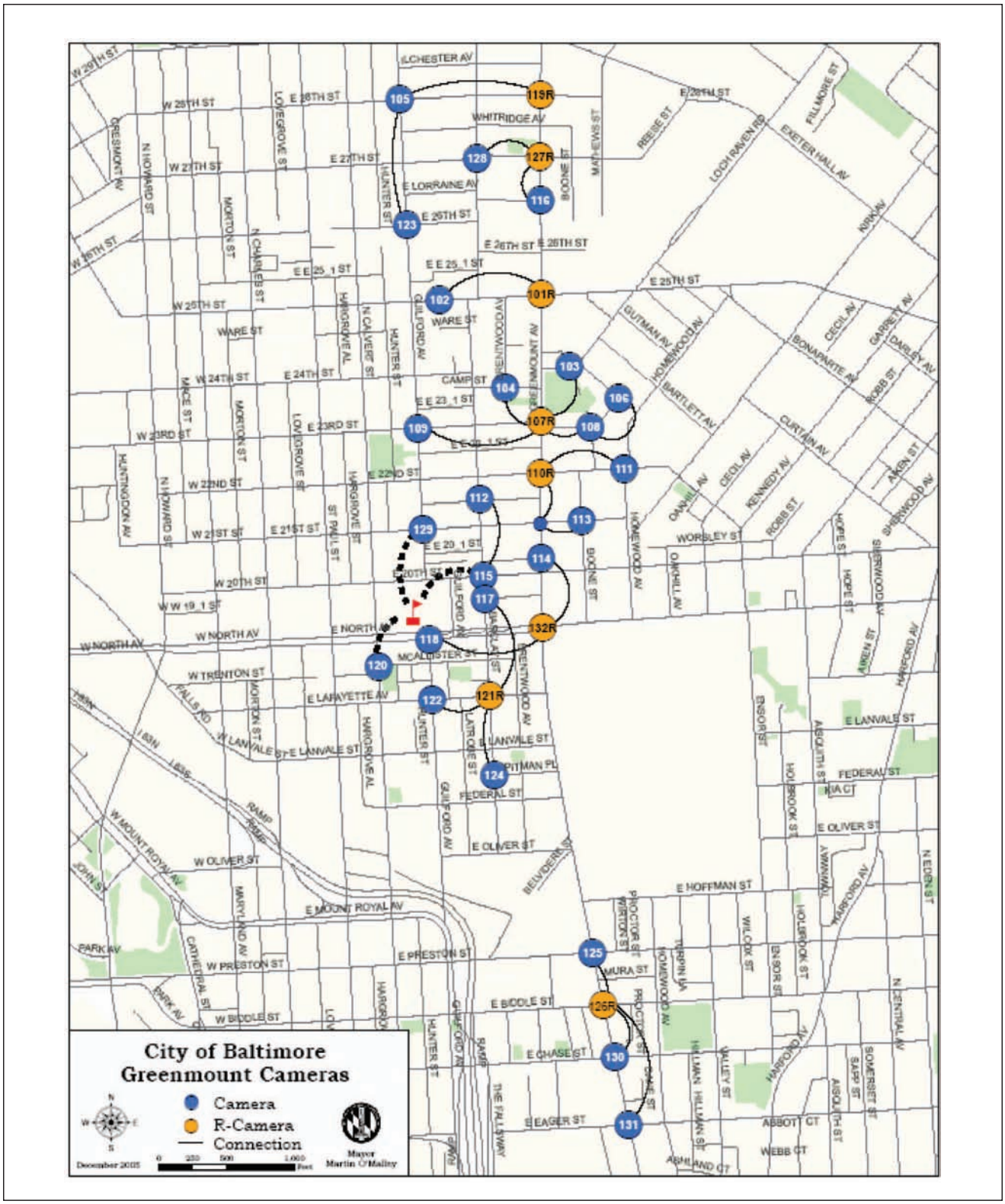


Figure D-2: Map of Greenmount Camera Area, Baltimore

Source: Map obtained from the Baltimore Police Department and Mayor's Office.

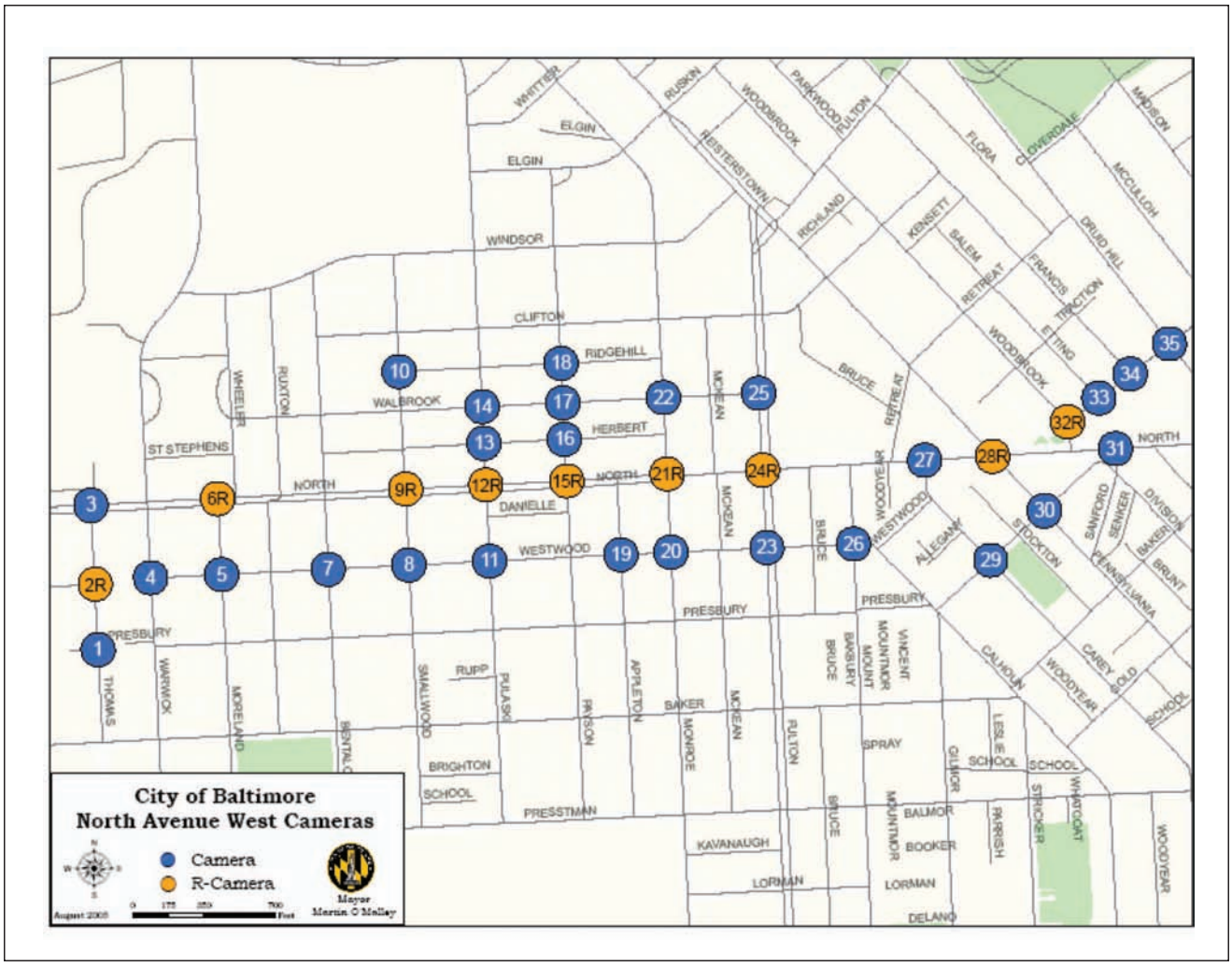


Figure D-3: Map of North Avenue Camera Area, Baltimore

Source: Map obtained from the Baltimore Police Department and Mayor's Office.

Figure D-4: Map of Tri-District Camera Area, Baltimore

Source: Map obtained from the Baltimore Police Department and Mayor's Office.

Appendix E.
Detailed Impact Analysis Findings

Table E-1. Detailed Impact Analysis Findings, Greenmount, Baltimore

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	64.00	50.76	-13.24	4.15†	
	Comparison	40.42	35.39	-5.03		-8.22†
	500 Ft Buffer	37.97	30.39	-7.57	2.88†	-2.55
	1000 Ft Buffer	61.81	52.52	-9.29	2.64†	-4.27
Arson	Treatment	0.23	0.30	0.08	-0.57	
	Comparison	0.10	0.09	-0.01		0.08
Burglary	Treatment	8.81	7.42	-1.38	1.51	
	Comparison	5.48	5.03	-0.45		-0.93
Larceny Inside	Treatment	6.06	4.76	-1.31	1.85	
	Comparison	3.23	1.79	-1.44		0.13
Larceny Outside	Treatment	14.84	9.88	-4.96	4.09†	
	Comparison	7.19	4.39	-2.80		-2.16
Motor Vehicle Theft	Treatment	4.84	3.24	-1.60	2.98†	
	Comparison	4.74	3.24	-1.50		-0.10
Robbery	Treatment	6.03	4.45	-1.58	-2.13†	
	Comparison	4.19	2.88	-1.31		-0.26
Violent	Treatment	23.13	20.30	-2.83	2.05	
	Comparison	15.26	17.79	2.53		-5.36†
	500 Ft Buffer	9.52	9.00	-0.52	1.42	-3.05
	1000 Ft Buffer	12.16	13.33	1.17		-1.36

Source: The Urban Institute

†Significant at $p < .05$.

Table E-2. Detailed Impact Analysis Findings, North Avenue, Baltimore

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	62.55	64.23	1.68	-0.47	6.14
	Comparison	43.92	39.46	-4.46		
Arson	Treatment	0.05	0.31	0.26	-2.33	0.21
	Comparison	0.18	0.23	0.05		
Burglary	Treatment	8.71	10.15	1.44	-1.53	1.03
	Comparison	5.82	6.23	0.41		
Larceny Inside	Treatment	4.76	4.38	-0.38	0.63	0.95
	Comparison	3.87	2.54	-1.33		
Larceny Outside	Treatment	9.26	8.50	-0.76	0.85	1.30
	Comparison	7.45	5.38	-2.06		
Motor Vehicle Theft	Treatment	6.74	5.58	-1.16	1.45	-1.74
	Comparison	4.50	5.08	0.58		
Other	Treatment	0.29	0.46	0.17	-1.25	-0.03
	Comparison	0.18	0.38	0.20		
Robbery	Treatment	7.53	6.42	-1.10	1.13	-0.83
	Comparison	3.32	3.04	-0.28		
Violent	Treatment	25.21	28.42	3.21	-1.29	5.24
	Comparison	18.61	16.58	-2.03		

Source: The Urban Institute

†Significant at $p < .05$.

Table E-3. Detailed Impact Analysis Findings, Tri-District, Baltimore

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	37.61	29.12	-8.49	3.83†	-12.35†
	Comparison	32.53	36.38	3.86		
	500 Ft Buffer	21.92	20.62	-1.31	0.78	-5.16
	1000 Ft Buffer	28.82	26.04	-2.78	1.43	-6.64†
Arson	Treatment	0.11	0.35	0.24	0.11	0.27
	Comparison	0.18	0.15	-0.03		
Burglary	Treatment	6.11	5.65	-0.45	0.71	-1.69
	Comparison	5.03	6.27	1.24		
Larceny Inside	Treatment	3.39	1.54	-1.86	4.33†	-1.54†
	Comparison	1.97	1.65	-0.32		
	500 Ft Buffer	1.95	1.15	-0.79	2.37†	-0.47
	1000 Ft Buffer	2.55	2.69	0.14	-0.29	0.46
Larceny Outside	Treatment	4.05	3.46	-0.59	0.99	-4.12†
	Comparison	7.55	11.08	3.52		
	500 Ft Buffer	3.53	2.81	-0.72	1.66	-4.24†
	1000 Ft Buffer	6.21	3.46	-2.75	5.09†	-6.27†
Motor Vehicle Theft	Treatment	2.87	1.88	-0.98	2.31†	-1.01
	Comparison	3.63	3.65	0.02		
Robbery	Treatment	3.84	2.08	-1.77	2.99†	-2.06†
	Comparison	3.47	3.77	0.30		
	500 Ft Buffer	2.00	2.31	0.31	-0.56	0.01
	1000 Ft Buffer	2.95	2.88	-0.06	0.12	-0.36
Violent	Treatment	16.66	14.04	-2.62	1.67	-1.72
	Comparison	10.47	9.58	-0.90		

Source: The Urban Institute

†Significant at $p < .05$.

Table E-4. Detailed Impact Analysis Findings, Humboldt Park, Chicago

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	301.39	243.53	-57.86	4.03†	
	Comparison	349.57	330.00	-19.57		-38.30†
	500 Ft Buffer	141.48	134.17	-7.31	0.80	12.25
	1000 Ft Buffer	193.91	196.78	2.86	-0.34	22.43
Arson	Treatment	0.61	0.33	-0.28	1.43	
	Comparison	0.91	0.81	-0.11		-0.17
Burglary	Treatment	5.61	7.81	2.20	-2.74†	
	Comparison	5.74	7.11	1.37		0.82
Drug	Treatment	115.22	77.31	-37.91	3.09†	
	Comparison	120.57	116.14	-4.43		-33.49†
	500 Ft Buffer	56.70	52.11	-4.58	0.52	-0.16
	1000 Ft Buffer	52.87	64.33	11.46	-2.08†	15.89
Larceny	Treatment	20.35	20.17	-0.18	0.13	
	Comparison	30.83	29.25	-1.58		1.39
Motor Vehicle Theft	Treatment	8.57	9.06	0.49	-0.57	
	Comparison	10.35	7.89	-2.46		2.95†
	500 Ft Buffer	3.70	4.31	0.61	-0.97	3.07†
	1000 Ft Buffer	7.57	7.31	-0.26	0.33	2.20
Prostitution	Treatment	0.00	0.58	0.58	-1.28	
	Comparison	0.35	0.42	0.07		0.51
Robbery	Treatment	11.52	8.53	-2.99	3.05†	
	Comparison	11.43	11.61	0.18		-3.17†
	500 Ft Buffer	2.87	3.00	0.13	-0.34	-0.05
	1000 Ft Buffer	5.70	5.22	-0.47	0.74	-0.65
Vandalism	Treatment	20.30	20.92	0.61	-0.37	
	Comparison	23.61	23.39	-0.22		0.83
Violent	Treatment	78.13	70.36	-7.77	2.16†	
	Comparison	86.96	85.06	-1.90		-5.87
Weapons	Treatment	3.96	2.58	-1.37	2.87†	
	Comparison	3.78	4.56	0.77		-2.15†
	500 Ft Buffer	2.00	1.50	-0.50	1.38	-1.27
	1000 Ft Buffer	2.91	2.22	-0.69	1.52	-1.46

Source: The Urban Institute

†Significant at $p < .05$.

Table E-5. Detailed Impact Analysis Findings, West Garfield Park, Chicago

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	180.65	192.67	12.01	-1.62	
	Comparison	214.91	213.53	-1.39		13.40
Arson	Treatment	0.48	0.44	-0.03	0.18	
	Comparison	0.74	0.69	-0.04		0.01
Burglary	Treatment	5.39	5.28	-0.11	0.11	
	Comparison	11.48	10.94	-0.53		0.42
Drug	Treatment	43.91	50.58	6.67	-1.53	
	Comparison	14.17	21.92	7.74		-1.07
Larceny	Treatment	20.35	22.72	2.37	-1.58	
	Comparison	43.48	39.28	-4.20		6.57
Motor Vehicle Theft	Treatment	6.39	6.81	0.41	-0.52	
	Comparison	16.09	12.17	-3.92		4.33†
	500 Ft Buffer	4.39	4.64	0.25	-0.40	4.17†
	1000 Ft Buffer	5.30	5.64	0.33	-0.45	4.25†
Prostitution	Treatment	2.87	6.03	-0.29	-3.31†	
	Comparison	6.39	13.83	3.72		-4.28
Robbery	Treatment	11.43	8.92	3.16	2.46†	
	Comparison	12.13	9.11	7.44		0.50
Vandalism	Treatment	12.13	14.25	-2.52	-1.79	
	Comparison	22.83	20.17	-3.02		4.78†
	500 Ft Buffer	5.35	7.83	2.12	-3.49†	5.14†
	1000 Ft Buffer	7.57	9.47	-2.66	-1.98	4.57†
Violent	Treatment	24.43	23.17	2.49	-0.07	
	Comparison	26.09	20.86	1.91		3.96
Weapons	Treatment	2.26	2.28	0.21	-0.04	
	Comparison	2.43	3.00	-6.47		-0.55

Source: The Urban Institute

†Significant at $p < .05$.

Table E-6. Detailed Impact Analysis Findings, Individual Camera Analysis, D.C.

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	67.24	67.10	-0.13	0.04	
	Comparison	67.86	68.17	0.32		-0.45
Arson	Treatment	0.00	0.14	0.14	-2.12†	
	Comparison	0.19	0.03	-0.16		0.29†
Assault w/ Deadly Weapon	Treatment	13.43	11.07	-2.36	2.12†	
	Comparison	6.24	6.03	-0.21		-2.16
Burglary	Treatment	6.38	6.00	-0.38	0.51	
	Comparison	8.05	7.90	-0.15		-0.23
Larceny	Treatment	20.38	25.41	5.03	-2.91†	
	Comparison	33.76	36.79	3.03		2.00
Murder	Treatment	1.29	0.52	-0.77	2.73†	
	Comparison	0.86	0.45	-0.41		-0.36
Motor Vehicle Theft	Treatment	10.33	9.83	-0.51	0.49	
	Comparison	12.33	10.69	-1.64		1.14
Robbery	Treatment	14.05	12.72	-1.32	1.22	
	Comparison	5.86	5.72	-0.13		-1.19
Sexual Assault	Treatment	1.38	1.41	0.03	-0.09	
	Comparison	0.57	0.55	-0.02		0.05
Violent	Treatment	16.10	13.00	-3.10	2.55†	
	Comparison	7.67	7.03	-0.63		-2.46

Source: The Urban Institute

†Significant at $p < .05$.

Table E-7. Detailed Impact Analysis Findings, Cluster Camera Analysis, D.C.

Crime Type	Area	Before	After	Change	T-test	Difference-in-Differences
All Crime	Treatment	41.76	38.86	-2.90	0.04	
	Comparison	40.67	42.52	1.85		-4.75
Arson	Treatment	0.10	0.03	-0.06	0.88	
	Comparison	0.05	0.00	-0.05		-0.01
Assault w/ Deadly Weapon	Treatment	8.14	6.14	-2.00	2.16†	
	Comparison	1.95	1.93	-0.02		-1.98
Burglary	Treatment	4.24	3.38	-0.86	2.01†	
	Comparison	3.81	2.52	-1.29		0.43
Larceny	Treatment	16.86	17.07	0.21	-0.10	
	Comparison	29.52	32.66	3.13		-2.92
Murder	Treatment	0.48	0.66	0.18	-0.79	
	Comparison	0.05	0.07	0.02		0.16
Motor Vehicle Theft	Treatment	5.86	5.72	-0.13	0.13	
	Comparison	2.76	2.55	-0.21		0.08
Robbery	Treatment	5.71	5.34	-0.37	0.46	
	Comparison	2.43	2.62	0.19		-0.56
Sexual Assault	Treatment	0.38	0.52	0.14	-0.70	
	Comparison	0.10	0.17	0.08		0.06
Violent	Treatment	9.00	7.31	-1.69	1.72	
	Comparison	2.10	2.17	0.08		-1.77

Source: The Urban Institute

†Significant at $p < .05$.

Appendix F. Detailed Cost-Benefit Estimations

This section provides additional information on estimating the confidence intervals for the cost-benefit analysis in Baltimore and Chicago. Detailed tables with both the upper and lower bounds are provided in addition to the estimated benefit per month. As with the impact analysis, significant results do not necessarily mean that they are included in the cost-benefit estimation. Only those crime categories that were statistically significant were included in the calculation, and the same rule applied with the buffers in that the 500-ft and 1000-ft areas were only included if the target area had significantly changed.

Monetizing Confidence Bounds

Providing only point estimates in cost-benefit analysis is questionable, as it does not reflect how reliable those estimates are at capturing the actual benefits we would expect. Thus, this cost-benefit analysis reports not only monetized estimates at a specific point, but also monetizes the 95 percent confidence bounds of the estimate. This was done for every neighborhood within each city except for Baltimore's Downtown area, because the nature of the structural break analysis employed in that site does not lend itself to monetizing confidence. For structural break, the bounds represent dates for which the change might occur instead of the bounds for the change in crime. Thus the table associated with Baltimore's Downtown (refer to Table 4.9) only has a point estimate. To avoid confusion, we discuss only the point estimates in text for the two sites for which a cost-benefit analysis was conducted. In doing so, this analysis recognizes that there is uncertainty and variation surrounding the estimate in the sample. These particular bounds reflect the variation in the observed quantity of crime; they do not explore variation in the estimated values of each crime category. A more traditional sensitivity analysis may also introduce additional variation (aside from what is observed in the sample) to represent the variation that might occur from replicating this study in other places. Such an analysis may introduce changes to the price and/or the quantity of crimes being used to arrive at the estimate in order to see how sensitive the resulting monetized estimate is to these changes.

Conducting such a sensitivity analysis would invariably lead to wider bounds, as more variation is being introduced. While this would make the lower bound estimate more conservative, it would also provide a higher upper bound estimate. There are two reasons we opted to monetize confidence bounds rather than incorporate a more traditional sensitivity analysis. First, the jurisdictions under study in Baltimore and Chicago were interested in determining whether their particular approach to implementing a public surveillance system was cost-beneficial. By reporting only on the variation observed within each sample respectively, the confidence-bounded estimates are more informative to them. Second, though the sensitivity analysis would provide more conservative estimates on the lower side of the bounds, its estimates on the upper bound would be much higher than the confidence-bounded estimates. The larger upper bound reported in the sensitivity analysis may motivate other jurisdictions to adopt a camera system when those estimates may not be realistic for them. To prevent such an event from occurring, using monetized confidence bounds rather than a traditional sensitivity analysis appears more prudent.

Baltimore, Downtown

The downtown area in Baltimore was the only area that was analyzed using structural break analysis. Table F-1 shows the monetized values that align with the structural breaks that were found for each of the crime categories assessed. Refer to the site specific chapter for details on whether the breaks were included in the cost-benefit estimation. For example, researchers found that some of the breaks were not aligned with camera activities and therefore omitted from the overall cost-benefit analysis.

Table F-1: Baltimore, Downtown Structural Break Results with Benefit Estimates

	Estimated Benefit per Month		
Offense	Target Area	500-ft Buffer	1000-ft Buffer
Burglary	–	-$69,621.91	-$69,621.91
Larceny Inside	-$86,449.22*	-$30,073.77	-$30,103.18
Larceny Outside	-$84,316.85*	–	-$103,052.30
Motor Vehicle Theft	–	–	–
Robbery	–	–	–
Violent Crime	–	–	$774,618.40

Source: The Urban Institute.

* Significant at the 0.05 level and included in cost-benefit estimation.

Baltimore, Tri-District

Table F-2: Baltimore, Tri-District Difference-in-Differences Results with Benefit Estimates, Target Area

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$8,589.99	-$15,565.75	-$39,721.50
Larceny Inside*	-$2,886.57	-$11,176.85	-$19,467.14
Larceny Outside*	-$1,330.75	-$19,471.41	-$37,612.07
Motor Vehicle Theft	$11,254.95	-$7,486.54	-$26,227.88
Robbery*	-$12,376.70	-$223,323.31	-$434,269.93
Violent Crime	$453,272.00	-$173,288.00	-$799,847.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Note: Although larceny outside was significant, it was ultimately not included in the site's calculation of benefit because the change in the treatment area was not significant without the control area.

Table F-3: Baltimore, Tri-District Difference-in-Differences Results with Benefit Estimates, 500-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$11,735.36	-$10,608.85	-$32,953.05
Larceny Inside	$7,192.93	-$359.41	-$7,911.68
Larceny Outside*	-$6,030.05	-$23,115.63	-$40,201.13
Motor Vehicle Theft	$21,454.93	$3,399.13	-$14,656.81
Robbery	$168,190.86	-$34,266.50	-$236,723.85
Violent Crime	$956,482.00	$364,941.00	-$226,599.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Note: Although larceny outside was significant, it was ultimately not included in the site's calculation of benefit because the change in the treatment area was not significant without the control area. As such, this change was not included in the target area estimations and therefore is not included in any buffer estimate as well.

Table F-4: Baltimore, Tri-District Difference-in-Differences Results with Benefit Estimates, 1000-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$15,026.93	-$9,385.79	-$33,798.50
Larceny Inside	$11,657.74	$2,637.89	-$6,381.96
Larceny Outside*	-$10,212.58	-$28,341.04	-$46,469.49
Motor Vehicle Theft	$23,678.96	$4,241.87	-$15,195.22
Robbery	$114,579.05	-$81,885.17	-$278,349.40
Violent Crime	$572,774.00	$55,986.00	-$460,801.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Note: Although larceny outside was significant, it was ultimately not included in the site's calculation of benefit because the change in the treatment area was not significant without the control area. As such, this change was not included in the target area estimations and therefore is not included in any buffer estimate as well.

Baltimore, Greenmount

Table F-5: Baltimore, Greenmount Difference-in-Differences Results with Benefit Estimates, Target Area

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$18,925.81	-$12,231.12	-$43,388.04
Larceny Inside	$13,341.06	$963.17	-$11,414.72
Larceny Outside	$3,980.47	-$15,884.76	-$35,750.07
Motor Vehicle Theft	$20,890.23	-$1,390.49	-$23,671.35
Robbery	$185,246.74	-$31,784.87	-$248,817.69
Violent Crime	$468,862.00	-$419,527.00	-$1,307,916.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-6: Baltimore, Greenmount Difference-in-Differences Results with Benefit Estimates, 500-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$32,138.43	$4,274.52	-$23,589.52
Larceny Inside	$19,056.84	$9,573.97	$91.10
Larceny Outside	$5,490.04	-$17,947.64	-$41,385.33
Motor Vehicle Theft	$20,541.49	$224.73	-$20,091.89
Robbery	$264,537.88	$100,554.78	-$63,429.52
Violent Crime	$129,054.00	-$494,905.00	-$1,118,863.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-7: Baltimore, Greenmount Difference-in-Differences Results with Benefit Estimates, 1000-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$46,113.91	$16,093.64	-$13,926.75
Larceny Inside	$9,488.68	-$3,083.48	-$15,655.71
Larceny Outside	-$4,882.24	-$41,853.86	-$78,825.48
Motor Vehicle Theft	$38,391.09	$11,784.59	-$14,821.91
Robbery	$317,582.77	$123,241.16	-$71,100.44
Violent Crime	$339,594.00	-$369,277.00	-$1,078,148.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Baltimore, North Avenue

Table F-8: Baltimore, North Avenue Difference-in-Differences Results with Benefit Estimates, Target Area

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$39,360.48	$5,510.48	-$28,339.51
Larceny Inside	$19,700.38	$8,610.88	-$2,478.70
Larceny Outside	$20,124.87	$3,981.94	-$12,160.91
Motor Vehicle Theft	$1,112.88	-$29,243.65	-$59,600.31
Robbery	$166,589.22	-$82,239.35	-$331,067.92
Violent Crime	$1,221,562.00	$324,011.00	-$573,541.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-9: Baltimore, North Avenue Difference-in-Differences Results with Benefit Estimates, 500-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$9,849.27	-$4,364.61	-$31,392.82
Larceny Inside	$16,542.26	$8,402.42	$262.50
Larceny Outside	$24,293.72	$11,291.86	-$1,710.01
Motor Vehicle Theft	-$511.39	-$25,254.67	-$49,997.80
Robbery	$190,779.33	$20,205.97	-$150,368.61
Violent Crime	$612,180.00	-$18,600.00	-$649,381.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-10: Baltimore, North Avenue Difference-in-Differences Results with Benefit Estimates, 1000-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Burglary	$23,695.68	-$5,806.57	-$35,308.95
Larceny Inside	$3,346.94	-$9,976.48	-$23,299.97
Larceny Outside	$23,662.47	$8,150.80	-$7,360.79
Motor Vehicle Theft	$47,873.05	$16,475.93	-$14,921.20
Robbery	$99,193.70	-$90,392.57	-$279,978.83
Violent Crime	$716,025.00	$53,349.00	-$609,326.00

Source: The Urban Institute.

* Significant at the 0.05 level.

Chicago, Humboldt Park

Table F-11: Chicago, Humboldt Park Difference-in-Differences Results with Benefit Estimates, Target Area

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Arson	$14,607.28	-$5,217.06	-$25,041.72
Burglary	$42,836.18	$10,864.49	-$21,107.19
Drug*	-$41,117.66	-$368,072.73	-$695,027.68
Larceny	$43,650.72	$10,256.92	-$23,136.95
Motor Vehicle Theft*	$75,610.25	$42,378.20	$9,146.01
Prostitution	$98.35	$34.03	-$30.29
Robbery*	-$54,993.45	-$383,218.31	-$711,443.18
Vandalism	$42,397.71	$6,170.24	-$30,057.22
Violent Crime	$656,364.00	-$322,980.00	-$1,302,324.00
Weapon*	-$16,592.54	-$65,328.50	-$114,064.16

Source: The Urban Institute.

* Significant at the 0.05 level.

Note: Although motor vehicle theft was significant once the control area was introduced in the DiD analysis, it was ultimately not included in the site's calculation of benefit because the change in the treatment area was not significant without the control area.

Table F-12: Chicago, Humboldt Park Difference-in-Differences Results with Benefit Estimates, 500-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Arson	$22,429.92	$5,329.88	-$11,770.17
Burglary	$15,490.28	-$12,153.01	-$39,796.31
Drug	$268,660.97	-$1,739.04	-$272,139.06
Larceny	$40,199.51	$10,567.73	-$19,064.12
Motor Vehicle Theft*	$72,726.97	$44,096.16	$15,465.50
Prostitution	$19.06	-$4.55	-$28.16
Robbery	$241,699.19	-$5,547.09	-$252,794.58
Vandalism	$35,985.07	$5,050.80	-$25,883.47
Violent Crime*	$2,771,295.00	$1,712,930.00	$654,566.00
Weapon	$6,166.84	-$38,748.60	-$83,664.04

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-13: Chicago, Humboldt Park Difference-in-Differences Results with Benefit Estimates, 1000-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Arson	$17,784.07	-$187.71	-$18,159.50
Burglary	$20,859.57	-$9,687.40	-$4,023.42
Drug	$398,417.68	$174,663.98	-$49,089.72
Larceny	$45,156.76	$9,626.40	-$25,903.96
Motor Vehicle Theft	$63,428.50	$43,003.54	-$225.74
Prostitution	$37.24	$10.15	-$16.94
Robbery	$196,495.65	-$78,541.69	-$353,579.03
Vandalism	$35,941.47	$1,379.12	-$33,183.24
Violent Crime	$1,579,093.00	$662,000.00	-$255,094.00
Weapon	$3,348.10	-$44,557.16	-$92,462.11

Source: The Urban Institute.

* Significant at the 0.05 level.

Chicago, West Garfield Park

Table F-14: Chicago, West Garfield Park Difference-in-Differences Results with Benefit Estimates, Target Area

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Arson	$18,897.91	$337.82	-$18,222.27
Burglary	$48,074.94	$5,535.64	-$37,003.66
Drug*	$89,454.11	-$11,788.48	-$113,031.18
Larceny	$127,331.46	$48,345.09	-$30,641.35
Motor Vehicle Theft*	$102,815.22	$62,283.01	$21,750.79
Prostitution	$2.17	-$283.37	-$568.91
Robbery*	$424,600.90	$60,585.26	-$303,431.58
Vandalism	$62,160.02	$35,436.21	$8,712.33
Violent Crime	$1,192,252.00	-$322,980.00	-$1,302,324.00
Weapon*	$19,574.14	-$16,690.56	-$52,954.95

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-15: Chicago, West Garfield Park Difference-in-Differences Results with Benefit Estimates, 500-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Arson	$17,673.75	$2,626.09	-$12,419.08
Burglary	$47,467.10	$11,691.63	-$24,083.83
Drug	$58,707.17	-$2,455.94	-$63,619.06
Larceny	$116,441.59	$38,763.10	-$38,915.38
Motor Vehicle Theft*	$97,794.70	$59,888.12	$21,981.70
Prostitution	-$194.26	-$454.81	-$715.37
Robbery	$622,782.80	$325,553.46	$28,324.13
Vandalism	$60,980.89	$38,149.66	$15,318.43
Violent Crime	$1,502,113.00	$614,068.00	-$273,977.00
Weapon	$12,134.91	-$18,418.33	-$48,971.57

Source: The Urban Institute.

* Significant at the 0.05 level.

Table F-16: Chicago, West Garfield Park Difference-in-Differences Results with Benefit Estimates, 1000-ft Buffer

Offense	LB Estimated Benefit per month	Estimated Benefit per month	UB Estimated Benefit per month
Arson	$19,410.39	$2,890.25	-$13,630.19
Burglary	$46,176.34	$9,067.05	-$28,042.38
Drug	$166,443.28	-$80,807.14	-$328,057.56
Larceny	$134,670.71	$57,207.74	$57,207.74
Motor Vehicle Theft	$100,811.90	$61,137.65	$21,463.41
Prostitution	-$104.02	-$409.20	-$714.37
Robbery	$670,791.91	$349,349.51	$27,905.90
Vandalism	$58,587.92	$33,860.08	$9,132.17
Violent Crime*	$1,786,666.00	$966,895.00	$147,123.00
Weapon	$34,816.05	-$1,691.25	-$38,198.24

Source: The Urban Institute.

* Significant at the 0.05 level.

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