Capital Needs of the Public Housing Stock in 1998

Formula Capital Study

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Executive Summary

This document reports the results of the Formula Capital Study, a study designed to estimate capital needs for the public housing stock as of 1998 and to support HUD in revising the allocation rules for distributing funds to public housing authorities under the new Capital Fund.

The study focuses on two key measures of need, existing modernization needs and accrual needs.

Existing modernization needs are the costs of repairs and replacements beyond ordinary maintenance required to make the housing decent and sustainable with modest amenities. This includes all capital costs associated with four types of repairs and replacements:

- repairing or replacing systems with immediate repair needs to restore them to working condition, not including costs for routine maintenance;
- additional costs associated with upgrades to some systems, but excluding major reconfiguration of units;
- additions to other systems;
- replacing systems that have reached the end of their useful life, even if they are still in working order.

Accrual needs are the costs needed each year to cover expected ongoing repairs and replacements beyond ordinary maintenance, assuming that existing modernization needs are met.

The estimates of need are based on physical inspections at a sample of 684 developments containing 229,973 units in 219 housing authorities. The inspection sample represents the vast majority of public housing units nationwide—1,194,370 out of the estimated total study universe of 1,206,467 units. Relative to the 1,286,131 units funded under the Comprehensive Grant Program (CGP) and Comprehensive Improvement Assistance Program (CIAP) in FY99, the study universe excludes some 80,000 units slated for demolition or transformation with HOPE VI funding.

Inspections were conducted using updated versions of inspection protocols and costing methods based on those originally developed by Abt Associates Inc. for HUD's 1985 Modernization Needs Study. Due to resource constraints, the inspection protocols did not call for inspecting systems that would allow us to assess modernization costs associated with detecting or abating special hazards such as asbestos or lead paint, modifications for accessibility for the disabled, improvements for increasing energy efficiency, or major

reconfiguration of units. Our inspection-based estimates of existing modernization needs do ***not*** include costs for the excluded categories of units listed in the previous paragraph, or for the excluded categories of costs listed above. Even in the 1985 Abt Modernization Needs Study, asbestos abatement and modifications for accessibility for the disabled were not empirically costed. Cost estimates for lead-based paint and redesign were intended as national estimates and did not enter the 1990 formula. In order to provide a more complete estimate of total national modernization needs, we used the study data to infer costs for the excluded categories of units, and we used external estimates for some of the excluded categories of costs.

The study's key findings on existing modernization needs and accrual needs follow.

Existing Modernization Needs

- The total inspection-based existing modernization needs for the 1,194,370 units included in the inspection universe was $22.5 billion in 1998—an average of $18,847 per unit.
- When estimates for Alaska, Hawaii, Guam, and the U.S. Virgin Islands and for lead-paint abatement, energy efficiency, and modifications for accessibility for the disabled are added, the estimate of existing modernization needs in the total universe of 1,206,467 units increases to $24.6 billion, an average of $20,390 per unit.
- Inspection-based existing modernization needs per unit are correlated with housing authority size. The per-unit average was $13,868 in housing authorities with under 250 units, $17,631 in housing authorities with 250 to 1,249 units, $18,875 in housing authorities with 1,250 to 6,600 units, and $21,462 in housing authorities with over 6,600 units (excluding New York, Chicago and Puerto Rico). Inspection-based existing modernization needs in New York City, Chicago, and Puerto Rico were higher than the national per-unit average—$23,074, $26,184, and $22,172, respectively—and were somewhat higher than in the other very large housing authorities.
- As expected, due to more wear and tear on unit systems, the per-unit inspection-based existing modernization needs were substantially higher in family developments compared with elderly developments, averaging $20,748 versus $12,962.
- One quarter of the stock had inspection-based existing modernization needs below $8,799 per unit. At the high end, one quarter had needs above $26,692 per unit. The median value was $16,908.
- Existing modernization needs appear to have declined substantially since 1990, when HUD last estimated needs in the stock. In 1998 dollars, the total existing

unfunded need decreased from about $33 billion in 1990 to about $22 billion in 1998. The decrease was about 35 percent stockwide, and 29 percent on a per-unit basis.

Accrual Needs

- Assuming that the inspection-based existing modernization needs were completely met, each year approximately $2 billion would be required to address ongoing accrual needs or, on average, $1,679 per unit. (No attempt was made to create an estimate of annual accrual needs for the total universe comparable to the estimate of existing modernization needs in the total universe. In other words, accruals were not estimated for the portion of modernization needs not included in the inspection protocol (e.g., modifications for accessibility for the disabled), as was done for the estimate of existing modernization needs in the total universe. The accruals would likely be minimal for systems such as lead paint abatement and asbestos removal.)
- Accrual costs do not vary substantially across properties; the 25th percentile ($1,301) and the 75th percentile ($1,962) are close to the median of $1,627.
- Average annual accrual needs per unit are highest among the smallest housing authorities. This may be due to a combination of several factors. Many of the smaller housing authorities have newer stocks. Further, the stock in smaller agencies is often in better condition than the stock in larger agencies, as can be seen by their lower modernization needs. Our system of modeling accrual assumes that all over-age systems are replaced as part of existing modernization. In newer properties, fewer systems have reached the end of their useful lives, so fewer systems are replaced as part of existing modernization, and more as part of ongoing accrual. As a result, average annual accrual needs are higher, as many systems will reach their life expectancy and need to be replaced over the next 20 years. Also, our accrual modeling assumes that accrual costs are proportional to square feet in the property. Properties in small housing authorities tend to have fewer units per building, and as a result their accrual costs per square foot for major systems are higher than in larger housing authorities. Moreover, as an engineering model (like the model used in the 1990 formula), our accrual model does not take into account neighborhood and climatic conditions that might accelerate physical deterioration in some large housing authorities.
- Accrual costs are higher in family developments, about $1,815 per unit compared with $1,259 per unit in elderly developments.
- Stockwide, annual accrual needs increased by about 1 percent between 1990 and 1998. At a per-unit level the increase was about 10 percent.

Shares of Need Across Housing Authorities

In addition to providing national estimates of need, a second purpose of the study was to provide HUD with information needed to support revision of the formula for allocating capital funds to public housing authorities under the new Capital Fund. This requires estimating capital needs for each development in the stock and summing to the housing authority level. Collecting data for every single development would be prohibitively costly and time-consuming. Instead, as was done for the development of the CGP formula in the early 1990s, this study adopted the approach of modeling existing modernization needs and accrual needs at the development level based on development, housing authority, and neighborhood characteristics for the nationally representative sample of properties selected for the study. The model-based estimates were applied to the full stock of public housing to obtain development-level estimates of need. The development-level estimates were then summed to create housing authority-level estimates of need.

Using these estimates of need, HUD can allocate its limited resources according to a variety of policy-driven formulas. For example, funds can be allocated in proportion to existing modernization needs, in proportion to accrual needs, or in proportion to some combination of the two. The current CGP formula allocates funds by giving "backlog" (the cost of repairs and replacements beyond ordinary maintenance required to restore all property systems to original working order) and accrual each equal weight. Another alternative could be to provide relatively more funding to housing authorities with higher average needs so that over time they could improve relative to other properties.

Because the 1999 shares allocated under CGP and CIAP result from formulas that approximated the distribution of need as of the mid-1980s, we can compare these shares with the shares of total need derived from the current Formula Capital Study, to get some idea of how relative needs have changed across housing authority groups over the past decade. In order to control the comparison, we will apply the 1999 CGP/CIAP formula patterns of need per unit and the Formula Capital Study patterns of need per unit to the full universe of 1,286,131 units that CGP and CIAP funded in FY99.

- Comparing the 1999 CGP/CIAP shares with the shares of total need derived from the Formula Capital Study indicates that the shares of existing modernization needs and accrual needs have increased among both the small (under 250 units) and medium size (250 to 1,249 units) housing authorities. For example, small housing authorities accounted for 7 percent of the backlog in the CGP/CIAP estimates and 11 percent of existing modernization needs in 1998 under the Formula Capital Study. Medium housing authorities accounted for 18 percent of backlog under the CGP/CIAP allocation and 24 percent of existing modernization needs in 1998 under the Formula Capital Study. Accrual shares also increased somewhat for these categories of housing authorities. This implies that over time the ***relative***

needs of these agencies have grown. In other words, although the average need per unit is still ***lower*** in smaller agencies compared with larger agencies, their needs relative to larger agencies have increased.

- Both existing modernization needs and accrual needs shares remained constant at 26 percent of the total for housing authorities with 1,250 to 6,600 units.
- Among the largest housing authorities (6,600 units or more including New York City, Chicago, and Puerto Rico), relative needs have decreased. On a per-unit basis, their needs are still substantially higher than the needs of the smaller housing authorities, but relatively their needs have gone down. Under the CGP/CIAP allocation the largest housing authorities accounted for 49 percent of existing modernization needs and 37 percent of accrual needs. The Formula Capital Study estimates that in 1998 these shares have decreased to 39 percent and 31 percent, respectively.

The reasons for the differences in shares across the two periods include:

- The meaning of "existing modernization needs" has been expanded from the original definition of "backlog" to place more emphasis on upgrading systems and replacing all over-age systems that have reached the end of their useful life.
- Some modernization needs have been met since 1985, and probably have been met at a higher rate in housing authorities that showed greater need under the current CGP/CIAP distributions.
- Because they will not remain in the stock in their current configuration, some of the highest need developments (HOPE VI and properties with approved demolition plans) have been excluded from the sample, and thus did not contribute to the Formula Capital Study estimates of per-unit needs.

Further details on the information presented in this Executive Summary are contained in the following report. A summary of the overall Formula Capital Study goals, the sample used for analysis, the data collection procedures, and definitions of technical terms used in this document are presented in Chapter One. Chapter Two provides estimates of capital needs for the public housing stock as a whole and for subgroups of housing authorities. Chapter Three provides details on models that predict measures of need at the development level based on development, housing authority, and neighborhood characteristics. The model-based estimates are applied to the full stock of public housing to obtain property- and housing authority-level estimates of need in order to assist HUD in its revisions of the allocation formula for funding public housing capital needs under the new Capital Fund. Further details on sampling, data collection, the methods used to calculate capital needs from inspection data, and model coefficients are presented in Appendices A, B, C, and D, respectively.

Chapter One: Overview

Formula Capital Study Overview

This document provides findings from the Formula Capital Study,[1] a study designed to inform revisions to the allocation rules for distributing capital funds to public housing authorities (PHAs), including agencies currently funded under the Comprehensive Grant Program (CGP), and its extension to agencies formerly funded under the Comprehensive Improvement Assistance Program (CIAP).

In order to encourage the comprehensive handling of modernization needs by public housing authorities, Congress enacted in 1991 a Comprehensive Grant Program formula approach to provide funds for modernizing the larger housing authorities (initially 500 or more units, then lowered to 250 or more units). Since 1992 the Comprehensive Grant Program formulas have been the primary mechanism for allocating modernization funding for public housing. The components of this formula system are estimates of capital improvement needs, annual accrual of needs, other sources of funding available to housing authorities, and a range of development characteristics. Although the formula work was debated at every point, the Comprehensive Grant Program formula approach achieved considerable policy and technical acceptance, because it was based on extensive, rigorous statistical testing of a large sample of standardized physical inspections. The multi-billion dollar Comprehensive Grant Program has become the primary source of capital funds for public housing. Other sources of funding for capital needs include the CIAP system for housing authorities with fewer than 250 units. In addition, many large developments that require a relatively higher level of funds to meet their physical and social needs are currently receiving funding under the HOPE VI program.

It is time for a comprehensive review of the Comprehensive Grant formulas. The last standardized inspections of public housing properties took place in the mid-1980s, and the last formula debate took place in the early 1990s. Housing authorities have had about six years of experience with the Comprehensive Grant formulas. The timeliness of re-examining the formulas is made compelling by recent debates in Congress and the Executive Branch over the future of public housing.

1 This work was funded under three separate task orders: Task Order 8 under Contract 18404, Task Order 17 under Contract 18374, and Task Order 14 under Contract 5964.

The goals of the Formula Capital Study were to:

- estimate capital needs nationally and for various categories of housing authorities; and
- provide information for HUD to use in revising the formulas for allocating capital funds to housing authorities under the new Capital Fund program.

In order to assess the CGP formulas, it was necessary to estimate capital needs for a sample of properties and relate the estimates of need to various housing authority and development characteristics. For this study, a nationally representative sample of 684 developments in 219 housing authorities was inspected to obtain estimates of their capital needs. These 684 developments contained 229,973 units, and are representative of the vast majority of units nationwide—1,194,370 out of the estimated total universe of 1,206,467 units. The inspection information was combined with information collected directly from the housing authorities and other secondary databases to create an up-to-date database of capital needs and background information for these developments.

Study Sample and Universe

The data collection was conducted in two phases. Inspections for the original sample of 625 developments were conducted from January through May 1998. In August 1998 HUD decided to expand the sample, focusing on properties in very small housing authorities and properties in the three largest housing authorities—New York City, Chicago, and Puerto Rico. The inspections for the supplemental sample of 59 developments were conducted from November 1998 through January 1999. Further details on sampling are presented in Appendix A.

The initial universe data file received from HUD in August 1997 contained 1,308,050 units. In defining the sampling universe we excluded two categories of developments:

- The study was intended to estimate the capital needs for developments likely to remain in the stock (as compared with developments that will be demolished or replaced through HOPE VI) and to be funded under the Capital Fund. Therefore, developments with approved demolition plans, completed demolitions, or approved HOPE VI implementation grants were ***excluded*** from the sampling universe. For the same reason, Indian Housing Authorities were also excluded from the sampling universe, as they will not be funded through the Capital Fund.
- In order to eliminate prohibitively expensive data collection costs, the sampling universe ***excluded*** developments in Alaska, Hawaii, Guam, and the U.S. Virgin Islands. For the same reason, the sampling universe also ***excluded*** all developments explicitly identified as scattered-site in HUD's master universe file.

After the exclusions described above, the sampling universe consisted of 1,178,003 units in 12,611 developments in 3,144 housing authorities. While on site, the inspectors identified additional properties that should have been excluded because they received 1998 HOPE VI implementation grants or were no longer public housing. Following these additional exclusions, the final estimated sampling universe was 1,133,963 units.

To provide a more complete picture of national needs, we have adjusted the sample weights and made other adjustments so that the sample represents all developments and units likely to be funded through the Capital Fund. The first adjustment included adding back into the universe scattered-site developments, units in HOPE VI developments that are not included in the HOPE VI program, and any units not slated for demolition in developments with approved demolition plans, bringing the inspection universe of units to 1,194,370. Units not in the original sampling universe were "brought back" to the inspection universe by increasing the weights for similar categories of properties that were included in the sampling universe. We then added in all units in Alaska, Hawaii, Guam, and the U.S. Virgin Islands. Our all-inclusive estimated universe for the total projections of need is 1,206,467 units. Again, note that this "universe" of 1,206,467 units excludes almost 80,000 units either approved for demolition or funded by HOPE VI implementation grants, that were funded by the FY99 CGP. Further details are presented in Appendix A.

Data Collection and Methodology Summary

In order to assess and revise the CGP formulas, it was necessary to estimate capital needs for a sample of properties and relate the estimates of need to various housing authority and development characteristics for the sample. To do so, we needed a range of housing authority- and development-level data. A database on the characteristics of the sample properties has been assembled from three major sources:

- on-site inspections conducted by trained architects and engineers from the DLR Group using the Observable Systems Approach to estimate capital needs;
- existing computerized datasets from HUD (containing data on developments and housing authorities and their residents);
- existing background data obtained directly from housing authorities (e.g., modernization spending and plans), which was obtained using a data abstraction form.

The information contained in this database was used to estimate property-level, housing authority-level and national capital needs, and to develop alternative formulas for allocations. Further details on data collection are provided in Appendix B.

On-Site Inspections

Capital needs were assessed by inspectors using the Observable Systems Approach developed by Abt Associates Inc. The approach was initially developed by Abt Associates Inc. for the 1985 HUD Modernization Needs Study and was refined by Abt Associates Inc. for several later studies including the 1990 Assessment of HUD-Insured Multifamily Housing Stock, the 1991 Assessment of Capital Needs for the San Francisco Housing Authority, and the 1995 Assessment of the HUD-Insured Multifamily Housing Stock.[2] The Observable Systems Approach combines on-site inspection and rating of a property's condition with a computerized costing system based on a consistent set of repair/replacement costs that are adjusted for regional price differences.

The term "observable systems" is used to indicate that the physical condition of the system is capable of being observed and assessed in the field, and that "destructive" testing is not involved (e.g., opening up a wall to check for insulation or broken pipes). In certain instances the observation is a judgement, based on knowledge of the conditions of such systems, modified by whatever data (either inferred or provided) are available at the site. The main advantage of the Observable Systems approach is that it is a cost-effective way to estimate property and national needs using a sample of units and buildings from a nationally representative sample of developments.

The inspection protocol included observing 135 mechanical, electrical, and architectural systems in a sample of units and buildings in the property and for the site as a whole. A "system" is defined as an observable component at the site, building, unit, or project level. Unit systems include interior construction (walls, partitions, floor sub-bases), interior finishes (wall surfaces, floor coverings, interior doors), kitchen fixtures (cabinets, ranges, refrigerators), bathroom fixtures (toilets, vanities, tubs), and unit-level mechanical and electrical systems (heating, cooling, electrical, and communication systems). Building systems include building exterior closures (foundation, slab, exterior wall, insulation), exterior features (canopies, exterior stairs, building-mounted site lights, fire escapes, balconies, porches, decks, sheds), and building mechanical systems (boilers, switchgears, heating risers, etc.). Central facility systems include central facility interior construction (common room interior, laundry room interior, mail facility interior, restroom interior, etc.) and central facility equipment (laundry equipment, central kitchen and bath fixtures, and mail facilities). Site systems include site areas (landscaping, roadways, parking lots, parking garages, paved pedestrian areas,

2 Dixon Bain et al., *Study of the Modernization Needs of the Public and Indian Housing Stock* (Cambridge, MA: Abt Associates Inc., March 1988); James Wallace et al., *Current Status of HUD-Insured (or Held) Multifamily Rental Housing* (HUD, PD&R 1993); Judie Feins et al., *Viability Review for Physical Improvements for the San Francisco Housing Authority* (Cambridge, MA: Abt Associates Inc., September 1991); Meryl Finkel et al., *Status of HUD-Insured (or Held) Multifamily Rental Housing in 1995* (Cambridge, MA: Abt Associates Inc., December 1998). Details on the precise protocols and forms used for the current study are provided in the HUD Formula Capital Study *Inspection Manual* (Abt Associates Inc., January 1998).

curbing, fencing, retaining walls, site drainage, pole-mounted site lighting, etc.), site amenities (basketball courts, site furniture, dumpsters and enclosures) and site distribution systems. Full details on systems and system groupings are presented in Exhibit C-2 in Appendix C.

The term "action level" refers to the level or nature of the repair required to restore the system to its original condition. For each observable system the inspector chooses among five action levels, each of which has a specific set of sub-actions associated with it. The five action levels are:

- No Action Required
- Minor Action Required
- Moderate Action Required
- Major Action Required
- Replacement Required

Each action level is precisely and objectively defined for the system in question, so that assessments can be consistent across inspectors. The inspection booklets were developed based on these systems and actions. The inspection instruments require inspectors to record their evaluations of condition by indicating which of five ordinal categories most accurately describes the nature of the improvement needed. For any system, each action level denotes a specific repair action. For example, for ranges and hoods (a dwelling unit system), the Minor (MIN) action is to replace a burner and clean the hood; the Moderate (MOD) action is to replace the hood; the Major (MAJ) action is to replace the range; and Replacement (REP) involves replacing the range and the hood. Not all systems have five action levels. For example, for refrigerators, the only action is REP, which replaces the refrigerator. The ***Inspection Manual*** for this study details each allowable action level for each system.

For some systems, in addition to identifying immediate repair needs for that system, a determination was made as to whether the system needed any additions or upgrades in order to ensure that the housing was decent and sustainable. Two tools were used to help the inspector make this determination. The first was direct observations and discussions with the property escort about the various systems. (Housing authorities were instructed to provide an escort who was familiar with the property's systems.) The second tool was the Summary Project Observations and Windshield Survey (SPOWS) form. This form was used to record general descriptions of the development and the surrounding neighborhood, allowing the inspector to place the inspected property in context within its neighborhood. To complete the Windshield Survey component of the SPOWS, the inspector was to spend approximately 15 minutes driving around the neighborhood making the necessary observations. Inspectors were instructed to pay particular attention to the characteristics of other low-income housing in the neighborhood.

With this information in hand, the inspector was then asked to assess the feasibility of upgrading or adding selected systems. In several of the inspection booklets (Building Envelope, Building Mechanical and Electrical, Unit and Site), the inspector was to determine whether by some investment beyond routine repairs, a property or system should be upgraded to be more comparable to other housing in the neighborhood. These determinations were based on direct observations of the system (age, technology, evidence of repair problems, etc.), discussions with the property escort about the various systems, and the observations made while completing the SPOWS. Examples of systems that could be upgraded or added include: windows, stairways, common rooms, laundry rooms, air conditioning, site parking, site lighting, landscaping, fencing and playgrounds. Determinations of unit upgrade actions were slightly different as they were based on broad assessments of three living areas (kitchen, bathrooms, unit interior) instead of individual system-level judgements. All upgrade determinations involved a series of questions asking first whether the upgrade was necessary and second whether the upgrade was feasible.

Depending on the system assessed, the inspector determined the upgrade action recommended:

- current system did not need to be changed;
- current system needed to be upgraded with higher quality materials, such as windows that needed to be upgraded to thermopane glass;
- current system needed to be upgraded with higher quality materials and expanded, such as site furniture that needed to be upgraded using better materials, and then needed to be expanded in terms of numbers;
- current system did not need to be upgraded, but should be expanded, such as site parking areas that did not require upgrading, but more spaces needed to be produced;
- system was not present but should be added, such as central air conditioning.

The system's age was recorded for many systems. Age was determined through observation of the system and conversations with the property escort. If age was unknown the system was given the same age as the building or property. System age also indicates at what point the system is in its expected life cycle, and is important in the accrual calculations which are based on a system’s useful life. For each accrual year (years 2-20) the system’s age is increased by one year. In any year that a system’s accrual age equals its expected life, the repair/replace cost is added into the accrual total for that year.

After the inspection data was converted to electronic form, Abt Associates Inc. applied a set of repair, replacement, or upgrade costs to each item inspected. All costs in the cost file are for the Washington, D.C. metropolitan area and include costs of labor, materials and

contractor fees. Using the precise definitions of the action levels described above (and further in the Inspection Manual), a series of costs were developed for each action level, for each system, that reflect materials commonly used in public or low-income housing. These costs were developed by Abt Associates Inc. with the assistance of a specialized costing contractor, A.M. Fogarty & Associates, Inc. In the above example for ranges and hoods, the MIN cost is $108 for each kitchen requiring MIN action (replace a burner and clean the hood); MOD costs are $246 for each kitchen requiring a MOD level of repair (replace the hood); MAJ costs are $480 for each kitchen (replace the range); and REP costs are $720 (replace the range and hood).

If the inspector indicated that a system requires upgrading—or in the case of the unit, that a particular area requires upgrading—and that it is feasible to do so, the cost associated with the upgrade is usually used instead of the cost for the repair action. For example, if the kitchen needs upgrading, the cost to do a partial upgrade, which upgrades *some* of the kitchen systems is $5,180. (The systems in the kitchen include the walls, ceiling, floor covering, cabinets, sink, range and refrigerator.) The cost for a full upgrade, which upgrades *all* the kitchen systems, is $7,680. The cost for a kitchen rehab, which includes upgrading all the kitchen systems and moving partitions, is $15,180. When both upgrade and repair actions are indicated, the more expensive cost is applied. Costs for each action level for each system and the costs for upgrading or adding selected systems are presented in Exhibit C-1 in Appendix C.

Once the property-level costs were estimated, they were multiplied by two adjustment factors. First, they were adjusted for local cost variations using the R.S. Means locational adjustment factors. Second, they were adjusted by a factor of 7 percent to account for soft costs (design costs and architect and engineering costs) and by a factor of 10 percent to account for housing authority management costs.[3]

From these, we developed dollar estimates based on capital needs for the sampled developments and computed the capital needs estimates for the inspection universe of public housing. We refer to these costs as the ***"inspection-based existing modernization needs for the inspection universe."*** These inform our analysis of the reliability and funding impact of formula funding proxies across types of housing authorities. The cost estimation procedures are described in more detail in Appendix C.

Inspectors ***did not*** make any observations relating to:

- detecting or abating special hazards such as presence of asbestos or lead paint;
- modifications for accessibility for the disabled;

3 No adjustments to costs were made for contingencies and unforseen circumstances.

- improvements for increasing energy efficiency; or
- major redesign or reconfiguration of units.

Thus, our inspection-based cost estimates do not include these repairs. Costs for routine maintenance items such as maintaining elevators, cleaning gutters and chimneys, or replacing missing outlets and light fixtures are also not included in the inspection-based modernization cost estimates. The 1990 formula estimates also excluded maintenance items and capital cost categories for lead-based paint abatement, access for the disabled, energy efficiency, and major redesign. (Estimates of costs of abating lead paint, modifications for accessibility for the disabled, and improvements for increasing energy efficiency needs were added to the inspection-based estimates to obtain ***estimates of existing modernization needs for the total universe***.)

Background Data Provided by the Housing Authorities

A data abstraction form was mailed to all housing authorities in the sample to obtain data on past and future spending for modernization, as well as certain descriptive characteristics of the housing authority and its developments in the sample. Since many of the data items requested were taken directly from the Comprehensive Grant Program application, housing authorities were requested to complete the form or attach the relevant parts of that documentation to the form.

The form collected three types of data:

- descriptive data on total units managed under Federal and non-Federal programs, and any special management arrangements in place (e.g., private management or receivership);
- modernization history and plans for the next five years for the housing authority; and
- modernization history and plans for the next five years for each sampled development.

Secondary Datasets

Existing computerized datasets from HUD (containing data on developments, housing authorities and their residents) were used to create a sampling universe and provide descriptive characteristics of housing authorities and their developments, such as development age, size, vacancy rates, and modernization history. These secondary datasets include HUD's Public and Indian Housing (PIH) master files, PIH Integrated Business System (IBS), Public Housing Management Assessment Program (PHMAP) data, the 1998 Picture of Subsidized Households (a HUD database in the HUD User website that offers a variety of resident and

neighborhood data on each development in the stock), and the 1990 Census data files. Additional details on these datasets are provided in Appendix B.

Technical Terms Used in the Study

This document uses several different definitions of capital needs as well as several different "universes" for estimating these needs. To avoid confusion, we present definitions of each term below. Although the complete terms are somewhat cumbersome, we feel that using the full terms throughout the document will help to maintain the distinctions. The terms will also be used in context in the chapters that follow, so that the reader might proceed directly to Chapter Two and refer back to this glossary as needed.

Universe Definitions:

Sampling Universe. Universe of units included in the study sampling frame. This included the vast majority of public housing units. We excluded all units in Alaska, Hawaii, Guam and the U.S. Virgin Islands, all units in properties that received HOPE VI implementation grants or had demolitions plans approved as of 1998, and all units in scattered-site and Turnkey properties. Our estimate of the sampling universe is 1,133,963 units.

Inspection Universe. Universe of units included in the inspection-based estimates of need. This is the sampling universe plus units in scattered-site developments, units in HOPE VI developments that are not included in the HOPE VI rehabilitation, and any units not slated for demolition in developments with approved demolition plans. The total inspection universe includes 1,194,370 units and was derived by re-weighting the sample of developments selected for the sampling universe.

Total Universe. This is the universe of units that includes all units in the inspection universe plus 12,097 units in Alaska, Hawaii, Guam and the U.S. Virgin Islands. Our estimate of the total universe includes 1,206,467 units.

CGP/CIAP Universe. This includes all 1,286,131 public housing units from HUD's 1999 CGP and CIAP universe files. This is the universe HUD funded in its most recent formula allocation. Therefore it is used in analyses that compare shares of need based on the study's model-based estimates with the current CGP/CIAP shares. The number differs from the Total Universe estimate primarily because the CGP/CIAP universe includes units slated for demolition and units slated for transformation under HOPE VI.

Estimates of Existing Modernization Needs:

Direct Estimate of (Inspection-Based) Existing Modernization Needs in the Inspection Universe. This measure of existing modernization needs is obtained by multiplying the

estimate of existing modernization needs per unit for each inspected sample property by its sampling weight. Because the sum of the weights equals the inspection universe of 1,194,370 units, the weighted sum of the estimates of existing modernization needs equals a national estimate of existing modernization needs. This estimate includes only inspection-based needs, and does not include categories of need such as lead paint abatement, energy efficiency, and disabled access. For simplicity, in the document this is termed the "direct estimate of existing modernization needs."

Estimate of Existing Modernization Needs in the Total Universe. For the 1,206,467 units in the total universe, this national estimate adds to the direct estimate of inspection-based existing modernization needs in the inspection universe, estimates to account for several categories of need not included in our inspection protocols (lead paint abatement, unit-level energy efficiency, disabled access) and the categories of properties not included in the inspection universe (12,097 units in Alaska, Hawaii, Guam, and the U.S. Virgin Islands).

Model-Based Estimates of Existing Modernization Needs for the Inspection Universe. This measure of inspection-based existing modernization needs is based on statistical modeling. The model first relates development-level existing modernization needs to development, housing authority, and location characteristics. The estimated equation derived from the sample developments is applied to each property in the inspection universe of 1,194,370 units and in the CGP/CIAP universe of 1,286,181 units.

Estimates of Accrual Needs:

Estimate of Annual Accrual Needs in the Inspection Universe. This measure of accrual needs is parallel to the direct estimate of inspection-based existing modernization needs in the inspection universe. It is obtained by multiplying the estimate of accrual for each inspected sample property by its sampling weight.

Estimate of Accrual Needs in the Total Universe. No attempt was made to provide national total estimates of accrual that take into account the categories of need excluded from the inspection protocol, or the categories of properties excluded from the inspection universe.

Model-Based Estimates of Accrual. This measure of accrual needs is parallel to the estimate of existing modernization needs in the total universe. The models were developed using the inspection sample, and the results were applied to both the inspection universe and the CGP/ CIAP universe.

Chapter Two:
Measures of Capital Needs

This chapter focuses on the two fundamental measures of capital needs used for this study, existing modernization needs and accrual needs. These measures are used to produce direct estimates of existing modernization needs for the inspection universe and the direct estimates of existing modernization needs for the total universe. This chapter focuses on the direct estimates of need—in other words, the estimates that were obtained by weighting the study sample estimates to obtain estimates for the inspection universe.

Measures of Need

Existing modernization needs equal the costs of repairs and replacements beyond ordinary maintenance required to make the housing decent and sustainable with modest amenities. This includes all capital costs associated with four types of repairs and replacements:

- repairing or replacing systems with immediate repair needs to restore them to working condition, not including costs for routine maintenance;
- additional costs associated with modest upgrades to some systems;
- additions to other systems such as those described below; and
- replacing systems that have reached the end of their useful life, even if they are still in working order.

An example of a system where the modernization cost is an immediate repair is “roadways.” The modernization cost for roadways would be the cost of repairing and replacing deteriorated portions of the roadways.

Systems that may require upgrades whether or not immediate repairs are required include landscaping, kitchens, bathrooms, and windows. Even if these systems are in working order, modest upgrades may be required to make the housing decent and sustainable with modest amenities.

Systems that may require additions as part of existing modernization needs include parking areas, central air conditioning, window security grates, and tot lots. These systems may or may not be present initially. More parking spaces, a tot lot, or central air conditioning may be needed to make the housing decent and sustainable with modest amenities.

Systems that may need to be replaced because they have reached the end of their useful life include roofs and boilers. For example, a unit boiler that is over 25 years old may still be in

working order, but is likely to fail soon and should be replaced as part of a modernization effort.

System repair costs were obtained from A.M. Fogarty & Associates, Inc., a firm with extensive experience in costing for private and public housing construction and modernization. Using the precise definitions of the action level repair actions, they developed a series of costs for each action level for each system that reflect the materials commonly used for public and low-income housing. Costs are for the Washington, D.C. metropolitan area (and adjusted for other locations using the R.S. Means Location Adjustment factor at the zip code level), and include parts, labor and contractor fees for the modernization project. Costs do not include soft costs such as design costs, architect and engineering costs, and costs associated with PHA management of the modernization process. These latter categories were accounted for through an adjustment factor of 17 percent added to the measures of need.

As noted in the previous chapter, the inspections did not include observations on the costs of detecting or abating special hazards such as asbestos or lead paint, modifications for accessibility for the disabled, unit reconfiguration, or improvements for increasing energy efficiency. Thus, our inspection-based measures of need do not include these components. For the estimate of existing modernization needs in the total universe presented later in this chapter, we have added approximations for some of these components based on the best available data on incidence and costs.

Accrual needs equal the costs needed each year to cover expected ongoing repairs and replacements beyond ordinary maintenance, assuming that the existing modernization needs are met. Accrual costs were calculated for each of the 20 years following the current modernization using the following methodology. Each of the 135 observed systems[1] was assigned an "accrual interval" and an "accrual action" depending upon the standard wear of the system. Accrual intervals and accrual actions were compiled by Abt Associates Inc. from industry standards and earlier work by Abt Associates Inc. and ICF, Inc., and were carefully reviewed by several outside experts and housing authority representatives for a recent HUD study on the capital needs of the HUD-insured multifamily housing stock. They were also adjusted based on input from a group of members of the Capital Fund Negotiated Rulemaking Committee. The *accrual interval* is the interval at which a periodic replacement or repair of the system is required. As described in Appendix C, for some systems such as kitchen appliances and carpets, accrual intervals depend on property occupancy. They are shorter for family developments than for elderly developments. For other systems, such as yards and screen doors, useful lives are shorter in high-density family buildings than in lower-density family buildings. For some unit systems, such as flooring, useful lives were lower the greater

1 Some systems were deemed inappropriate for accrual estimates because they generally will not need replacement or standard maintenance over the 20-year horizon for this study (for example, site distribution systems), or are considered maintenance items (for example, painting interior walls).

the number of bedrooms (and, typically, occupants in the unit). The accrual system does not take account of differences in climate, or neighborhood density, or distress. The *accrual action* is the action that is undertaken at the accrual interval (e.g., replacement or major repair). For example, boilers are expected to be replaced after a certain number of years, but landscaping only needs periodic minor maintenance.

For each of the next 20 years, depending on each system age and accrual interval, our model assessed whether an action needed to be undertaken for that system in that year, and then used the accrual actions and their associated costs to estimate annual accrual costs. System age for each of the observed systems was recorded by the inspector at the time of the inspection. Moderate repair, major repairs, replacements, upgrades, and additions undertaken as part of addressing existing modernization needs reset system ages to zero. In any year that a system's accrual age equals its expected life, then the repair/replace cost is added into the accrual total for that year. Accrual costs were estimated only for the systems included in the inspection-based components of national need and were calculated in 1998 dollars.

Inspection-Based Measures of Need

Housing authorities are divided into the following categories for analysis:

- All housing authorities
- All housing authorities except New York City, Chicago, and Puerto Rico
- Housing authorities with less than 250 units
- Housing authorities with 250 to 1,249 units
- Housing authorities with 1,250 to 6,600 units
- Housing authorities with more than 6,600 units (except for New York City, Chicago, and Puerto Rico)
- New York City Housing Authority
- Chicago Housing Authority
- Puerto Rico Housing Authority

Exhibit 2-1 presents our ***direct estimates of the measures of existing modernization needs*** for the 1,194,370 units in the ***inspection universe***. All dollar values are locally adjusted using the RS Means adjustment factor by zip code, reflecting local 1998 costs. To facilitate comparing physical needs across properties having different numbers of units, all property costs are expressed on a "per-unit" basis. ***Direct estimates of existing modernization needs in the total universe***, including estimates for the uninspected categories of units and costs, are presented in Exhibit 2-2, later in this chapter.

Exhibit 2-1: Direct Estimates of the Measures of Need For the Inspection Universe

Housing Authority Size	All	All (except NYC, Chicago, PR)	<250 Units	250-1,249 Units	1,250-6,600 Units	6,600+ Units (except NYC, Chicago, PR)	NYC	Chicago	Puerto Rico
Sample Properties									
Overall	684	568	126	187	177	78	50	21	45
Elderly	178	169	34	57	57	21	1	8	0
Family	506	399	92	130	120	57	49	13	45
Inspection Universe Units[a]	1,194,370	952,638	197,525	342,347	291,365	121,401	156,432	32,177	53,123
CGP/CIAP Units	1,286,131	1,030,191	203,687	336,648	342,266	147,590	160,209	38,788	56,943
Direct Estimates of the Existing Modernization Needs, per Unit									
Means									
Overall	$18,847	$17,720	$13,868	$17,631	$18,875	$21,462	$23,074	$26,184	$22,172
Elderly	$12,962	$12,624	$10,595	$13,272	$13,050	$13,379	$19,910	$20,149	—
Family	$20,748	$19,823	$15,340	$19,439	$21,387	$23,991	$23,139	$28,935	$22,172
Median	$16,908	$15,681	$12,693	$15,675	$16,801	$18,771	$22,915	$26,740	$21,486
25th Percentile	$8,799	$8,273	$7,023	$8,799	$8,687	$11,901	$9,399	$19,263	$12,671
75th Percentile	$26,692	$25,117	$20,652	$24,281	$27,852	$29,942	$30,627	$33,074	$28,574
Total across All Units	$22,510,219,390	$16,880,288,094	$2,739,322,131	$6,035,998,697	$5,499,493,979	$2,605,490,052	$3,609,527,611	$842,514,846	$1,177,843,156
Average Annual Accrual Years 1-20, per Unit									
Means									
Overall	$1,679	$1,668	$1,821	$1,640	$1,645	$1,554	$1,918	$1,346	$1,379
Elderly	$1,259	$1,270	$1,486	$1,212	$1,217	$1,176	$999	$1,029	—
Family	$1,815	$1,832	$1,971	$1,818	$1,830	$1,672	$1,936	$1,490	$1,379
Median	$1,627	$1,597	$1,721	$1,588	$1,547	$1,410	$1,896	$1,312	$1,312
25th Percentile	$1,301	$1,272	$1,386	$1,241	$1,204	$1,103	$1,697	$1,018	$1,176
75th Percentile	$1,962	$1,958	$2,021	$1,934	$1,918	$1,824	$2,163	$1,623	$1,487
Total across All Units	$2,005,347,230	$1,589,171,659	$359,608,089	$561,579,172	$479,379,921	$188,600,096	$299,984,953	$43,298,980	$73,256,617

a Excludes units approved for demolition or HOPE VI, and excludes all units in Alaska, Hawaii, Guam, and the U.S. Virgin Islands. The size categories are based on the number of units in the housing authority after exclusion of units. Thus, some housing authorities that currently are in one size category in the CGP/CIAP universe are in a different size category in the inspection universe. Thus, the number of units in the two universes are not perfectly comparable across housing authority sizes.

For each category of housing authorities the following information is presented:

- Total number of sample properties.
- Total sample properties defined as elderly (average bedrooms per unit less than 1.5, except when average bedrooms per unit is between 1.2 and 1.5 and the property has more than 100 units with 2 or more bedrooms).
- Total sample properties defined as family (average bedrooms per unit at least 1.5, or any property with an average bedrooms per unit between 1.2 and 1.5 and at least 100 units with 2 or more bedrooms).
- Estimate of the inspection universe based on the weighted inspection sample.
- 1999 CGP/CIAP universe. This differs from the inspection universe because the CGP/CIAP universe counts units with approved HOPE VI or demolition plans, as well as units in Alaska, Hawaii, Guam, and the U.S. Virgin Islands. In addition, the study universe is based on 1997 data and the CGP/CIAP universe is based on 1999 data.

For each capital needs measure the following statistics are presented:

- Mean across all units.
- Mean for units in elderly properties.
- Mean for units in family properties.
- Median, 25th percentile, and 75th percentile across all units.
- Total across all units (equals the overall mean multiplied by the number of units in the universe).

Direct Estimates of Existing Modernization Needs for the 1,194,370 Units in the Inspection Universe

- The national average of the direct estimate of existing modernization needs in the inspection universe was $18,847 per unit, with a median of $16,908 per unit.

- The average per-unit direct estimate of existing modernization needs is correlated with housing authority size. The average direct estimate of existing modernization needs was $13,868 in housing authorities with under 250 units, $17,631 in housing authorities with 250 to 1249 units, $18,875 in housing authorities with 1,250 to 6,600 units, and $21,462 in housing authorities with over 6,600 units (excluding New York, Chicago and Puerto Rico). The per-unit direct estimates of existing modernization needs in New York City, Chicago, and Puerto Rico were higher than the national

average: $23,074, $26,184, and $22,172, respectively, and were somewhat higher than in the other very large housing authorities.

- The 25th and 75th percentiles provide indications of the overall distribution of needs. Nationwide, one quarter of the units had direct estimates of existing modernization needs of under $8,799 per unit and one quarter had needs over $26,692 per unit. The median value was $16,908.
- As expected, the average per-unit direct estimate of existing modernization needs is substantially higher in family developments compared with elderly developments, $20,748 versus $12,962.

Direct Estimates of Average Annual Accrual Years 1-20 for the 1,194,370 Unit Inspection Universe

- Exhibit 2-1 presents the average annual accrual needs over years 1 to 20 in 1998 dollars. Nationwide, assuming that the inspection-based existing modernization needs were completely addressed, each year approximately $2 billion would be required to address the ongoing accrual needs, or on average, $1,679 per unit.
- Accrual costs do not vary substantially across properties; the 25th percentile ($1,301) and the 75th percentile ($1,962) are close to the median ($1,627) and average ($1,679).
- In Chicago and Puerto Rico, the per-unit average annual accrual was slightly less than the national average, $1,346 and $1,379, respectively. The reason accrual needs in Chicago are less than the national average is because many of their systems need to be replaced as part of the modernization effort. Thus, in the first few years following modernization, accrual costs are low. In Puerto Rico, several expensive systems that were missing from the housing stock, such as domestic hot water generators, window upgrades, unit air conditioners, unit refrigerators, and unit ranges were assumed to be added to the existing modernization needs to make the housing stock more comparable to the rest of the nation. These systems will not incur accrual costs until they reach the end of their useful life, a useful life that sometimes exceeds the 20-year cutoff of our model.
- Except for New York City, average annual accrual needs per unit are highest among the smallest housing authorities. This may be due to a combination of several factors. Many of the smaller housing authorities have newer stocks. Further, the stock in smaller agencies is often in better condition than the stock in larger agencies, as can be seen by their lower modernization needs. Our system of modeling accrual assumes that all over-age systems are replaced as part of existing modernization. In newer properties, fewer systems have reached the end of their useful lives, so fewer systems are replaced as part of existing modernization, and more as part of ongoing accrual.

As a result, average annual accrual needs are higher, as many systems will reach their life expectancy and need to be replaced over the next 20 years. Our accrual modeling also assumes that accrual costs are proportional to square feet in the property. Properties in small housing authorities tend to have fewer units per building, and as a result their accrual costs per square foot for major systems are higher than in larger housing authorities. Moreover, as an engineering model (like the model used in the 1990 formula), our accrual model does not take into account neighborhood and climatic conditions that might accelerate physical deterioration in some large housing authorities.

- Accrual costs are higher in family developments, about $1,815 per unit compared with $1,259 per unit in elderly developments.

Estimates of Existing Modernization Needs for the Total Universe

As noted earlier, the direct estimates of existing modernization needs in the inspection universe do not include all categories of units or all categories of modernization costs. Exhibit 2-2 presents our best estimate of existing modernization needs for the total universe as a whole. This estimate of existing modernization needs for the total universe includes the inspection-based measure of needs plus estimates to account for the categories of need (e.g., lead paint abatement) and categories of properties (e.g., Alaska, Hawaii) not included in our inspection protocols. The estimate of existing modernization needs in the total universe is 24.6 billion. Exhibit 2-2 presents the estimate for the additional units for Alaska, Hawaii, Guam and U.S. Virgin Islands, and those for lead paint abatement, accessibility for the disabled, and energy efficiency.

Exhibit 2-2: Estimates of Existing Modernization Needs for the Total Universe[a]

Estimate of existing modernization needs in the inspection universe (for 1,194,370 units in the inspection universe)	$22,510,291,390
Addition for Alaska, Hawaii, Guam and U.S. Virgin Islands	$248,283,650
Addition for lead paint abatement	$1,118,000,000
Addition for accessibility for the disabled	$358,311,000
Addition for energy efficiency [b]	$361,934,700
National estimate of total existing modernization needs	$24,596,820,740

a Does not include estimates for asbestos removal or for major reconfiguration of units. Also excludes $3 billion of pipeline funding not yet expended.

b Only includes costs for unit-level actions to improve energy efficiency.

Estimate for Alaska, Hawaii, Guam, and the U.S. Virgin Islands: Our estimate of needs for each of these locations equals the actual number of units in the location multiplied by the

national average inspection-based modernization needs per unit, multiplied by the ratio of 1999 CGP amounts per unit for the site relative to the national average. For example, Alaska had 1,335 units of public housing. The average direct estimate of existing modernization needs for the inspection universe per unit is $18,847. The 1999 CGP amount per unit for Alaska was $2,502 and the national average was $2,251. Thus our estimate of existing modernization needs for Alaska equals 1,335 x $18,847 x ($2,502/$2,251) = $27,966,319.

Estimates for lead paint abatement: HUD estimates that as of the end of 1998 lead paint needed to be abated in about 430,000 units.[2] Assuming that abatement is part of an overall modernization effort, the estimated cost per unit is about $2,600, for a total universe cost of $1.118 billion.[3]

Estimates of costs for accommodating persons with disabilities: These costs vary significantly depending on the specific conditions of the unit and on other work being conducted. On one hand, if other modernization work is being undertaken, the costs can be minimal. On the other hand, it can reportedly cost over $20,000 per unit in other circumstances. Our conversations with numerous housing authorities and other experts led to a rough total universe estimate of about $10,000 per unit. Overall the requirement is to make 5 percent of all units accessible during a modernization effort. Assuming that 2 percent are already accessible, we estimate that 3 percent of all units require action, for a total of 36,194 units at a cost of $358,311,000.

Estimates of modernization to improve energy efficiency: As with other costs, the costs for improving unit energy efficiency vary greatly depending on the particular circumstances of the unit and building. A "typical" retrofit package including low-cost lighting, weatherstripping, low-flow faucet aerators and showerheads, water heater pipe insulation, water heater tank wraps, thermostats, storm windows, air sealing, and attic insulation can cost about $680 to $1,000 per unit. A more intensive package including some window replacements costs about $2,500 per unit.[4] Without making direct on-site observations, we estimate that because many units are undergoing modernization, on average an additional $300 per unit would be required to improve unit energy efficiency, for a total universe estimate of $361,940,000.

Estimates of costs for removing asbestos hazards: Estimates of the costs of removing asbestos hazards range from about $8.75 per square foot (for vinyl asbestos tile) to $11.35 per

2 Based on information provided by Stevenson P. Weitz from HUD's Office of Lead Hazard Control.

3 If abatement is not part of an overall modernization effort, costs will be higher, about $5,500 per unit. Costs will also be higher if the work is delayed beyond three years. If the work is delayed beyond three years, there are requirements for risk assessments and costly interim measures.

4 Based on costs from Goldman, C., K.. Greely, and J. Harris, *Retrofit Experience in the U.S. Multifamily Buildings: Energy Savings, Costs, and Economics*, Volume II. (Berkeley, CA: Lawrence Berkeley Laboratory, Applied Science Division, 1998.) Adjusted for inflation.

square foot (for cement asbestos board). Our inspections show that an average 2-bedroom public housing unit is about 750 square feet, thus the asbestos removal cost is about $6,560 to $8,500 per unit requiring action. We have not been able to obtain any estimates on the number of units requiring action, so for the current estimates ***we have not included*** the cost of removing asbestos.

Unexpended funds: The estimates of existing modernization needs reflect observed condition and costs as of mid-1998. They ***do not take into account*** the approximately $3 billion of modernization funds from FY1997 and earlier, available but not expended as of the time of the inspections in mid-1998.

Comparing 1990 and 1998 Estimates of Needs[5]

A natural question is how the estimated needs of the stock in mid-1998 (the mid-point of inspections in this study), compare with the estimated needs of the stock in January 1990 (the date of estimates of backlog and accrual need used in the HUD study that shaped the current Comprehensive Grant formulas). This section first compares estimates of existing modernization needs and then compares accrual estimates.

Comparing 1990 and 1998 Estimates of Existing Modernization Needs

Although the specific categories and definitions of need vary in the two studies, the basic concepts are close enough that a comparison is meaningful. The 1990 national estimates of unfunded backlog included several elements. The largest cost element was the Mandatory Backlog Need, which included all costs associated with repairing or replacing all non-working systems in the stock. In addition to Mandatory Repairs, the unfunded backlog included a series of Project Specific Additions that were identified by the housing authorities in the study and were agreed to by the inspectors.[6] As described above, the current study's estimates of existing modernization needs include all costs associated with repairs and replacements, upgrades and additions to some systems, and replacement of all over-age systems, i.e., systems that have reached the end of their useful life.

Comparing the 1990 and 1998 estimates of modernization needs for the inventory requires that adjustments be made to each of the estimates. In adjusting the 1990 data, the first step is to inflate the 1990 dollars to mid-1998 levels using a 27 percent Consumer Price Index (CPI) cost-of-living adjustment factor. A second step is to add 5.4 percent to the 1990 data for soft costs, bringing the 1.11 multiplier for soft costs in 1990 to 1.17, the figure used in the 1998 study. A final step is to add to the 1990 backlog an estimate of $6.64 billion for over-age

5 For this analysis we had assistance from HUD staff.

6 See *Report to Congress on Alternative Methods for Funding Public Housing Modernization* (Washington, DC: U.S. Department of Housing and Urban Development, April 1990).

systems past their useful life—$6.64 billion was the amount that inspections and accrual models tallied in the 1998 study. In 1990 over-age systems were included in the accrual account, even though it now seems more appropriate to treat over-age systems as existing modernization because most of them probably fail within several years after an inspection date or are repaired under comprehensive modernization.

At the same time, the 1998 data can be made more comparable to the 1990 categories of need by representing the data as unfunded need in mid-1998, just as the 1990 data represented unfunded need in January 1990. To represent unfunded need in 1998, the estimates of existing modernization need in the 1998 study are reduced by $3 billion, which is the amount of Comprehensive Grant and CIAP funds from FY97 and earlier years that were unexpended as of mid-1998. The $3 billion is deducted from the categories of existing modernization need in proportion to their share of total need prior to the deduction.

As a result of the adjustments, the 1990 and 1998 data become more comparable. The existing need for 1998 and the backlog need for 1990 both consist of essential repairs, upgrades, and additions; appropriate repairs for over-age systems and estimates for lead-based paint abatement, handicapped access, and net energy conservation (although the repair standards and specific systems may differ). Both exclude the cost of asbestos removal, the cost of demolition, and the cost of major redesign and reconfiguration.

Exhibit 2-3 shows that a standardized comparison of the total national unfunded needs is marked by a steep decline from 1990 to 1998—a decline in 1998 dollars from $33.26 billion to $21.6 billion, or 35 percent. At the per-unit level the decline in total national unfunded needs is 29 percent. It is important to note that the decline in unfunded needs may not be uniform across housing authorities. In fact, it is likely that some housing authorities may have experienced an increase in unfunded needs. Part of the difference between 1990 and 1998 unfunded needs is accounted for by the different number and composition of units in the 1990 and 1998 studies. The 1990 study estimates applied to 1.312 million public housing units, whereas the 1998 study estimates applied to 1.206 million units. The 1998 study excluded units with past and approved demolition and with approved HOPE VI major revitalization, both of which would have had high per-unit needs. The reduction of 106,000 units from the 1990 to 1998 studies is only 8.1 percent, versus a 29 percent reduction in existing need per unit. Even if the units dropped from 1990 to 1998 are assumed to have twice the existing need per unit as the units that remain, the reduction of units would still account for less than half of the overall decline in need.

Exhibit 2-3
Comparing the 1990 and 1998 Estimates of Unfunded Need
(in 1998 dollars)

	1990 Adjusted	1998 Adjusted
Number of units	1.312 million	1.206 million
Repair, add, upgrade, over-age	$31.53 billion	$19.98 billion
LBP abatement	$.48 billion	$.98 billion
Disabled access	$.40 billion	$.32 billion
Energy conservation	$.85 billion	$.32 billion
Existing unfunded need: Aggregate total	$33.26 billion	$21.60 billion
Existing unfunded need: per unit	$25,330	$17,910
Existing need: aggregate total	N/A	$24.6 billion

Notes: The 1990 data come from Table 2.1 of the 1990 HUD *Report to Congress on Alternative Methods for Funding Public Housing Modernization.* The 1998 data come from Exhibit 2-2 above.

Comparing 1990 and 1998 Estimates of Accrual Needs

In contrast to estimates of existing needs that resulted primarily from direct inspections, the estimates of accrual needs in both 1990 and 1998 were derived from system lifetime models that were applied to data gathered during the inspection. Both accrual models shared many assumptions. They were both developed using expert experience. Both were physical system models that emphasized predictable aging of existing systems. In their assumed lifetimes of systems, both adjusted for family and elderly developments. The 1998 model also adjusted somewhat for household density of the unit and development. Neither model adjusted for neighborhood or climatic differences across properties. As with the modernization needs comparisons, adjustments were made to make the numbers comparable. The 1990 accrual data are inflated to 1998 dollars using a 27 percent CPI cost. Soft costs are reflected by adding another 5.4 percent, as was done for existing modernization needs. To account for the impact of deferred modernization in the 1990 model (which was not included in the 1998 model), 1990 costs were reduced by 8.7 percent.[7] To account for the fact that the 1990 system included over-age systems in accrual the 1990 numbers were reduced by .332 billion a year (6.64 billion divided by 20). The 1998 data come from Exhibit 2-2 above.

7 The 1998 model did not account for the impact of deferred modernization on accrual. We believe the magnitude would be smaller than in 1990 because deferred needs that would contribute to accrual relative to recent appropriations were less in 1998 than in 1990.

As shown in Exhibit 2-4, while unfunded existing modernization needs declined markedly from 1990 to 1998, the twenty-year average accrual projected in 1998 is slightly more than the comparable twenty-year accrual average for 1990. In per-unit terms the 1998 value is about 10 percent higher than the 1990 value. The moderate increase in the per-unit accrual estimate may be due to the overall change in average system lifetimes, to the lessened need for immediate repairs in the stock in 1998, and to the greater recognition of household density in the 1998 accrual model.

Exhibit 2-4
Comparing the 1990 and 1998 Estimates of Accrual Need
(1998 dollars)

	1990 Adjusted)	1998 Adjusted
Number of units	1.312 million	1.206 million
Total accrual need per year, average for 20 years	$2.01 billion	$2.03 billion
Per unit accrual need per year, average for 20 years	$1,530	$1,680

Note: The 1990 accrual data come from Table 2.2 of the 1990 HUD *Report to Congress on Alternative Methods for Funding Public Housing Modernization.* The 1998 numbers come from Exhibit 2-2 above.

Chapter Three:
Modeling Public Housing Capital Needs

This chapter presents the results of using rigorous statistical techniques, together with the sample of up-to-date physical needs assessment data, to model the nation's public housing capital needs at the development and public housing authority (PHA) levels. The model can form the basis of the new Capital Fund's revised needs-based formula for allocating HUD capital funds to each housing authority across the country. The chapter will proceed as follows. First, we discuss the rationale and methodology for modeling capital needs. The following section describes the model HUD used for predicting capital needs for the Comprehensive Grant Program (CGP). We then present the development process of the revised model in detail, along with the strengths and limitations of the various alternative models. The chapter concludes with a discussion of the new model and its policy ramifications in terms of funding distribution.

Rationale and Methodology for Modeling Capital Needs

A key purpose of the Formula Capital Study was to assist HUD in revising the formulas for allocating capital funds to public housing authorities, replacing both CGP and CIAP. This requires estimating capital needs for the public housing stock. Collecting physical needs data for every single development in the public housing stock would be prohibitively costly and time-consuming. Instead, this study adopted the approach of scientific sampling that only required the collection of physical needs information on a nationally representative sample of developments. This sample of 684 developments from 219 housing authorities nationwide, as discussed earlier and in Appendix A, can be used to generate aggregate capital needs estimates (referred to as weighted-sample estimates, or direct estimates) for the inspection universe and for groups of housing authorities. However, the Capital Fund formula is designed to allocate funding to ***individual*** housing authorities, rather than groups of housing authorities. In other words, the formation and revision of the formula requires capital needs information for every single housing authority (rather than groups of housing authorities) across the nation. This inevitably calls for an indirect method to estimate the modernization needs of each development and housing authority for which we do not have direct inspection-based measures.

There are two acceptable approaches to generalizing estimates from a representative sample to member units of the universe outside of the sample—a cell-mean approach or a multiple regression model. The first approach is that, starting by categorizing the housing developments in the inspection sample into meaningful groupings (cells), we can relate capital needs estimates to the characteristics that define each group. For public housing developments and housing authorities that were not included in the inspection sample, this approach can be used if we assume that these developments have the same level of capital

needs as the sample developments with similar characteristics. In practice, the average value of the per-unit direct need estimates of each group could be used. We call this the ***cell-mean*** approach. One obvious and natural choice for a grouping criterion is housing authority size—that is, housing authorities with less than 250 units, housing authorities with 250 to 1,249 units, housing authorities with 1,250 to 6,600 units, and housing authorities with more than 6,600 units. Based on the estimates by size category presented in Chapter Two, this would yield the following basis for estimating capital needs:

- For housing authorities with less than 250 units, inspection-based existing modernization needs are $13,868 per unit and accrual needs are $1,821 per unit per year.

- For housing authorities with 250 to 1,249 units, inspection-based existing modernization needs are $17,631 per unit and accrual needs are $1,640 per unit per year.

- For housing authorities with 1,250 to 6,600 units, inspection-based existing modernization needs are $18,875 per unit and accrual needs are $1,645 per unit per year.

- For housing authorities with more than 6,600 units (excluding New York City, Chicago, and Puerto Rico), inspection-based existing modernization needs are $21,462 per unit and accrual needs are $1,554 per unit per year.

As an illustrative example, the Fall River Housing Authority in Massachusetts has 1,803 public housing units under its jurisdiction and it thus falls in the third PHA-size category. No Fall River developments were selected into the inspection sample, therefore up-to-date direct measures of capital need are not readily available. The total estimated inspection-based existing modernization and accrual needs for the housing authority, according to the cell-mean approach, are $34,031,625 ($18,875 × 1,803) and $2,965,935 per year (i.e., $1,645 × 1,803), respectively.

The obvious advantage of the cell-mean approach for modeling capital needs and funds allocation is its administrative simplicity. No additional data collection is required. This approach, however, inevitably ignores the heterogeneity (besides housing authority size) among housing authorities in terms of development attributes, and in regional and neighborhood characteristics. This could lead to misallocation of funding.

The second method for indirect needs estimate involves the use of ***multiple regression techniques***. It can be viewed as a multivariate extension of the cell-mean approach, and can lead to a more equitable and reliable way of allocating capital funds to local housing authorities. It is preferable to the cell-mean approach because it estimates capital needs

according to an array of housing authority and development factors, rather than just PHA size. Using the sample of standardized inspection data and a host of secondary databases containing background information on the developments, multiple regression techniques will relate capital needs estimates to a complex array of development, housing authority, and location characteristics. It is a statistical technique that allows the outcome measure (also called the dependent variable) to be expressed as a linear combination of predictors (also called covariates, independent or explanatory variables) multiplied by their respective regression coefficients (also called regression weights).[1]

Current Need Estimation Model Used by HUD

The current CGP formula was established on the foundation of multiple regression models built by HUD researchers in the early 1990s, using a set of inspection data collected by Abt Associates Inc. in 1985.[2] The funding allocation formula for CGP depends on regression equations that predict capital needs for every development in the country in housing authorities with over 250 units, based on an array of development, housing authority, and neighborhood characteristics. Separate models were built to predict "backlog" and "accrual." These concepts are ***similar*** to the current study's concepts of inspection-based estimates of existing modernization needs and accrual needs, although some variations exist.[3]

For the "backlog" model of the current CGP formula, the need predictors were:

- Average number of bedrooms in the units in a development
- Proportion of units in a development available for occupancy by very large families

1 For technical details, please see, for example, William H. Greene, *Econometric Analysis*, 3rd Edition (Upper Saddle River, NJ: Prentice-Hall, 1997).

2 *Study of Modernization Needs of the Public and Indian Housing Stock - National, Regional and Field Office Estimates: Backlog of Modernization Needs* (Abt Associates Inc., Cambridge, MA: 1988). *Future Accrual of Capital Repair and Replacement Needs of Public Housing* (Fairfax, VA: ICF Inc., 1989). *Report to Congress on Alternative Methods for Funding Public Housing Modernization* (Washington, DC: US Department of Housing and Urban Development, 1990).

3 For the backlog measure used in the current CGP formula, HUD relied on data from the 1985 Abt Associates Inc. Modernization Needs Study in HUD's 1990 Report to Congress. Although the inspection and costing approaches were similar to those used in the Formula Capital Study, there are some differences in the definitions of backlog versus inspection-based estimates of existing modernization needs. The CGP formula "backlog" estimate included immediate repair needs, items that had to be added to meet local codes or HUD requirements, and some property-specific additions needed or desirable for long-term viability. The national total "backlog" estimate in the 1988 report also included lead-based paint testing and abatement and renovation and redesign for wheelchair access, but these were not included in the formula modeling. As noted in Chapter Two, the current existing modernization needs measure places more emphasis on upgrades and assumes replacement of over-age systems. The CGP accrual model is based on ICF's accrual estimates, which are similar in concept to the current definitions but rely on the inspection items included in the previous study, and were estimated using a different modeling approach (survival modeling).

- Extent to which units for families are in high-rise elevator developments
- Building age (defined by the Date of Full Availability)
- For large housing authorities, the total number of units with 2 or more bedrooms (with 5,000 deducted from that number and the resulting value bounded by zero and 15,000)
- R.S. Means location cost factor
- Severe population decline in the city (defined as population loss from 1970 to 1980 in excess of 12 percent for the city; resulting value is set to zero for elderly projects or when population loss is less than 12 percent).

For the "accrual" model of the current CGP formula, the need predictors were:

- Average number of bedrooms in the units in a development
- Proportion of units in a development available for occupancy by very large families
- Building age (defined by the Date of Full Availability)
- Low-density factor: the extent to which the buildings in a development average fewer than 5 units
- R.S. Means location cost factor
- For housing authorities that own or operate 250 or more units, the total number of units.

Using these models, backlog and accrual needs were estimated for all developments in CGP-eligible housing authorities. Estimates were calibrated to 1990 dollars. Housing authority-level estimates were then obtained by summing across all developments in each PHA. To create an estimate of net unfunded backlog and accrual, a portion of the CIAP funds allocated to each PHA in FY1984-1991 and a portion of MROP funds from FY88 to FY93 were deducted from the housing authority-level estimates of backlog that had been calibrated to reflect 1990 estimates of need. The total national backlog and accrual were estimated by summing the estimates across each housing authority. Then, each housing authority was assigned “shares” of total backlog and total accrual needs, which were their percentages of the total national estimates. The actual allocation share was based on a 50 percent weight for backlog and a 50 percent weight for accrual. Each year, the capital funds HUD allocates to any given housing authority eligible for CGP equal that housing authority’s share multiplied by the total CGP appropriation, with adjustments later made for status as a moderately troubled housing authority.

Development Process of the Revised Models for the Model-Based Estimation of Capital Needs

This section presents the process Abt Associates Inc. used in deriving and testing the revised capital needs estimation models. The quantities we modeled are the per-unit inspection-based existing modernization needs and the accrual needs of public housing developments as defined

in Chapter Two. Specifically, in this step we used the needs estimates before they were adjusted for local cost variations using the R.S. Means adjustment factors. Predicted estimates generated from the models were then multiplied by the R.S. Means cost adjustment factors at the final stage. Regression models were built using inspection-based data from the representative sample of 684 developments in the Formula Capital Study, together with a wealth of data from housing authorities, HUD's Integrated Business System (IBS), and the 1998 "Picture of Subsidized Households" database available on the HUD User web page. Please refer to Appendix B for the documentation and data quality of the various data sources.

In developing the models, inspection data obtained from the New York City, Chicago, and Puerto Rico housing authorities were excluded from the regression estimation.[4] This decision was motivated by two factors. First, cross-tabulations of the inspection data revealed that capital needs as well as development characteristics in those very large housing authorities were atypical of the whole public housing stock. Inclusion of those properties in the modeling process would considerably lower the statistical goodness-of-fit of the final models and could potentially distort the regression equations for the whole stock. Second, the sampling strategy of the study ensured that these housing authorities had a sufficient number and variety of inspected properties to sustain precise sample-based estimates of their capital needs. In other words, direct estimates from the inspection sample for these housing authorities may be used to determine capital needs.

The remainder of this section is organized as follows. We first discuss the criteria for and process of selecting valid need predictors. The method of measuring goodness-of-fit among the alternative models and specifications is then described. Finally, we examine the final models and present some interpretations.

Selecting Predictor Variables

Our variable selection process was primarily guided by what we expected to influence the level of existing modernization needs and accrual needs in public housing. Previous studies and professional judgement have informed us that, for instance, the average number of bedrooms per unit in a development should have an impact on the capital needs per unit, as it represents the mix of elderly and family units and is associated with the square footage per unit that can require repair. Another important determinant is the development's building age. This represents years of physical wear and possible under-maintenance and should be positively related to capital needs, everything else being equal. Furthermore, other characteristics of the property such as negative development features observed by the study

4 Although projects in Puerto Rico were excluded from the model development process, formula shares for Puerto Rico were estimated using the models.

inspectors, housing authority characteristics, and neighborhood location of the development are also expected to affect capital needs.

Besides plausibility and conventional wisdom, the following are additional criteria for selecting predictor variables:

Statistical significance. The variable must be significantly related to the capital need measures in the regression equation. In technical terms, the estimated regression coefficient of the need predictor must be statistically different from zero at the 90 or 95 percent confidence level.

Non-collinearity. The variable cannot be highly associated with the other predictor variables already in the regression equation.

Net explanatory power. When the variable is added to the regression, it should substantially improve the overall fit of the regression equation. In technical terms, after adding the predictor, the adjusted R-squared statistics of the regression should increase noticeably.

Ease of collection. A measure of the variable is readily available in one of the HUD databases, or it can be easily collected from housing authorities in a standardized format. Otherwise, administrative costs of collecting the variable for every public housing development in the country could be prohibitively high.

Guided by these criteria, we have experimented with over 30 predictors in the model-building process. Exhibit 3-1 shows an exhaustive list of all the development, housing authority, and neighborhood predictor variables we have tried. Most of them were not selected as the need predictors for the final models because they violated the principle of non-collinearity, and their addition to the regression equations brought insignificant net-explanatory power. For example, we found that the need predictor that measures the proportion of single-parent households residing in the property is closely associated both with the average number of bedrooms and the variable that indicates whether the development is family occupancy type. Therefore, the indicator for single-parent households should not be used if we want to keep either of the latter two variables in the model. It should be noted that the exclusion of this predictor in the final models does not imply that the proportion of single-parent households among tenants has no bearing on a development's capital needs. Rather, it suggests that predictors such as family occupancy type and average number of bedrooms may already

Exhibit 3-1: Property, Housing Authority, and Neighborhood Characteristics Variables Used in the Model Development Process

Variables:	Data Source:
Property Characteristics:	
Average Number of Bedrooms (BRs)[a]	Inspection Data

Average Sq. Ft. Per Unit	Inspection Data
Total Development Size (Units)	Inspection Data
Construction Building Age (defined by construction completion date)	Inspection Data
Building Age (defined by Date of Full Availability)	HUD IBS File
High-rise	Inspection Data
High-rise Family (i.e., both High-rise and family)	Inspection Data
Townhouse	Inspection Data
Single-Family	Inspection Data
Housing Authority Size (Units)	PIH Master File
Family[b]	Inspection Data
Large Family (i.e., avg. BR > 2.5)	Inspection Data
Low-Density Factor (i.e., max [(5-units/bldg, 0)])	Inspection Data
Property Quality Descriptors:	
Number of Negative Development Features	Inspection Data
Total Number of Negative Housing Quality Standards (HQS) Scores	Inspection Data
Evidence of Rodents	Inspection Data
Evidence of Cracks or Leaks	Inspection Data
Poor Quality Building Maintenance	Inspection Data
Poor Quality Grounds Maintenance	Inspection Data
Modernization Experience and Plans:	
Percent Units Receiving No Major Mod Funds Last 5 Yrs	Inspection Data
Percent Units Receiving No Major Mod Funds Last 10 Yrs	Inspection Data
Housing Authority Estimate of Development's Hard Costs Per Unit	Data from Housing Authority
Housing Authority Estimate of housing authority's Hard Costs Per Unit	Data from Housing Authority
Per-Unit Mod Funds in 1993-1996	Data from Housing Authority
Per-Unit Mod Funds in Next 4 Years	Data from Housing Authority
Development Tenant Demographics:	
Percent Households with Very Low Income	Picture of Subsidized Households
Percent Single-Parent Households	Picture of Subsidized Households
Average Household Size	Picture of Subsidized Households
Percent Elderly/Disabled	Picture of Subsidized Households
R.S. Means Adjustment Factor:	
R.S. Means Location Cost Adjustment Factor	R.S. Means
PHMAP Indicators:	
PHMAP Grade for Modernization	PHMAP
Overall PHMAP Grade	PHMAP
Percent Occupied Units	Picture of Subsidized Households
Housing Authority-Level Adjusted Vacancy Rate	PHMAP
Neighborhood Characteristics:	
Poverty Rate in Census Tract	Picture of Subsidized Households
Overall Neighborhood Quality Fair or Poor	Inspection Data
Census Region	U.S. Census File
Metropolitan Location	U.S. Census File
Central City Location	U.S. Census File

a Studio units defined as 0 bedrooms. The current CGP formula also counts studio units as 0 bedrooms. The FY99 CIAP formula counts studio units as 1 bedroom.

b Developments with an average bedroom size greater than 1.5 or greater than 1.2 with 100 or more 2+ bedroom units.

capture the impact of such a tenant population on the property's capital needs level. The same line of reasoning can be applied to explain the exclusion of other need predictors in the final models. We arrived at two final sets of alternative models—four for predicting pre-R.S. Means-adjusted model-based estimates of existing modernization needs, and four for predicting pre-R.S. Means-adjusted model-based estimates of accrual needs. (In other words, the models predict need prior to R.S. Means adjustments. However, for all cost estimates presented in this report, we applied the adjustment factors.) Exhibit 3-2 and Exhibit 3-3 present the list of predictors we used in each of the models. Several similarities and differences among the models deserve comment before we proceed to the discussion of the goodness-of-fit measures:

- First, Model 1-a and Model 1 use essentially the same set of need predictors for model-based estimates of existing modernization needs. The only difference between them is that the former consists of two separate regression equations—one estimated for developments in housing authorities with less than 250 units and another one estimated for developments in housing authorities with 250 or more units. Cross-tabulations of the inspection data have indicated that the two groups of properties have noticeably different levels of per-unit capital needs. This modeling strategy allows the regression equations to further capture the heterogeneity among the developments and arrive at more precise indirect need estimates. The same is true for Model 2-a versus Model 2. For accrual needs, Models 3-a and 4-a are both different from Models 3 and 4 in the same manner, that is, using separate models for properties in housing authorities with above and below 250 units, respectively.

- Second, for model-based estimates of existing modernization needs, Models 2 and 2-a are augmented from Models 1 and 1-a by adding a set of need predictors that measure housing authority characteristics and other physical attributes of the property. (For model-based estimates of accrual needs, the same is true for Models 4 and 4-a versus Models 3 and 3-a.) These measures are not readily available for public housing developments outside of the inspection sample and the administrative cost to collect those data for the whole stock may be burdensome.

Goodness-of-fit Measures of the Alternative Models

Several statistics and methods are widely used by the research community when choosing the preferable specification among alternative sets of regression models.[5] They all center on the

5 Sanford Weisberg, *Applied Linear Regression*, 2nd Edition (New York: John Wiley & Sons, 1985); Russell Davidson and James MacKinnon, *Estimation and Inference in Econometrics* (New York: Oxford University Press, 1993).

Exhibit 3-2: Variables Used in Alternative Models of Inspection-Based Existing Modernization Needs

	Model 1	Model 1-a	Model 2	Model 2-a
Average Number of Bedrooms (per unit)	✔	✔	✔	✔
Total Number of Units at the Development	✔	✔	✔	✔
Building Age is More than 20 Years (Yes/No)	✔	✔	✔	✔
Housing Authority with Less Than 250 Units (Yes/No)	✔	Two separate models: housing authorities < 250 units; housing authorities ≥ 250 units.	✔	Two separate models: housing authorities < 250 units; housing authorities ≥ 250 units.
R.S. Means Location Adjustment Factor	✔	✔	✔	✔
Census Regions (Northeast, South, West, Midwest)	✔	✔	✔	✔
Non-Metropolitan Location (Yes/No)	✔	✔	✔	✔
Number of Negative Development Features			✔	✔
Total Negative HQS Score			✔	✔
Poor Quality Building Maintenance (Yes/No)			✔	✔
Percent Units with No Major Modernization Funds in Last 10 Years			✔	✔
Per-Unit Modernization Funding in 1993-1996			✔	✔
R-Squared Statistics				
Weighted	0.16	0.17[a]	0.33	0.33[a]
Housing Authorities < 250 units	NA	0.20	NA	0.38
Housing Authorities ≥ 250 units	NA	0.16	NA	0.32

a Weighted average of estimates from models for housing authorities with less than 250 units and housing authorities with 250 or more units.

Exhibit 3-3: Variables Used in Alternative Models of Inspection-based Accrual Needs

	Model 3	Model 3-a	Model 4	Model 4-a
Average Number of Bedrooms (per unit)	✔	✔	✔	✔
Low-Density Factor	✔	✔	✔	✔
Building Age	✔	✔	✔	✔
Housing Authority with Less Than 250 Units (Yes/No)	✔	Two separate models: housing authorities < 250 units; housing authorities ≥ 250 units.	✔	Two separate models: housing authorities < 250 units; housing authorities ≥ 250 units.
R.S. Means Location Adjustment Factor	✔	✔	✔	✔
Census Regions (Northeast, South, West, Midwest)	✔	✔	✔	✔
Non-Metropolitan Location (Yes/No)	✔	✔	✔	✔
Family Occupancy Type (Yes/No)	✔	✔	✔	✔
Housing Authority with More Than 6,600 Units (Yes/No)	✔	✔	✔	✔
Percent of Units with No Major Modernization Funds in last 10 Years			✔	✔
Percent of Units with No Major Modernization Funds in last 5-10 Years			✔	✔
Per-Unit Modernization Funding in 1993-1996			✔	✔
Housing Authority-level Adjusted Vacancy Rate			✔	✔
R-Squared Statistics				
Weighted	0.46	0.45[a]	0.44	0.44[a]
Housing Authorities < 250 units	NA	0.45	NA	0.44
Housing Authorities ≥ 250 units	NA	0.45	NA	0.44

a Weighted average of estimates from models for housing authorities with less than 250 units and housing authorities with 250 or more units.

concept of goodness-of-fit of the regression model. In layman's terms, they measure how well the model fits the sample of observations. One often-used measure is the ***R-squared statistic***—it indicates, in proportion, how much the variance in the dependent variable can be explained by the set of predictors in a regression equation.[6] Applied researchers in the modeling field have suggested that regression models with an R-squared of around 0.2 is already noteworthy; an R-squared of 0.5 is considered to be relatively high.[7] The bottom of Exhibit 3-2 and Exhibit 3-3 reported the R-squared statistics of the alternative models. For instance, for existing modernization needs, Model 2 explains approximately 33 percent of the variation of the existing modernization needs in the inspection sample while Model 2-a yields essentially as good a fit (32 percent in R-squared statistic) for small housing authorities and a better fit (38 percent in R-squared statistic) for large housing authorities. Therefore, guided by the R-squared statistics alone, we found that Model 2-a seems to be the preferable choice among the models for predicting per-unit existing modernization needs, and Model 3 provides the best fit for per-unit accrual needs.

However, the merit of using the R-squared statistic as a model selection tool has sometimes been criticized in the research literature.[8] First, and most importantly, R-squared statistics of a model can shift substantially with the exclusion or inclusion of a few influential observations (that is, observations with rather extreme values in the dependent or independent variables) in the sample. This is called the "outlier effect" in the statistics literature. In simple terms, R-squared statistics may not capture the overall goodness-of-fit of a model. Comparing R-squared statistics alone thus may not lead to the best model specification if there are "outlier" observations in the sample. In addition, other researchers have shown that the value of R-squared statistics may be sensitive to whether a constant term is included in the regression equation.

Another way to assess the goodness-of-fit of alternative regression models that may work better for the current situation is through ***model prediction***. The procedures and reasoning of the model prediction exercise are the following. The 568[9] sample properties we used in the regression models are first divided into sixteen groups according to four housing

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6 To be precise, we reported ***adjusted R-squared*** statistics in the text. Compared to the simple R-squared, adjusted R-squared is a more reliable statistic, since it checks whether the contribution of a new predictor to the overall fit of the regression model will be offset by the loss in the degrees of freedom (defined as the number of observations minus the number of variables).

7 William H. Greene, *Econometric Analysis*, 3rd Edition (Upper Saddle River, NJ: Prentice-Hall, 1997).

8 For details, see Robert S. Pindyck and Daniel L. Rubinfeld, *Econometric Models and Economic Forecasts*, 4th Edition (New York: McGraw-Hill, Inc., 1997); William H. Greene, *Econometric Analysis*, 3rd Edition (Upper Saddle River, NJ: Prentice-Hall, 1997).

9 Developments from the New York City, Chicago, and Puerto Rico housing authorities were excluded from the prediction exercise since they were not included in developing the regression models.

authority-size categories (less than 250 units, 250 to 1,249 units, 1,250 to 6,600 units, and more than 6,600 units excluding New York City, Chicago, and Puerto Rico) and four census regions (Northeast, South, West, and Midwest). Next, for developments in each group, we compute the following quantities:

- ***Direct estimates.*** They are calculated by multiplying the inspection-based need estimates of each individual sample development by the corresponding sample weight. Development-level estimates are then aggregated to group totals.

- ***Cell-mean predicted estimates***. As mentioned earlier in this chapter, the cell-mean approach for need estimates is based on housing authority size alone. In other words, the method assumes that all developments in the same housing authority-size category have the same level of per-unit capital needs (i.e., cell means). There are four size categories (cells), namely less than 250 units, 250 to 1,249 units, 1,250 to 6,600 units and more than 6,600 units, and each category is associated with a single level of per-unit existing modernization need and per-unit accrual need. As an illustrative example, for housing authorities with less than 250 units, the method considers the inspection-based existing modernization needs to be $13,868 per unit for all developments, regardless of regional locations. Therefore, to calculate the total estimate for housing authorities with less than 250 units in the Northeast region, we multiply $13,868 by the actual number of units of small-size housing authorities in the Northeast region (as measured by the sum of the sample weights of those developments).

- ***Model-based predicted estimates***. For each sample development, this is computed by entering the values of the relevant predictor variables multiplied by the corresponding coefficients in each of the regression models to estimate development-level needs. The model-based development-level estimates are then multiplied by the R.S. Means adjustment factor to account for local cost variations, weighted by the number of units they represent (using sample weights) and aggregated to group totals.

Exhibit 3-4 and Exhibit 3-5 present these estimates and their comparison. The objective of this exercise is to compare the cell-mean estimates and model-based estimates to the direct estimates grouped at the housing authority-size and region levels—the "best" model/approach should be able to generate reliable and precise need estimates that are very close to the direct estimates grouped at those levels. We believe, for the following reasons, this is a more suitable testing procedure than the R-squared statistics for selecting alternative models in this study:

- The R-squared statistic, as a model selection tool, only measures alternative models' goodness-of-fit at the housing development level. However, because the

Exhibit 3-4: Goodness-of-fit Comparison of Alternative Models: Inspection-Based Existing Modernization Needs[a] (In Millions of Dollars)

	Number of sample properties	Direct need estimate	Prediction									
			Cell-mean approach	% Diff.	Model 1	% Diff.	Model 1-a	% Diff.	Model 2	% Diff.	Model 2-a	% Diff.
Housing authority size1 (<250 units)	126	$2,739	$2,739	n.a.	$3,175	15.9	$2,739	0.0	$2,938	7.3	$2,808	2.5
Housing authority size2 (250-1,249 units)	187	$6,036	$6,036	n.a.	$5,869	-2.8	$6,148	1.9	$5,939	-1.6	$5,937	-1.6
Housing authority size3 (1,250-6,600 units)	177	$5,500	$5,500	n.a.	$5,248	-4.6	$5,377	-2.2	$5,540	0.7	$5,627	2.3
Housing authority size4 (6,600+ units)	78	$2,605	$2,605	n.a.	$2,589	-0.6	$2,616	0.4	$2,643	1.5	$2,711	4.1
Average absolute % difference				n.a.		6.0		1.1		2.8		2.6
Average % difference				n.a.		2.0		0.0		2.0		1.8
Housing authority size1-Northeast	12	$199	$359	80.3	$358	79.6	$185	-7.0	$293	47.0	$170	-14.8
Housing authority size1-South	72	$1,747	$1,458	-16.5	$1,772	1.4	$1,761	0.8	$1,698	-2.8	$1,826	4.5
Housing authority size1-West	18	$342	$358	4.8	$427	25.1	$345	1.1	$369	8.0	$361	5.7
Housing authority size1-Midwest	24	$452	$564	24.8	$617	36.7	$447	-1.0	$578	28.0	$451	-0.2
Housing authority size2-Northeast	49	$1,530	$1,591	4.0	$1,408	-8.0	$1,501	-1.9	$1,392	-9.0	$1,434	-6.3
Housing authority size2-South	87	$2,600	$2,763	6.3	$2,764	6.3	$2,814	8.2	$2,778	6.8	$2,719	4.6
Housing authority size2-West	16	$664	$553	-16.6	$588	-11.3	$622	-6.3	$602	-9.3	$576	-13.2
Housing authority size2-Midwest	35	$1,242	$1,129	-9.1	$1,108	-10.8	$1,210	-2.6	$1,167	-6.0	$1,208	-2.7
Housing authority size3-Northeast	39	$1,035	$1,206	16.5	$1,165	12.6	$1,223	18.2	$1,186	14.6	$1,224	18.3
Housing authority size3-South	78	$2,613	$2,414	-7.6	$2,362	-9.6	$2,333	-10.7	$2,511	-3.9	$2,447	-6.4
Housing authority size3-West	25	$744	$750	0.7	$678	-9.0	$713	-4.2	$769	3.3	$787	5.7
Housing authority size3-Midwest	35	$1,107	$1,130	2.1	$1,043	-5.8	$1,108	0.1	$1,074	-3.0	$1,170	5.7
Housing authority size4-Northeast	27	$1,256	$997	-20.6	$1,055	-16.0	$1,080	-14.0	$1,140	-9.2	$1,185	-5.7
Housing authority size4-South	33	$838	$1,043	24.5	$959	14.5	$940	12.2	$943	12.6	$931	11.1
Housing authority size4-West	7	$199	$213	6.9	$253	27.0	$260	30.6	$210	5.5	$221	11.0
Housing authority size4-Midwest	11	$313	$352	12.6	$322	3.0	$337	7.6	$350	12.0	$375	19.7
Average absolute % difference				15.9		17.3		7.9		11.3		8.5
Average % difference				0.4		0.5		0.1		0.4		0.1
R-squared statistics			n.a.		0.16		0.17[b]		0.33		0.33[b]	

Notes:
Percent difference (% diff.) = [(model-based (or cell-mean) estimate - direct need estimate)/direct need estimate] × 100%.

a Prediction exercise excludes developments of New York City, Chicago, and Puerto Rico housing authorities in the inspection sample.

b Weighted average of estimates from models for housing authorities with less than 250 units and housing authorities with 250 or more units.

Exhibit 3-5: Goodness-of-fit Comparison of Alternative Models: Inspection-Based Accrual Needs[a] (In Millions of Dollars)

	Number of sample properties	Direct need estimate	Prediction									
			Cell-mean approach	% Diff.	Model 3	% Diff.	Model 3-a	% Diff.	Model 4	% Diff.	Model 4-a	% Diff.
Housing authority size1 (<250 units)	126	$360	$360	n.a.	$339	-5.7	$360	0.1	$337	-6.3	$360	0.1
Housing authority size2 (250-1,249 units)	187	$561	$561	n.a.	$584	4.0	$569	1.3	$584	4.1	$565	0.7
Housing authority size3 (1,250-6,600 units)	177	$479	$479	n.a.	$477	-0.5	$472	-1.5	$479	-0.1	$478	-0.4
Housing authority size4 (6,600+ units)	78	$189	$189	n.a.	$189	0.1	$189	0.1	$188	-0.3	$188	-0.3
Average absolute % difference				n.a.		2.6		0.7		2.7		0.4
Average % difference				n.a.		-0.5		0.0		-0.6		0.0
Housing authority size1-Northeast	12	$47	$47	1.3	$41	-12.9	$46	-0.8	$40	-14.7	$45	-3.3
Housing authority size1-South	72	$182	$192	5.2	$178	-2.3	$182	-0.3	$176	-3.4	$181	-0.4
Housing authority size1-West	18	$64	$47	-26.3	$53	-16.6	$64	0.9	$54	-15.7	$66	3.5
Housing authority size1-Midwest	24	$67	$74	10.0	$68	0.4	$68	0.4	$68	0.8	$68	0.3
Housing authority size2-Northeast	49	$138	$148	7.2	$144	4.4	$140	1.3	$142	2.7	$137	-0.7
Housing authority size2-South	87	$250	$257	2.6	$262	4.6	$257	2.6	$262	4.7	$256	2.0
Housing authority size2-West	16	$63	$51	-17.8	$67	6.3	$62	-1.7	$69	9.5	$63	0.7
Housing authority size2-Midwest	35	$110	$105	-4.9	$111	0.9	$110	-0.4	$112	1.4	$110	-0.8
Housing authority size3-Northeast	39	$107	$105	-2.1	$107	-0.6	$106	-1.7	$109	1.3	$108	0.7
Housing authority size3-South	78	$208	$210	1.0	$200	-3.9	$201	-3.6	$200	-4.0	$201	-3.5
Housing authority size3-West	25	$66	$65	-1.4	$70	4.9	$64	-3.2	$70	5.6	$65	-1.7
Housing authority size3-Midwest	35	$97	$98	1.1	$100	3.0	$102	4.4	$100	2.6	$103	5.7
Housing authority size4-Northeast	27	$77	$72	-5.8	$77	0.6	$77	0.2	$76	-1.3	$76	-1.0
Housing authority size4-South	33	$68	$76	11.0	$67	-0.9	$68	0.3	$68	-0.1	$69	1.2
Housing authority size4-West	7	$14	$15	7.0	$18	27.9	$17	21.0	$18	27.1	$17	15.2
Housing authority size4-Midwest	11	$30	$26	-13.6	$26	-11.8	$26	-11.0	$26	-11.1	$27	-8.9
Average absolute % difference				7.4		6.4		3.4		6.6		3.5
Average % difference				-0.1		0.0		0.0		0.0		0.0
R-squared statistics			n.a.		0.46		0.45[b]		0.44		0.44[b]	

Notes:
Percent difference (% diff.) = [(model-based (or cell-mean) estimate - direct need estimate)/direct need estimate] × 100%.
a Prediction exercise excludes developments of New York City, Chicago, and Puerto Rico housing authorities in the inspection sample.
b Weighted average of estimates from models for housing authorities with less than 250 units and housing authorities with 250 or more units.

Capital Fund formula is designed to distribute funds to housing authorities (rather than housing developments), our ultimate concern should be whether the "best" model can perform well at the housing authority and housing authority size-region level. In other words, whereas it is still pivotal that we control for heterogeneous factors at the housing development level in the regression models, accuracy of the model's needs prediction at the housing authority level is more important (relative to accuracy at the housing development level, as measured by the R-squared statistics).

- It is difficult to fully control for all the differences among housing developments in the regression models. These unobserved heterogeneous factors as well as "outlier" observations at the housing development level can easily distort the R-squared statistics. Comparing R-squared statistics alone therefore may not lead to the "best" model. However, when the model-based estimates are grouped into housing authority-size and region levels, variations in the predicted needs caused by uncontrolled heterogeneities and outliers among housing developments are likely to cancel or balance out each other. This gives the alternative models' overall goodness-of-fit a more robust assessment.[10]

When the cell-mean estimates and the model-based estimates are compared to the direct estimates, we compute the following statistics[11] to indicate a model's predictive power:

- Difference (percent) for each of the four housing authority size categories
- Difference (percent) for each of the sixteen housing authority-region categories
- Average difference (percent) for the four housing authority size categories
- Average difference (percent) for the sixteen housing authority-region categories
- Average absolute-difference (percent) for the four housing authority size categories
- Average absolute-difference (percent) for the sixteen housing authority-region categories

Intuitively, the smaller these statistics are, the greater the predictive power of the model. Judging from this set of statistics in the two exhibits, for both inspection-based existing

10 An alternative remedy is to estimate the existing modernization and accrual needs models at the housing authority level, by aggregating the per-unit capital needs and predictor variables from the inspection sample developments into weighted housing authority-level data. However, compared to our recommended approach of estimating the models at the housing development level, this method has a major disadvantage: it will substantially reduce the total number of observations available to the regression models from a sizable 568 (developments) to a modest 216 (housing authorities).

11 We define percent difference (% diff.) = [(model-based (or cell-mean) estimate - direct need estimate)/direct need estimate] × 100%.

modernization needs and accrual needs, the model-based methods clearly out-perform the cell-mean approach. Among the models for predicting per-unit existing modernization needs, although Models 2 or 2-a have the highest R-squared value, Model 1-a yields predicted (model-based) estimates that are on average much closer to the direct estimates.[12, 13] In absolute values, for instance, the average difference between the predicted and the direct need estimates is only 7.9 percent across the sixteen housing authority size-region categories for Model 1-a. That is the smallest difference among the models presented in Exhibit 3-4. Also, compared to Model 2-a, Model 1-a does not impose administrative burden to collect additional data—for example, the government cost of hiring study inspectors to collect standard information for the "number of negative development features" variable in Model 2-a for the entire stock would be prohibitively expensive. Taking all these model-selection criteria (namely, R-squared, predictive power statistics, and ease of data collection) into consideration, we recommend Model 1-a as the preferable model for predicting per-unit inspection-based existing modernization needs.

For per-unit accrual needs, Exhibit 3-5 indicates that all four models have very similar R-squared statistics. Relative to the other models, Model 3-a has smaller differences when we compare the model-based need estimates to direct estimates. The average absolute value of differences between the model-based estimates and direct estimates is only 3.4 percent across the sixteen housing authority size-regions for Model 3-a. This implies that Model 3-a provides the best "goodness-of-fit" in terms of predictive power. In addition, it also has the virtue that all the necessary variables required in the model are readily available or can be computed from the HUD master universe file for the entire public housing stock. In other words, the model also satisfies the "ease of data collection" principle. We therefore recommend Model 3-a as the model for predicting per-unit accrual needs.

12 Besides the possibilities of "outliers" and uncontrolled heterogeneities mentioned above, this inconsistency can be due to the disparities of capital needs and other housing authority attributes across regions. The overall R-squared statistic of a model can be easily distorted if the model fits the data particularly well (or worse) in a few of the sixteen housing authority size-region categories. Moreover, relative to Model 1-a, the additional set of variables in Model 2-a may not be crucial for predicting capital needs at the housing authority-size and region levels.

13 The single R-squared statistic reported for Model 1-a is calculated as a weighted average of the two R-squared statistics from models for housing authorities with less than 250 units and housing authorities with 250 or more units. The same method was used to calculate the weighted R-squared statistics for Models 2-a, 3-a and 4-a.

Recommended Models for Predicting Capital Needs

The final set of recommended models for estimating inspection-based existing modernization needs and accrual needs are shown in Exhibits D-1 and D-2 of Appendix D, using Models 1-a and 3-a.[14] Exhibit 3-6 presents the basic descriptive statistics for variables used in the regression models from the inspection sample. Overall, the models provide a decent fit to the sample observations—for existing modernization needs, the R-squared statistics are 0.20 and 0.16 for models of developments in housing authorities with less than 250 units and developments in housing authorities with 250 units or more, respectively; for accrual needs, the models for both housing authority-size classes have an R-squared of 0.45. The predictors in the accrual needs models in general explain a larger proportion of variation of the dependent variable than do the models existing modernization needs. Moreover, compared to the model for existing modernization needs, the accrual needs models are associated with more for significant regression coefficients.[15] This is probably due to the fact that the accrual needs measure itself is a "modeled" quantity in the physical needs assessment process. It is thus relatively easy to capture its range of values by a regression equation.

Using separate models for developments in housing authorities above and below 250 units, the final set of predictors for per-unit inspection-based existing modernization needs consists of:

- Average number of bedrooms in the units in a development
- Total number of units in a development
- Whether the development's building age is greater than 20 years
- R.S. Means location cost factor
- Whether the development is located in a non-metropolitan area
- Whether the development is located in the South census region
- Whether the development is located in the West census region
- Whether the development is located in the Midwest census region.

14 The recommended models use exactly the same set of need predictors recommended to HUD for the Negotiated Rule-Making Committee Meetings held in the summer of 1999. The model coefficients reported here, however, made use of a more complete and up-to-date database. Specifically, we have updated the information of one data element (i.e. the non-metropolitan location status of each sample property). This increased the usable sample from 525 to 568 properties. The sample of small PHAs increased from 95 to 126, and the sample of large PHAs from 430 to 442. The models now yield estimates that are more robust. The resulting coefficient estimates are slightly different from those reported to the HUD Negotiated Rule-Making Committee Meeting. But, overall, these differences are essentially negligible and show no material impact in terms of potential funding allocation by housing authority size categories. Some comparisons are shown in Appendix D.

15 Given the sample size limitation, particularly in the group of housing authorities with less than 250 units, it is not unexpected to observe that some of the regression coefficients in the recommended models do not attain statistical significance at the conventional 90- or 95- percent levels.

Exhibit 3-6: Descriptive Statistics of Variables (Weighted) Used in the Recommended Inspection-Based Existing Modernization Need and Accrual Need Models (for Inspection Sample of Properties); Needs not Adjusted by Inter-Area Costs

Developments in Housing Authorities with less than 250 Units				
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Per-unit Existing Modernization Needs	15523.45	12207.33	42.805	55714.86
Per-unit Average Annual Accrual Needs	1956.647	595.309	723.626	4235.313
Average Number of Bedrooms	1.869	0.725	0.340	3.676
Low-Density Factor	1.909	1.376	0	4
Family Development	0.690	0.464	0	1
Total Units in Development	61.055	39.169	4	170
Building Age	27.674	10.689	4	56
Building Age > 20 Years	0.760	0.429	0	1
R.S. Means Location Adjustment Factor	0.936	0.126	0.713	1.340
Non-metropolitan Location	0.620	0.487	0	1
Census Region:				
Northeast[a]	0.131	0.339	0	1
South	0.532	0.501	0	1
West	0.131	0.338	0	1
Midwest	0.206	0.406	0	1
Number of Observations from Inspection Sample: 126				
Developments in Housing Authorities with 250 or More Units[b]				
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Per-unit Existing Modernization Needs	18688.25	12709.35	0	63570.88
Per-unit Average Annual Accrual Needs	1628.164	590.074	574.142	4833.754
Average Number of Bedrooms	1.879	0.800	0	3.795
Low-Density Factor	0.843	1.269	0	4.081
Family Development	0.712	0.453	0	1
Total Units in Development	234.003	200.027	6	1136
Building Age	35.341	13.256	4	61
Building Age > 20 Years	0.883	0.322	0	1
PHA with More Than 6600 Units	0.161	0.368	0	1
R.S. Means Location Adjustment Factor	1.015	0.135	0.713	1.287
Non-metropolitan Location	0.153	0.360	0	1
Census Region:				
Northeast[a]	0.266	0.442	0	1
South	0.441	0.497	0	1
West	0.107	0.310	0	1
Midwest	0.186	0.389	0	1
Number of Observations from Inspection Sample: 442 [b]				

a Denotes reference category in regressions.

b Excludes observations in New York City, Chicago and Puerto Rico housing authorities in the inspection sample.

Note: Because needs in this table are not adjusted by inter-area costs, the per-unit existing modernization needs and the per-unit accrual needs are not comparable to those in Exhibit 2-1, where needs are adjusted for inter-area costs.

Using separate models for developments in housing authorities above and below 250 units, the final set of predictors for per-unit accrual needs includes:

- Average number of bedrooms in the units in a development
- Low-density factor: the extent to which the buildings in a development average fewer than 5 units
- Building age of the development
- Whether the development is a family development
- Whether the development is associated with a housing authority that owns or operates more than 6,600 units
- R.S. Means location cost factor
- Whether the development is located in a non-metropolitan area
- Whether the development is located in the South census region
- Whether the development is located in the West census region
- Whether the development is located in the Midwest census region.

Policy Implications of the Revised Models

This section presents the model-based inspection-based needs estimates for the 1999 CGP/ CIAP universe of public housing and explores some of the policy implications of the recommended models in terms of HUD capital funds allocation. We first used the latest HUD master universe file (as of June 1999) to generate the model-based capital needs estimates for every public housing development in the 1999 CGP/CIAP universe using the recommended inspection-based existing modernization needs and accrual needs models. All model estimates were multiplied by an R.S. Means adjustment factor to account for local cost variations. Development-level estimates were then aggregated into housing authority-level totals. For the New York City and Chicago housing authorities, the direct estimates were used for the reasons mentioned previously in this chapter. To estimate needs for units in Puerto Rico, we applied the model results for housing authorities with 250 or more units to the characteristics of Puerto Rico's stock. Exhibit 3-7 shows how these total and per-unit needs estimates are distributed across different size housing authorities.

These model-based estimates are related to the direct estimates reported in Exhibit 2-1 of Chapter Two. Several important differences and similarities between the quantities in the two exhibits deserve comment:

- The direct estimates in Exhibit 2-1 are based on the inspection universe and exclude units approved for demolition or HOPE VI, and units in Alaska, Hawaii, Guam, and the U.S. Virgin Islands. However, the model-based estimates presented in Exhibit 3-7 reflect the full 1999 CGP/CIAP universe. The total estimates of capital needs are higher for the full 1999 CGP/CIAP universe because it includes more units. In addition, the distribution of shares of total

Exhibit 3-7: National Distribution of Model-Based Capital Need Estimates for the 1999 CGP/CIAP Universe

Public Housing Authority Size	Total Units[a]	Existing Modernization Needs		Average Annual Accrual Needs	
		Total	Per-Unit	Total	Per-Unit
Less than 250 units	203,687	$2,578,361,860	$12,658	$360,953,187	$1,772
250 to 1,249 units	336,648	$5,728,615,775	$17,017	$555,179,453	$1,649
1,250 to 6,600 units	342,266	$6,327,732,638	$18,488	$571,954,000	$1,671
More than 6,600 units[b]	204,533	$4,718,442,859	$23,069	$319,871,450	$1,564
New York City[c]	160,209	$3,679,503,620	$22,967	$302,163,581	$1,886
Chicago[c]	38,788	$1,041,543,510	$26,852	$53,555,225	$1,381
National Total	1,286,131	$24,074,200,262	$18,718	$2,163,676,896	$1,682

a Unit counts based on the HUD Master Universe file for June 1999.

b Excluding units in New York City and Chicago housing authorities, but including units in Puerto Rico.

c Estimates based on unit counts from the HUD Master Universe file and per-unit need estimates from the inspection sample.

needs estimates is not exactly comparable in the two exhibits because the variations in the two universe counts vary by housing authority size category. However, when we compare the estimates with the direct estimates just for the inspection universe, the total numbers are identical at $22.5 billion for inspection-based existing modernization needs, and $2 billion per year for accrual needs.

- Given the above qualification, the per-unit needs estimates reported in the two exhibits are roughly comparable. While there are some discrepancies, many of the per-unit model-based estimates of need are in close proximity to the direct estimates. For instance, for properties in housing authorities with 250 to 1,249 units, the direct estimates of existing modernization needs in the inspection universe and accrual needs are $17,017 and $1,649 per unit respectively, while the corresponding model-based estimates are $17,017 and $1,624 per unit. For housing authorities with 1,250 to 6,600 units, the per-unit model-based estimates are also very close to the ones from the direct estimates. The discrepancies between the model-based and direct estimates for other housing authority-size categories are probably attributable to the differences in universe counts between the 1999 CGP/CIAP and inspection universes. Overall, the tabulations provide some confirmation regarding the reliability and accuracy of our

recommended models in predicting capital needs that are close to most of the inspection-based estimates.[16]

As mentioned earlier in the chapter, the models can form the basis of a new needs-based formula for allocating HUD capital funds to public housing authorities across the nation. Allocations can take many forms. One obvious choice is to allocate funds in proportion to capital needs—either just existing modernization needs, just accrual needs, or some combination of the two, such as is done under the current Comprehensive Grant Program. Other allocation rules could provide more weight to larger developments, to larger housing authorities, or to developments with higher needs.

To see the possible distributional implications of a new system, we have computed the "shares" (i.e., percentages) of total inspection-based existing modernization needs and total accrual needs for each housing authority size group, based on the model-based estimates of need for the 1999 CGP/CIAP universe reported in Exhibit 3-7. The results are presented in Exhibit 3-8. The allocation shares currently in use and calculated from the CGP and CIAP systems are shown for reference in the exhibit. To allow comparison with the current CGP allocation rule, we also included in the exhibit allocation shares that are based on a 50 percent weight for the existing modernization needs share and a 50 percent weight for the accrual needs share.

Overall, regardless of how the shares for existing modernization needs and accrual needs are combined into the final allocation shares, assuming future allocations are in proportion to the estimates of need, a moderate shift in funds allocation could occur between housing authority size categories. If shares for particular housing authorities vary considerably between the new and current systems, HUD can adopt an approach that implements the changes gradually. One approach could be, for example, for an individual authority to cap the funding reduction going from the current to the revised systems to a certain percent (for instance, 5 or 6 percent) of the housing authority's current allocation. This could temper the adverse effect on individual housing authorities that may experience a substantial shift in relative needs between the current and revised systems.

We now focus our discussion on the share comparison where the allocation shares are calculated as a 50 percent weight for the existing modernization needs share and a 50 percent weight for the accrual need share:

- As expected, both the revised and current shares are in proportion to the total number of units in each housing authority category. For example, the category of

16 Per-unit needs estimates for the New York City and Chicago housing authorities differ from those reported in Exhibit 2-1 because the inspection sample and 1999 CGP/CIAP universes have slightly different distributions of family and elderly developments.

Exhibit 3-8: Comparison of Current Funding Shares and Abt Associates Inc. Model-Based Shares for the 1999 CGP/CIAP Universe

Public Housing Authority Size	Percent of Total Units	50% Mod Share and 50% Accrual Share		100% Mod Share		100% Accrual Share	
		Current Formula	Abt Model	Current Formula	Abt Model	Current Formula	Abt Model
Less than 250 units	16%	13%	14%	7%[b]	11%	14%[b]	17%
250 to 1,249 units	26%	20%	25%	18%	24%	23%	26%
1,250 to 6,600 units	27%	25%	26%	26%	26%	26%	26%
More than 6,600 units[a]	31%	42%	35%	49%	39%	37%	31%
National Total	100%	100%	100%	100%	100%	100%	100%

a Including units in New York City, Chicago, and Puerto Rico housing authorities.

b Under the 1990 formula methods, housing authorities of less than 250 units had about 10.5 percent of total need (based on a 50/50 averaging of backlog and accrual need). In actual allocations, this share was raised in recent years and reached 12.5 percent in FY99, which is closer to their share of need in this study.

housing authorities with more than 6,600 units as a whole contains the largest proportion of units (31 percent). This category has the largest revised share (35 percent) and the largest current share (42 percent).

- In addition, similar to the distribution of the current shares, revised shares are associated with individual housing authority size. On average, larger housing authorities get larger shares of the total funding relative to their share of total units compared with smaller authorities. In other words, fund allocation is not strictly proportional to the housing authority's unit size. For instance, in the revised share distribution, the category of housing authorities with less than 250 units accounts for 16 percent of the stock and its allocation share is only 14 percent; housing authorities with more than 6,600 units as a whole operate 31 percent of the total units and their allocation share is 35 percent. This reflects the fact that most of the large housing authorities have per-unit capital needs above the national average level, while many of the small housing authorities have below-average per-unit needs. (Please refer to estimates presented in Exhibit 2-1 and Exhibit 3-7.)

- For the categories of housing authorities with less than 250 units and with 1,250 to 6,600 units, the revised shares are very close to the ones in the current system.

- Compared to shares in the current system, revised shares will increase for both the small (from 13 percent to 14 percent) and medium (from 20 percent to 25 percent) housing authorities, while allocation to the very large housing authorities decreases

(from 42 percent to 35 percent for housing authorities with more than 6,600 units including New York City, Chicago, and Puerto Rico). This implies that the per-unit relative needs, as measured by the definitions of capital needs in this study, of mid-size and small housing authorities have grown relatively more over the decade than the very large housing authorities, although the per-unit needs (in absolute terms) are still substantially higher in large housing authorities.

- Shares for housing authorities with 1,250 to 6,600 units, which account for approximately 27 percent of the total public housing stock, stay roughly the same (increased slightly from 25 percent to 26 percent) between the current and revised formula systems.

Appendix A:
Description of Sampling Strategy

The inspection sample for this study includes 684 developments containing 229,973 units in 219 housing authorities and is representative of the ***vast majority*** of developments nationwide—1,194,370 out of a total of 1,206,467 units.

The inspection sample for this study is composed of two samples drawn separately: the original sample, consisting of 625 developments in 199 housing authorities; and a supplemental sample consisting of 59 developments in 23 housing authorities. The supplemental sample included 16 additional inspections from developments in New York City, Puerto Rico and Chicago (housing authorities which were in the original sample). Therefore, excluding any double counting of housing authorities, the total sample size upon which our analysis is based is 684 developments in 219 housing authorities.

This appendix is organized in six sections:

- sampling strategy overview;
- selection of the housing authorities and developments for the original sample;
- revisions to the original sample of housing authorities and developments after it was drawn and fielded;
- selection of the supplemental sample;
- summary of the final sample, including both the original and supplemental components;
- adjustments made to the inspection universe estimates to account for exclusions.

I. Sampling Strategy Overview

The original statement of work for this study specified that about 625 developments were to be inspected in about 200 housing authorities. In each sampled development, between one and three buildings and between one and three units were to be sampled. The housing authorities were to be stratified by region, size, and PHMAP rating. Developments were to be stratified by family-elderly status and either vacancy rate or a combination of 1985 backlog estimate and post-1985 modernization expenditures. Certain types of developments were to be excluded: small developments in large housing authorities (because they are not typical), and certain types of scattered-site developments (because they are expensive to field). Each sampled development was to be given a probability of selection proportional to its number of units.

In close consultation with the HUD GTM, we developed a sampling approach that achieved the type of sample allocation required by HUD. The sampling plan we used is a multiple-stage

probability sample based on probability-proportional-to-size (PPS) sampling, where size is indicated by the number of units available in the housing authority. This resulted in the selection of 647 developments in 205 housing authorities—more than the number required, in order to provide a replacement sample should some developments and housing authorities prove to be ineligible or not respond. In fact, some housing authorities and developments did drop out after the sample was drawn, as described in a later section of this appendix.

Rather than stratifying and pre-specifying the number of authorities by region/size class, we used an *implicit* stratification approach by sorting the list of authorities by region, size category and vacancy category so that the systematic selection process naturally picked up a representative sample.

The original universe file provided by HUD included 1,308,050 units. Several important exclusions to the study universe were made.

- Because the study was intended to estimate the capital needs of developments likely to remain in the stock (as opposed to being demolished or replaced) and funded through the Capital Fund, developments with approved demolition plans, completed demolitions, or approved HOPE VI implementation grants were ***excluded*** from the study universe (77,743 units in 303 developments). The study universe was defined in August 1997, and the sample was drawn in September 1997. All properties with approved demolition plans, completed demolitions, or approved HOPE VI implementation grants as of December 1997 also were excluded from the study universe. Further reductions to the estimated universe were made when inspectors identified other ineligible properties in the field (January - May 1998).[1] Because their capital needs are not addressed through the Capital Fund, Indian Housing Authorities were also excluded from the sampling universe.

- In order to eliminate prohibitively expensive data collection costs the study universe ***included*** only developments located in the contiguous 48 states, the District of Columbia, and Puerto Rico (i.e., all 12,097 units in Alaska, Hawaii, Guam, and the U.S. Virgin Islands were excluded). For the same reason, the study universe also ***excluded*** scattered-site developments (39,641 units in 593 developments) and Turnkey developments (566 units).

1 The initial sample exclusions decreased the universe by about 120,000 units. The inspectors identified 22 ineligible properties once they were in the field. Six had received FY 1998 HOPE VI implementation grants or had approved demolition plans, 11 were no longer public housing, and 5 were scattered-site unit acquisition developments. These 22 properties represent about 40,000 units nationwide.

After the exclusions described above, the sampling universe consisted of 1,178,003 units in 12,611 developments in 3,144 housing authorities. While on site the inspectors identified additional properties that should have been excluded because they received 1998 HOPE VI implementation grants or were no longer public housing. Following these additional exclusions, the estimated sampling universe was 1,133,963 units.

As described in Section VI below, we increased the weights for some family developments in order to compensate for scattered-site developments, units in HOPE VI developments that were not included in the HOPE VI rehabilitation, and any units not slated for demolition in developments with approved demolition plans. Following these adjustments, the inspection universe included 1,194,370 units, which are all included in the inspection-based estimates of need. To provide a full picture of national needs, we also included all developments in Alaska, Hawaii, Guam and the U.S. Virgin Islands for a total universe estimate of 1,206,467 units.

II. Selection of the Original Sample

This section describes the approach for selecting specific housing authorities and developments for the study's original sample.

A. Selecting Housing Authorities to be Sampled

The selected sample was composed of the "base" sample of 200 housing authorities (as originally required by HUD) and a replacement sample of 5 housing authorities. The replacement sample was intended to compensate for both ineligible housing authorities and non-respondents. We pursued all 205 housing authorities, recognizing that our final sample might be slightly more or less than 200 depending on the actual number of ineligibles and non-respondents that we found.

Housing authorities were selected with probability proportional to size (PPS). Some large authorities were selected with certainty. In the first stage, all housing authorities with more than 5,746 units were selected with certainty (units in the universe / housing authorities to be selected, or 1,178,003 / 205 = 5,746). This yielded 17 "certainty sites." We then iteratively identified additional certainty sites. To do this we had to specify a new threshhold size (above which a site would be picked with certainty) for the next iteration. This threshold was specified by the same ratio that governed the first iteration (units remaining in universe / remaining housing authorities to be selected out of 205), net of the previous iterations' selected housing authorities. So for the next iteration, the new size threshold was 4,546 or the ratio of [(total units - units in certainty sites previously selected)/(205-number of certainty sites previously selected)]. The final sample included 25 certainty sites. Together, these account for 408,368 units, or 34.7 percent of the total universe.

The remaining, "non-certainty" housing authorities were selected with probability proportional to size. In order to ensure representativeness along dimensions of interest to HUD, before selection the housing authorities were sorted by region, and within region by size category (<250 units, 250-1249, 1250-4546) and vacancy category (<=10% >10%). The sorting was back-to-back (high to low, low to high) to further guarantee representativeness.

B. Selecting the Allocation of Developments to be Sampled

The first step in selecting developments was to determine how many developments to select within each type of housing authority. As with housing authorities, we constructed a replacement sample of developments. Thus the sample of developments included the base sample of 625 developments as originally required by HUD, plus a replacement sample of 22 developments. The replacement sample consisted of 12 extra developments in the 5 replacement non-certainty housing authorities, and 10 extra developments to compensate for developments that might be identified as ineligible once inspectors began their work. For example, we expected that inspectors could encounter properties that received new HOPE VI implementation grants, or large scattered-site developments that were not identified as such on the sampling-frame files. As shown in Exhibit A-1 and described further below, the total sample of developments including both the base sample and the replacement sample was:

Exhibit A-1: Allocation of Original Developments by Housing Authority Type

Housing Authority Type	Number of Housing Authorities	Number of Developments in Base Sample	Number of Developments in Replacement Sample	Total Number of Developments in Sample
New York City	1	40	2	42
Other Certainty	24	177	4	181
Non-Certainty:				
Original	175	408	4	412
Replacement	5		12	12
Total Non-Certainty	180	408	16	424
Total All	205	625	22	647

Base Sample. For the base sample, we allocated 34.7 percent of all sample developments (217) to the certainty sites because this group represents 34.7 percent of all public housing units. HUD decided that because New York City represents such a large portion of all public housing units (13 percent) it was unnecessary to allocate sample to New York City in proportion to its size. Doing so would have yielded a sample of 81 developments in New York City. Instead, only 40 developments were to be inspected in New York City (this represents 6 percent of sampled developments). The remaining 177 developments allocated to the certainty sites were sampled from the other 24 sites in proportion to their size.

The under-sampling of New York City necessarily implies a slight over-sampling of developments in the remaining certainty sites. They represent 22 percent of all units in the universe, but 28 percent of the sample of developments. In other words, the sample compensated for under-sampling in New York City by a corresponding over-sampling in the other certainty sites. For national projections, all developments were weighted based on the inverse of their probability of selection.

The remaining base sample included 408 properties allocated to the non-certainty sites (65.3 percent of 625).

Replacement Sample. For the development-level replacement sample, we selected 12 developments in the 5 extra non-certainty sites. We also selected 10 developments across all categories of housing authorities to cover sample losses that may result from ineligible developments that were to be identified in the field. These could be due to new HOPE VIs funded (estimate of 5 in our sample), new demolitions (estimate of 3 in our sample), and large scattered sites that were not originally identified (estimate of 2 in our sample).

Based on discussions with HUD staff on the likely locations of ineligible properties, 2 of these additional 10 properties were allocated to New York City, 4 to the remaining certainty sites and 4 to the non-certainty sites.

C. Selection of Specific Developments to Inspect

After determining the number of developments we would sample in each housing authority category, we proceeded to select specific developments. A two-stage development sample strategy was required to ensure that we would obtain the exact number of developments desired. The requirement for the sample was to select 205 housing authorities and 647 unique developments. We considered three categories of developments: those in New York City, those in the remaining (non-New York City) certainty sites, and those in non-certainty sites. In the first stage we over-sampled developments in each of these three categories: 50 in New York City, 200 in the remaining certainty sites, and 540 in the non-certainty sites. In the second stage, we randomly subsampled from each of the three categories to get the exact number of properties required for each group. This resulted in 42 developments drawn from New York City, 181 from the other certainty sites, and 424 from the non-certainty sites—647 in all. Selection from the certainty sites and non-certainty sites is discussed in more detail below.

Non-Certainty Sites. For the non-certainty sites we selected 3 developments from each of the 180 non-certainty sites for a total of 540 potential developments from this group. However, because some housing authorities had fewer than 3 developments, and others had some very large developments that were larger than the sampling interval, some properties were essentially selected more than once. The number of unique projects selected in the first stage

was 474. Since we wanted to identify 424 unique properties for inspection, the properties with multiple "hits" received double or triple weights rather than decrease the number of properties selected in Stage 1. At the second stage this group of 474 properties was randomly subsampled to the required number of 424 developments, and properties had weights of 1, 2 or 3 depending on how many times they were selected in the first-stage sample.[2]

Certainty Sites. Within the certainty sites excluding New York City, we began with a selection of 200 properties. Because of multiple "hits," this actually consisted of only 197 unique properties. In the second stage these were randomly subsampled to the required 181.

In New York City we started with 50 properties in the first stage, and randomly subsampled to the required 42 properties in the second stage. There were no multiple "hits" in the first stage in New York City.

All selections from the base and replacement samples were fielded. No other corrections were made for ineligibles.

Treatment of Non-respondents. As noted above, our sample included 5 additional housing authorities to allow for some attrition of housing authorities due to ineligibility or refusal to participate. It would have been very difficult to add additional housing authorities to the inspection sample once the field effort was underway, thus the additional 5 housing authorities were the only correction made.

For each development we pre-selected a replacement for each property, randomly selecting the property listed above or below the selected one ***within the same housing authority***. If there were no additional properties in the housing authority when we encountered a non-respondent, then the housing authority was dropped. Our selection of 5 extra housing authorities was made to allow for this type of attrition.

D. Summary Comparison of Universe and Sample Characteristics

How well did the sample mirror the sample universe in the end? In Exhibit A-2, we compare the *weighted* sample (where the weights are equal to the inverse of selection probabilities) with the universe of units. Given that our sampling approach was intended to reflect the universe of units in the stock, it is clear from Exhibit A-2 that our sample represented the universe well. Exhibits A-3 and A-4 compare the universe of housing authorities (A-3) and developments (A-4) with the sample. Consistent with probability proportional to size sampling for both housing authorities and developments, Exhibit A-3 shows that large and extra-large housing authorities were over-represented in the sample, and Exhibit A-4 shows

2 The second stage subsampling of developments eliminated 3 of the 180 non-certainty sites. These were sites that had just one development that was not selected in the second stage development sample.

Exhibit A-2: Comparison of Original Sampling Universe and Weighted Original Sample, in Unit Terms

	Sampling Universe		Universe Estimate Based on Sample (Weighted)	
	Number	**Percent**	**Number**	**Percent**
Units by Region				
Northeast	430,908	36.6	431,634	36.7
South	439,973	37.3	439,982	37.4
Rest	307,122	26.1	303,697	25.8
Total	1,178,003		1,175,312[a]	
Units by Average Bedroom Size				
1.5 BRs or less	347,459	29.5	331,822	28.2
More than 1.5 BRs	830,054	70.5	843,491	71.8
Total	1,178,003		1,175,312	
Units by Development Size				
Less than 300 units	832,399	70.7	825,867	70.3
300 or more units	345,604	29.3	349,446	29.7
Total	1,178,003		1,175,312	
Units by Development Vacancy Rate				
Vacancy rate 10% or less	971,174	82.4	983,092	83.6
Vacancy rate more than 10%	206,829	17.6	192,220	16.4
Total	1,178,003		1,175,312	
Units by Authority Size				
Less than 250 units	205,384	17.4	197,572	16.8
250 -1249 units	327,801	27.8	336,191	28.6
1250 - 6600 units	290,955	24.7	289,060	24.6
More than 6600 units	197,431	16.8	196,058	16.7
New York City	156,432	13.3	156,432	13.3
Total	1,178,003		1,175,312	

a The weighted number of units does not equal the total universe because, as described above, as part of the second stage sampling of developments, a random sample of properties was selected. At this point the probability sample diverged from actual measurement because some of the sampled properties had been selected once, some twice, and some three times.

Exhibit A-3: Description of Original Sampling Universe and Original Sample of Housing Authorities

	Sampling Universe		Sample	
	Number	**Percent**	**Number**	**Percent**
Housing Authorities by Region				
Northeast	500	15.9	57	27.8
South	1,512	48.1	85	41.5
Rest	1,132	36.0	63	30.7
Total	3,144[a]		205	
Housing Authorities by Average Bedroom Size				
1.5 BRs or less	1,166	37.1	45	22.0
More than 1.5 BRs	1,978	62.9	160	78.0
Total	3,144		205	
Housing Authorities by Authority Size[b]				
Less than 250 units	2,358	75.0	48	23.4
250 -1249 units	654	20.8	77	37.6
1250 - 6600 units	117	3.7	65	31.7
More than 6600 units	14	0.4	14	6.8
New York City	1	0.0	1	0.5
Total	3,144		205	
Housing Authorities by Development Vacancy Rate				
Vacancy rate 10% or less	2,612	83.1	151	73.7
Vacancy rate over 10%	532	16.9	54	26.3
Total	3,144		205	

a Excludes developments in Alaska, Hawaii, Guam and the U.S. Virgin Islands.

b Authority size is measured as the sum of units available in all eligible developments in the authority. Excluded from the size measure are developments with approved demolition plans, developments with an approved HOPE VI implementation grant, and scattered-site developments with over 300 units.

Exhibit A-4: Description of Original Sampling Universe and Original Sample of Developments

	Sampling Universe		Sample	
	Number	**Percent**	**Number**	**Percent**
Developments by Region				
Northeast	2,799	22.1	209	32.3
South	5,702	45.2	262	40.5
Rest	4,130	32.8	176	27.2
Total	12,611[a]		647	
Developments by Average Bedroom Size				
1.5 BRs or less	4,213	33.4	184	28.4
More than 1.5 BRs	8,398	66.6	463	71.6
Total	12,611		647	
Developments by Development Size				
Less than 300 units	12,041	95.5	472	73.0
300 or more units	570	4.5	175	27.0
Total	12,611		647	
Developments by Development Vacancy Rate				
Vacancy rate 10% or less	10,637	84.3	526	81.3
Vacancy rate over 10%	1,974	15.7	121	18.7
Total	12,611		647	

a Excludes developments in Alaska, Hawaii, Guam and the U.S. Virgin Islands, as well as developments with approved HOPE VI or Demolition Plans and scattered-site developments.

that large developments were over-represented. However, as is evident from Exhibit A-2, our weighting procedures ensured a sample that was representative of the universe of public housing units.

III. Revisions to the Original Sample

Some changes—attrition and replacements—occurred to the sample from the time it was drawn through the time the physical inspections were completed and the data were cleaned. These accounted for a decrease of 6 housing authorities and 22 developments between the sample originally drawn and that used for the analysis. Changes are summarized in Exhibit A-5.

Exhibit A-5: Revisions to the Original Sample

Housing Authority Type	Initial Sample		Revised Sample	
	Housing Authorities	Developments	Housing Authorities	Developments
New York City	1	42	1	42
Other Certainty	24	181	24	175
Non-Certainty	180	424	174	408
Total	205	647	199	625

A. Revisions to the Sample of Housing Authorities

Recall that we selected 205 housing authorities initially. Three small housing authorities dropped out because they had no developments selected in the second stage sample (they each had only one small development—100 units or fewer—selected in the first stage sample, but not in the second stage sample). These housing authorities included:

- KS037 - Wellington Housing Authority
- KY149 - Housing Authority of Martin County Housing
- NE030 - Fairbury Housing Authority

Consequently, inspections were actually fielded in only 202 housing authorities.

Three other housing authorities were excluded from the final sample because inspectors found that *all* of their developments were ineligible (e.g., their developments were no longer traditional public housing). These housing authorities were:

- OH016 - Mansfield Housing Authority
  (Turtle Creek Apts. was dropped because it had been converted to Section 8)
- MO005- Housing Authority of the City of Kinloch
  (Dunbar Gardens was dropped because it had been approved for demolition)
- MS095- South Delta Regional Housing Authority
  (Indianola and Rolling Fork were both converted to Section 8)

B. Revisions to the Sample of Developments

The original sample contained 647 developments. This was subsequently adjusted to account for ineligible developments and replacements. In total, 22 developments were dropped from the sample and were not replaced because they were ineligible for the study. These are summarized below:

- Sixteen developments were identified as HOPE VI sites or were no longer part of HUD's public housing stock (because they had been sold, converted, or demolished). They are:

	Development	**Reason for Ineligibility**
1.	AR004007-Highland Park	Demo/Disposition
2.	DC001038 -Eastgate Gardens	In Process of Being Demolished
3.	IL100001 - Coles County HA	Sect. 23 leased conversion, now public housing under a different project code.
4.	IL003001 -Warner Homes	HOPE VI
5.	MO002018 - Heritage House	HOPE VI
6.	MO005003 - Dunbar Gardens	Demo/Disposition
7.	MS095001 - Indianola	Section 23 leased, converted to Section 8
8.	MS095008 - Rolling Fork	Converted to Section 8
9.	NC012007 - Kimberly Park Terrace	HOPE VI
10.	NJ003002 - Pioneer Homes	HOPE VI
11.	NJ021002 - Brook Sloate Terrace	Sold to Homeownership Program
12.	OH016004 - Turtle Creek Apts.	Converted to Section 8
13.	PA002051- Whitman	Turnkey
14.	PA006002 - McKees Rocks Terrace	HOPE VI
15.	RQ005084 - Los Crisantes I and II	Demolished - funding source unknown
16.	TN005010 - Vine Hill	HOPE VI

- One property (Moses White Estates - FL003027) was not inspected because it was 100 percent offline.

- Five developments were dropped without replacement from the sample because they were *scattered-site unit acquisitions;* that is, the housing authority maintains

only the unit, not the building or site. The condo association fee, which is paid by the housing authority, is used for capital improvements to the building or site. There are approximately 2,800 units of this type of housing in the Maryland area. Because this type of development is atypical of the traditional housing stock, the formula model would not be applicable. These developments were:

1. MD002089 - Housing Authority of Baltimore City
2. MD002040 - Housing Authority of Baltimore City
3. MD004024 - Montgomery County Housing Authority
4. MD004027 - Montgomery County Housing Authority
5. VA004016 - Park Place

The net result of these changes to our sample is that our list of inspected developments dropped to 625 (647-22). This is summarized in Exhibit A-6 below.

Exhibit A-6: Summary of Revisions to Original Sample of Developments

	Number of Developments
Original Sample	**647**
- Received FY 1997 HOPE VI Implementation or Demolition Grants	6
- No longer public housing stock	10
- Scattered-site unit acquisition developments	5
- Property is 100% offline but has not received demolition funding (not inspected)	1
Final Sample	**625**

There were several other changes to the sample which, while not affecting the sample size, did represent departures from our original plan. One housing authority refused to let us inspect two of their developments that were in the original sample, but allowed us to inspect the two replacement developments from its authority. These were:

Dropped:	**Replaced by**:
1. DC001004 - Frederick Douglas	DC001019 - Kenilworth Courts;
2. DC001014 - Stanton Dwelling	DC001043 - Potomac Gardens.

Two properties remain in our sample but had limited inspections for reasons specified below:

1. OH004021 - The President — Undergoing major CGP modernization.
2. MD002025 - The Broadway — Has an off-line high-rise and several on-line garden buildings. The inspection included only the stock remaining on-line.

IV. The Supplemental Sample

After the original sample described above had been selected, additional funding permitted HUD to supplement the study with additional housing authorities and developments. In particular, HUD wanted to select more developments representative of very small housing authorities (those with fewer than 250 units), and very large housing authorities (Puerto Rico, Chicago, and New York City). A sample of 60 developments in 23 housing authorities was selected, using the same sampling strategy described above for the original sample.

Although we selected 60 developments, we only obtained inspection data from 59 developments. The reason is that one property from a small housing authority in Illinois appeared to be two different properties when we drew the sample (it had two different project codes and different names), but turned out to be a one-building development.

The supplemental sample is summarized in Exhibit A-7.

Exhibit A-7. Supplemental Sample, Completed Inspections

Type of Housing Authority	Number of Housing Authorities	Number of Developments
New York City	1	8
Puerto Rico	1	6
Chicago	1	2
Small Housing Authorities with Less Than 250 Units	20	43
Total Supplemental Sample	23	59[a]

a Note: One property selected had two different project codes, and different names, but turned out to be a one-building development.

The supplemental sample was combined with the original one and the development weights adjusted to provide a unified, nationally representative sample.

V. Summary of Entire Sample

Exhibit A-8 summarizes the combined sample, consisting of the original and supplemental samples. Exhibit A-9 lists all housing authorities and developments in the combined sample.

As a result of the ineligible properties identified during the inspection process, we updated the estimates of the sampling universe. Each dropped property represents other similar properties in the universe. Thus, Exhibit A-10 presents our original estimate of the sampling universe, our revised estimate of the sampling universe based on inspection results, and a summary of the final combined sample.

Exhibit A-8. Summary of the Combined Sample (Original and Supplemental)

	Original Sample		Supplemental Sample		Combined Sample	
	# Housing Authorities	# Develop-ments	# Housing Authorities	# Develop-ments	# Housing Authorities	# Develop-ments
Non-certainty Sites						
< 250 units in HA	43	83	20	43	63	126
Other non-certainty	131	325	0	0	131	325
Certainty Sites						
New York City	1	42	1	8	1[a]	50
Chicago	1	19	1	2	1[a]	21
Puerto Rico	1	39	1	6	1[a]	45
Other certainty sites (>4546 units)	22	117	0	0	22	117
Total	199	625	20[a]	59	219	684

a The New York, Chicago, and Puerto Rico housing authorities were contained in both the original and supplemental samples. The numbers represented in the total columns for the supplemental sample and total sample count them only once.

Exhibit A-9: The Final Sample of Housing Authorities and Developments

Developments from Housing Authorities with Fewer than 250 Units

AL009	**HOUSING AUTHORITY OF THE CITY OF ATTALLA**	**UNITS**
AL009003	HANDY MANOR	64
AL009004	ALFORD COURT	46
AL058	**WINFIELD HOUSING AUTHORITY**	
AL058001	HIGHLAND COURTS	32
AL058003	WESTWOOD HGHTS	44
AL058004	NORTH WESTWOOD HGHTS	76
AL108	**RAGLAND HOUSING AUTHORITY**	
AL108001	MCDONNALD COURTS	20
AL108002	MCDONNALD COURTS	20
AL108003	MCDONALD COURTS	20
AL137	**HOUSING AUTHORITY OF THE CITY OF FAYETTE**	
AL137002	HOUSING AUTHORITY OF THE CITY OF FAYETTE	50
AL137003	HOUSING AUTHORITY OF THE CITY OF FAYETTE	70
AL150	**HOUSING AUTHORITY OF THE CITY OF CLANTON**	
AL150001	NORFIELD	80
AL150002	WESTFIELD	48
AL150003	NORTH HAVEN	50
AR066	**RUSSELLVILLE HOUSING AUTHORITY**	
AR066002	RUSSELLVILLE	38
AR066003	RUSSELLVILLE	60
AR066004	RUSSELLVILLE HOUSING AUTHORITY	58
AR104	**SPRINGDALE HSG AUTHORITY**	
AR104001	PHILLIPS PLAZA	170
CA009	**HOUSING AUTHORITY OF THE CITY OF UPLAND**	
CA009002	LOS OLIVOS	97
CA067	**ALAMEDA COUNTY HSG AUTH**	
CA067007	ALAMEDA COUNTY HSG AUTH	18
CA067008	SENIOR HOUSING COMPLEX	100
CA067013	MISSION VIEW APARTMENTS	42
CA069	**CITY OF MADERA HOUSING AUTHORITY**	
CA069001	MADERA	48
CA069003	MADERA	50
CA069004	MADERA	34
CO005	**TRINIDAD HOUSING AUTHORITY**	
CO005001	TRINIDAD	50
CO005003	TRINIDAD	40
CO044	**HOUSING AUTHORITY OF THE CITY OF BRUSH**	
CO044001	BRUSH	30
CT009	**MIDDLETOWN HOUSING AUTHORITY**	
CT009002	SBONA TOWERS	129
FL071	**LAKE WALES HOUSING AUTHORITY**	
FL071001	GROVE MANOR	140
FL071002	SUNRISE PARK	100
GA065	**HOUSING AUTHORITY OF THE CITY OF WEST POINT**	
GA065003	O. J. COOK APTS	109
GA065004	O. J. COOK APTS	28
GA074	**HOUSING AUTHORITY OF THE CITY OF ELBERTON**	
GA074001	HILLSIDE HMS	40
GA074002	ELBERTA HOMES	65
GA074006	FOUNTAIN HOMES	20
GA080	**HOUSING AUTHORITY OF THE CITY OF EASTMAN**	
GA080003	HARRELL AVENUE APARTMENTS	23
GA080010	STUCKEY HOMES	50
GA098	**HOUSING AUTHORITY OF THE CITY OF PELHAM**	
GA098001	MARTHA U. TWITTY HOMES	32
GA098005	MIZE HOMES	100
GA179	**HOUSING AUTHORITY OF THE CITY OF BUENA VISTA**	**UNITS**
GA179001	WOOTEN HOMES	32
GA179002	BROAD STREET HOMES	12
GA179004	T.W. HOLLIS HOMES/MATTHEW	35
GA185	**HOUSING AUTHORITY OF THE CITY OF JACKSON**	
GA185001	TYLER TERR MALLET PARK	37
GA185002	MALLET PARK	52
IA022	**IOWA CITY HOUSING AUTHORITY**	
IA022003	IOWA CITY	14
IA022006	IOWA CITY HOUSING AUTHORITY	20
IL108	**HOUSING AUTHORITY OF THE COUNTY OF LAWRENCE, IL.**	
IL108001	LEWIS MANOR	75
IL108003	LANTERMAN GILLESPIE	4
IN039	**ANGOLA HOUSING AUTHORITY**	
IN039001	ELLIOTT MANOR	106
IN039002	NORTHLAKE MANOR	79
KS007	**WASHINGTON HOUSING AUTHORITY**	
KS007001	COLONIAL ACRES	50
KS016	**SOUTH HUTCHINSON HOUSING AUTHORITY**	
KS016001	SUNRISE ACRES	144
KS077	**GIRARD HOUSING AUTHORITY**	
KS077001	WATER STREET APARTMENTS	24
KY033	**HOUSING AUTHORITY OF CATLETTSBURG**	
KY033001	FOREST HEIGHTS	53
KY033002	GRANDVIEW MANOR	97
KY072	**HOUSING AUTHORITY OF PRINCETON**	
KY072001	HILLVIEW CT	64
KY072002	HYACINTH VILLAGE	40
LA093	**HOUSING AUTHORITY OF THE TOWN OF WHITE CASTLE**	
LA093001	HOUSING AUTHORITY OF WHITE CASTLE	42
LA093002	HOUSING AUTHORITY OF WHITE CASTLE	58
LA093003	HOUSING AUTHORITY OF WHITE CASTLE	34
LA096	**HOUSING AUTHORITY OF THE TOWN OF HAYNESVILLE**	
LA096001	HOUSING AUTHORITY OF HAYNESVILLE	60
LA096002	HOUSING AUTHORITY OF HAYNESVILLE	60
MA019	**WOBURN HOUSING AUTHORITY**	
MA019001	SPRING COURT	100
MA059	**PLYMOUTH HOUSING AUTHORITY**	
MA059001	HIGH CLIFF APARTMENTS	82
ME022	**SOUTHWEST HARBOR HOUSING AUTHORITY**	
ME022001	RIDGE APTS	32
ME022002	NORWOOD COVE APTS	18
MI119	**IRON COUNTY HOUSING COMMISSION**	
MI119001	PLEASANT VALLEY APTS	43
MI119002	IRON COUNTY SCATTERED	19
MO011	**HOUSING AUTHORITY OF THE CITY OF MOBERLY**	
MO011001	ALLEN+DALE COUNTRY VIEW	150
MO011002	MOBERLY TOWERS	100
MO021	**HOUSING AUTHORITY OF THE CITY OF POTOSI**	
MO021001	LOOMIS HEIGHTS	94
MO021002	VALLEY VIEW HEIGHTS	22
MS067	**THE HOUSING AUTHORITY OF THE TOWN OF RICHTON**	
MS067001	PA BOWEN APTS	8
MS067003	WALLEY/RICH RITCHIE	49
MS080	**THE HOUSING AUTHORITY OF THE CITY OF WALNUT**	
MS080001	WALNUT HOUSING AUTHORITY	22
MS080002	WALNUT HA'S ALEXANDER APARTMENTS	12
MS090	**THE HOUSING AUTHORITY OF THE CITY OF SENATOBIA**	
MS090001	SENATOBIA HOUSING AUTHORITY	42
MS090002	SENATOBIA HOUSING AUTHORITY	33
MS090004	SENATOBIA HOUSING AUTHORITY	44

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

NC017	**REDEVELOPMENT COMMISSION OF THE TOWN OF TARBORO**	
NC017002	REDEVELOPMENT COMM TARBORO	50
NC017003	REDEVELOPMENT COMM TARBORO	59
NC017004	REDEVELOPMENT COMM TARBORO	34
ND002	**HOUSING AUTHORITY OF THE CITY OF WILLISTON**	
ND002001	NOR-PARK HOMES	60
ND002002	WILLISTON	49
ND002004	WILLISTON	20
NE141	**ALLIANCE HOUSING AUTHORITY**	
NE141002	ALLIANCE HOUSING AUTHORITY	24
NE141003	ALLIANCE HOUSING AUTHORITY	25
NE141004	ALLIANCE HOUSING AUTHORITY	10
NH017	**SALEM HOUSING AUTHORITY**	
NH017001	MILLVILLE ARMS	75
NH017002	TELFER CIRCLE	75
NJ020	**BURLINGTON HOUSING AUTHORITY**	
NJ020001	COL EDWARD B STONE VILLA	90
NM008	**HOUSING AUTHORITY OF THE CITY OF RATON**	
NM008001	HOUSING AUTHORITY OF THE CITY OF RATON	50
NM008003	OPERATION BREAKTHROUGH	71
NY044	**GENEVA HOUSING AUTHORITY**	
NY044001	ELMCREST APTS	91
NY044010	GENEVA HOUSING Authority	124
NY059	**ILION HOUSING AUTHORITY**	
NY059001	LONDON TOWERS	160
NY086	**NORTH HEMPSTEAD HOUSING AUTHORITY**	
NY086006	NEW CASSEL SNR/MAGNOLIA	90
OK010	**HOUSING AUTHORITY OF THE CITY OF DRUMRIGHT**	
OK010001	HOUSING AUTHORITY OF THE CITY OF DRUMRIG	58
OK010003	PENN OAKS	70
OK046	**HOUSING AUTHORITY OF THE TOWN OF HYDRO**	
OK046001	HOUSING AUTHORITY OF THE TOWN OF HYDRO	16
OK106	**HOUSING AUTHORITY OF THE CITY OF LANGSTON**	
OK106001	HOUSING AUTHORITY OF THE CITY OF LANGSTON	31
OK106002	HOUSING AUTHORITY OF THE CITY OF LANGSTON	30
OR005	**HOUSING AUTHORITY OF LINCOLN COUNTY**	
OR005001	FIRCREST	30
OR005002	OCEAN SPRAY	30
OR005005	H.A. OF LINCOLN COUNTY	25
TN016	**SWEETWATER HOUSING AUTHORITY**	
TN016001	FAIRVIEW TERRACE	36
TN016002	NORTHWEST APARTMENTS	4
TN016004	HOUSING AUTHORITY SWEETWATER	61
TN031	**MILAN HOUSING AUTHORITY**	
TN031002	NORTHSIDE TERRACE WEST	100
TN043	**ROGERSVILLE HOUSING AUTHORITY**	
TN043002	JOHN R. CHILES MEMORIAL	50
TN043004	FUGATE HILL	48
TN045	**MILLINGTON HOUSING AUTHORITY**	
TN045001	MILLINGTON HOUSING AUTHORITY	89
TX097	**HOUSING AUTHORITY OF SAVOY**	
TX097001	HOUSING AUTHORITY OF SAVOY	6
TX097002	HOUSING AUTHORITY OF SAVOY	10
TX097003	HOUSING AUTHORITY OF SAVOY	9
TX283	**HOUSING AUTHORITY OF GATESVILLE**	
TX283001	HOUSING AUTHORITY OF GATESVILLE	60
TX283003	HOUSING AUTHORITY OF GATESVILLE	24
TX383	**HOUSING AUTHORITY OF SAN AUGUSTINE**	
TX383001	CEDAR HILLS	68
WI048	**NEW LONDON HOUSING AUTHORITY**	
WI048001	FRANKLIN PARK APTS	63
WI204	**SAUK COUNTY HOUSING AUTHORITY**	
WI204001	SAUK CO FAMILY LOW RENT	15
WI204002	WASHINGTON SQUARE	25
WV015	**HOUSING AUTHORITY OF THE CITY OF BECKLEY**	
WV015002	BECKWOODS	60
WV015003	EAST PARK	35
WY004	**HOUSING AUTHORITY OF THE CITY OF CASPER**	
WY004001	HOUSING AUTHORITY OF THE CITY OF CASPER	36
WY004002	HOUSING AUTHORITY OF THE CITY OF CASPER	24
WY004005	HOUSING AUTHORITY OF THE CITY OF CASPER	15

Developments from Housing Authorities with 250 to 1,249 Units

AL048	**HOUSING AUTHORITY OF THE CITY OF DECATUR**	
AL048001	EAST ACRES	127
AL048002	CASHIN HOMES	105
AL048009	W T JORDAN APTS	82
AL049	**GREATER GADSDEN**	
AL049001	COLLEY HOMES	224
AL049003	EMMA SANSOM HOMES	220
AL049005	CAMPBELL COURT	150
AL057	**SYLACAUGA HOUSING AUTHORITY**	
AL057001	DREW CT	102
AL057003	SYLAVON COURT	167
AL077	**HOUSING AUTHORITY TUSCALOOSA**	
AL077005	ROBERTSON TOWERS	102
AL077006	SAMUEL B HAY CT	186
AL077007	CRESCENT EAST/BRANSCOMB	284
AL152	**HOUSING AUTHORITY NORTHPORT**	
AL152002	EAST CIRCLE	70
AL152003	WEST CIR/VALLEY HLS/15TH	150
AL152004	KNOLL/NORTHGATE/WEST CR	150
AR016	**CAMDEN HOUSING AUTHORITY**	
AR016002	CARVER COURTS	80
AR016005	CAMDEN HOUSING AUTHORITY	60
AR016006	LINCON CTR RIVERSIDE CT	138
AR027	**HOUSING AUTHORITY OF THE CITY OF MARIANNA**	
AR027001	HOUSING AUTHORITY OF THE CITY OF MARIANNA	100
AR027004	HOUSING AUTHORITY OF THE CITY OF MARIANNA	100
AZ009	**MARICOPA COUNTY HOUSING DIVISION**	
AZ009001	COFFELT LAMOREAUX	296
AZ009015	FATHER FIDELIS KUBAN	50
AZ009019	VARNEY HOMES	12
CA039	**HOUSING AUTHORITY OF THE CITY OF CALEXICO**	
CA039002	H W GOING HOUSING PROJECT	30
CA039003	HIGUERA HOMES	50
CT003	**HARTFORD HOUSING AUTHORITY**	
CT003002	DUTCH POINT COLONY	186
CT003011	BETTY KNOX APARTMENTS	199
CT003015	HARTFORD SCATTERED SITE I	134
CT023	**BRISTOL HOUSING AUTHORITY**	
CT023001	CAMBRIDGE PARK	200
CT023003	JOHN F KENNEDY APARTMENTS	80
CT023004	BONNIE ACRES EXTENSION	60
FL007	**HOUSING AUTHORITY OF THE CITY OF DAYTONA BEACH**	
FL007002	HALIFAX PARK	62
FL007011	MALEY APTS	150

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

FL010	**HOUSING AUTHORITY OF THE CITY OF FORT LAUDERDALE**	
FL010001	DIXIE COURT	149
FL010003	SUNNYLAND HOMES	82
FL010005	SAILBOAT BEND	105
FL057	**PALATKA HOUSING AUTHORITY**	
FL057001	PALATKA HOUSING AUTHORITY	200
FL057004	DR JAMES A LONG HOMES	84
FL057005	ROSA RAGSDALE	96
GA096	**HOUSING AUTHORITY OF THE CITY OF CAMILLA**	
GA096003	JACKSON HOMES	8
GA096008	WALKER HOMES	34
GA096014	JESTER HOMES	100
IL007	**ALEXANDER COUNTY HOUSING AUTHORITY**	
IL007001	ELMWOOD PLACE	118
IL007002	MC BRIDE PLACE	158
IL007005	LOARN SHUEMAKER	43
IL009	**THE HOUSING AUTHORITY OF HENRY COUNTY**	
IL009001	FAIRVIEW APTS	122
IL009004	WASHINGTON APTS	74
IL010	**GRTR METRO. AREA HSNG AUTH OF ROCK ISLAND COUNTY**	
IL010001	OAK GROVE	97
IL010005	WILLIAM YOUNG HOMES	50
IL010012	SILVIS	156
IL030	**ST. CLAIR COUNTY HOUSING AUTHORITY**	
IL030006	MATHISON MANOR/JAMES	178
IL030010	CENTREVILLE	109
IL047	**MACOUPIN COUNTY HOUSING AUTHORITY**	
IL047006	MACOUPIN COUNTY HOUSING AUTHORITY	6
IL047008	MACOUPIN COUNTY HOUSING AUTHORITY	20
IL047017	MACOUPIN COUNTY HOUSING AUTHORITY	20
IL053	**HOUSING AUTHORITY OF THE COUNTY OF JACKSON,IL.**	
IL053001	MURPHYSBORO	90
IL053007	MURPHYSBORO	60
IL053009	ELKVILLE	14
IL061	**HOUSING AUTHORITY OF THE COUNTY OF FRANKLIN**	
IL061001	WEST FRANKFORT HOUSING	176
IL061002	SESSER HOUSING	36
IL100	**HOUSING AUTHORITY OF THE COUNTY OF COLES**	
IL100002	HOUSING AUTHORITY COUNTY COLES	200
IN003	**FORT WAYNE HOUSING AUTHORITY**	
IN003005	BEACON HEIGHTS	100
IN003010	TALL OAKS	105
IN003015	RIVER COVE	74
IN012	**HOUSING AUTHORITY OF THE CITY OF NEW ALBANY**	
IN012003	PARKVIEW	350
IN012006	PARKVIEW TOWERS	100
IN012007	RIVERVIEW TOWERS	164
IN029	**HOUSING AUTHORITY OF THE CITY OF EAST CHICAGO**	
IN029001	JAMES HUNTER	109
IN029006	EAST CHICAGO HOUSING AUTHORITY	346
LA004	**HOUSING AUTHORITY OF LAKE CHARLES**	
LA004001	BOOKER T WASHINGTON CTS	72
LA004002	HIGH SCHOOL PK HMS	72
LA004005	LLOYD OAKS	150
LA005	**HOUSING AUTHORITY OF THE CITY OF LAFAYETTE**	
LA005004	LILLIAN ROAD	74
LA005009	LAFAYETTE HOUSING AUTHORITY	92
LA024	**BOGALUSA HOUSING AUTHORITY**	
LA024001	SUNSET ACRES	70
LA024004	SUNSET ACRES ADDITION	22
LA054	**HOUSING AUTHORITY OF RUSTON**	
LA054001	LOUISE DRIVE AND GREENWOOD HOMES	100
LA054002	TRUMAN DR. SITE B, MARYLAND PL. A	82
LA054003	EASTWOOD, FAM, MARYLAND PL., ELD.	108
MA008	**CHICOPEE HOUSING AUTHORITY**	
MA008001	CABOT MANOR APT	150
MA008002	MEMORIAL APT	157
MA008003	CANTERBURY ARMS APT	76
MA016	**CHELSEA HOUSING AUTHORITY**	
MA016002	MACE APART. (CLINTON ST)	96
MA016004	MARGOLIS APART(CLARK AVE)	152
MD009	**HOUSING AUTHORITY OF CRISFIELD**	
MD009001	SOMMERS COVE APTS	50
MD009003	SOMMERS COVE APTS	100
ME009	**BANGOR HOUSING AUTHORITY**	
ME009001	CAPEHART	354
ME009004	NASON PARK MANOR	50
MI004	**HAMTRAMCK HOUSING COMMISSION**	
MI004001	COLONEL HAMTRAMCK HOMES	300
MI004002	HAMTRAMCK SENIOR PLAZA	150
MI070	**MARQUETTE HOUSING COMMISSION**	
MI070001	PINE RIDGE APTS	140
MO002	**KANSAS CITY HOUSING AUTHORITY**	
MO002005	RIVERVIEW	232
MO002013	BRUSH CREEK TOWERS	135
MO018	**HOUSING AUTHORITY OF THE CITY OF KENNETT**	
MO018001	KENNETT HOUSING AUTHORITY	100
MO018003	KENNETT HOUSING AUTHORITY	30
MO018004	KENNETT HOUSING AUTHORITY	60
NC022	**HOUSING AUTHORITY OF THE CITY OF GREENVILLE**	
NC022002	KEARNEY PARK	160
NC022006	NEWTOWN	78
NC027	**HENDERSONVILLE HOUSING AUTHORITY**	
NC027001	HENDERSONVILLE HOUSING AUTHORITY	149
NC027004	ETOWAH FLETCHER	31
NC027005	LINCOLN CIRCLE	50
NC066	**BURLINGTON HOUSING AUTHORITY**	
NC066001	BURLINGTON HOUSING AUTHORITY	248
NC066003	EARL-GEROW HOMES	50
NJ004	**NORTH BERGEN HOUSING AUTHORITY**	
NJ004002	LAWLER TWS	251
NJ004003	TERRACE APTS	252
NJ004004	CULLUM TWS	308
NJ013	**PASSAIC HOUSING AUTHORITY**	
NJ013001	SPEER VLG	383
NJ013008	MAURICE J. MILLER APTS.	30
NJ014	**ATLANTIC CITY HOUSING AUTHORITY**	
NJ014003	BUZBY HOMES VLGE	122
NJ014004	HOLMES VLGE	279
NJ014005	ALTMAN TERR/INLET TWR	346
NJ032	**RAHWAY HOUSING AUTHORITY**	
NJ032001	GLENDENNING HMS	76
NJ032004	WALTER SCHAFFHAUSER TOWER	40
NJ037	**IRVINGTON HOUSING AUTHORITY**	
NJ037001	CAMPTOWN GARDENS	126
NJ037004	CAMPTOWN GARDENS	188
NJ037005	CAMPTOWN GARDENS	241
NJ039	**PLAINFIELD HOUSING AUTHORITY**	
NJ039002	ELMWOOD GRDNS	120
NJ039003	RICHMOND TWS	225
NM001	**ALBUQUERQUE DEPARTMENT OF FAMILY AND COMMUNITY SERVICES**	
NM001013	608 GROVE-5609 GIBSON SE	78
NM001023	6109 COPPER NE	48
NY016	**BINGHAMTON HOUSING AUTHORITY**	
NY016001	CARLISLE HILL	150
NY016002	NORTH SHORE TOWERS	224
NY016005	SARATOGA APTS	267

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

NY030	**ELMIRA HOUSING AUTHORITY**	
NY030001	HOFFMAN PLAZA	144
NY030002	GEORGE E. BRAGG TOWERS	146
NY030004	EDWARD FLANNERY APTS.	209
OR001	**HOUSING AUTHORITY OF THE COUNTY OF CLACKAMAS**	
OR001001	CLACKAMAS HEIGHTS	100
OR001004	OREGON CITY VIEW MANOR	99
OR001007	CLACKAMAS COUNTY HOUSING AUTHORITY	33
OR011	**HOUSING AUTHORITY OF THE CITY OF SALEM**	
OR011002	HOUSING AUTHORITY CITY OF SALEM	108
OR011003	ORCHARD VILLAGE	30
OR011006	PRINGLE CREEK	62
PA017	**WASHINGTON COUNTY HOUSING AUTHORITY**	
PA017003	FREDERICK TERRACE	70
PA017004	HIGHLAND TERRACE	95
PA017012	CANONSBURG	18
PA028	**MONROE COUNTY HOUSING AUTHORITY**	
PA028005	WEST GATE	99
PA028006	KISTLER PLAZA	45
PA046	**HOUSING AUTHORITY OF THE CO OF CHESTER**	
PA046001	PARKWAY WOODLAND CTS.	46
PA046004	KING TERR FAIRVIEW VILL	75
PA046005	222 N CHURCH OAK PLACE	107
PA047	**WILKES BARRE HOUSING AUTHORITY**	
PA047001	LINCOLN PLAZA	200
PA047002	O KARMA TERRACE	198
PA047005	VALLEY VIEW TERRACE	209
RI005	**NEWPORT HOUSING AUTHORITY**	
RI005003	TONOMY HILL	498
RI005005	DONOVAN MANOR	164
RI015	**WEST WARWICK HOUSING AUTHORITY**	
RI015001	W WARWICK MANOR	126
RI015003	CLYDE TOWER	124
SC019	**HOUSING AUTHORITY OF UNION**	
SC019001	COLUMBUS TILLMAN APT	86
SC019003	CHAMBERS AVE APTS	120
SC019005	HUNT DRIVE APTS	17
SC035	**HOUSING AUTHORITY OF NEWBERRY**	
SC035001	JULIAN GRANT HOMES	200
SC035004	E GORDON ABLE HOMES	55
SC057	**HOUSING AUTHORITY OF N CHARLESTON**	
SC057001	THREE OAKS/BUSKIRK	88
SC057004	NORTH PARK VILLAGE	533
TN002	**JOHNSON CITY HOUSING AUTHORITY**	
TN002002	KEYSTONE APARTMENTS	225
TN002007	PINECREST VILLAGE	100
TN015	**ATHENS HOUSING AUTHORITY**	
TN015005	WESTWOOD HEIGHTS	55
TN015007	FORREST HILLS	137
TN027	**HUMBOLDT HOUSING AUTHORITY**	
TN027001	ROSEDALE COURTS	60
TN027002	FT. HILL CIRCLE	60
TN027003	HAVEN HGTS/WESTSIDE CT	90
TN039	**SHELBYVILLE HOUSING AUTHORITY**	
TN039001	PARKWAY APARTMENTS	109
TN039003	RIDGEWAY APARTMENTS	50
TN039007	BRITTANY HILLS APTS	60
TN058	**GREENEVILLE HOUSING AUTHORITY**	
TN058001	EARL H. SMITH HOMES	126
TN058003	WESLEY HEIGHTS HOMES	35
TN058004	HIGHLAND HILLS VILLAGE	100
TX014	**HOUSING AUTHORITY OF TEXARKANA**	
TX014001	BOWIE COURTS	120
TX014005	15TH STREET APARTMENTS	50
TX014006	ROBISON TERRACE	130
TX018	**HOUSING AUTHORITY OF LUBBOCK**	
TX018002	GREEN FAIR	215
TX018006	CHERRRY POINT/CONV-RENTAL	34
TX037	**HOUSING AUTHORITY OF ORANGE**	
TX037001	PINE GROVE HOMES	98
TX037002	ARTHUR ROBINSON HOMES	70
TX037003	ARTHUR ROBINSON HOMES	88
TX078	**HOUSING AUTHORITY OF SHERMAN**	
TX078001	HOUSING AUTHORITY OF SHERMAN	298
VA001	**PORTSMOUTH REDEVELOPMENT HOUSING AUTHORITY**	
VA001002	SWANSON HOMES	210
VA001007	WASHINGTON PRK	160
VA004	**ALEXANDRIA REDEVELOPMENT HOUSING AUTHORITY**	
VA004003	SAMUEL MADDEN HOMES	100
VA004004	JAMES BLAND HOMES	148
VA025	**SUFFOLK REDEVELOPMENT HOUSING AUTHORITY**	
VA025002	CYPRESS MANOR	113
VA025003	PARKER RIDDICK APARTMENTS	93
WA003	**HOUSING AUTHORITY CITY OF BREMERTON**	
WA003001	WEST PARK	582
WA006	**HOUSING AUTHORITY CITY OF EVERETT**	
WA006001	BAKER HEIGHTS	244
WA006002	GRANDVIEW HOMES	146
WV003	**HOUSING AUTHORITY OF THE CITY OF WHEELING**	
WV003002	GRANDVIEW MANOR	298
WV003004	HIL-DAR	100
WV003010	BOOKER T WASHINGTON	107

Developments from Housing Authorities with 1,250 to 4,545 Units

AL002	**MOBILE HOUSING BOARD**	
AL002006	GULF VILLAGE	198
AL002009	JESSE THOMAS HOMES	380
AL002010	R V TAYLOR PLAZA	450
AL006	**HOUSING AUTHORITY OF THE CITY OF MONTGOMERY**	
AL006002	CLEVELAND COURT	150
AL006012	GIBBS VILLAGE	500
AR004	**LITTLE ROCK HOUSING AUTHORITY**	
AR004004	JOSEPH A. BOOKER	230
AZ001	**CITY OF PHOENIX HOUSING DEPARTMENT**	
AZ001002	FRANK LUKE	230
AZ001006	FRANK LUKE ADDN	138
CA005	**CITY OF SACRAMENTO**	
CA005001	816 REVERE STREET	300
CA005008	1725 K STREET	80
CA005013	1043 43RD AVENUE	28
CO001	**HOUSING AUTHORITY OF THE CITY AND COUNTY OF DENVER**	
CO001008	SUN VALLEY HOMES	169
CO001015	A B HIRSCHFELD TOWERS	250
CO001018	DENVER HOUSING AUTHORITY	69
CT001	**BRIDGEPORT HOUSING AUTHORITY**	
CT001002	MARINA VILLAGE	364
CT001005	P.T. BARNUM APTS.	360
CT001010	FIRESIDE APTS. EXT 2	248

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

CT004	**NEW HAVEN HOUSING AUTHORITY**	
CT004025	EDITH D JOHNSON TOWERS	96
CT004031	WILLIAM T. ROWE	175
CT004036	BROOKSIDE	300
FL003	**TAMPA HOUSING AUTHORITY**	
FL003009	CENTRAL PARK VILLAGE	472
FL003012	J L YOUNG GARDEN	450
GA007	**HOUSING AUTHORITY OF THE CITY OF MACON**	
GA007002	TINDALL HEIGHTS	294
GA007011	MCAFEE TOWERS	199
IL003	**PEORIA HOUSING AUTHORITY**	
IL003002	HARRISON HOMES	462
IL003003	HARRISON HOMES - NORTH	154
IL022	**ROCKFORD HOUSING AUTHORITY**	
IL022006	NORTH MAIN MANOR	187
IL022007	FAIRGROUNDS VALLEY	209
IL022008	HOMEOWNERSHIP	127
IN011	**HOUSING AUTHORITY OF THE CITY OF GARY**	
IN011004	DELANEY WEST	228
IN011025	GENESIS TOWERS	142
KY004	**HOUSING AUTHORITY OF LEXINGTON**	
KY004004	BLUEGRASS PK ASPENDALE	269
KY004008	PIMLICO APTS	206
KY004013	ATIYA PLACE/CAMELOT/WILSO	96
LA006	**HOUSING AUTHORITY OF MONROE**	
LA006006	BERG JONES LANE PRJCT	300
LA006010	BOOKER T WASHINGTON	151
LA006013	MCKEEN PLAZA I	100
MA001	**LOWELL HOUSING AUTHORITY**	
MA001001	NORTH COMMON VILLAGE	538
MA001011	FRANCIS GATEHOUSE MILL	90
MA003	**CAMBRIDGE HOUSING AUTHORITY**	
MA003001	WASHINGTON ELMS	175
MA003005	NEWTOWNE COURT	268
MA003006	HARRY S TRUMAN APTS	67
MA012	**WORCESTER HOUSING AUTHORITY**	
MA012005	PLEASANT TOWER APT	133
MA012008	LINCOLN PARK TOWER APT	199
MD004	**HOUSING OPPRTY COM OF MONTGOMERY CO**	
MD004002	ELIZABETH HOUSE	160
MI001	**DETROIT HOUSING COMMISSION**	
MI001008	FREDERICK DOUGLASS	688
MI001027	WARREN WEST	138
MI001028	CONNER WAVENEY	139
MN001	**PUBLIC HOUSING AGENCY OF THE CITY OF SAINT PAUL**	
MN001001	MCDONOUGH HOMES	484
MN001015	FRONT AVENUE HI-RISE	152
MN001016	RAVOUX HI-RISE	220
MS040	**MISSISSIPPI REGIONAL HOUSING AUTHORITY NO. VIII**	
MS040026	PECAN CIRCLE HOMES	72
MS040027	PATTERSON HOMES	40
NC003	**HOUSING AUTHORITY OF THE CITY OF CHARLOTTE**	
NC003002	FAIRVIEW HOMES	402
NC003011	BOULEVARD HOMES	300
NC003019	PARKTOWNE TERRACE	164
NC012	**HOUSING AUTHORITY OF THE CITY OF WINSTON-SALEM**	
NC012002	HAPPY HILL GARDENS	178
NC012003	PIEDMONT PARK	240
NJ003	**ELIZABETH HOUSING AUTHORITY**	
NJ003001	MRAVLAG MANOR	419
NJ003006	FORD LEONARD TWS	116
NJ009	**JERSEY CITY HOUSING AUTHORITY**	
NJ009002	MARION GRDNS	233
NJ009009	A HARRY MOORE APTS	644
NJ010	**CAMDEN HOUSING AUTHORITY**	
NJ010002	WILLIAM S. ABLETT VILLAGE	306
NJ010003	FRANK D. ROOSEVELT MANOR	268
NJ010006	WESTFIELD ACRES	511
NJ012	**BAYONNE HOUSING AUTHORITY**	
NJ012001	PAMRAPO GRDNS	108
NJ012007	HOOK VLG/KVK ANNEX	250
NJ012008	BACK BAY GRDNS	252
NJ021	**PATERSON HOUSING AUTHORITY**	
NJ021003	A. HAMILTON DEVELOPMENT	486
NJ021007	DR. NORMAN COTTON HOMES	115
NV002	**CITY OF LAS VEGAS HOUSING AUTHORITY**	
NV002009	ERNIE CRAGIN TERRACE	83
NV002021	ARTHUR E. SARTINI PLAZA	220
NV002022	VERA JOHNSON MANOR	183
NY002	**BUFFALO MUNICIPAL HOUSING AUTHORITY**	
NY002006	JASPER PARRISH PLACE	211
NY002010	KENFIELD	629
NY002021	SLATER CTS.	24
NY009	**ALBANY HOUSING AUTHORITY**	
NY009001	ROBERT WHALEN HOMES	108
NY009004	LINCOLN PARK HOMES	271
OH001	**COLUMBUS METROPOLITAN HOUSING AUTHORITY**	
OH001001	POINDEXTER VILLAGE	406
OH001014	WORLEY TERRACE	226
OH001043	THORNWOOD COMMONS	86
OH005	**DAYTON METROPOLITAN HOUSING AUTHORITY**	
OH005001	PARKSIDE HOMES	560
OH005005	DESOTO BASS COURTS	200
OH005017	WILMINGTON PIKE (ELDERLY)	90
OH006	**LUCAS METROPOLITAN HOUSING AUTHORITY**	
OH006001	CHARLES F WEILER HOMES	378
OH006030	TENEYCK TOWERS	153
OH006037	LUCAS MHA	87
OH007	**AKRON METROPOLITAN HOUSING AUTHORITY**	
OH007005	BELCHER APARTMENTS	155
OH007028	SUMMIT LAKE	239
OH008	**TRUMBULL METROPOLITAN HOUSING AUTHORITY**	
OH008001	TRUMBULL HOMES	224
OH008002	HIGHLAND TERRACE	200
OH008006	MCKINLEY TOWERS	105
OK002	**HOUSING AUTHORITY OF THE CITY OF OKLAHOMA CITY**	
OK002012	AMBASSADOR COURTS	200
OK002014	FRED FACTORY GARDENS	74
OK073	**HOUSING AUTHORITY OF THE CITY OF TULSA**	
OK073010	SANDY PARK	160
OK073012	PARKVIEW TERRACE	225
OK073017	SOUTH HAVEN MANOR	100
OR002	**HOUSING AUTHORITY OF PORTLAND**	
OR002001	COLUMBIA VILLA	478
OR002017	SCHRUNK RIVERVIEW	118
PA006	**ALLEGHENY COUNTY HOUSING AUTHORITY**	
PA006023	PROSPECT TERRACE	89
PA006026	PARK APTS	190
PA011	**BETHLEHEM HOUSING AUTHORITY**	
PA011001	PEMBROKE VILLAGE	196
PA011002	MARVINE VILLAGE	400
PA018	**WESTMORELAND COUNTY HOUSING AUTHORITY**	
PA018009	ARNOLD MANOR	80
PA018015	PARNASSUS MANOR	104
PA018023	JEANNETTE TOWNHOUSES	30
RI001	**PROVIDENCE HOUSING AUTHORITY**	
RI001004	HARTFORD PARK	372
RI001006	HARTFORD PARK EXTENSION	84

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

SC002	**HOUSING AUTHORITY OF COLUMBIA**	
SC002001	GONZALES GARDENS	280
SC002004	SAXON HOMES	400
SC002010	MARION STREET HIGHRISE	146
SC003	**HOUSING AUTHORITY OF SPARTANBURG**	
SC003005	PHYLLIS GOINS COURTS	180
SC003007	CAMMIE CLAGETT COURTS	150
TN003	**KNOXVILLE COMMUNITY DEVEL CORP**	
TN003008	WALTER P. TAYLOR HOMES	227
TN003010	CAGLE TERRACE	271
TN003014	FRANK MONTGOMERY VILLAGE	360
TN004	**CHATTANOOGA HOUSING AUTHORITY**	
TN004002	EAST LAKE COURTS	433
TN004005	MAURICE POSS HOMES	192
TN004008	EMMA WHEELER HOMES	340
TX001	**AUSTIN HOUSING AUTHORITY**	
TX001004	MEADOWBROOK COURTS	160
TX001015	NORTH LOOP APARTMENTS	130
TX001016	NORTHGATE WEST APARTMENTS	50
TX005	**HOUSING AUTHORITY OF THE CITY OF HOUSTON**	
TX005006	CLAYTON HOMES	252
TX005011	LINCOLN PARK	264
TX009	**HOUSING AUTHORITY OF DALLAS**	
TX009005	FRAZIER COURTS	248
TX009009	RHOADS TERRACE	389
TX009022	AUDELIA MANOR	122
VA006	**NORFOLK REDEVELOPMENT HOUSING AUTHORITY**	
VA006009	TIDEWATER PRK	626
VA006011	CALVERT	314
VA006018	ROBERT PARTREA	114
VA007	**RICHMOND REDEVELOPMENT HOUSING AUTHORITY**	
VA007004	HILLSIDE CT	402
VA007006	WHITCOMB CT	447
VA007010	SMALL HOUSE PROGRAM	82
WA002	**HOUSING AUTHORITY OF KING COUNTY**	
WA002004	PARK LAKE HOMES I	572
WA002020	SOUTHRIDGE HOUSE	80
WA002026	BURNDALE HOMES	50
WA005	**HOUSING AUTHORITY CITY OF TACOMA**	
WA005004	SALISHAN	238
WA005010	602 WRIGHT	48

Developments in Certainty Sites from Housing Authorities with 4,546 to 6,600 Units

AL001	**HOUSING AUTHORITY OF THE BIRMINGHAM DISTRICT**	
AL001003	METROPOLITAN GARDENS	910
AL001004	SOUTHTOWN	456
AL001007	JOSEPH H LOVEMAN VILLAGE	500
AL001009	SMITHFIELD COURT	464
AL001018	RALPH KIMBROUGH HOMES	231
CA001	**SAN FRANCISCO HOUSING AUTHORITY**	
CA001002	POTRERO TERRACE	469
CA001015	PING YUEN	234
CA001016	ALEMANY	156
KY001	**HOUSING AUTHORITY LOUISVILLE**	
KY001001	CLARKSDALE	721
KY001004	SHEPPARD SQUARE	327
KY001005	IROQUOIS HOMES	853
KY001018	LOURDES HALL	62
MN002	**MINNEAPOLIS PHA IN AND FOR THE CITY OF MINEAPOLIS**	
MN002009	HIAWATHA APARTMENTS	281
MN002016	PARK CENTER	180
MN002026	FRIENDSHIP MANOR	84
MN002031	CHARLES HORN TOWERS	491
MN002037	HAMILTON MANOR	220
MO001	**ST. LOUIS HOUSING AUTHORITY**	
MO001001	CARR SQUARE VILLAGE	182
MO001002	CLINTON PEABODY	566
MO001017	WEST PINE APARTMENTS	127
TN001	**MEMPHIS HOUSING AUTHORITY**	
TN001001	LAMAR TERRACE	427
TN001005	DIXIE HOMES	68
TN001007	OATES MANOR	280
TN001012	FOWLER HOMES	320
TN005	**METROPOLITAN DEVELOPMENT HOUSING AGENCY**	
TN005007	SAM LEVY HOMES	478
TN005008	PRESTON TAYLOR HOMES	544
TN005012	ANDREW JACKSON COURTS	398
TN005014	I.W. GERNERT HOMES	181
TX003	**HOUSING AUTHORITY OF EL PASO**	
TX003008	CHELSEA PLAZA	330
TX003014	JOHN D. CRAMER MEMORIAL	144
TX003023	DWIGHT D. EISENHOWER APTS	260
TX003032	HARRY S. TRUMAN APTS	90
TX006	**SAN ANTONIO HOUSING AUTHORITY**	
TX006004	WHEATLEY COURTS	232
TX006035	VILLAGE EAST/OLIVE PARK	50
TX006042	W.C. WHITE	75
WA001	**SEATTLE HOUSING AUTHORITY**	
WA001008	HIGH POINT	723
WA001012	CAL-MOR CIRCLE	74
WA001017	DENNY TERRACE	222
WA001033	BEACON TOWERS	108

Developments in Certainty Sites from Housing Authorities with More than 6,600 Units

CA004	**HOUSING AUTHORITY OF THE CITY OF LOS ANGELES**	
CA004001	RAMONA GARDENS	498
CA004003	PUEBLO DEL RIO	390
CA004005	ALISO VILLAGE	684
CA004013	NICKERSON GARDENS	1056
CA004020	ESTRADA COURTS EXTENSION	200
CA004022	SAN FERNANDO GARDENS	448
CA004027	DANA APTS/SEC 23/TKY III	10
DC001	**D.C HOUSING AUTHORITY**	
DC001009	BARRY FARMS DWELLINGS	427
DC001018	EAST CAPITOL DWELLINGS	577
DC001019	KENILWORTH COURTS	415
DC001043	POTOMAC GARDENS	350
DC001064	FORT LINCOLN	119
DC001065	JUDICIARY HOUSE	271
FL005	**MIAMI-DADE HOUSING AUTHORITY**	
FL005004	JAMES E SCOTT HOMES	754
FL005012	JOE MORETTI APTS	288
FL005015	ANNIE COLEMAN	144
FL005025	CLAUDE PEPPER TOWERS	166
FL005026	HALEY SOFGE TOWERS	475
FL005032	RAINBOW VILLAGE	100
FL005069	MOODY VILLAGE	64
FL005081	MOODY GARDENS	34

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

GA006	**HOUSING AUTHORITY OF THE CITY OF ATLANTA GEORGIA**	
GA006010	UNIVERSITY HOMES	500
GA006012	BOWEN HOMES	650
GA006014	PALMER HOUSE	249
GA006028	BANKHEAD COURTS	392
GA006048	3601 PIEDMONT ROAD	208
GA006053	HIGHTOWER MANOR	129
IL002	**CHICAGO HOUSING AUTHORITY**	
IL002001	IDA B WELLS HOMES	1662
IL002003	ROBERT H. BROOKS HOMES	230
IL002007	ALTGELD GARDENS	1500
IL002009	DEARBORN HOMES	792
IL002011	PHILIP MURRAY HOMES	500
IL002017	GRACE ABBOTT HOMES	766
IL002018	IDA B. WELLS EXTENSION	384
IL002022	STATEWAY GARDENS	1189
IL002024	JULIA LATHROP	923
IL002025	TRUMBULL PARK HOMES	409
IL002030	WILLIAM GREEN HOMES	924
IL002032	43RD PRINCETON HOMES	399
IL002034	WASHINGTON PARK	1401
IL002043	MIDWEST TERRACE APTS	129
IL002045	CALLNER APARTMENTS	151
IL002046	RAYMOND HILLIARD CENTER	704
IL002048	BRITTON BUDD APTS	172
IL002063	LINCOLN PERRY APTS	267
IL002066	3920-40 N CLARK APTS	194
IL002071	1845 N LARRABEE APTS	86
IL002072	2720 N SHEFFIELD APTS	206
LA001	**HOUSING AUTHORITY OF NEW ORLEANS**	
LA001002	C. J. PEETE	723
LA001005	LAFITTE	896
LA001008	SAINT BERNARD	706
LA001010	C. J. PEETE EXTENSION	542
LA001012	B. W. COOPER EXTENSION	812
MA002	**BOSTON HOUSING AUTHORITY**	
MA002001	CHARLESTOWN	1133
MA002009	FRANKLIN HILL	365
MA002019	BROMLEY PARK	566
MA002024	OLD COLONY	867
MA002026	MARY COLLINS	44
MA002047	GENERAL WARREN	94
MA002058	WEST NEWTON ST	134
MA002071	PATRICIA WHITE	222
MA002089	FRANKLIN FIELD 1/5	338
MD002	**HOUSING AUTHORITY OF BALTIMORE CITY**	
MD002001	LATROBE HOMES	701
MD002003	PERKINS HOMES	688
MD002004	POE HOMES	298
MD002011	CHERRY HILL HOMES	600
MD002022	WESTPORT HOMES	200
MD002025	THE BROADWAY	99
MD002031	ROSEMONT/DUKELAND	136
MD002039	CLAREMONT HOMES EXT	152
NJ002	**NEWARK HOUSING AUTHORITY**	
NJ002005	BAXTER TERR	477
NJ002008	FELIX FULD	287
NJ002015	ETELLA WRIGHT	1136
NJ002021	KRETCHMER-BOYDEN	1000
NJ002022	BAXTER-CRANE	1000
NJ002027	NEWARK HOUSING AUTHORITY	104
NY005	**NEW YORK CITY HOUSING AUTHORITY**	
NY005001	RED HOOK I (EAST)	1824
NY005002	QUEENSBRIDGE	1517
NY005005	EAST RIVER	1158
NY005007	CLASON POINT GARDENS	386
NY005008	JACOB RIIS	1187
NY005010	ST NICHOLAS	1508
NY005011	BREUKELEN	1595
NY005012	BARUCH	2193
NY005019	EDENWALD	2039
NY005021	LA GUARDIA	1098
NY005024	SEN. ROBERT F. WAGNER SR.	2162
NY005027	HAMMEL	712
NY005029	RED HOOK II	348
NY005030	GENERAL GRANT	1940
NY005034	SAMUEL J. TILDEN	1047
NY005035	LOUIS HEATON PINK	1500
NY005036	JAMES MONROE	1102
NY005039	RICHMOND TERRACE	488
NY005040	WEST BRIGHTON I II	634
NY005041	WILLIAMSBURG	1620
NY005047	LAFAYETTE	890
NY005053	ROBERT FULTON	944
NY005054	ELEANOR ROOSEVELT I	763
NY005062	POLO GROUNDS TOWERS	1614
NY005067	33-35 SARATOGA AVE	125
NY005074	WYCKOFF GARDENS	529
NY005095	2440 BOSTON ROAD PLAZA	235
NY005114	SHEEPSHEAD BAY	1056
NY005116	LOUIS ARMSTRONG II	257
NY005123	CONEY ISLAND I SITES 45	374
NY005181	JACOB RIIS	578
NY005183	DYCKMAN	1167
NY005184	RAVENSWOOD	2165
NY005189	ATLANTIC TERMINAL URA	300
NY005190	MORRISANIA AIR RIGHTS URA	843
NY005216	REDFERN	604
NY005217	DR. BETANCES VI	155
NY005249	BOYNTON AVE REHAB	82
NY005259	LOWER EAST SIDE INFILL	192
NY005267	GLENMORE PLAZA	438
NY005213	BROWNSVILLE	1338
NY005220	BRONX RIVER	1467
NY005220	CYPRESS HILLS	1441
NY005220	FARRAGUT	1390
NY005213	INGERSOLL	1796
NY005213	KING TOWERS	1375
NY005213	LINCOLN	1283
NY005213	MARCY	1705
NY005220	SOUNDVIEW	1258
NY005213	WALD	1821
OH003	**CUYAHOGA METROPOLITAN HOUSING AUTHORITY**	
OH003008	RIVERSIDE PARK APTS	409
OH003013	GARDEN VALLEY	358
OH003021	WADE APARTMENTS	224
OH003035	BEACHCREST APTS	231
OH003041	MILES ELMARGE	134
OH004	**CINCINNATI METROPOLITAN HOUSING AUTHORITY**	
OH004002	ENGLISH WOODS	750
OH004004	LINCOLN COURT	921
OH004010	FINDLATER GARDENS ADD.	292
OH004017	STANLEY ROWE TOWERS	428
OH004021	THE PRESIDENT	100
OH004040	SCATTERED SITES EAST WEST	218
PA001	**HOUSING AUTHORITY, CITY OF PITTSBURGH**	
PA001002	BEDFORD DWELLINGS	420
PA001009	NORTHVIEW HEIGHTS	731
PA001012	GARFIELD HEIGHTS	632
PA001013	ADDISON ADDITION	194
PA001031	MURRAY TOWERS	69
PA002	**PHILADELPHIA HOUSING AUTHORITY**	
PA002001	JAMES W JONHSON HOMES	530
PA002002	TASKER HOMES	962
PA002030	ABBOTTSFORD HOMES	562
PA002031	BARTRAM VILLAGE	493
PA002039	WESTPARK APARTMENTS	325
PA002049	MORTON HOMES II	117
PA002061	PASCHALL APARTMENTS	219

Exhibit A-9: Final Sample of Housing Authorities and Developments *(continued)*

RQ005	**PUERTO RICO PUBLIC HOUSING ADMINISTRATION**	
RQ001002	SANTIAGO IGLESIAS, PONCE	280
RQ001008	DR PILA IGLESIAS, PONCE	586
RQ001015	EXT MANUEL DE LA PILA	120
RQ002009	LUIS LLORENS TORRES	2570
RQ002010	VISTA HERMOSA	894
RQ002011	ERNESTO RAMOS ANTONINI	864
RQ002014	LAS MARGARITAS	344
RQ003017	VIRGILIO DAVILA	448
RQ003019	JUAN JIMENEZ GARCIA	256
RQ003027	SANTA RITA DE CASIA	156
RQ003033	JOSE GAUTIER BENITEZ	492
RQ003035	VISTA ALEGRE	74
RQ003038	MANUEL R ADAMES	64
RQ003046	AGUSTIN RUIZ MIRANDA	80
RQ003081	EXT. MANUEL A. PEREZ	900
RQ003089	VILLA DEL PARQUE	100
RQ003091	EL RECREO	300
RQ003100	DR AGUSTIN STAHL	400
RQ004003	FRANKLIN D ROOSEVELT	599
RQ004009	MANUEL HERNANDEZ ROSA	268
RQ005004	RAUL CASTELLON	200
RQ005010	BRISAS DEL TURABO	178
RQ005015	CONDOMINIO GLADIOLAS I	295
RQ005020	DR PEDRO J PALOU	160
RQ005022	LA CEIBA	300
RQ005031	JARDINES DE CAMPO RICO	196
RQ005033	EL TREBOL	152
RQ005034	ALTURAS DE CUPEY	250
RQ005035	VILLA ESPERANZA	300
RQ005038	LAS MARGARITAS	231
RQ005039	JARD. DE MONTE HATILLO	698
RQ005048	CARIOCA	200
RQ005080	JARDINES DE CUPEY	308
RQ005088	LIRIOS DEL SUR	320
RQ005103	TORRES DE SABANA	451
RQ005104	LOS MURALES	213
RQ005105	LAS VIOLETAS	88
RQ005111	JARDINES DE CONCORDIA	200
RQ005114	COVADONGA	504
RQ005151	SIERRA LINDA	200
RQ005160	LAS DELICIAS	100
RQ005168	LOS LAURELES	100
RQ005171	PONCE HOUSING	131
RQ005214	BELLA VISTA HEIGHTS	100
RQ005250	MAYAGUEZ PUBLIC HOUSING	48

Exhibit A-10: Description of Initial and Post-Inspection Sampling Universe and Combined Final Sample

	Initial Sampling Universe		Post-Inspection Sampling Universe		Final Sample	
	Number	Percent	Number	Percent	Number	Percent
Units by Region						
Northeast	431,634	36.7	417,289	36.8	211	30.8
South	439,982	37.4	424,003	37.4	285	41.7
Rest	303,697	25.8	292,673	25.8	188	27.5
Total	1,175,312[a]	100.0	1,133,965[a]	100.0	684	100.0
Units by Development Average Bedroom Size						
1.5 BRs or less	331,822	28.2	301,500	26.6	183	26.8
More than 1.5 BRs	843,491	71.8	832,464	73.4	501	73.2
Total	1,175,312	100.0	1,133,965	100.0	684	100.0
Units by Development Size						
Less than 300 units	825,867	70.3	786,296	69.3	500	73.1
300 or more units	349,446	29.7	347,668	30.7	184	26.9
Total	1,175,312	100.0	1,133,965	100.0	684	100.0
Units by Development Vacancy Rate						
Vacancy rate 10% or less	983,092	83.6	961,600	84.8	517	82.9
Vacancy rate more than 10%	192,220	16.4	172,362	15.2	108	17.1
Total	1,175,312	100.0	1,133,965	100.0	684	100.0
Units by Housing Authority Size						
Less than 250 units	197,572	16.8	190,221	16.8	126	18.4
250-1249 units	336,191	28.6	326,631	28.8	187	27.3
1250-6600 units	289,060	24.6	273,620	24.1	177	25.9
More than 6600 units	196,058	16.7	187,059	16.5	144	21.1
New York City	156,432	13.3	156,432	13.8	50	7.3
Total	1,175,312	100.0	1,133,963	100.0	684	100.0

a Excludes Alaska, Hawaii, Guam and the U.S. Virgin Islands, and all scattered-site, HOPE VI, and Demolition developments.

VI. Adjustments to the Universe

The universe file we originally received from HUD included 1,308,050 units. We excluded several categories of developments and units from the Final Sample of Housing Authorities and Developments.

- All 77,743 units in developments with approved demolition plans, completed demolitions, or approved HOPE VI implementation grants.

- All 12,097 units in developments located outside the contiguous 48 states, the District of Columbia, and Puerto Rico (i.e., developments in Alaska, Hawaii, Guam, and the U.S. Virgin Islands).

- All 39,641 units in developments explicitly listed as scattered-site on HUD's data bases.

- All 566 units in Turnkey developments.

After these exclusions, the sampling universe consisted of 1,178,003 units. During the inspections, the inspectors identified additional units in excluded categories of properties, so that following the inspections, our revised estimate of the sampling universe was 1,133,963 units.

To provide a full picture of national needs, we made estimates for a portion of the excluded developments and units. We assumed that all scattered-site developments and developments with HOPE VI implementation grants and approved demolition plans are family developments and therefore their modernization needs are similar to the needs in other family developments in their housing authority. Thus the sample weights were adjusted as follows to account for these additional units that were not included in the original study universe, but are to be funded under the Capital Fund:

- For all developments with HOPE VI implementation grants, approved demolition plans and completed demolition, we received from HUD the number of units not included in the rehabilitation or demolition. For developments in any of the 219 housing authorities in our study sample, we increased the weight of family developments in that housing authority to account for the additional units. For any HOPE VI or demolished developments not in the sample housing authorities, we increased the weight of family developments in all sample developments within the same housing authority size category to account for the additional units.

- A similar approach was taken to adjust the weights to account for the scattered-site developments, and for the unit-acquisition units in the Maryland area. For any

scattered-site developments in the 219 housing authorities in our study sample, we increased the weight of family developments in that housing authority to account for the additional units. For any scattered-site developments not in sample housing authorities, we increased the weight of family developments in all sample developments within the same housing authority size category to account for the additional units.

Exhibit A-11 presents our final compilation of the universe, reflecting our revised results following the inspections and taking into account the additions to the universe described above.

Because we did not include Alaska, Hawaii, Guam or the U.S. Virgin Islands in our original sampling frame, we cannot make adjustments to our existing weights to account for these locations. Instead, we can add their actual number of units (12,097) to the sample-based estimate to come up with a national total estimate of 1,206,467 units to be funded by the Capital Fund.

Exhibit A-11: Final Universe

	Initial Sampling Universe		Post-Inspection Sampling Universe		Inspection Universe (Adds in Excluded Units)	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Units by Region						
Northeast	431,634	36.7	417,289	36.8	438,758	36.7
South	439,982	37.4	424,003	37.4	442,187	37.0
Rest	303,697	25.8	292,673	25.8	313,425	26.2
Total	1,175,312[a]	100.0	1,133,965	100.0	1,194,370	100.0
Units by Development Average Bedroom Size						
1.5 BRs or less	331,822	28.2	301,500	26.6	301,767	25.3
More than 1.5 BRs	843,491	71.8	832,464	73.4	892,604	74.7
Total	1,175,312	100.0	1,133,965	100.0	1,194,370	100.0
Units by Development Size						
Less than 300 units	825,867	70.3	786,296	69.3	823,156	68.9
300 or more units	349,446	29.7	347,668	30.7	371,214	31.1
Total	1,175,312	100.0	1,133,965	100.0	1,194,370	100.0
Units by Development Vacancy Rate						
Vacancy rate 10% or less	983,092	83.6	961,600	84.8	994,466	83.3
Vacancy rate more than 10%	192,220	16.4	172,362	15.2	199,904	16.7
Total	1,175,312	100.0	1,133,965	100.0	1,194,370	100.0
Units by Housing Authority Size						
Less than 250 units	197,572	16.8	190,221	16.8	197,525	16. 5
250-1249 units	336,191	28.6	326,631	28.8	342,347	28.7
1250-6600 units	289,060	24.6	273,620	24.1	291,365	24.4
More than 6600 units	196,058	16.7	187,059	16.5	206,701	17.3
New York City	156,432	13.3	156,432	13.8	156,432	13.1
Total	1,175,312	100.0	1,133,963	100.0	1,194,370	100.0

[a] Excludes Alaska, Hawaii, Guam and the U.S. Virgin Islands.

Appendix B:
Data Collection

This appendix describes the data collection methods used for the Formula Capital Study. Our analysis is based on data collected from three main sources:

- on-site physical inspections of public housing buildings and units to estimate capital needs (the sampling strategy is described in Appendix A; the method by which we assigned costs to the inspection data is described in Appendix C);
- modernization funding and other background data collected directly from public housing authorities; and
- secondary sources of data containing various housing authority-level and development-level characteristics from several HUD databases.

Data collection methods for each of these types of data are described below.

I. Physical Inspections

As soon as the sample was approved by HUD, Abt Associates Inc. and HUD notified sampled housing authority directors and modernization coordinators of the requirements for this study. Exhibit B-1 contains the letters from HUD and Abt Associates Inc. notifying the housing authorities of this study. The physical condition of the public housing stock was assessed on-site by architects and engineers from the DLR Group, a national architectural and engineering firm based in Omaha, Nebraska. The purpose of the on-site physical inspections was to obtain current information on the physical condition of public housing at a level of detail sufficient to indicate the nature of physical deficiencies and the costs that would be required to remedy immediate repair needs and address existing modernization needs, as well as to estimate the ongoing accrual of physical needs over the next 20 years.

Observable Systems Method. The immediate repair needs and existing modernization needs were estimated using the Observable Systems Approach, which was initially developed by Abt Associates Inc. for the 1985 Modernization Needs Study of Public Housing and refined for several additional studies.[3] Under this method, the condition of each property's systems

3 Dixon Bain et al., *Study of the Modernization Needs of the Public and Indian Housing Stock* (Cambridge, MA: Abt Associates Inc., March 1988); James Wallace et al., *Current Status of HUD-Insured (or Held) Multifamily Rental Housing* (HUD, PD&R 1993); Judie Feins et al., *Viability Review for Physical Improvements for the San Francisco Housing Authority* (Cambridge, MA: Abt Associates Inc., September 1991); Meryl Finkel et al., *Status of HUD-Insured (or Held) Multifamily Rental Housing in 1995* (Cambridge, MA: Abt Associates Inc., December 1998). Details on the precise protocols and forms used for the current study are provided in the HUD Formula Capital Study *Inspector's Manual*, (Abt Associates Inc., January 1998).

Exhibit B-1: Letters from HUD and Abt Associates Inc. to Housing Authorities

B-1 cont.

is observed, evaluated, and assessed on-site (see Chapter One for more details); and then costed in a consistent manner off-site using a regionalized database of repair costs and a computerized costing program (see Appendix C for further discussion).

Five types of information were collected for each property:

- current condition—observations on 135 site-, building-, and unit-level systems that were used in the study to estimate immediate repair needs (the cost to bring all systems up to working condition);

- upgrade feasibility—determination of whether a property could be physically upgraded to ensure decent and sustainable housing with modest amenities by replacing or adding to selected systems, for use in estimating existing modernization needs;

- property characteristics and takeoffs—an inventory of all building and unit types and conditions, average sizes of units, typical building dimensions, and the dimensions of certain systems, used by the study both in costing immediate repair and existing modernization needs and estimating future accruals of repair and replacement costs;

- neighborhood characteristics—a windshield survey and a summary observation form were used to describe the attributes of the development and the surrounding neighborhood; and

- housing quality (HQ) questions—a checklist of items that helps to identify developments in substandard condition.

Our assessment of physical needs excluded three categories of expenditures that many public housing authorities will be required to comply with:

- Modifications for accessibility for the disabled, as required by Section 504 of the Rehabilitation Act of 1973, as amended;
- Measures taken solely to mitigate hazards of lead paint or asbestos; and
- Improvements for increasing energy efficiency.

The only exception to this is that the replacement of a heating system or appliance, for example, assumes installing a standard quality replacement according to current practice, and not simply replacing the old system.

Inspection Protocol. The inspection protocol included observing conditions of 135 mechanical, electrical, and architectural systems. See Appendix C for a list of these systems.

For each system, the inspector judged and recorded the level of remedial action needed to restore the system to its original condition. The action levels were "No Action," "Minor Action," "Moderate Action," "Major Action," and "Replace," based on the observed condition. Minor defects that could be corrected through routine maintenance (e.g., faucet washer replacement) were excluded.

The DLR Group inspectors used a standard set of eight inspection booklets developed by Abt Associates Inc.—Site, Building Envelope, Building Mechanical and Electrical, Central Mechanical and Electrical, Unit, Takeoffs, Stock Inventory Quality Distribution, Central Facilities—to collect all relevant system-level information. For each observable system, the inspector noted presence or absence of the system; age; type, if appropriate (e.g., battery or hard-wired smoke detectors); number, if appropriate (e.g., the number of windows); and the repair action level associated with the observed condition.

A detailed Inspection Manual was developed to describe each system and the repair actions pertaining to each system, as well as to document the inspection protocol. For each system, the manual defines the system, explains where and how to observe the system, and then describes the repair needs associated with each action level. The manual also describes the process to follow in determining upgrade feasibility for selected systems. This process will be described in detail at the end of this appendix. The manual gives an overview of the study, and describes the procedures to use to prepare for the inspection, including selecting which buildings and units to inspect. Finally, the manual covers the process of recording the inspection data accurately, procedures to follow in reviewing the data, and where to get help.

The action levels assigned to each observable condition were provided to all inspectors during a week-long training session in Atlanta which included both classroom training and hands-on training. The classroom training included a complete review of the systems and the different levels of repair action, as well as the proper protocol to follow during the inspections. The hands-on training involved teams of inspectors going on-site to several of Atlanta's public housing developments to actually conduct the inspection under the guidance of a senior inspector experienced in the Observable Systems methodology.

The comprehensive training and uniform set of instructions helped to assure consistency across individual inspectors. Exhibits B-2 and B-3 are samples of an inspection booklet and the corresponding action level description from the Inspection Manual. The examples are taken from the "Full Bathroom" section of the "Unit" booklet. (Exhibit B-2 is a page from that booklet.) Under the section labeled "Full Bathrooms" are the seven systems observed in the bathroom inspection. Some systems (walls and ceilings, accessories) require only an action level in order to estimate repair cost; others require a type (e.g., the materials in use, or size), as well as an action level for the repair estimate. For example, under the Bathroom Floor Cover and Sub-base System, "Type" is necessary because replacing a *ceramic* tile floor

would be more costly than replacing a *resilient* tile floor or linoleum. Exhibit B-3 is taken from the Inspection Manual of conditions and action levels.

Using architectural drawings, when available, or "pacing off" when no plans were available, the inspectors calculated takeoff measurements for site areas and distribution systems, average unit square footage for all unit sizes present at the property, and key building dimensions for up to three predominant types/sizes of buildings. These measurements were recorded in the Takeoff booklet.

The Property Quality Distribution contained within the Stock Inventory Quality Distribution form was used to obtain overall descriptions of the development stock and the relative quality of units and buildings at the development. This form was also used to guide the selection of buildings and units to inspect, which is described below.

In advance of the inspector's visit, the DLR Group sent a Property Quality Distribution form to the property manager. The manager completed the information on the number of units by size (bedrooms and bathrooms) and condition, as well as the number of buildings by type (high-rise, walk-up, garden/townhouse, single-family detached) and condition. A definition guide on conditions (excellent, good, fair and poor) was attached to the form to make it easier for the manager to categorize the units and buildings. When the inspectors arrived on-site, they reviewed the Property Quality Distribution form with the property manager and discussed the general characteristics of the property, including:

- Number, type (high-rise, walk-up, etc.), and age of buildings,[4]
- Number of units by bedroom and bathroom size,[4] and
- The property manager's assessment of the overall condition of buildings and units (i.e., what proportion the manager estimated were in excellent, good, fair, or poor condition.).[5]

4 The inspector recorded this information on the Stock Inventory and Quality Distribution form.

5 Initially the property manager recorded this information on the Property Quality Distribution form, and then after confirmation, the inspector transferred this information to the Stock Inventory and Quality Distribution form.

Exhibit B-2: Example of Inspection Booklet

UNIT 21

{LABEL]

Unit Name/Address_____

Bedrooms: _____

Bathrooms: _____

Unit Quality: E G F P

Office Use Sequence: _____

ID	UNIT SYSTEM	AB (✓)	TYPE	#	ACTIONS: NO ACT	MIN	MOD	MAJ	REP	AGE	COMMENTS / HOUSING QUALITY QUESTIONS
	INTERIOR (excluding kitchens & baths)										
201	WALLS & CEILINGS: PARTITIONS								%		WALLS / CEILINGS:
202	SURFACES										EVIDENCE OF SIGNIFICANT LEAKS? **G** YES **G** NO
203	FLOOR SUB-BASE								%		LARGE CRACKS? **G** YES **G** NO
204	FLOOR COVERING: CARPET								%		PEELING PAINT OR PLASTER MORE THAN 1 FT. SQUARE? **G** YES **G** NO
	RESILIENT								%		
205	INTERIOR DOORS & FRAMES						#	#	#		
	KITCHEN										
206	WALLS AND CEILINGS								%		
207	FLOOR SUB-BASE & COVERING										
208	CABINETS/COUNTERS/SINK										
209	RANGE ONLY										
	RANGE AND HOOD										
210	REFRIGERATOR										
	FULL BATH Number: _____										
211	WALLS AND CEILINGS								%		SIGNIFICANT LEAKS? **G** YES **G** NO
212	FLOOR SUB-BASE & COVERING										LARGE CRACKS? **G** YES **G** NO
213	FIXTURES: SINK										PEELING PAINT/PLASTER? **G** YES **G** NO
	TOILET										FLUSH PROPERLY? **G** YES **G** NO
	TUB/SHOWER										
214	ACCESSORIES										
215	VANITIES										
	HALF BATH Number: _____										
211	WALLS AND CEILINGS								%		SIGNIFICANT LEAKS? **G** YES **G** NO
212	FLOOR SUB-BASE & COVERING										LARGE CRACKS? **G** YES **G** NO
213	FIXTURES: SINK										PEELING PAINT/PLASTER? **G** YES **G** NO
	TOILET										FLUSH PROPERLY? **G** YES **G** NO
214	ACCESSORIES										
215	VANITIES										

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Exhibit B-3: Example from Inspector Manual

211. Bathroom Wall and Ceilings—Partitions and Surfaces

Common Elements: Items common to the bathroom walls and ceilings include wall structures, ceiling structures, paint, wallpaper, rubber or wood base, and tile.

Where to Observe: The walls and ceilings located in the inspected unit bathrooms should be observed.

Inspection Method:
- **G** Walk around the bathroom in the inspected unit and observe the condition of the walls and ceilings. If the unit has multiple full or half bathrooms, inspect the first full and half bathroom encountered. Quickly determine if the other bathrooms are similar. If not, note the differences on the form.
- **G** Record the percentage of the walls and ceilings that need to be replaced.

Special Note: Include the tile around the tub or shower in this system.

Definition of Action Levels:

Minor Action: The surface is intact but exhibits minor aging or deterioration and needs to be painted.
Moderate Action: The surface has occasional damage requiring surface patching and painting.
Major Action: The surface has incurred considerable damage, requiring surface material restoration, including tile replacement and paint.
Replace: The surface and framing system need to be replaced and painted. *Record the percentage of the walls and ceilings that need to be replaced.*

212. Bathroom Floor Sub-base and Covering

Definition: The floor sub-base refers to a rough floor, laid on joists, which serves as a base for the finished floor. The floor covering could consist of tile, sheetgood, or carpet. There are two types of floor covering:
- **G** Ceramic tile
- **G** Resilient sheetgoods

Where to Observe: The floor located in the inspected unit bathrooms should be observed.

Inspection Method:
- **G** Record whether the floor covering is ceramic or resilient.
- **G** Record the age of the floor.
- **G** The actual floor sub-base cannot be observed directly, but the inspector can note if the floor is warped or buckled.

Definition of Action Levels:

Minor Action: Not applicable.
Moderate Action: Not applicable.
Major Action: The floor covering is severely deteriorated and needs to be replaced.
Replace: The floor is buckling, warped, or splintered, requiring the replacement of the floor covering and sub-base.

213. Bathroom Fixtures

Definition: Bathroom fixtures include the sink, toilet and tub. There are two types of fixtures for a tub/ shower (full bath):
- **G** Ceramic/porcelain
- **G** Fiberglass

Common Elements: Items include the sink, toilet, tub and fittings.

Where to Observe: These fixtures can be observed in the bathroom.

Inspection Method:
- **G** Each fixture is rated separately.
- **G** Record the age of the fixtures.
- **G** Record whether the tub/shower is ceramic or fiberglass (ceramic includes tile and/or enamel on cast iron).

213. Bathroom Fixtures

Definition of Action Levels:

Sink:

Minor Action: The fittings need to be repaired or replaced.
Moderate Action: Not applicable.
Major Action: Not applicable.
Replace: The sink needs to be replaced.

Toilet:

Minor Action: The fittings need to be repaired or replaced.
Moderate Action: Not applicable.
Major Action: Not applicable.
Replace: The toilet needs to be replaced.

Tub/Shower:

Minor Action: The fittings need to be repaired or replaced.
Moderate Action: Not applicable.
Major Action: Not applicable.
Replace: The tub/shower needs to be replaced.

214. Bathroom Accessories

Common Elements: Common bathroom accessories include a medicine cabinet, towel bar, shower rod, and a wall-attached soap dish.

Where to Observe: These items can be observed in the bathroom.

Inspection Method:
- **G** Record the age of the bathroom accessories.
- **G** Observe the condition of these items directly.
- **G** Ask the residents if the accessories are stable and operate properly.

Definition of Action Levels:

Minor Action: Not applicable.
Moderate Action: Two to three accessories are broken or missing and need to be replaced (excluding the medicine cabinet).
Major Action: Replace medicine cabinet only.
Replace: A majority of the accessories and the medicine cabinet are broken or missing and need to be replaced.

215. Vanities

Definition: This item refers to the vanity structure itself and not to the sink. There are two types of vanities:
- **G** Two feet
- **G** Three feet

Where to Observe: The vanity can be observed in the bathroom.

Inspection Method:
- **G** Record whether the vanity in the inspected unit is two feet or three feet wide.
- **G** Record the age of the vanity.
- **G** Observe the structure of the vanity by opening and closing the vanity doors; observe the condition of the vanity directly.

Definition of Action Levels:

Minor Action: Not applicable.
Moderate Action: Not applicable.
Major Action: Not applicable.
Replace: The vanity is beyond repair and needs to be replaced.

Building and Unit Sampling Procedures. From the composite of the property described on the Project Quality Distribution form, inspectors selected up to three buildings and three units to inspect, based on predominant quality categories, and predominant building types and unit types. For buildings, inspectors were instructed to always inspect a high-rise if one was present, then to inspect worse quality buildings, while including as many building types as possible. If multiple quality buildings were present, inspectors were instructed to select buildings in the worst condition first. For example, if the property had one high-rise building and twenty townhouse buildings (representing all four quality categories), the inspector would inspect the high-rise and two townhouse buildings (one in poor condition and one in fair condition).

For units, inspectors were instructed to inspect units from predominant sizes with the provision that they select units that, in the manager's opinion, were in the worst physical condition.[6] If all units at the property were in good condition, then the inspector made the selection based solely on predominant unit size. If, however, there were units ranging in quality from poor to excellent, the inspector would select poor, fair, and good units and not inspect units in excellent condition. This protocol was followed to obtain direct observations of elements most costly to repair. Adjustments to property-level repair costs for the relatively less expensive repairs of better quality units are described in Appendix C.

Upgrade Feasibility. For some systems, in addition to identifying immediate repair needs for that system, a determination was made about whether the system needed any additions or upgrades in order to ensure that the housing was decent and sustainable. Two tools were used to help the inspector make this determination. The first was direct observations and discussions with the property escort about the various systems. (Housing authorities were instructed to provide an escort who was familiar with the property's systems.) The second tool was the Summary Project Observations and Windshield Survey (SPOWS) form. This form was used to record general descriptions of the development and the surrounding neighborhood, allowing the inspector to place the inspected property in context within its neighborhood. To complete the Windshield Survey component of the SPOWS, the inspector was to spend approximately 15 minutes driving around the neighborhood and making necessary observations. Inspectors were instructed to pay particular attention to the characteristics of other low-income housing in the neighborhood.

With this information in hand, the inspector was then asked to assess the feasibility of upgrading or adding selected systems. Four of the inspection booklets (Building Envelope,

6 The value to the study of the manager's rating of units and buildings by overall condition depended primarily on the manager's ***consistency***, rather than on the manager's use of the exact definition of excellent, good, fair and poor. The inspector conducted quick "walk-throughs" of units in the various categories, in addition to conducting the actual inspections, to verify the consistency of the manager's ratings. If discrepancies existed, the inspector adjusted the distribution to reflect the differences.

Building Mechanical and Electrical, Unit and Site), the inspector was to determine whether by some investment beyond routine repairs, a property or system should be upgraded to be more comparable to other housing in the neighborhood. These determinations were based on direct observations of the system (age, technology, evidence of repair problems, etc.), discussions with the property escort about the various systems, and the observations made while completing the SPOWS. Examples of systems that could be upgraded or added include: windows, stairways, common rooms, laundry rooms, air conditioning, site parking, site lighting, landscaping, fencing and playgrounds. Unit upgrade determinations were slightly different as they were based on broad assessments of three living areas (kitchen, bathrooms, unit interior) instead of individual system-level judgements. All upgrade determinations involved a series of questions asking first whether the upgrade was necessary and second whether the upgrade was feasible. Although reconfiguration and major redesign were excluded, some of the proposed upgrades yielded significant costs per unit—for example, kitchens with major rehab needs were costed at $15,000 per unit upgrade (prior to inter-area cost adjustment).

Depending on the system assessed, the inspector determined the upgrade action recommended:

- current system does not need to be changed;
- current system must be upgraded but not expanded (for example, the windows need to be upgraded using better more energy efficient materials, but the number of windows in the property remains unchanged);
- current system must be upgraded and expanded (for example, the site furniture needs to be upgraded using better materials, such as replacing a wooden bench with a molded, concrete bench, as well as adding more of these benches to the property);
- current system does not need to be upgraded, but should be expanded (for example, the dumpsters and enclosures do not need to be upgraded using better materials, but the number of dumpsters and enclosures available for the property needs to be increased); or,
- system is not present and should be added (for example, there are no playgrounds or tot lots on the property, but one needs to be added).

This information was recorded in the inspection booklets, as shown in the example in Exhibit B-4 under the section titled “Upgrade Feasibility for this Building.” Exhibit B-5 shows the incidence of upgrade actions by system type for the inspected sample.

Housing Quality (HQ) Questions. Inspectors were also asked to answer a short series of Housing Quality (HQ) questions, which were developed by researchers at HUD in the 1980s. These HQ questions were added to the inspection booklets and placed near the system they most closely represent. These measures of housing condition, when used with other data,

Exhibit B-4: Example of Upgrade Questions and HQ Questions

[LABEL]

Building Name/Address:

_____

ID	BUILDING ENVELOPE SYSTEM	AB (✓)	TYPE	#	ACTIONS: NO ACT	MIN	MOD	MAJ	REP	AGE	COMMENTS / HOUSING QUALITY QUESTIONS
47	DECKS (WITHOUT ROOF)						#		#		
48	ATTACHED STORAGE SHEDS						#		#		
COMMON AREAS											
49	VESTIBULES										HALLWAYS / STAIRS:
50	CORRIDORS								%		WORKING LIGHTS PRESENT? **G** YES
51	STAIRWAYS (# flights)								%		LOOSE / MISSING STEPS? **G** YES
52	INTERIOR LIGHTING										LOOSE RAILINGS? **G** YES
53	MAIL FACILITIES (# of boxes)								#		MAJOR ROACH INFESTATION OR RAT SIGNS? **G** YES
54	LAUNDRY ROOMS										NOXIOUS ODOR / SMELL OF URINE? **G** YES
55	LAUNDRY EQUIPMENT (# pieces)							#			
56	COMMON ROOMS										
57	COMMON KITCHENS										
58	UNDERGROUND GARAGE (# levels)										

Year of last modernization of this building: 19____ **G** No major modernization

Office use only:
SIQD: _____
TO: _____

UPGRADE FEASIBILITY FOR THIS BUILDING

SYSTEM	Is it necessary to upgrade this system for mixed-income conversion?[1] No/Not Present	Yes
Exterior Wall	**G** 0	**G** 1
Windows	**G** 0	**G** 1
Exterior Common Doors	**G** 0	**G** 1
Exterior Stairways	**G** 0	**G** 1
Interior Stairways	**G** 0	**G** 1
Vestibules	**G** 0	**G** 1
Corridors	**G** 0	**G** 1
Common Rooms	**G** 0	**G** 1
Common Laundry Rooms	**G** 0	**G** 1

SYSTEM	Is it necessary to add the system (or expand the current system) for mixed-income conversion?[1] No	Yes	IF YES, is it practical and physically feasible to add or expand this system? No	Yes	How ma should added
Window Security Grates	**G** 0	**G** 1	**G** 0	**G** 1	
Storm/Screen Doors	**G** 0	**G** 1	**G** 0	**G** 1	
Building-Mounted Lights	**G** 0	**G** 1	**G** 0	**G** 1	
Canopies	**G** 0	**G** 1	**G** 0	**G** 1	
Balconies	**G** 0	**G** 1	**G** 0	**G** 1	
Porches (with roof)	**G** 0	**G** 1	**G** 0	**G** 1	
Decks (without roof)	**G** 0	**G** 1	**G** 0	**G** 1	
Attached Storage Sheds	**G** 0	**G** 1	**G** 0	**G** 1	
Common Laundry Equipment	**G** 0	**G** 1	**G** 0	**G** 1	

[1] Mixed-income refers to a mix of the current tenants (incomes less than 30% of the median) and those of modestly higher incomes (30-50% of the median).

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Exhibit B-5
Incidence of Upgrade Actions
Site Form

System	Percentage
Upgrade Landscaping	36
Upgrade Site Parking Areas	20
Add Site Parking Areas	17
Feasible to Add Site Parking Areas	13
Upgrade Site Lighting	6
Add Site Lighting	16
Feasible to Add Site Lighting	16
Upgrade Private Yards and Enclosures	3
Add Private Yards and Enclosures	11
Feasible to Add Private Yards and Enclosures	10
Upgrade Site Furniture	18
Add Site Furniture	28
Feasible to Add Site Furniture	28
Add Playgrounds/Tot Lots	30
Feasible to Add Playground/Tot Lots	28
Add Paved Pedestrian Areas	4
Feasible to Add Paved Pedestrian Areas	4
Add Fencing	5
Feasible to Add Fencing	5
Add Retaining Walls	1
Feasible to Add Retaining Walls	1
Add Basketball Courts	16
Feasible to Add Basketball Courts	13
Add Dumpsters and Enclosures	11
Feasible to Add Dumpsters/Enclosures	10
Add Pitched Roofs	4
Feasible to Add Pitched Roofs	3

Exhibit B-5 *(continued)*
Incidence of Upgrade Actions
Building Envelope Form

System	Percentage
Upgrade Exterior Wall	15
Upgrade Windows	22
Upgrade Exterior Common Doors	8
Upgrade Exterior Stairways	3
Upgrade Interior Stairways	9
Upgrade Vestibules	5
Upgrade Corridors	9
Upgrade Common Rooms	2
Upgrade Common Laundry Rooms	2
Add Window Security Grates	9
Feasible to Add Window Security Grates	9
Add Storm/Screen Doors	11
Feasible to Add Storm/Screen Doors	11
Add Building Mounted Site Lights	21
Feasible to Add Building Mounted Site Lights	20
Add Canopies	3
Feasible to Add Canopies	3
Add Balconies	3
Feasible to Add Balconies	2
Add Porches	5
Feasible to Add Porches	5
Add Decks	4
Feasible to Add Decks	4
Add Sheds	10
Feasible to Add Sheds	8
Add Common Laundry Equipment	9
Feasible to Add Common Laundry Equipment	8

Exhibit B-5 *(continued)*
Incidence of Upgrade Actions
Building Mechanical and Electrical Form

System	Percentage
Upgrade Central Air Conditioning	0
Add Central Air Conditioning	17
Feasible to Add Air Conditioning	12
Upgrade Communication System	2
Add Communication System	6
Feasible to Add Communication System	6
Upgrade Emergency Call Alarm System	1
Add Emergency Call Alarm System	4
Feasible to Add Emergency Call Alarm System	4
Upgrade Closed Circuit Television	1
Add Closed Circuit Television	4
Feasible to Add Closed Circuit Television	4

Exhibit B-5 *(continued)*
Incidence of Upgrade Actions
Unit Form

Area	Percentage Needing Any Level of Upgrade
Upgrade Some Kitchen Systems[a]	33
Upgrade All Kitchen Systems[a]	5
Rehab Kitchen: Upgrade All Kitchen Systems and Move Partitions[a]	2
Upgrade Some Full Bathroom Systems[b]	30
Upgrade All Full Bathroom Systems[b]	4
Rehab Full Bathroom: Upgrade All Full Bathroom Systems and Move Partitions[b]	1
Upgrade Some Half Bathroom Systems[b]	1
Upgrade All Half Bathroom Systems[b]	0
Rehab Half Bathroom: Upgrade All Half Bathroom Systems and Move Partitions[b]	1
Upgrade Some Unit Interior Systems[c]	32
Upgrade All Unit Interior Systems[c]	4
Rehab Unit Interior: Upgrade All Unit Interior Systems and Move Partitions[c]	2

a Kitchen systems include: walls, ceiling, floor covering, cabinets, counters, sink, range, refrigerator.

b Full bath systems include: walls, ceiling, floor covering, sink, toilet, tub, vanity; half bath systems include walls, ceiling, floor covering, sink, toilet, vanity.

c Unit interior systems: include walls, ceilings, floor covering.

have helped identify and categorize substandard housing conditions. Since one of the goals of the Formula Capital Study was to help identify a short list of questions (a "checklist") that are useful for determining, without conducting a comprehensive inspection, whether a development has severe capital needs, these questions may be useful. Also, because these are questions used elsewhere by HUD, they may be helpful in comparing the study results with other categories of properties. See Exhibit B-4 for an example of HQ questions for the "Hallways/Stairs" systems.

II. Data Collected from Housing Authorities

To obtain data on past and planned modernization spending from the housing authorities, we developed data abstraction forms for housing authority-level and development-level data (Exhibits B-6 and B-7, which appear at the end of this chapter), which were sent to all housing authorities in the study. Most of the data requested was of the type reported in the Comprehensive Grant Plans (for larger authorities) or CIAP applications (for small authorities). Wherever possible the form referred to specific elements in the Comprehensive Grant Plans (or CIAP applications), so that housing authorities could either attach the relevant part of that documentation or complete the form. Data was requested at the housing authority level as well as at the development level for the developments in our study. The data elements we requested *at the housing authority level* were:

- Number of units covered by various funding sources (e.g., federal public housing, Section 8, state assistance)
- Number of units removed from the Annual Contributions Contract (ACC)
- Special arrangements governing the housing authority (e.g., private management, HUD takeover)
- Number of units after completing the next five years of modernization
- Estimated cost of modernization, current fiscal year
- Estimated hard cost for physical needs modernization, current fiscal year
- Number of units covered by estimates of modernization spending
- Modernization funding received in 1996 and 1997, by spending categories and total
- Planned modernization spending, next four years, by spending category and total

We also requested *development-level data* for each of the developments slated to be inspected at that housing authority. The data elements requested were:

- Special arrangements governing the development (e.g., private management, HUD takeover)

- Number of units planned to be rehabbed, next five years
- Number of units planned to be demolished, next five years
- Number of units to be added, next five years
- Number of units to remain as is, next five years
- Lead-based paint/Asbestos abatement expenditures, most recent year and last three years
- Hard cost for physical needs per unit
- Modernization funding received in 1997
- Modernization funding received in four previous years (1993-96)
- Modernization funding planned for next four years

We requested information from all of the housing authorities in both the original and supplemental sample. In the original sample, this consisted of 625 developments in 199 housing authorities. We received data from 190 housing authorities, covering information on 599 developments. This represents a 95 percent response rate for housing authorities and a 96 percent response rate with regard to developments.

In the supplemental sample, we requested information on 59 developments from 20 housing authorities.[7] We received responses from all 20 housing authorities covering 53 developments. This represents a response rate of 100 percent for housing authorities and 90 percent with respect to developments. Combining the two samples, our overall response rate was 96 percent for housing authorities, covering 95 percent of developments in the total sample.

Although a high response rate was achieved, the quality of the data provided by the housing authorities varied greatly. In a few cases, backup documentation was provided, making it easy to confirm the accuracy of the numbers. However, in many cases the data items were either left blank or contained numbers that appeared to be incorrect or inconsistent. In these cases, it was difficult to confirm the accuracy of the number since no documentation was provided. Smaller housing authorities appeared to have difficulty completing the form, as they are not required to complete the Comprehensive Grant applications that force the larger housing authorities to track and plan modernization spending.

The analysis file contains the following information from the housing authority Background Data forms:

- Per-Unit Estimate Hard Cost for Physical Needs—development level
- Per-Unit Estimate Hard Cost for Physical Needs—housing authority level
- Per-Unit Modernization Funding Received in 1993-1996

7 Although the supplemental sample consists of 23 housing authorities, 3 of these were already in our original sample (we only sampled new developments there), so in fact we requested new information from only 20 housing authorities.

- Per-Unit Modernization Funding in Next Four Years
- Ratio of Public Housing Units to the Total

III. Secondary Data

This section describes the secondary data sources used to complete the database used for analysis for this study. Besides the inspection data and data provided directly from the public housing authorities, we used the following secondary datasets, most of which were directly available from HUD Central Office computers. These datasets include the:

- PIH Master Universe File
- PIH Integrated Business System (IBS)
- HUD's Picture of Subsidized Households Database
- HUD's Public Housing Management Assessment Program (PHMAP) Database

PIH Master Universe File. This 1997 database provided by HUD was used to create the sampling universe for the study. The database also provided the variables "number of available units for each housing authority," "vacancy rate," and "average bedroom size," that were used in the analysis file.

PIH Integrated Business System (IBS). This system, extracted in 1997, was provided to Abt Associates Inc. by HUD. The database was used to extract "date of full availability" (DOFA) and "structure type." It also contained the most up-to-date contact information for the housing authorities in our sample.

HUD's Picture of Subsidized Households Database. The 1998 Picture of Subsidized Households is a HUD database available on the HUD User Website (http://www.huduser.org/datasets/assthsg/statedata98) and offers a variety of data about HUD-subsidized housing. In total, the database contains information on approximately five million HUD-subsidized units; of these, about a quarter (1.3 million) are units in public housing developments. Data are presented at the levels of county, state, housing authorities, Census tracts, and developments. With regard to public housing, data are available on 3,200 housing authorities and 14,045 developments. Data from HUD files is the most recent available (usually from 1998), and not always complete. Certain data elements from the 1990 Census are also contained in this database. Our analysis file included the following variables from The Picture of Subsidized Housing database:

- Percent of Single Parents with Children
- Average Household Size
- Percent of Elderly or Disabled
- Percent of Head of Household that are Older Than 62 Years
- Occupied Units as a Percent of Available Units

HUD's Public Housing Management Assessment Program (PHMAP) Database. This database evaluates the performance of public housing authorities in major areas of management operations. The PHMAP database used for this study was created in 1996. The database does not contain any information for Puerto Rico and many of the fields within the database are missing information.

Our analysis file contains the following variables from the PHMAP database:

- Overall PHMAP Score
- Grade for Modernization
- Actual Vacancy Rate - Housing Authority Level
- Adjusted Vacancy Rate - Housing Authority Level
- Percent of Rents Uncollected

IV. Quality Control and Data Cleaning

Quality control measures were employed during all stages of the data collection process. For example, the inspection forms and the data abstraction forms used to collect data from the housing authorities were carefully designed and pre-tested to ensure that they obtained the necessary information in a consistent and accurate manner. In addition, the inspectors from the DLR Group were experienced professionals who participated in a week-long training to ensure a complete understanding of the Observable Systems methodology and the protocol to use in dealing with housing authorities. Finally, after the inspection forms were completed they were reviewed by the inspector, a senior DLR staff member, and Abt Associates Inc. coding staff to identify any missing information, apparent errors, or inconsistencies. These problems were then corrected through consultation with the inspector.

In addition to the quality control measures listed above, for each data collection component of this study Abt Associates Inc. staff did extensive data cleaning for completeness and consistency. After the data was produced in an electronic format, a multi-stage data cleaning process was performed by Abt Associates Inc. project staff, testing for internal consistency and checking for plausible ranges. Problems were resolved by consulting hard-copy forms and requesting clarification from DLR Group staff. Any out-of-range values from the inspection data were looked up and re-verified.

Finally, for each data collection component, a quality control check on at least 10 percent of the work was conducted. This quality control check included repeating 10 percent of the physical needs inspections, as well as 100 percent verification on all data entry tasks.

Exhibit B-6: Data Abstraction Form, Housing Authority Level:

HUD FORMULA CAPITAL STUDY

PUBLIC HOUSING AGENCY BACKGROUND DATA FORM

The seven questions on this data form will provide essential information on this agency. Many of the items are reported to HUD as part of the Comprehensive Grant Plan or CIAP application.

Name of this PHA: _____

Person to contact with questions about this form: _____ Phone #: (_____)_____

1. Subsidized Housing Programs at this Public Housing Agency:

For the most recent year, please specify the number of units covered for each program listed. If this HA does not receive funding from the listed sources, check "Does Not Apply".

Funding Source	Does Not Apply	Units Covered by Program
Federal Public Housing	**G**	#
Section 8 vouchers and certificates	**G**	#
State-funded public housing programs	**G**	#
State tenant-based assistance	**G**	#
Municipally funded public housing programs	**G**	#
USDA rural rental housing program (formerly FmHA)	**G**	#
Other (*specify:*) _____	**G**	#

2. For the most recently completed (Federal or Agency) fiscal year, how many public housing units were removed from the ACC?

FFY____ (or Agency FY _____) Units removed from the ACC: _____ **G** None

2a. Estimate of public housing units ***to be removed*** during the current fiscal year: _____ **G** None

3. Special Arrangements

Is this PHA subject to special arrangements such as private management, receivership or HUD takeover, or some other arrangement?

Private management (modernization only) **G** Yes **G** No

Private management (overall) **G** Yes **G** No

Receivership or HUD takeover **G** Yes **G** No

Other *(Specify below:)* **G** Yes **G** No

Other Special Arrangements: _____

_____

_____

INFORMATION ON MODERNIZATION FROM COMPREHENSIVE PLANS OR OTHER SOURCES

Comp Grant-eligible agencies:
Much of the following information is normally specified in Comprehensive Plans. Please provide this information to us either by attaching the relevant excerpt from your Comprehensive Plan, or by writing the information directly on this form.

CIAP agencies:
Please record the information directly on this form.

4. Number of Units after Completing the next 5 Years of Planned Modernization

Please indicate the total number of units you expect to have in five years. Include in this total ***all*** units, not just modernized ones. Be sure to include modernization funded through CIAP, CGP, funded Vacancy Reduction Grants, and funded HOPE VI Implementation grants.

4a. Which is the "5th year" that the information refers to: FFY _____

Number of units to be rehabbed, next 5 years _____
Number of new units to be added, next 5 years _____
Number of units maintained as is, next 5 years _____
Number of units to be demolished, next 5 years _____

Net total units after 5 years _____

5. Please attach *HUD Form 52831* for the current Federal Fiscal year,[1] **OR** please provide the estimated modernization costs for the current year as well as the estimate of hard costs for physical needs in the space below.

5a. What is the preliminary **estimated grand total of cost of HA modernization** for the current year? If none is estimated, please write in "0."

$_____

G If estimated from a source other than HUD Form 52831, please describe the method used to derive it: _____

_____
_____

5b. What is **the preliminary total estimated hard cost for physical needs** for this HA? If none is estimated, please write in "0."

$_____

G If estimated from a source other than HUD Form 52831, please describe the method used to derive it: _____

_____
_____

5c. What is the **total number of units** included in this estimate?

_____

1 CGP agencies only.

6. Modernization Funding Received in 1997 and 1996.

Please attach (Comp Grant agencies) Form *HUD-52837, Annual Statement / Performance and Evaluation Report, Part I: Summary*, ***or*** (CIAP agencies) *HUD Form 52825, CIAP Budget/Progress Report* for the years 1997 and 1996, **OR** please indicate modernization funding received in 1997[1] and 1996 for the expense categories listed below. Please report the ***actual*** amounts (not estimated amounts). Please indicate at the bottom of the table if the numbers are obligated, expended, or original estimates. If no funding was received, please write in "0."

Funding	1997	1996
Non-CGP (or Non-CIAP) funds	$	$
CGP/CIAP funds: Check whether the funding source is: G CGP or G CIAP		
Operations	$	$
Management improvements	$	$
Administration	$	$
Audit[2]	$	$
Liquidated damages	$	$
Fees and costs	$	$
Site acquisition	$	$
Site improvement	$	$
Dwelling structures	$	$
Dwelling equipment—nonexpendable	$	$
Nondwelling structures	$	$
Nondwelling equipment	$	$
Demolition	$	$
Replacement reserve[2]	$	$
Relocation costs	$	$
Mod used for development	$	$
Contingency[2]	$	$
Total CGP (or CIAP) grant amount	$	$
Lead-based paint activities (LBP)	$	$

Numbers reported are: *(check one)*

G Expended
G Obligated
G Original estimates

G Expended
G Obligated
G Original estimates

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[1] Whether from that funding stream or from that year and previous years.
[2] CGP agencies only.

7. Modernization Spending Planned, by Categories, for next Four Years

Comp Grant HAs:
Please attach the most recent *Form HUD-52834, Five Year Action Plan, Part I: Summary*, from your current Comprehensive Plan. If unavailable, please indicate your total planned modernization spending for the next four years for the spending categories listed below.

Which years does the information refer to?
Year 2 = FFY 19_____
Year 3 = FFY _____
Year 4 = FFY _____
Year 5 = FFY _____

	Total, Next Four Years
Non-CGP funds	$
CGP funds::	
Physical improvements	$
Management improvements	$
HA-wide nondwelling structures and equipment	$
Administration	$
Other	$
Operations	$
Demolition	$
Replacement reserve	$
Mod used for development	$
Total CGP grant amount	$

HUD FORMULA CAPITAL STUDY
BACKGROUND DATA FORM FOR DEVELOPMENTS

Sampled Development: _____

Person to contact with questions about this form: _____ Phone #: (_____)_____

1. Special arrangements:

	Yes	No	
Resident management	G	G	
Private management	G	G	
Other	G*	G	* *Describe:* _____

2. Modernization: Please provide the number of units at this development in the next 5 years:

Number of units to be rehabbed, next 5 years	_____
Number of new units to be added, next 5 years	_____
Number of units maintained as is, next 5 years	_____
Number of units to be demolished, next 5 years	_____
Net total units after 5 years	_____

3. LBP/Asbestos abatement expenditures:

Most recent year: $_____ **G** Actual **G** Estimate *Source:* _____

Total, last 3 years (including most recent year): $_____ **G** Actual **G** Estimate *Source:* _____

4. Please attach *HUD Form 52832* (Comp Grant agencies only), **OR** list here the estimate of *per-unit* hard cost for physical needs:[1]

$_____ per unit Number of units: _____

5. Please attach *HUD Form 52837* (Comp Grant agencies only), *Performance and Evaluation Report, Part II*: Supporting Pages for 1997,[2] **OR** list here the:

Modernization funding *received in FY 1997* for this development: total actual cost (obligated or expended numbers are preferred; if they are not available, please provide revised or original numbers):

$_____

Number reported is (check one): **G** Expended **G** Obligated **G** Revised estimate **G** Original estimate

6. Please attach *HUD Form 52837* (Comp Grant agencies only), *Performance and Evaluation Report, Part II*: Supporting Pages for 1993-1996,[2] **OR** list here the:

Modernization funding *received in the four prior years (1993-1996)*, for this development: total actual cost (obligated or expended numbers are preferred; if they are not available, please provide revised or original numbers):

$_____

Number reported is (check one): **G** Expended **G** Obligated **G** Revised estimate **G** Original estimate

7. Please attach *HUD Form 52834*, *Five Year Action Plan, Part I: Summary, Part A: Work Statements*, and *Part II, Supporting Pages, Physical Needs*, **OR** list here the modernization spending *planned for the next four years*, for this development: total estimated cost:

$_____

---

[1] Please provide the estimated per-unit hard cost for physical needs. This is the estimated hard cost of ***needed physical improvements*** at this development divided by the number of units at this development. ***Needed physical improvements*** are those needed to bring the development (dwelling and non-dwelling structures, dwelling and non-dwelling equipment, and site) up to a level at least equal to the modernization and energy conservation standards, as well as replacement of equipment, systems, and structure elements needed within the next five years.

[2] For CIAP-receiving agencies, attach *HUD Form 52825, CIAP Budget/Progress Report, Parts II and III.*

HUD FORMULA CAPITAL STUDY BACKGROUND DATA FORM

INSTRUCTIONS

1. **Special Arrangements**. Please indicate if the sampled development is subject to special arrangements such as resident management, private management, or other arrangement.

Information on Modernization

Comp Grant HAs:. For developments with modernization funded under the Comprehensive Grant Program, much of the information requested is normally specified in Comprehensive Plans. Please provide this information to us either by attaching the relevant excerpt, or by writing the information directly on this form— whichever is more convenient for you.

CIAP HAs: If requested information is available on a standard HUD form, you may attach the form. Otherwise, please provide the estimates directly on this form.

2. **Net Total Units after Completing the next 5 Years of Planned Modernization**. Please indicate the number of units to be rehabilitated, new units, other units maintained as is, and units to be demolished after completing the next five years of planned modernization.

   Be sure to include modernization funded through CIAP or CGP.

3. Please list the total expenditures related to lead-based paint or asbestos abatement for the most recent year and the total expenditures for the most recent three years. If actual expenditures are not available, please provide an estimate and its basis.

4. Please provide the estimated per-unit hard cost for physical needs. This is the estimated hard cost of ***needed physical improvements*** at this development divided by the number of units at this development.

   Needed physical improvements are those needed to bring the development (dwelling and non-dwelling structures, dwelling and non-dwelling equipment, and site) up to a level at least equal to the modernization and energy conservation standards, as well as replacement of equipment, systems, and structure elements needed within the next five years.

5. **Modernization Funding *Received in 1997***. Please indicate modernization funding received in 1997 for the major work categories listed in the modernization plan. Obligated or Expended numbers are preferred. If they are not available, please provide revised or original numbers. In computing the total, include not only development-specific activities but also the development's portion of PHA-wide activities.

6. **Modernization Funding *Received in the Four Most Recent Years***. Please indicate modernization funding received in the four most recent years (generally, these are the years 1993-1996) for the major work categories listed in your Comprehensive Plans or CIAP grants for those years. Obligated or Expended numbers are preferred. If they are not available, please provide revised or original numbers. In computing the total, include not only development-specific activities but also the development's portion of PHA-wide activities.

7. **Modernization Spending *Planned for the next Four Years***. Please indicate planned modernization spending in major work categories for the next four years (Comp Grant HAs: Years 2-5 of the current Comprehensive Plan; generally these are the years 1998-2001). Please provide a sum over all four years. In computing the total, include not only development-specific activities but also the development's portion of PHA-wide activities.

Appendix C:
System for Estimating Inspection-Based Existing Modernization Needs And Accrual Costs From Inspections

This appendix outlines the approach used to estimate existing modernization needs and accrual costs based on the observations made during physical inspections of the properties. ***Existing modernization needs*** are costs that would have to be expended in order to provide decent and sustainable housing with modest amenities. These costs include ***immediate repair needs***, which are the costs required to repair or replace systems that are not in working order. Existing modernization needs also include costs for ***upgrades and additions*** to some systems and the ***replacement of systems*** that have reached the end of their expected useful life, even if they are still in working order. Accrual costs are costs expected in the future that are associated with major repair and replacement of systems as they age over the next 20 years.

The first section of this appendix describes the method for arriving at costs of immediate repair needs. The second section describes the method used to obtain existing modernization needs costs. The third section addresses the method for estimating the future accrual of major repair and replacement costs.

I. Estimating Immediate Repair Needs from Property Inspections

The process of estimating immediate repair needs based on the property inspections involved five steps:

- Conducting a ***physical inspection*** of the overall site and up to 3 buildings and 3 units within each property in the sample (135 systems or groupings of physical features were inspected in the properties);

- Generating a system-level ***cost file***;

- Calculating system-level ***costs for the site and inspected units and buildings***;

- Computing ***property-level costs*** by inferring costs for uninspected units and buildings from inspected units and buildings; and

- Adjusting the property-level costs for ***locational cost differences*** and for ***soft costs*** associated with the modernization process.

Physical Inspection of the Property

The physical inspection method—the Observable Systems Method—was described previously in "Appendix B: Data Collection Summary." The inspection produces information for each property on: the current condition and immediate repair action level for each of 135 systems for the site and for the buildings and units that were inspected; modernization needs to provide decent and sustainable housing with modest amenities; and property takeoffs—a complete inventory of the presence, count, age, type, and dimensions of components.

System-Level Cost File for Computing Physical Needs

As was discussed in Appendix B, under the Observable Systems Method, the costs of carrying out the repair actions recorded by the inspector were computed off-site using a computerized cost file and program. The first step in generating the cost file was developing up to five system-specific, categorized levels of repair, ranging from no action to replacement of a system, to correspond to action levels the inspector would use to describe the repairs needed to bring the system up to a working, safe, and sound condition. The action level groups are:

- NA for no action
- MIN for minor repair
- MOD for moderate repair
- MAJ for major repair, and
- REP for replace.

For any system, each action level denotes a specific repair action. For example, for ranges and hoods (a dwelling unit system), the MIN action is to replace a burner and clean the hood; the MOD action is to replace the hood; the MAJ action is to replace the range; and REP involves replacing the range and the hood. In the above example for ranges and hoods the MIN cost is $108 for each kitchen requiring MIN action. MOD costs are $246 for each kitchen requiring a MOD level of repair. MAJ costs are $480 for each kitchen. REP costs are $720. Costs for each action level for each system are presented in Exhibit C-1.[1] System repair costs were obtained from A.M. Fogarty & Associates, Inc., a firm with extensive experience in costing for private and public housing construction and modernization. Using the precise definitions of the action levels described above, A.M. Fogarty & Associates, Inc. developed a series of costs for each action level for each system that reflect the materials commonly used for public or low-income housing. Abt Associates Inc. has used this firm's estimation services for several HUD studies. Costs are for the Washington, D.C.

1 In a few cases the cost element for a more major action is less than the cost element for a lesser action due to action-level definitions and cost algorithms that account for implied percentages and quantities.

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
***SITE SYSTEMS						
Landscape	0.12	0.29	0.88	1.18	Landscape-SF	
Roadways	0.15	0.39	0.83	2.40	Road-SF (min 1000)	
Parking Areas-Lots	0.12	0.50	2.08	2.40	Parking-SF;# of new spaces	360 SF per square
Parking Areas-Garages	0.02	0.77	2.18	2.75	Park-SF (min 1000)	
Paved Pedestrian Areas	0.31	0.77	2.30	4.57	PvdPed SF (min 1000)	
Curbing-Bituminous	N/A	N/A	N/A	5.42	Curbing LF	
Curbing-Concrete	N/A	N/A	4.69	14.08	Curbing LF	
Curbing-Granite	N/A	2.28	8.38	N/A	Curbing LF	
Fencing-Chain Link	N/A	N/A	N/A	15.74	Fencing LF	
Fencing-Wrought Iron	N/A	N/A	N/A	64.14	Fencing LF	
Fencing-Wood Stockade	N/A	N/A	N/A	16.04	Fencing LF	
Fencing-Concrete	N/A	N/A	N/A	138.00	Fencing LF	
Fencing-Tubular	N/A	N/A	N/A	43.70	Fencing LF	
Retaining Walls-Concrete	N/A	3.06	N/A	35.82	Retain Wall-LF	
Retaining Walls-RR Ties	N/A	0.75	N/A	25.34	Retain Wall-LF	
Site Drainage-Underground	N/A	900.00	2814.00	4500.00	# Catch Basin	
Site Drainage-Surface	N/A	0.58	2.50	N/A	Landscape SF	
Dumpsters and Enclosures	1100.00	2750.00	4700.00	6200.00	# Dumpsters	
Pole Mounted Site Lighting	500.00	800.00	2000.00	3500.00	# Poles	
Private Yards and Enclosures	N/A	580.00	N/A	1162.00	# Yards	
Site Furniture	40.00	250.00	250.00	250.00	# Units	Min 10% of units, Mod 25%, Maj 66%, Replace 100%
Basketball Courts	3142.00	5152.00	N/A	12274.00	# Courts	
Site Electrical Distribution-Over	N/A	N/A	55.00	80.00	Site Elec Dist-LF	
Site Electrical Distribution-Under	N/A	N/A	115.00	150.00	Site Elec Dist-LF	
Heating Water Distribution-Steam	N/A	N/A	N/A	350.00	Heat Water Dist-LF	
Heating Water Distribution-Hot Water	N/A	N/A	N/A	189.00	Heat Water Dist-LF	
Domestic Hot Water Lines	N/A	N/A	N/A	43.00	Dom Hot Water -LF	
Domestic Cold Water Lines	N/A	N/A	N/A	28.00	Dom Cold Water-LF	
Gas Lines	N/A	N/A	N/A	34.00	Gas Lines-LF	
Main Water Service	N/A	N/A	N/A	47.00	Main Water Serv-LF	
Site Sanitary Lines	N/A	N/A	N/A	42.00	Site Sanitary-LF	
Septic System	N/A	N/A	400.00	8000.00	Units	
Sewage Ejectors	800.00	1400.00	2000.00	3500.00	# Ejectors	
Hydrants	N/A	N/A	N/A	2200.00	# Hydrants	

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
***UNIT SYSTEMS						
Walls & Ceilings: Partitions (not K&B)	N/A	N/A	N/A	3.25	SF	
Walls & Ceilings: Surfaces (not K&B)	0.74	1.44	N/A	2.60	SF	
Floor Sub-base (not K&B)	N/A	N/A	N/A	3.55	SF	
Floor Covering-Carpet (not K&B)	N/A	N/A	N/A	2.39	SF	
Floor Covering-Resilient (not K&B)	N/A	N/A	N/A	2.98	SF	
Interior Doors & Frames	N/A	66.00	324.00	496.80	# Doors needing action	
Kitchen Walls & Ceilings: Partitions & Surfaces	0.90	1.50	N/A	3.90	SF	
Kitchen Floor Covering & Sub-base	N/A	N/A	4.31	8.57	SF	
Cabinets/Counter Top/Sink	960.00	600.00	2100.00	3300.00	# needing replacement	
Range	66.00	N/A	400.00	N/A	# needing replacement	
Range & Hood	108.00	246.00	480.00	720.00	# needing replacement	
Refrigerator	N/A	N/A	N/A	840.00	# needing replacement	
Bathroom Walls & Ceilings: Partitions & Surfaces	0.66	4.60	8.68	13.20	SF	
Bathroom Flr Cvr & Sub-base-Tile	N/A	N/A	9.64	13.19	SF	
Bathroom Flr Cvr & Sub-base-Resil			3.59	7.14	SF	
Bathroom Fixtures-Sink	225.00	N/A	N/A	500.00	# needing replacement	
Bathroom Fixtures-Toilet	175.00	N/A	N/A	575.00	# needing replacement	
Bathroom Fixt-Tub/Shower-Porcelain	300.00	N/A	N/A	1400.00	# needing replacement	
Bathroom Fixt-Tub/Shower-Fiberglass	300.00	N/A	N/A	845.00	# needing replacement	
Bathroom Accessories	N/A	108.00	191.00	250.00	# needing replacement	
Bathroom Vanities-24"	N/A	N/A	N/A	405.00	# needing replacement	
Bathroom Vanities-36"	N/A	N/A	N/A	570.00	# needing replacement	
HVAC Unit-Heat Only	N/A	440.00	N/A	984.00	# needing replacement	
HVAC Unit-Heat/Cool	N/A	770.00	N/A	5880.00	# needing replacement	
HVAC-Swamp Cooler	N/A	660.00	N/A	1650.00	# needing replacement	
HVAC Unit-W/A-Coil	N/A	1050.00	N/A	6900.00	# needing replacement	

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
***UNIT SYSTEMS (Continued)						
Radiation-Hydronic	N/A	10.70	N/A	21.40	LF	
Radiation-Electric	N/A	N/A	N/A	11.60	LF	
Unit Boiler	N/A	875.00	N/A	2610.00	# needing replacement	
Unit Furnace	N/A	550.00	N/A	1122.00	# needing replacement	
Unit Dom Hot Water Generation	N/A	165.00	N/A	520.00	# needing replacement	
Temperature Controls	N/A	N/A	N/A	81.00	# Temp Controls	
Wall/Window Air Conditioner	N/A	N/A	N/A	750.00	# Wall/Window AC's	
Unit Electrical Panel	N/A	N/A	N/A	1230.00	1 per Unit	
Unit Electrical Wiring	N/A	N/A	N/A	3.50	Total Unit SF	
Bell/Intercom System	N/A	N/A	N/A	194.90	# needing replacement	
Closed Circuit TV	N/A	N/A	N/A	115.00	# needing replacement	
Emergency Call Alarm System	N/A	N/A	N/A	140.00	# needing replacement	
Smoke/Fire Detection-Battery	N/A	N/A	N/A	44.00	# needing replacement	
Smoke/Fire Detection-Hard Wire	N/A	N/A	N/A	148.00	# needing replacement	

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
***BUILDING ENVELOPE						
Foundation-4 Foot	0.72	N/A	16.86	N/A	Perimeter-LF	
Foundation-8 Foot	N/A	8.40	33.30	N/A	Perimeter-LF	
Slab—Slab	N/A	0.50	2.09	6.32	Footprint-SF	
Slab-Basement	N/A	0.50	2.15	6.40	Footprint-SF	
Exterior Wall-Masonry	1.10	N/A	4.25	16.20	Masonry-SF	
Exterior Wall-Plaster	1.10	N/A	1.58	10.00	Plaster-SF	
Exterior Wall-Wood	1.10	1.40	1.28	7.75	Wood-SF	
Exterior Wall-Vinyl/Aluminum	1.10	1.40	0.80	5.50	Vinyl/Aluminum-SF	
Insulation-Wall	N/A	N/A	0.60	N/A		
Insulation-Ceiling	N/A	N/A	1.25	N/A		
Roof Covering-EDPM	0.28	0.55	2.15	4.63		
Roof Covering-Shingle	0.20	0.40	1.60	2.30		
Roof Covering-Built-Up	0.25	0.52	2.06	5.15		
Roof Covering-Tile	1.00	1.98	7.90	8.90		
Roof Covering-Metal	1.25	2.60	10.50	11.60		
Parapet Wall	N/A	79.00	N/A	79.00	Perimeter-LF	3 ft high
Chimney (Brick)	138.94	N/A	N/A	1120.37	# Chimneys	2'x2'x4' high
Roof Hatches-Small	N/A	N/A	N/A	521.00	# Roof Hatches	< 10 SF
Roof Hatches-Medium	N/A	N/A	N/A	720.00	# Roof Hatches	10-20 SF
Roof Hatches-Large	N/A	N/A	N/A	1300.00	# Roof Hatches	20-30 SF
Skylights-Small	N/A	N/A	N/A	521.00	# Skylights	< 10 SF
Skylights-Medium	N/A	N/A	N/A	666.00	# Skylights	10-20 SF
Skylights-Large	N/A	N/A	N/A	873.00	# Skylights	20-30 SF
Penthouses-Small	N/A	N/A	2787.40	5654.00	# Penthouses	4'x10'x8'
Penthouses-Medium	N/A	N/A	5830.00	11330.00	# Penthouses	8'x14'x10'
Penthouses-Large	N/A	N/A	10560.00	21560.00	# Penthouses	20''x20'x10'
Roof Drainage-Exterior	N/A	N/A	N/A	2.20	SF	
Roof Drainage-Interior	N/A	N/A	1.10	N/A	SF	
Windows-Small	198.00	235.00	275.00	550.00	# Windows needing action	<15 SF
Windows-Medium	396.00	451.00	550.00	750.00	# Windows needing action	<30 SF

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
Windows-Large	594.00	649.00	715.00	1300.00	# Windows needing action	>30SF
Window Security Grates	N/A	N/A	82.50	400.00	# Grates needing action	
Exterior Common Doors-Wood	220.00	N/A	1275.00	1500.00	# Doors needing action	
Exterior Common Doors-Metal	220.00	N/A	1275.00	1500.00	# Doors needing action	
Exterior Common Doors-Glass	220.00	N/A	1275.00	1500.00	# Doors needing action	
Unity Entry Doors-Wood	220.00	N/A	665.50	821.70	# Doors needing action	
Unity Entry Doors-Metal	220.00	N/A	737.00	893.20	# Doors needing action	
Unity Entry Doors-Glass	220.00	N/A	929.50	1085.70	# Doors needing action	
Storm/Screen Doors	N/A	N/A	N/A	400.00	# Doors needing action	
Canopies-Small	N/A	253.00	N/A	913.00	# Canopies needing action	6'x4'
Canopies-Medium	N/A	1013.10	N/A	3653.10	# Canopies needing action	6'x16'
Canopies-Large	N/A	3168.00	N/A	11418.00	# Canopies needing action	10'x30'
Exterior Stairways-Wood	385.00	N/A	825.00	2500.00	# Flights needing action	
Exterior Stairways-Concrete	605.00	N/A	1210.00	5005.00	# Flights needing action	
Building Mounted Site Lights	N/A	350.00	N/A	660.00	# Lights needing action	
Fire Escapes	N/A	385.00	N/A	7986.00	# escps*#stories	
Balconies-Wrought Iron	41.00	132.00	N/A	N/A	# Balconies needing action	
Balconies-Wood	44.00	58.00	1425.00	3000.00	# Balconies needing action	
Balconies-Masonry	35.50	126.00	N/A	N/A	# Balconies needing action	
Porches (w/roof)	N/A	990.00	N/A	10000.00	# Porches needing action	
Decks (without roof)	N/A	880.00	N/A	6000.00	# Decks needing action	
Attached Storage Sheds	N/A	440.00	N/A	2500.00	# Sheds needing action	
Vestibules	6.45	N/A	12.00	N/A	Vestibules SF	
Corridors	5.01	7.23	12.78	15.00	Corridors SF	
Stairways	4.59	6.17	15.00	38.94	SF	
Interior Lighting	N/A	1.10	N/A	3.03	SF	
Mail Facilities-Kiosk	N/A	N/A	N/A	120.00	# Mail Boxes needing action	
Mail Facilities-Box	N/A	N/A	N/A	84.96	# Mail Boxes needing action	
Laundry Rooms	3.86	8.15	12.00	31.80	SF	
Laundry Equipment	N/A	220.00	1000.00	1660.00	# pieces of equipment needing action	
Common Rooms	3.86	7.20	N/A	12.00	Common Room -SF	
Common Kitchens	4.62	7.70	N/A	44.00	Common Kitchen -SF	
Underground Garage	0.02	0.77	1.10	N/A		

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
**BME/CME						
Heating Risers	110.00	137.50	192.50	290.00	Units	
Gas Distribution	100.00	175.00	275.00	300.00	Units	
Dom. Hot & Cold Water Distribution	137.50	247.50	400.00	525.00	Units	
Sanitary Distribution-PVC	55.00	110.00	220.00	330.00	Units	
Sanitary Distribution-Cast Iron	137.50	247.50	385.00	495.00	Units	
Fire Sprinkler System	0.28	0.55	2.20	38500.00	SF for minor-major; 1 for replace	
Smoke/Ventilation Control	N/A	0.10	0.15	0.35	Area SF	
Sump Pumps-Residential	N/A	220.00	N/A	550.00	# Sump Pumps	
Sump Pumps-Commercial	N/A	440.00	N/A	1760.00	# Sump Pumps	
Compactors-Small	N/A	1100.00	N/A	5500.00	# Compactors	
Compactors-Large	N/A	1166.00	N/A	11000.00	# Compactors	
Central Vent & Exhaust	N/A	0.83	1.38	2.20	Area SF	
Central Air Conditioning	N/A	1.65	N/A	5.00	Area SF	
Switchgear	N/A	N/A	0.39	1.65	Area SF	
Building Power Wiring	N/A	N/A	N/A	2.70	Area SF	
Emergency Lights	N/A	N/A	N/A	467.50	Bldg Units / 6	
Emergency Generator	250.00	500.00	10000.00	20000.00	# Generators	
Smoke/Fire Detection-Battery	N/A	N/A	N/A	44.00	Bldg Units / 4	
Smoke/Fire Detection-Hardwire	N/A	N/A	N/A	148.50	Bldg Units / 4	
Communication System	N/A	N/A	N/A	1500.00	Bldg Units / 6	
Emergency Call Alarm System	N/A	N/A	N/A	1500.00	Bldg Units / 6	
Master TV Antenna	N/A	N/A	2200.00	4950.00	Bldg Units / 6	
Closed Circuit TV	N/A	N/A	N/A	1500.00	Bldg Units / 6	
Hot Air Furnace	N/A	247.50	742.50	1650.00	Units	
Purchased Steam Supply	N/A	75.00	185.00	740.00	Units	
Solid Fuel Storage	N/A	55.00	185.00	555.00	Units	
Heat Exchanger	N/A	30.00	110.00	210.00	Units	
Cold Water Supply-Pump	N/A	10.00	15.00	25.00	Units	
Cold Water Supply-Soft	N/A	10.00	15.00	25.00	Units	
Cold Water Supply-Both	N/A	15.00	25.00	30.00	Units	

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
****BME/CME (Continued)**						
Boilers-Hot Water	N/A	385.00	605.00	1650.00	Units	
Boilers-Steam	N/A	404.00	635.00	1730.00	Units	
Boiler Room-Piping	330.00	550.00	990.00	1650.00	Units	
Boiler Room-Equipment	220.00	550.00	1100.00	1650.00	Units	
Boiler Room-Controls	N/A	165.00	N/A	660.00	Units	
DHW Generation	55.00	165.00	220.00	275.00	Units	
Elevator Shaftways-Hydraulic	3300.00	4400.00	6600.00	13200.00	# Elevators	
Elevator Shaftways-Hoist	2750.00	3300.00	5500.00	11000.00	# Elevators	
Shaftway Doors	550.00	1650.00	2200.00	3300.00	# Floors	
Cabs	1100.00	2750.00	2750.00	3850.00	# Elevators	
Machinery-Hydraulic	5500.00	11000.00	16500.00	27500.00	# Elevators	
Machinery-Hoist	2200.00	4400.00	6600.00	22000.00	# Elevators	
Interior Construction	10.00	20.00	35.00	65.00	Footprint-SF	

Exhibit C-1: Repair Action Level Cost Elements

SYSTEMS	MINOR	MODERATE	MAJOR	REPLACE	UNIT OF MEASURE	ASSUMPTIONS
****Central Facilities**						
Structure Exterior-Masonry	10.00	20.00	40.00	120.00	Exterior-SF	
Structure Exterior-Plaster	10.00	15.00	35.00	115.00	Exterior-SF	
Structure Exterior-Wood	10.00	15.00	20.00	100.00	Exterior-SF	
Structure Exterior-Vinyl	10.00	15.00	20.00	95.00	Exterior-SF	
Community Room-Interior	10.00	20.00	35.00	65.00	Community Room-SF	
Kitchen Cabinet/Sink/Counter	1800.00	900.00	2200.00	3200.00	# Cabinets	
Kitchen Stove-No Hood	50.00	N/A	550.00	N/A	# Stoves w/out hood	
Kitchen Stove With Hood	75.00	200.00	N/A	750.00	# Stoves w/hood	
Kitchen Refrigerator	N/A	N/A	N/A	950.00	# Refrigerators	
Laundry Room-Interior	10.00	20.00	35.00	85.00	Laundry Room SF	
Laundry Equipment	N/A	150.00	750.00	1250.00	# Pieces	
Mail Facilities-Interior	10.00	20.00	35.00	65.00	Mail Facilities SF	
Mail Equipment-Kiosk	N/A	N/A	N/A	120.00	# Boxes	
Mail Equipment-Box	N/A	N/A	N/A	84.96	# Boxes	
Restroom Sink	225.00	N/A	N/A	500.00	# Sinks	
Restroom Toilet	175.00	N/A	N/A	575.00	# Toilets	
Restroom Accessories	N/A	500.00	N/A	1500.00	# Restrooms	
Restroom Interior	20.00	20.00	70.00	150.00	Restroom SF	
Other Room Interior	10.00	20.00	35.00	65.00	Other Room SF	

metropolitan area, and include parts, labor and contractor fees for the modernization project. Costs do not include soft costs such as design costs, architect and engineering costs, and costs associated with PHA management of the modernization process. Adjustments for locations outside Washington, D.C. and for soft costs are discussed below.

Not all systems have 5 action levels. For example, for refrigerators, the only action is REP, which replaces the refrigerator at a cost of $840. The ***Inspection Manual*** for this study details each allowable action level for each system.

System-Level Costs for the Site and Inspected Units and Buildings

In this step, the inspector's observations and the cost files were combined to calculate, for each property, costs for repair actions on items that have been inspected. A mathematical algorithm was applied to each system the inspector checked off as needing some level of repair. The basic concept is multiplying unit cost by a quantity measure, where the quantity measure may be scaled by a percentage of the item affected.

For example, for windows the algorithm first checks for the size of the windows—small (<15 sf), medium (15-30 sf), or large (>30 sf). For each window size found, the algorithm multiplies the number of windows of that size by the cost element associated with the windows action level noted on the Building Envelope booklet. For example, if a property had 10 small windows requiring MIN action, and 10 small windows requiring replacement, then the immediate repair needs for windows would be $7,480. The calculation is as follows: 10 (number of small windows requiring MIN action) * $198 (the MIN cost for a small window) + 10 (number of small windows requiring REP action) * $550 (the REP cost for a small window). If the windows instead were large, the algorithm would be: 10 * $594 + 10 * $1,300 = $18,940.

A COBOL program was written to process the clean database by relating all the inspection data collection instruments to each other via the HUD Project ID. An immediate repair needs cost was then calculated for each system that required some repair or replace action. When a cost element was on a per square foot basis, the algorithms made use of the takeoff data. Other cost algorithms were based on the number requiring action, as in the case of windows described above. Exhibit C-1 shows the multiplier for each cost element in addition to showing the cost for each action level.

After the per-system costs were calculated, they were grouped together to form system groups. For example, the Building Envelope system group called ***Windows and Doors*** includes the inspection systems: windows, window security grates, exterior common doors, unit entry doors, and storm/screen doors. Exhibit C-2 shows which observable systems are included in each analysis group.

Exhibit C-2
System Groups and the Associated System Components for Physical Needs Estimates

System Group Name	System Component
Unit Interior Construction	Interior Walls-Partitions
	Floors: Sub-base
Unit Interior Finish	Interior Walls-Surface
	Floor Covering: Carpet
	Floor Covering: Resilient
	Interior Doors
	Kitchen Walls
	Kitchen Floor
	Bathroom Walls
	Bathroom Floor
Kitchen Fixtures	Kitchen Cabinet/Counter
	Kitchen Range
	Refrigerator
Bathroom Fixtures	Bathroom Fixtures
	Bathroom Accessories
	Vanities
Unit Heating and Cooling	HVAC units
	Radiation
	Boiler (Unit level)
	Furnace (Unit level)
	DHW Generation (Unit level)
	Temperature Control
	Wall Air Conditioner
Unit Electrical	Electrical Panel
	Electrical Wiring
	Bell/Intercom
	CCTV
	ECAS
	Smoke Detector
Building Exterior Closure	Foundation
	Slab
	Exterior Wall
	Insulation
Roofs	Roof Covering
	Parapet Wall
	Chimney
	Roof Hatches
	Skylight
	Penthouse
	Roof Drainage
Windows and Doors	Windows
	Security Grates
	Exterior Common Doors
	Unit Entry Doors
	Storm/Screen Doors
Exterior Features	Canopies
	Exterior Stairs
	Bldg Mounted Site Lights
	Fire Escapes
	Balconies
	Porches
	Decks
	Sheds
Common Areas	Vestibules
	Corridors
	Interior Stairways
	Interior Lights
	Mail Facilities
	Laundry Rooms
	Laundry Equipment
	Common Rooms
	Common Kitchens
	Underground Garages

- continued -

Exhibit C-2 *(continued)*
System Groups and the Associated System Components for Physical Needs Estimates

System Group Name	System Component
Building Mechanical and Electrical	Heating Risers
	Gas Distribution
	Domestic Hot/Cold Water Dist
	Sanitary Distribution
	Fire Sprinkler System
	Smoke and Ventilation Control
	Sump Pump
	Compactors
	Switchgear
	Building Wiring
	Emergency Lights
	Emergency Generator
	Building Smoke Detector
	Communication System
	Building ECAS
	Master TV Antenna
	Building CCTV
	Cold Water Supply Station
Building Heating and Cooling	Central Vent/Exhaust
	Central Air Conditioning
	Furnace (Building level)
	Purchased Steam
	Fuel Storage
	Heat Exchanger
	Boiler (Building level)
	Boiler Room Piping
	Boiler Room Equipment
	Boiler Room Controls
	DHW Generation
Elevators	Shaftways
	Shaftway Doors
	Cabs
	Machinery
Site Areas	Landscaping
	Roadways
	Parking Lots
	Parking Garages
	Paved Pedestrian Area
	Curbing
	Fencing
	Retaining Wall
	Site Drainage
	Pole Mounted Site Lighting
Site Amenities	Site Furniture
	Yards and Enclosures
	Dumpsters
	Basketball Courts
Site Distribution	Site Electrical Distribution
	Hot Water Distribution
	Domestic Hot Water Lines
	Domestic Cold Water Lines
	Main Water Service
	Gas Lines
	Site Sanitary Lines
	Septic System
	Sewage Ejectors
	Hydrants
Central Mechanical & Electrical Interior Construction	Interior Construction
Central Facilities Interior Construction	Exterior Construction
	Common Room Interior
	Laundry Room Interior
	Mail Facility Interior
	Restroom Interior
	Other Room Interior
Central Facilities Equipment	Kitchen Cabinets
	Kitchen Stoves
	Kitchen Refrigerator
	Laundry Equipment
	Mail Facility Equipment
	Restroom Fixtures
	Restroom Accessories

Property-Level Costs

In order to generate costs for the property as a whole, costs for buildings and units that were not inspected needed to be estimated.[2]

For each property, costs were generated for the residential buildings and units that were *not inspected* based on their relationship to buildings and units that were inspected. During the inspection, the inspector, in conjunction with the property manager, filled out an additional form—the ***Stock Inventory and Quality Distribution*** (SIQD). For each building in the development (whether inspected or not), the inspector recorded the age, overall building quality (excellent, good, fair or poor), the building type (high-rise, walk-up, garden, single-family detached), and a count of units in each size category (0BR/1Bath, 1BR/1Bath, 2BR/1Bath, 2BR/1+Baths, 3BR/1Bath, 3BR/1+Baths, 4BR/1Bath, 4BR/1+Baths, 5BR/1Bath, 5BR/1+Baths) in the building. The form also collected data, at a property level, on how many units overall (without a breakdown at the building level) in each size category fell into each quality category (excellent, good, fair, and poor).

In order to estimate the immediate repair cost for the *uninspected* units, the first step was to compute per square foot costs for each *inspected* dwelling unit (the costs for the inspected units divided by the overall square feet for the particular units). The estimated cost for the uninspected units was then simply their square footage multiplied by the average repair costs of inspected units of the same quality category. This was straightforward because inspectors had recorded average size in square feet for each unit size.

Estimating the costs for uninspected buildings was similar,[3] but more complex because inspectors did not collect square footages of uninspected buildings. In order to be able to apply costs from the inspected sample to the uninspected sample, the costs for the inspected buildings had to be normalized to account for differences in building sizes. We chose to normalize building costs to a per 2-bedroom equivalent. The computation to normalize the inspected building costs was as follows:

1) For each of five samples (housing authorities with fewer than 250 units, New York City, Chicago, Puerto Rico, and all other housing authorities), the overall sample average square feet for each unit size category was calculated as a weighted average of the square footage of all units in all buildings in the analysis sample properties,

2 This is not true for Site Systems because all site elements were inspected.

3 Central Mechanical Building Systems and Central Facility Building Systems were each represented in a single Central Building inspection form and thus uninspected building costs did not need to be estimated.

regardless of whether the building was inspected. The weights were the unit size distributions in each building.

2) The number of 2BR/1Bath equivalent units in each building was calculated as the total square footage of living space in each building divided by the sample's average square footage of a 2BR/1 bath unit.[4] The total square footage of living space was calculated by multiplying the sample average square feet for each unit size by the number of units of that size in the building.

3) Building costs for each inspected building were normalized to a per-2BR cost equivalent by dividing total costs by the number of 2BR equivalent units in the building, thus generating a normalized cost for the inspected building, which could then be applied to the uninspected buildings.

Based on the assumption that buildings or units of the same type within the project will have similar costs, costs for the uninspected units and buildings were generated in one of the following ways:

- ***Same type-same quality***. If the inspection included a building of the same type and quality as the uninspected building, the normalized 2BR equivalent cost (in the inspected building) was multiplied by the number of 2BR equivalent units in the uninspected building to produce the uninspected building's cost. Similarly, if the inspection included a unit of the same size and quality as the uninspected unit, its per square foot cost was multiplied by the total square feet of the uninspected unit to generate the cost for that uninspected unit.

- ***Same type-different quality.*** Ratios between quality categories within building type were calculated using the normalized costs for the inspected buildings. If multiple inspected buildings of the same type but with different quality existed for the project, the inspected building with the closest quality was used as a cost reference point. (Inspected buildings with poorer qualities were chosen if a choice needed to be made. In other words, if a Good high-rise needed to be costed and both an Excellent and a Fair high-rise had been inspected, the Fair high-rise would have been chosen as the reference point.) Once the inspected reference point was chosen, the normalized 2BR equivalent cost was first multiplied by the sample average ratio between the costs for the uninspected and inspected qualities for that building type, where, as noted above, averages were calculated for each of 5 samples. In the above example, the normalized 2BR equivalent cost for the Fair high-rise would have been multiplied by the ratio

4 The weighted average square footage of a 2 bedroom 1 bath unit was 772.8 SF in housing authorities with fewer than 250 units, 698.6 SF in New York City, 772 SF in Chicago, 678.2 SF in Puerto Rico, and 731.5 in all other housing authorities.

between the average for a Good high-rise and the average for a Fair high-rise within that HA's size category. Next, the cost was multiplied by the appropriate factor[5] for the uninspected building.[6] For units, the quality ratios were calculated between the sample average per-square foot costs for each quality category. The inspected unit with the closest quality was chosen as the cost reference point and its normalized per-square foot cost was first multiplied by the appropriate quality ratio and then by the total square feet for the inspected units.

- ***Different building type***.[7] If the inspection included no building of the same type, the ratio between the project cost and the appropriate sample's average cost for inspected buildings was applied to the sample's average cost for the type being costed. This ratio equals the sum of the actual inspected normalized costs for the project divided by the sum of the sample's weighted costs (i.e., the costs for the inspected buildings using the sample average costs for the inspected type/quality categories). To cost buildings with types different from those inspected in the project, the sample's averages for the uninspected type and quality were multiplied first by this project-to-sample ratio, and then by the appropriate factor (number of 2BR equivalent units) for the uninspected building being costed. For example, if a Good high-rise existed in a project for which only Poor walk-ups had been inspected, a project-to-sample ratio would have been calculated by dividing the sum of the inspected Poor walk-up building costs by the sample's average for a Poor walk-up multiplied by the number of 2BR equivalents for each inspected building in the project. The sample average for a Good high-rise would then be multiplied by this project-to-sample ratio, and then multiplied by the number of 2BR equivalents in the Good high-rise being costed.[8]

- ***Same quality-different bedroom size.*** If an inspected unit had the same quality as an uninspected unit but was of a different size, the per-square foot cost of the inspected unit in that quality category was simply multiplied by the total square feet of the uninspected unit.

- ***Different quality-different bedroom size.*** If a unit had not been inspected within the quality category of the uninspected unit, the average per-square foot cost for all inspected units in the property was used to estimate costs of the uninspected unit.

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5 For buildings, the factor is the number of 2BR equivalents discussed above.

6 Overall, there were 19 properties that required estimating building costs for the same type but different quality buildings.

7 Based on the inspection protocol, this occurrence was rare, arising only when a property contained a great diversity of building types and quality levels.

8 Calculating building costs for different building types was required in 45 properties. Of the 45, more than half involved calculating the costs for single-family buildings using garden apartments as the base.

Adjustments to the Property-Level Cost Numbers for Locations and for Soft Costs

The cost element numbers created by A.M. Fogarty & Associates, Inc. were based on current costs for the Washington, D.C. area. Using the R.S. Means "Location Factors" from the Means Square Foot Costs Book for 1998, the property-level costs were adjusted by multiplying them by the ratio of the R.S. Means Index for the city where the property is located to the R.S. Means index for Washington, D.C. (which is 0.94). For example, the computed cost for a New York City property would be multiplied by 1.4255 (which is the New York-to-Washington, D.C. index ratio, 1.34 / 0.94).

The costs elements include all parts, labor, and contractor fees for modernization. The cost elements do not include soft costs such as design costs and architect and engineering fees, and do not include PHA costs for managing the modernization projects. ***To account for these costs, all capital needs estimates are inflated by a factor of 17 percent—7 percent for soft costs, and 10 percent for PHA management costs.***

II. Existing Modernization Needs

Existing modernization needs are the costs associated with bringing the property to a condition where it provides decent and sustainable housing with modest amenities. This includes repairing and replacing some systems, upgrading some systems, adding others, and replacing all systems that have reached the end of their useful life.

In addition to assessing the current physical condition of the properties, the inspectors recorded in the inspection booklets information on the *physical* feasibility of upgrading certain observable systems to ensure decent and sustainable housing with modest amenities. The inspector rated the feasibility of upgrading the property by adding amenities or improving the quality of materials in an existing system.

If the property was already in decent sustainable condition with modest amenities, no upgrade feasibility analysis was necessary. In addition, if the layout or size of the buildings or units was not conducive to the upgrades needed, the property was deemed infeasible for the system upgrade.[9]

Existing modernization costs are calculated several different ways, depending on the system. For some systems the existing modernization cost is the same as the immediate repair cost required to restore the system to working condition. For some systems modernization involves modest

9 Thus, the absence of an upgrade portion of existing modernization cost is either the result of infeasibility or the fact that the property is already in decent sustainable condition. In fact, however, in nearly all cases where upgrade was noted as required, it was also feasible.

upgrades beyond the immediate repairs, and for some systems modernization involves additions to the systems. In addition, systems that are beyond the end of their useful life are replaced, even if they are still in working order.

An example of a system where the modernization cost equals the immediate repair cost is "roadways." The modernization cost for roadways would be repairing and replacing deteriorated portions of the roadways.

Systems that may require upgrading even if no immediate repairs are required include kitchens, bathrooms, and windows. Even if these systems are in working order, modest upgrades may be required to make the housing decent and sustainable with modest amenities.

Systems that may require additions as part of existing modernization needs include parking areas, central air conditioning, window grates, and basketball courts. These systems may or may not be present initially. More parking spaces or central air conditioning may be needed to make the housing decent and sustainable with modest amenities.

Systems that have reached the end of their useful life should be replaced as part of the existing modernization even if they are still in working order. For example, a unit boiler that is over 25 years old may still be in working order, but is likely to fail soon and should be replaced.[10]

Some system costs are "additive" to the immediate repair cost—the immediate repair would still have to occur before upgrading the system. An example is landscaping. If the immediate repair action requires a portion of the current landscaping to be reseeded, this would have to occur regardless of the landscaping upgrade that adds more shrubs and trees.

Other systems have "instead of" costs. This means that the immediate repair action would not occur if the system were being upgraded. For example, there would be no reason to repair windows that were being upgraded as part of the modernization. Exhibit C-3 lists for each system that can be upgraded, whether its associated cost is additive to, or replaces the immediate repair cost.

Some of the systems can be either "additive" or "instead of" costs. For example, if yards and enclosures are added, the immediate repair costs are "additive." If yards and enclosures are upgraded, the immediate repairs are "instead of."

10 Our original costing system did not include replacing "over-age systems" as a part of existing modernization needs. Instead they were addressed as part of the first-year of accrual. In order to estimate this component of existing modernization needs we took the difference between the first-year accrual costs and the average accrual costs for years 2 through 20, assuming that the average over years 2 through 20 represents normal accrual, and the difference between the two numbers represents the portion of the first year's accrual that can be attributed to over-age systems.

Exhibit C-3
Listing of Upgrade Systems and Whether the Associated Costs Are "Additive" or "Instead of" the Immediate Repair Costs

Additive Systems[1]	**Instead of Systems**[2]
Landscaping	Parking
Site Furniture (Add)[3]	Site Lighting
Yards and Enclosures (Add)	Yards and Enclosures (Upg)[4]
Playground/Tot Lot	Site Furniture (Upg)
Paved Pedestrian Area	Exterior Wall
Fencing	Windows
Retaining Wall	Exterior Common Doors
Basketball Court	Vestibules
Dumpsters	Corridors
Pitched Roofs	Laundry Facilities
Exterior Stairs	Common Rooms
Building Mounted Site Lights	Central Air Conditioning (Upg)
Porches	Communication System (Upg)
Decks	ECAS (Upg)
Attached Storage Sheds	CCTV (Upg)
Interior Stairways	Unit Interiors
Window Security Grates	Unit Kitchen
Storm Door	Unit Bathrooms
Canopies	
Balconies	
Central Air Conditioning (Add)	
Communication System (Add)	
ECAS (Add)	
CCTV (Add)	

1 "Additive" systems are those systems whose costs are "additive" to the immediate repair cost—the immediate repair would still have to occur before upgrading the system.
2 "Instead-of" systems are those systems whose costs are "instead of" costs, meaning the immediate repair action would not occur if the system were being upgraded.
3 (Add) means that the system does not exist and needs to be added.
4 (Upg) means that the system exists presently but needs to be upgraded.

The method of calculating modernization costs is similar to that used for immediate repair costs. Cost elements were derived by A.M. Fogarty & Associates, Inc. Exhibit C-4 lists these elements for each system as well as the dimensional multiplier. Systems can be upgraded or added. Unit systems are upgraded as a system group rather than individually, with levels of some systems, all systems, and rehab. For example, for kitchens, upgrading "some systems" includes replacing the cabinet, countertop, sink, range, and refrigerator. Upgrading "all systems" includes replacing the systems mentioned under "some systems" plus replacing the walls and floor. "Rehab" includes replacing those systems mentioned under upgrading "all systems" plus moving partitions and rebuilding walls.

Exhibit C-4: Modernization System Elements				
UPGRADE COSTS	**UPGRADE**	**ADD**	**UNIT OF MEASURE**	**ASSUMPTIONS**
*****SITE UPGRADES**				
Landscaping	0.75		Landscape-SF	
Parking	2.08	750.00	Parking-SF;# of new spaces	360 SF per space
Site Lighting	2000.00	3500.00	# Poles	
Site Furniture	250.00	250.00	# Units/UPG; # site units divided by 6 for add	
Yards and Enclosures	485.00	1150.00	# Yards or # Site Units	400 SF
Playground/Tot Lot		50000.00	1 Playground/Tot Lot	
Paved Pedestrian Area		4.50	SF to add	
Fencing		30.00	LF to add	
Retaining Wall		200.00	LF to add	
Basketball Courts		15000.00	1 per project	
Pitched Roofs		25.00	Footprint of buildings to get roofs	
Dumpsters		7000.00	# to add	
*****ENVELOPE UPGRADES**				
Ext Wall-Plaster	10.00		Ext Wall-Plaster:SF	
Ext Wall-Wood	7.75		Ext Wall-Wood:SF	
Ext Wall-Vinyl	5.50		Ext Wall-Vinyl: SF	
Windows-Small	550.00		# Small Windows	
Windows-Medium	750.00		# Medium Windows	
Windows-Large	1300.00		# Large Windows	
Common Doors	1500.00		# Common Doors	
Exterior Stairs	2500.00		# Stairs	
Bldg Mtd Site Lights		660.00	# Bldg Units divided by 6	
Porches		10000.00	# To Add	8'x16'
Decks		6000.00	# To Add	8'x16'
Storage Sheds		2500.00	# To Add	
Vestibules	12.00		Vestibule-SF	10'x12'
Corridors	15.00		Corridor-SF	6' wide
Stairs	15.00		If Avail: Int Stair-SF; Else 160 times # Stories	

Exhibit C-4: Modernization System Elements

UPGRADE COSTS	UPGRADE	ADD	UNIT OF MEASURE	ASSUMPTIONS
***ENVELOPE UPGRADES (Cont'd)				
Laundry Room	12.00		SF of Laundry Room	
Laundry Equipment	1000.00	1000.00	# Pieces Laundry equipment (Add: # site units divided by 20 net # existing pieces of equipment)	
Common Rooms	12.00		Common Room-SF	
Security Grates		400.00	# Grates to Add	
Storm Door		400.00	# to Add	
Canopies		2500.00	# to Add	
Balconies		3000.00	# to Add	

***BME UPGRADES				
Central Air Conditioning	5.00	5.25	Bldg Gross Area-SF	
Communication System	1500.00	1500.00	Bldg Units/6	
Emer Call Alarm System	1500.00	1500.00	Bldg Units/6	
Closed Circuit TV	1500.00	1500.00	Bldg Units/6	

UPGRADE COSTS	UPG-SOME	UPG-ALL	REHAB	UNIT OF MEASURE	ASSUMPTIONS
***UNIT UPGRADES					
Interior (ex kitchen, bath)	5.00	14.00	38.00	Total Unit SF-(kit, bath SF)	
Kitchen	5180.00	7680.00	15180.00	1 per unit	
Full Baths	1700.00	2750.00	5500.00	# Full baths	
Half Baths	1100.00	1625.00	3150.00	# Half baths	

After the costs are calculated for the inspected site, units, and buildings, costs are generated for the full property (including uninspected units and buildings) using the same procedures followed for costing immediate repair needs.

- Building upgrade costs for inspected buildings are normalized to a per 2 bedroom equivalent, and unit upgrade costs are normalized to a per square foot cost;
- Costs are generated using one of the five methods[11] that were outlined above for immediate repair needs costs except that the quality ratio that is used for the same type/different quality method is only applied to the portion of the cost that represents the immediate repair needs. Costs to upgrade and add systems are not adjusted by the quality ratio; and
- Adjustments for locations and for soft costs are applied as discussed above.

As part of our data cleaning process, we capped the upper limits for the site-, building-, and unit-level immediate repair needs and existing modernization costs to eliminate the extreme outliers prior to applying the soft costs. This affected only a few properties. Exhibit C-5 presents the limits and the number of properties affected by the cap.

Inspectors ***did not*** make any observations relating to:

- detecting or abating special hazards such as presence of asbestos or lead paint;
- modifications for accessibility for the disabled; or
- improvements for increasing energy efficiency.

Thus, our initial cost estimates did not include these repairs. Costs for these additional components of modernization needs were added to the national estimates based on available data on incidence and costs for each component. In addition, costs for routine maintenance items such as maintaining elevators, or cleaning gutters and chimneys, replacing missing outlets and light fixtures were not included in the cost estimates.

11 Same type-same quality; same type-different quality; different type building, same quality/different bedsize, different quality/different bedsize.

Exhibit C-5: Outlier Caps

Category	Family (Per-Unit) Cap	Family Number Affected	Elderly (Per-Unit) Cap	Elderly Number Affected
Immediate Repair Needs[a]				
Site	15,000	4	5,000	2
Building	7,500	4	7,000	3
Unit	7,500	8	5,000	2
CME	10,000	1	NA	
Existing Modernization Costs[b]				
Site	25,000	6	7,500	3
Building	20,000	5	10,000	5
Unit	25,000	7	25,000	3

a Immediate Repair Needs are the costs needed to repair or replace systems that are not in working order.
b Existing Modernization Needs are the costs needed to provide decent and sustainable housing with modest amenities.

Puerto Rico Upgrades and Additions

The housing stock in Puerto Rico is very different from the rest of the sample. In order to make it more comparable to the rest of the public housing stock, each property in Puerto Rico was assigned the following upgrades and additions in the cost estimates:

- Building Envelope system window upgrades
- Unit system window air conditioners, if absent
- Unit system domestic hot water generators, if absent
- Unit system range, with hood, if absent
- Unit system refrigerator, if absent.

III. Estimating Accrual of Repair and Replacement Costs

Accrual cost estimates are the total amount a property will need to cover expected repairs and replacements for each Observable System over each of the next 20 years. Each system was given either a repair or a replacement cost depending upon the standard wear of the system. For example, boilers are expected to be replaced after a certain number of years, but landscaping only needs periodic maintenance. Some systems were deemed inappropriate for accrual estimates

because they generally will not need replacement or standard maintenance over the 20-year horizon used for this study. An example is the site-level domestic hot water lines. Over time, a portion of the lines may need to be replaced, but this is not an expected occurrence. The repair or replacement system cost is based on the same algorithm used for the immediate repair needs costings.

In addition to a repair/replacement cost, each accrual system was assigned an expected useful lifetime (or in the case of items which will be repaired, "action-intervals" are assigned).[12] For systems requiring replacement over time, the useful life is the age the system is expected to be when it must be replaced because it is worn-out or approaching failure. Boilers are expected to last 25 years. This is the expected life for the boiler systems. Site landscaping is not expected to wear out, but will need to be reseeded and replanted every 8 years. This is the action interval (rather than expected life) for landscaping. Exhibit C-6 lists for each system involved in accrual, the action level appropriate to accrual, and the useful life (or action interval). Useful lives for some of the systems differ based on the residential composition of the units. For example, for some systems such as doors or common kitchens, action intervals depend on property occupancy—they are shorter for family developments than for elderly developments. For other systems, such as yards and fencing, useful lives are shorter in high-density family buildings than low-density family buildings. For some unit systems, such as kitchen appliances and flooring, useful lives were greater the number of bedrooms (and, typically, occupants in the unit). The action intervals were defined in consultation with the Negotiated Rulemaking Committee that discussed the Capital Need Formula from March to August 1999.

For each of the next 20 years, for each accrual system, we tested whether the system would reach the end of its useful life (or action interval) that year.[13] As the starting point, we used the system ages where they were collected by the inspector; otherwise, we estimated system age to be the average age of the buildings in the project. We assumed, however, that any system that needed to be replaced as part of the existing modernization, was indeed replaced. Therefore, the age of such systems was set back to zero. In addition, we assumed that if a moderate or major repair action occurred as part of the repair of immediate needs, then the system age was also reset to zero. (Exceptions to this rule are pole-mounted lighting, emergency generators, hot air furnaces, sheds,

12 The basic reference for expected lives was Appendix B, "Accrual Actions and Expected Lives" from *Future Accrual of Capital Repair and Replacement Needs of Public Housing, Final Report*, prepared for HUD by ICF, Inc., April 1989 as an update of the Abt Associates Inc. public housing study (Dixon Bain et al., *Study of the Modernization Needs of the Public and Indian Housing Stock* (Cambridge, MA: Abt Associates Inc., March 1988). Abt Associates Inc. staff experienced in conventional residential building construction and management altered these lifetimes for some systems. HUD staff and members of the Negotiated Rules Making Committee further refined the expected life tables.

13 As discussed above, a portion of the first year's accrual was added to the estimate of existing modernization needs to account for over-age systems. Thus, the accrual estimates used in the analysis cover only years 2 through 20, since the first-year accruals is now assumed to be the average across those years.

porches, and decks, where only major repairs or system replacement reset age to zero.) The age was then increased for each accrual year. In any year that a system's accrual age equals its expected life, then the repair/replace cost was added into the accrual total for that year. The accrual yearly totals were calculated on the sites, units, and buildings that were actually inspected. These costs were then scaled up to reflect the total property. Accrual costs were scaled to property totals based on the proportion of the property's total square footage the inspected units and buildings represented. The property totals were then regionally adjusted as discussed previously, and the adjustment for soft costs and PHA management costs was made. Accrual costs were based on 1998 current dollars.

Exhibit C-6
Life Expectancies and Repair/Replace Action Levels for Accrual Systems

System	Life Expectancy: Elderly	Life Expectancy: Family—Low Density[a]	Life Expectancy: Family—High Density	Repair Action Level
Site Systems				
Landscaping	8	8	6	MIN
Roadways	20	20	16	MAJ
Parking Lots	20			MAJ
Parking Garages	20			MAJ
Paved Pedestrian	20	20	16	MAJ
Curbing	20			MAJ
Fencing-Chain Link	20	20	16	REP
Fencing-Wrought Iron	30	30	24	REP
Fencing-Wood	15	15	12	REP
Fencing-Concrete	30	30	24	REP
Retaining Walls-Concrete	20			MOD
Retaining Walls-RR Ties	15			MOD
Site Drainage	20			MOD
Pole Mounted Lighting	20			MAJ
Site Furniture	15	15	12	REP
Yards and Enclosures	20	20	16	REP
Dumpster	15	15	12	REP
Basketball	15	15	12	MOD
Domestic Hot Water Distribution	40			REP
Domestic Cold Water Distribution	40			REP
Sewage Ejector	25			REP
Building Systems				
Building Foundation	50			MIN
Exterior Wall	10			MIN
Roof-Membrane	25			MAJ
Roof-Shingles	25			MAJ
Roof-Builtup	25			MAJ
Roof Covering-Tile	30			MAJ
Roof Covering-Metal	30			MAJ
Parapet Wall	10			MOD
Chimney	25			MIN
Penthouse	25			MAJ
Roof Drainage	25			REP
Windows	40	30	30	REP
Security Grates	40			REP
Ext Common Door	30	20	16	MAJ
Unit Entry Door	30	20	16	MIN
Storm/Screen Door	15	10	8	REP
Canopies	20			MOD
Exterior Stairs	20	16	16	MIN

a The Family designator was split into high and low density at the property level with low density defined as fewer than 10 units per building and high density as 10 or more units per building.

Exhibit C-6 *(continued)*

System	Life Expectancy: Elderly	Life Expectancy: Family—Low Density[a]	Life Expectancy: Family—High Density	Repair Action Level
Bldg Mounted Site Lights	12	10	8	MOD
Fire Escapes	8			MOD
Balconies	40			REP
Porches	40			REP
Decks	25			REP
Sheds	40			REP
Vestibules	10	8	8	MIN
Corridors	10	8	8	MAJ
Stairways	10	8	8	MIN
Interior Lights	25	20	16	MOD
Mail Facilities	30	15	12	REP
Laundry Rooms	15	10	8	MOD
Common Rooms	10	8	8	MOD
Common Kitchen	25	15	12	MOD
Underground Garage	20			MAJ
BME Systems				
Heating Riser	30			MOD
Gas Distribution	40			MOD
Dom Hot/Cold Water	30			MAJ
Sanitary Dist	10			MIN
Fire Sprinkler System	20			MIN
Sump Pump	10			REP
Compactor	15	10	10	REP
Central Vent/Exhaust	25			MAJ
Central Air	20	15	15	REP
Emergency Lights	35			REP
Smoke Detector (Hardwired)	30	20		REP
Communication System	30			REP
Building ECAS	30			REP
Building CCTV	30			REP
Building Furnace	25			REP
Building Boiler	25			REP
Boiler Room Piping	50			REP
Boiler Equipment	25			REP
Boiler Room Controls	25			REP
DHW Generation	15			REP
Shaftway Doors	20	15		REP
Elevator Cabs	30	15		REP
Elevator Machinery	30	25		REP
Emergency Generator	35			REP
Purchased Steam Supply	30			MAJ
Heat Exchanger	35			MAJ
Cold Water Supply	30			REP

Exhibit C-6 *(continued)*

Unit Systems	Small Bedroom (0-1 BR)	Medium Bedroom (2 BR)	Large Bedroom (3 or more BR)	
Unit-Carpet	10	7	6	REP
Unit-Floor Resilient	20	15	12	MAJ
Kitchen Floor	15	10	8	MAJ
Kitchen Cabinet	20	15	12	REP
Kitchen Range	20	15	12	REP
Refrigerator	18	12	12	REP
Bath Floor-Ceramic	50	35	28	REP
Bath Floor-Resilient	20	10	8	MAJ
Bath Fixtures	30	20	16	REP
Bath Accessories	30	15	12	REP
Bath Vanities	30	15	12	REP
Unit HVAC	20			REP
Radiation[b]	25	20	20	REP
Unit Boiler	25			REP
Unit Furnace	20			REP
Unit DHW Generation	10			REP
Temperature Control	25			REP
Wall/Air Conditioner	15	12	12	REP
Bell/Intercom	30	20	20	REP
Unit CCTV	30			REP
Unit ECAS	30			REP
Unit Smoke Detector (Hardwired)	30	15	15	REP

b Electric only.

Appendix D:
Coefficients of Recommended Models

This appendix describes the set of recommended models for estimating inspection-based existing modernization needs and accrual needs. Regression coefficients of the need predictors are shown in Exhibit D-1 and Exhibit D-2.[1]

The signs and magnitudes of the regression coefficients associated with most of the needs predictors are largely consistent with conventional wisdom and our expectations. Due to collinearity between some of the predictor variables, it is difficult to interpret a few of the estimated coefficients in the models. For instance, coefficients for the R.S. Means cost adjustment factor and some of the region variables have signs (positive or negative) whose interpretations are not readily obvious. Also, the magnitude of some of these coefficients varies drastically across models. They might capture effects that are not directly measured by other variables in the models. However, the inclusion of these predictors in the models is crucial, because they capture the unobservable heterogeneities among the developments and prevent these from biasing the other predictor estimates in the models.

We do not intend to interpret every coefficient here. Rather, we will discuss some of the important ones presented in Exhibit D-1 and Exhibit D-2.

For existing modernization needs, the major findings are as follows:

- Overall, judging from the level of precision of the coefficient estimates, the average number of bedrooms per unit in a development is the major predictor for existing modernization needs. Everything else being equal, one additional bedroom per unit raises per-unit existing modernization needs by about $2,812 for developments in housing authorities with fewer than 250 units and $4,776 for housing authorities with 250 or more units.

1 The regression coefficients were estimated with the Weighted-Least-Square (WLS) procedure, using the sample weights. WLS, rather than Ordinary-Least-Square (OLS), is preferable because it can reduce the possible biases caused by the sampling scheme (i.e., design effects) and missing regressors. WLS is especially pertinent if the sample selection probability is correlated with the dependent variable in the model—in this study, we have over-sampled developments with high capital needs. For details, see Phillip S. Kott, 1991, "A Model-Based Look at Linear Regression with Survey Data." *The American Statistician*, Vol. 45(2): 107-112; William H. DuMouchel and Greg J. Duncan, 1983, "Using Sample Survey Weights in Multiple Regression Analyses of Stratified Samples." *Journal of the American Statistical Association*, Vol. 78 (383): 535-543. In addition, to correct for heteroscedasticity in the regression model's error terms introduced by the sample weights, we reported the Huber-White robust standard errors. Halbert White, 1980, "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity." *Econometrica*, Vol. 48: 817-838.

Exhibit D-1: Recommended Models for Predicting Capital Needs: Regressions (weighted) of Per-unit Inspection-Based Existing Modernization Needs

Model 1-a			
Developments in Housing Authorities with Fewer than 250 Units			
Predictor	**Coefficient**		**Standard Error[a]**
Average Number of Bedrooms per unit	2,812.4	*	1,574.7
Total Number of Units at the Development	10.9		41.2
Building Age > 20 years	1,749.3		2,585.5
R.S. Means Location Adjustment Factor	-32,183.0	**	12,271.2
Non-metropolitan Location	3,155.6		2,756.3
South Census Region	2,801.0		3,759.9
West Census Region	3,892.2		4,430.9
Midwest Census Region	-938.2		3,302.1
Constant	34,650.5	**	14,584.6
Number of observations from Inspection Sample:	126		
R-squared Statistic:	0.20		
Developments in Housing Authorities with More than 250 Units			
Predictor	**Coefficient**		**Standard Error[a]**
Average Number of Bedrooms per unit	4,775.5	***	713.8
Total Number of Units at the Development	9.7	***	2.8
Building Age > 20 years	5,528.5	***	1,537.7
R.S. Means Location Adjustment Factor	-7,571.4		8,713.9
Non-metropolitan Location	3,581.4	*	1,877.1
South Census Region	110.8		2,447.7
West Census Region	-518.7		1,976.1
Midwest Census Region	346.2		1,771.4
Constant	9,637.5		10,136.6
Number of observations from Inspection Sample:	442		
R-squared Statistic:	0.16		

Notes: [a] Huber-White robust standard errors are used to correct for heteroscedasticity introduced by sample weights.
*** Statistically significant at the 99 percent level.
** Statistically significant at the 95 percent level.
* Statistically significant at the 90 percent level.
Northeast Census Region is the reference category.
Excludes developments of New York City, Chicago, and Puerto Rico housing authorities in the inspection sample.

Exhibit D-2: Recommended Models for Predicting Capital Needs: Regressions (weighted) of Per-Unit Inspection-based Average Annual Accrual Needs

Model 3-a			
Developments in Housing Authorities with Fewer than 250 Units			
Predictor	**Coefficient**		**Standard Error[a]**
Average Number of Bedrooms per unit	227.2	*	119.1
Low-Density Factor	170.3	***	41.8
Building Age	-8.6	**	4.0
Family Occupancy Type	132.0		200.6
R.S. Means Location Adjustment Factor	-1,054.6	**	525.6
Non-metropolitan Location	-119.3		93.6
South Census Region	-420.6	**	187.0
West Census Region	133.4		174.4
Midwest Census Region	-311.8	*	163.4
Constant	2,684.0	***	594.7
Number of observations from Inspection Sample:	126		
R-squared Statistic:	0.45		
Developments in Housing Authorities with More than 250 Units			
Predictor	**Coefficient**		**Standard Error[a]**
Average Number of Bedrooms per unit	328.8	***	55.9
Low-Density Factor	96.2	***	21.7
Building Age	-7.7	***	2.0
Family Occupancy Type	173.3		108.4
PHA with More than 6,600 Units	-141.2	**	61.3
R.S. Means Location Adjustment Factor	-202.2		345.6
Non-metropolitan Location	-114.6	*	66.6
South Census Region	37.1		101.1
West Census Region	-96.7		79.4
Midwest Census Region	63.4		68.3
Constant	1,306.9	***	391.0
Number of observations from Inspection Sample:	442		
R-squared Statistic:	0.45		

Notes: [a] Huber-White robust standard errors are used to correct for heteroscedasticity introduced by sample weights.
*** Statistically significant at the 99 percent level.
** Statistically significant at the 95 percent level.
* Statistically significant at the 90 percent level.
Northeast Census Region is the reference category.
Excludes developments of New York City, Chicago, and Puerto Rico housing authorities in the inspection sample.

- As expected, building age has an impact on the per-unit existing modernization needs, especially for properties in housing authorities with 250 or more units. We found that developments in such housing authorities with a building age of at least 20 years are, on average, associated with $5,529 more in existing modernization needs per unit, compared with newer properties with similar attributes.

- Every additional unit in a development tends to raise per-unit existing modernization needs by approximately $10 holding all other characteristics constant.

For accrual needs models, the major findings are as follows:

- Every additional bedroom increases per-unit accrual needs by about $227 for developments in housing authorities with fewer than 250 units and $329 for housing authorities with 250 or more units, holding all other factors constant.

- Another important determinant of per-unit accrual needs is the low-density factor, which measures the extent to which the buildings in a development average fewer than 5 units. (In computation, it is calculated as 5 minus the number of units per building, with resulting values below zero set to zero.) It serves as a proxy for the impact of scattered-site projects on capital needs.

- Developments in very large housing authorities (more than 6,600 units) tend to be associated with a lower ($136) per-unit accrual need, everything else being equal. This finding is consistent with the univariate results reported in Exhibit 2-1 of Chapter Two, and probably reflects the fact that properties in those housing authorities are mostly equipped with relatively old building systems, which need to be replaced as part of the modernization effort. Thus in the first few years following modernization, accrual needs are relatively low.

The recommended models use exactly the same set of need predictors recommended to HUD for the Negotiated Rule-Making Committee Meetings held in the summer of 1999. The model coefficients reported here, however, made use of a more complete and up-to-date database. Specifically, we have updated the information of one data element (i.e. the non-metropolitan location status of each sample property). This increased the usable sample from 525 to 568 properties. The sample of small PHAs increased from 95 to 126 properties, and the sample of large PHAs from 430 to 442. The models now yield estimates that are more robust. The resulting coefficient estimates are slightly different from those reported to the HUD Negotiated Rule-Making Committee Meeting. But, overall, these differences are essentially negligible and show no material impact in terms of potential funding allocation by housing authority size categories. As an illustration, Exhibits D-3 and D-4 compare the estimates of existing modernization needs and accrual needs by housing authority size category at the per unit (Exhibit D-3) and total (Exhibit D-4) levels. As the exhibits show, in each size category the differences are very small.

Exhibit D-3: Comparison of Per-Unit Model-Based Capital Need Estimates For the 1999 CGP/CIAP Universe

Public Housing Authority Size	Total Units[a]	Per-Unit Existing Modernization Needs		Per-Unit Average Annual Accrual Needs	
		Negotiated Committee	Final Estimate	Negotiated Committee	Final Estimate
Less than 250 units	203,687	$12,613	$12,658	$1,800	$1,772
250 to 1,249 units	336,648	$16,931	$17,017	$1,648	$1,649
1,250 to 6,600 units	342,266	$18,466	$18,488	$1,671	$1,671
More than 6,600 units[b]	204,533	$23,060	$23,069	$1,557	$1,564
New York City[c]	160,209	$22,967	$22,967	$1,886	$1,886
Chicago[c]	38,788	$26,852	$26,852	$1,381	$1,381
National Total	1,286,131	$18,681	$18,718	$1,685	$1,682

a Unit counts based on the HUD Master Universe file for June 1999.

b Excluding units in New York City and Chicago housing authorities, but including units in Puerto Rico.

c Estimates based on unit counts from the HUD Master Universe file and per-unit need estimates from the inspection sample.

Exhibit D-4: Comparison of Total Model-Based Capital Need Estimates For the 1999 CGP/CIAP Universe

Public Housing Authority Size	Total Units[a]	Existing Modernization Needs		Average Annual Accrual Needs	
		Negotiated Committee	Final Estimate	Negotiated Committee	Final Estimate
Less than 250 units	203,687	$2,569,050,926	$2,578,361,860	$366,589,692	$360,953,187
250 to 1,249 units	336,648	$5,699,825,179	$5,728,615,775	$554,899,118	$555,179,453
1,250 to 6,600 units	342,266	$6,320,392,072	$6,327,732,638	$571,863,881	$571,954,000
More than 6,600 units[b]	204,533	$4,716,478,018	$4,718,442,859	$318,365,398	$319,871,450
New York City[c]	160,209	$3,679,503,620	$3,679,503,620	$302,163,581	$302,163,581
Chicago[c]	38,788	$1,041,543,510	$1,041,543,510	$53,555,225	$53,555,225
National Total	1,286,131	$24,026,793,325	$24,074,200,262	$2,167,436,895	$2,163,676,896

a Unit counts based on the HUD Master Universe file for June 1999.

b Excluding units in New York City and Chicago housing authorities, but including units in Puerto Rico.

c Estimates based on unit counts from the HUD Master Universe file and per-unit need estimates from the inspection sample.