CHAPTER FOUR
ECONOMIC IMPACT ANALYSIS METHODOLOGY

4.1 OVERVIEW OF ECONOMIC IMPACT ANALYSIS METHODOLOGY

This chapter presents EPA's methodology for analyzing the economic impacts of the Final Action covering the C&D industry. EPA has employed a number of different methods for assessing the economic impacts of the Final Action. EPA's approaches include modeling systems that analyze impacts at the industry level and national level. The industry-level analyses model the construction project and individual firm, and the national level analyses model national construction markets and the national economy as a whole.

As discussed in detail in Chapter Three, EPA's analyses focus on the impacts of three options: Option 1, Option 2, and Option 4. Option 1 requires enhanced inspection and BMP certification for all sites 1 acre or greater, but does not involve codifying provisions of the EPA CGP. Option 2 involves codifying provisions of the EPA CGP (the CGP component) with enhanced inspection and BMP certification provisions (the inspection and certification component) for sites with 5 or more acres of disturbed land. Option 4 also involves codifying provisions of the EPA CGP for sites with 5 or more acres of disturbed land, but does not include the enhanced inspection and BMP certification provisions. Option 2 is the same as Option 2 at proposal, while Option 4 is developed as a modified Option 2 (See Chapter Three, Table 3-1). Option 3 would not establish new regulations, but would instead continue to rely on the existing NPDES stormwater regulations (EPA's no-action alternative). EPA's analysis of Option 3 is, therefore, equivalent to a regulatory baseline analysis.

This introduction presents the assumptions EPA uses to develop a regulatory baseline in Section 4.1.1. Section 4.1.2 describes the incremental compliance costs that are presented in EPA's Technical Development Document (U.S. EPA, 2004) and summarizes how they were estimated. Section 4.1.3 provides an overview of the analyses in this EA report and discusses how EPA uses the incremental compliance costs in each of the analyses. The section also provides a "road map," listing the location of detailed discussions of the methodologies for each analysis.

4.1.1 The Regulatory Baseline

To measure impacts of any regulatory action, EPA first generally establishes a baseline against which to measure the incremental effects of a regulation. EPA's standard practice in developing regulatory baselines is to assume full compliance with all existing state and federal regulations that affect the entities in the analysis (see, for example, the EA for the industrial laundries subcategory [EPA, 2000]). For the C&D industry, EPA assumes that Options 2 and 4 affect markets that have fully implemented the existing Phase I and II stormwater regulations and any state-level requirements that are considered equivalent to the options under consideration (Section 4.1.2 provides a detailed discussion of state equivalencies). EPA also assumes that industry will be in 100 percent compliance following promulgation of the Final Action, which is a standard assumption in most EAs for ELGs. These baseline assumptions are unchanged from proposal, although EPA has done additional work since proposal to identify state-level equivalency to option requirements.

4.1.2 Engineering Costs

4.1.2.1 Description of the Engineering Cost Categories

All of the analyses in this EA are based on engineering cost estimates as presented in the Technical Development Document (U.S. EPA, 2004). EPA develops incremental pollution control cost estimates for three cost categories: ESC installation costs, design costs, and operating and maintenance (O&M) costs.

Installation costs comprise the costs associated with purchasing the physical components or materials required to build or install ESCs and the labor costs associated with installing those components or materials. They are initially estimated on the basis of a unit cost (e.g., per mile of silt fencing). They are converted to a per-site basis using assumptions about the number of units or fraction of units that are required for an ESC at a site in a particular state, of a specific size, type, and environmental setting (see Section 4.1.2.2). The installation costs also include costs associated with inspection and certification (if any) and permitting.

Design costs are associated with designing where and how the ESCs should be installed, and O&M costs are the continuing costs of maintaining the ESCs. EPA generally estimates these latter two cost categories based on percentages of installation costs. EPA estimates the cost of designing a silt fence installation, for example, to be 16 percent of the cost of installing the silt fence and estimates the O&M cost of maintaining the silt fence to be 100 percent of the cost of installing the silt fence. This is a standard engineering cost estimation approach based on typical costs incurred by the industry (see the Technical Development Document for more information).

4.1.2.2 Assumptions Used in Estimating Engineering Costs

To estimate the engineering costs, EPA assumes all costs are incurred in one year, so no discounting for time is introduced. This approach is different from that used in most other ELG development efforts. In the C&D industry, O&M costs are associated with the maintenance of ESCs during the construction process. Thus, O&M costs are incurred in the same year as the installation rather than being spread out over a long operating period, which is how O&M costs are typically incurred in other industries.

EPA does not include any profit, overhead, opportunity cost of capital, or interest in the engineering cost estimates derived as presented in the Technical Development Document. Where relevant to a specific analysis, EPA adds these costs into that analysis. Opportunity and interest costs, for example, are added to the national-level costs of compliance, but profit and overhead are not.[1]

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[1]Overhead costs and profit are both estimated as a fixed percentage of total costs in the baseline and post-compliance scenarios. Profit assumptions do not affect industry costs. Overhead costs, although accounted for in certain analyses, are not used to calculate industry compliance costs. To be conservative in determining potential impacts on consumers, impacts on final asking price are calculated assuming that compliance costs increase overhead by a fixed percentage (10 percent). In reality, however, the very small cost increases due to the options are unlikely to have any measurable effects on overhead, because most overhead costs are fixed costs that would not change with minor cost increases. An increase of a few labor hours to install and maintain ESCs, for example, will not have an effect on typical overhead costs, such as liability insurance costs, accounting fees, or office rental costs. Adding overhead costs at the fixed percentage of 10 percent would vastly overstate total costs to industry.

4.1.2.3 Land Use and Size Breakouts

EPA develops installation, design, and O&M cost estimates for four types of land use: single-family, multifamily, commercial, and industrial. EPA also designates a number of site sizes for each land use category: 0.5 acre, 3 acre, 7.5 acre, 25 acre, 70 acre, and 200 acre. EPA develops the costs for each of these land use categories by size on a state-by-state basis. This level of cost analysis allows EPA to determine the effect of state regulations considered equivalent to the various C&D options on the costs of compliance in each state.

4.1.2.4 State Equivalency Analysis

To determine the equivalency of state requirements, EPA carefully reviewed the state requirements related to construction permitting in all 50 states. EPA then compiled an assessment, on a requirement-by-requirement basis, that indicated whether a state had a requirement on its books considered equivalent to an Option 1, 2, or 4 requirement. If a state had a requirement to install runoff diversion, for example, and this requirement was deemed equivalent to an Option 2 or 4 requirement, then the cost to install runoff diversion would be eliminated for all sites in that state when EPA developed costs for Option 2 or 4. Alternatively, if the state did not have such a requirement and was not identified as a low rainfall state, EPA assumed the cost of runoff diversion, consistent with Options 2 or 4, would be incurred at sites in that state when calculating the costs of those options.

4.1.2.5 Accounting for Region-Specific Cost Factors

EPA makes one final adjustment to site costs, using cost factors from R.S. Means (2000) to account for the fact that costs in states vary from the national average. R.S. Means data, for example, indicate that costs of construction are 80 percent of the national average in Alabama, but 113 percent of the national average in California. For each state, all site costs are adjusted by that state’s cost factor.

4.1.2.6 Adapting Engineering Costs For Use in the Economic Models

In summary, EPA calculates the costs of installing an ESC at a site that is characterized by state, size, type, and environmental conditions and uses these costs to develop appropriate design and O&M costs. The Agency then uses the number of like sites in each state to calculate total installation, design, and maintenance costs for that type of site. Finally, EPA aggregates the site costs into size and type categories to create an estimate of total installation, design, and O&M costs for each state by size of site and type of land use. See the Technical Development Document (U.S. EPA, 2004) for more detailed information on these calculations.

Thus, EPA's engineering costs are initially developed as total costs on a per-state basis for up to 24 in-scope models per state based on four land use types and six site sizes (0.5-, 3-, 7.5-, 25-, 70-, and 200-acre sites). Due to data limitations, EPA cannot fully develop state-specific economic models. EPA does account for state-by-state differences in costs to some extent. For Option 1, in which costs per acre are relatively low and do not vary significantly by state, EPA calculates the weighted average per-acre costs by site size and construction type across all states. Options 2 and 4 posed more issues to consider. Option 2 has two components—inspection and certification and codification of EPA's CGP. Option 4 has one component—codification of EPA's CGP. All sites greater than 5 acres would be subject to these two options, but a large portion would not be affected by the CGP codification provision. These sites are in states deemed to have equivalent requirements to EPA's CGP (the "equivalent" states). About one-third of all acreage developed and subject to Option 2 or 4 is located in equivalent states. Another two-thirds is located in states considered "nonequivalent" since their requirements do not match EPA's CGP requirements. Some analyses of Options 2 and 4, therefore, use two costs—costs per acre developed and subject to the option and costs per CGP-affected acre. Additionally, for Option 2 only, inspection and certification costs are calculated over all acres developed and subject to Option 2. No states are considered to have requirements equivalent to the inspection and certification provisions in Options 1 and 2. The costs per acre associated with inspection and certification provisions are added to the costs of the CGP components per CGP-affected acre in the nonequivalent states for Option 2.

Section 4.3.1 discusses the estimates of numbers of acres developed annually. It also presents the numbers of CGP-affected acres, which are developed within the engineering cost models using EPA's assessment of state equivalency and other factors. The average per-acre costs by site size and type of construction across all developed acres and across CGP-affected acres are presented in Chapter Five.

4.1.3 Overview of the Economic Models and Their Use of Engineering Costs

EPA undertakes a number of different impact analyses in this EA, each one measuring a different aspect of impact that might be associated with options considered for the Final Action. These impacts are divided into two major groups: impacts on the individual projects and firms in the C&D industry and impacts at the national level, including national level costs to industry. See Figures 4-1a and 4-1b for a diagram of the inputs and outputs for each analysis undertaken in this EA. These figures also show where outputs from one analysis become inputs to another. The following discussion highlights the various analysis components illustrated in Figures 4-1a and b.

These analyses are all standard analyses EPA has used many times before to analyze other ELGs. The project-level analysis uses cash flow models that are similar to EPA's analysis of enterprises in the EA for the Concentrated Animal Feeding Operations ELG (U.S. EPA, 2002b). The firm-level analyses are similar to those used for the Metal Products and Machinery ELG (U.S. EPA, 2003), and EPA's partial equilibrium modeling approach is consistent with approaches used to analyze the Iron and Steel ELG (U.S. EPA, 2002c). None of the modeling approaches has changed substantially from proposal, but EPA has described more clearly how the models fit into systems of models and has named those systems to provide more clarity.

4.1.3.1 Industry-Level Analyses

EPA undertakes two analyses at the industry level–an analysis of impacts on C&D projects and an analysis of impacts on C&D firms (see Figure 4-1a). The methodologies for these industry-level analyses are presented in Section 4.2.

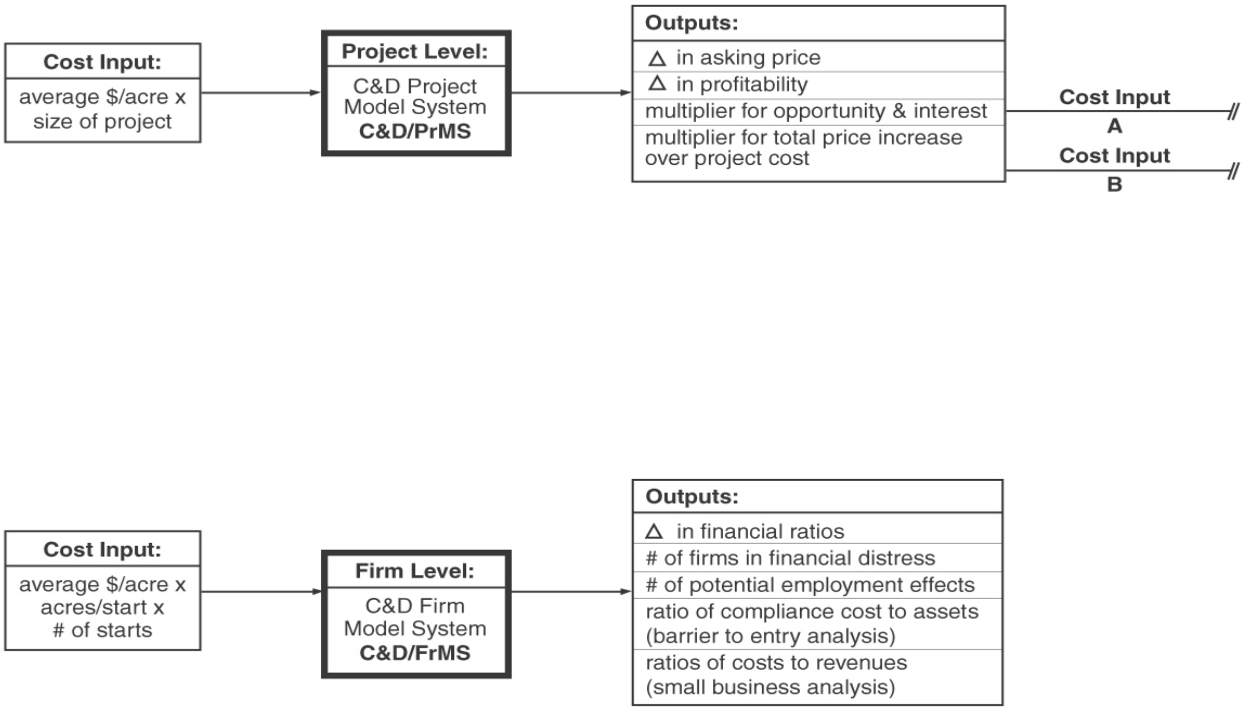

Figure 4-1a. Industry-Level Analysis

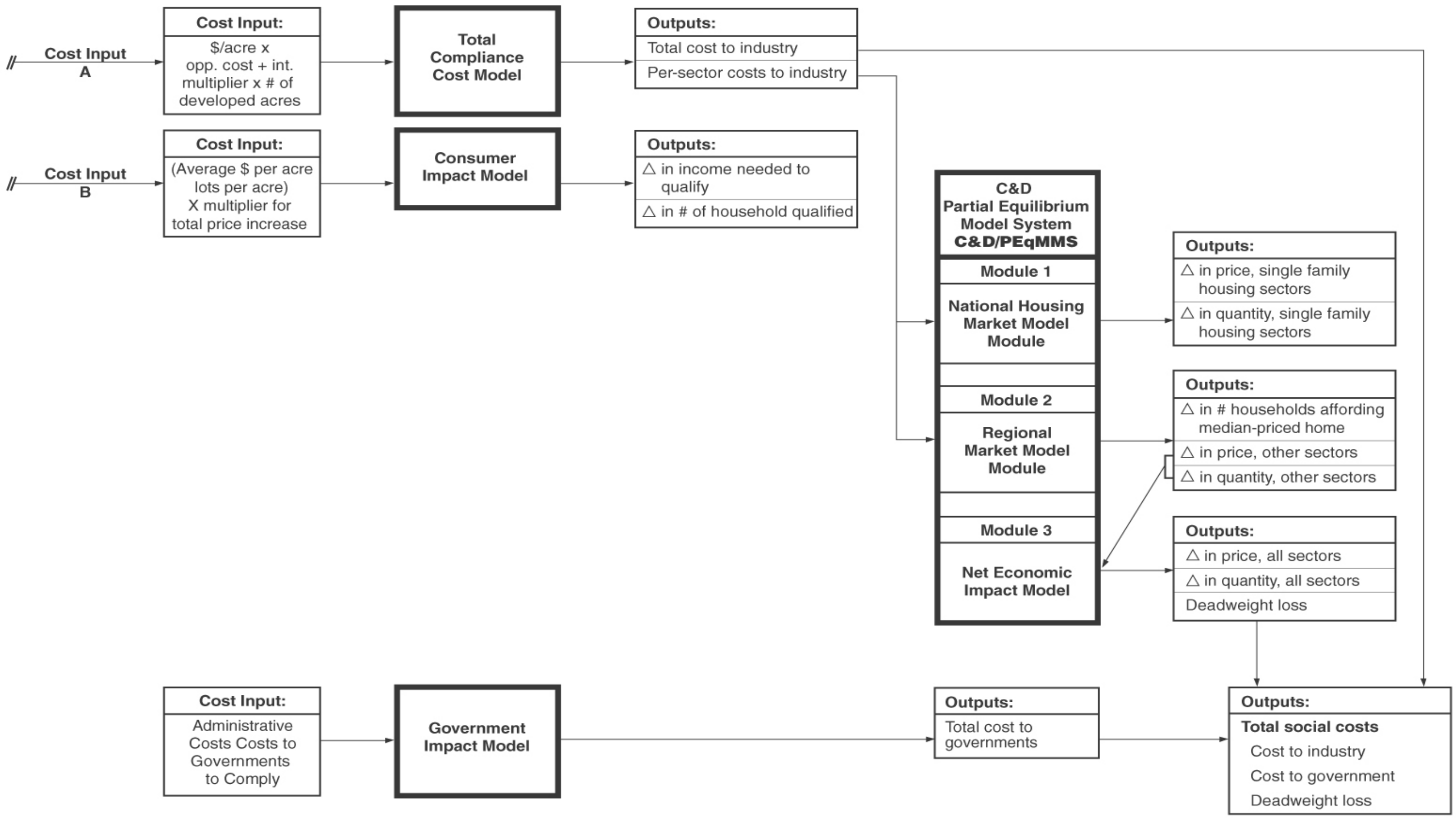

Figure 4-1b National-Level Analysis

4.1.3.1.1 C&D Project Model System

EPA's C&D Project Model System (C&D/PrMS) is composed of a various models representing C&D projects (the model projects), each simulating the cash flow of a C&D project for a certain site size and land use type. The cost inputs to the C&D/PrMS are the per-acre costs by land use and project size. These costs are derived by dividing the costs estimated by EPA engineers by the estimated numbers of acres developed annually and subject to the options, averaged across the 50 states as described in Section 4.1.2.6. When EPA inputs these costs into the C&D/PrMS, it can compute impacts for a wide variety of construction projects. For each type of construction project and each site size, the project cost per acre is input into a model that simulates all of the construction costs for that model project. EPA develops a total of 24 model projects. These projects match the four land use types and six site sizes (0.5-, 3-, 7.5-, 25-, 70-, and 200-acre sites) used in the engineering models, as described in Section 4.1.2.6.[2] EPA also develops an additional, simplified highway construction project model.

The per-acre costs are multiplied by the acreage associated with the site size (e.g., 7.5 acres is the acreage at a 7.5 acre site) to estimate a cost per site. The increased cost affects other cost items in a model project. These effects can be measured as either a change in the builder's asking price for a new house or a change in the profitability of the project. The model also outputs multipliers that are used in other analyses. These multipliers can be used with the cost per acre to create 1) the costs per acre plus opportunity and interest costs per acre (costs associated with self-financing or loans due to increased compliance costs) and 2) costs per acre plus all additional components (opportunity costs, interest costs, profit, and overhead) that contribute to the final asking price changes.

Section 4.2.1 provides more detailed information on how the engineering costs are used to determine impacts on projects. This section includes a description of the C&D/PrMS and the model projects, the C&D/PrMS analysis methodology, data sources, and assumptions used in the analysis. The project-level results are presented in Chapter Five, Section 5.3.

[2]The 0.5-acre site size is no longer used in the analysis because none of EPA's final options apply to sites of less than an acre, leaving 20 active model projects.

4.1.3.1.2 C&D Firm Model System

EPA's C&D Firm Model System (C&D/FrMS) is composed of a number of model C&D firms. Each model simulates the income statement and balance sheet for a C&D firm of a certain size (measured as numbers of starts or units per year) and land use type. The cost inputs to the C&D/FrMS are the per-acre costs calculated for developed acres (Option 1 and inspection and certification component of Option 2) or CGP-affected acres (the CGP component of Options 2 and 4) (see Section 4.1.2.6). EPA breaks out costs to estimate costs per acre across states deemed not to have requirements equivalent to Option 4 or the CGP component of Option 2. Acres developed in nonequivalent states are used with these costs. Acres developed in all states that are subject to the options are used to analyze Option 1 and the inspection and certification requirements of Option 2. This approach allows EPA to better estimate the number of firms that might experience financial stress under Option 2 or 4, depending on whether they are located in a high-cost or low-cost state.

The costs are used by the C&D/FrMS to compute impacts at the level of the construction firm. Costs per acre by site size are multiplied by the number of acres per construction start and the number of starts assumed for each model firm to estimate a compliance cost for each firm. Each of the four types of firms (single-family, multifamily, commercial, and industrial construction firms) are investigated (a highway construction firm model is also developed). The firm costs are used in the C&D/FrMS to yield information on changes in firm-level financial ratios. These changes are then used to determine numbers of firms that could experience financial stress as a result of incremental option costs and numbers of employees at firms potentially experiencing financial stress. These costs can also be compared to total and current assets of the model firms to determine if a barrier to entry by new firms might be present. Later, in Chapter Six, these firm-level costs are also used to determine impacts on small businesses.

The detailed methodology for the firm-level analysis is provided in Section 4.2.2. This section includes a description of the model firms, the C&D/FrMS analysis methodology, data sources, and assumptions used in the model firm analysis. The firm-level analysis results, including those from the economic achievability, barrier to entry, firm financial stress, and employment effects analyses, are presented in Chapter Five, Section 5.4.

4.1.3.2 National Level Analyses

The methodologies for most of the national level analyses are discussed in detail in Section 4.3 and are illustrated in Figure 4-1b. They are divided into several types:

- An approach for estimating national compliance costs to industry.
- An analysis of the impact on consumers driven by the potential for price increases for single-family homes.
- Analyses using partial equilibrium market models, including those estimating impacts on the 1) national housing market, 2) regional markets, and 3) the national economy as a whole. These form three modules of EPA's C&D Partial Equilibrium Modeling System (C&D/PEqMMS).
- An approach for estimating government impacts.

The methodology for estimating total social costs of the options under consideration (which include compliance costs, costs to governments, and net losses to the national economy) is discussed in Chapter Eight.

4.1.3.2.1 Total Compliance Cost Model

To compute the total compliance costs to industry, EPA uses the average cost per acre computed across all developed acres subject to the options (by land use type and project size), adjusted by the opportunity and interest cost multipliers calculated by the C&D/PrMS. These costs are multiplied by the number of acres estimated to be developed annually by project size and land use type. When these costs are aggregated, EPA determines the total cost to the construction industry of each option under consideration. EPA's Total Compliance Cost Model also calculates costs by industry sector. The total cost or the total cost by sector becomes an input to many of the remaining national-level analyses.

The detailed methodology is presented in Section 4.3.1. National compliance cost estimates are presented in Chapter Five, Section 5.5.

4.1.3.2.2 Consumer Impact Model

The Consumer Impact Model divides the average cost per acre for each site size in the single-family land use type by the number of lots per acre assumed. These costs are adjusted by the total cost multiplier, calculated by the C&D/PrMS, to judge the impact of the increase in residential housing price on an individual home. The model calculates the change in income that would be needed for a homebuyer to qualify for a home mortgage at the new price. It also calculates the number of households that no longer qualify for a house at that price, assuming standard lending practices.

The detailed methodology and the data used to create the Consumer Impact Model are presented in Section 4.3.2. Results of the analysis are presented in Chapter Five, Section 5.6.

4.1.3.2.3 C&D Partial Equilibrium Market Model System

EPA undertakes an analysis of 1) the national housing market and 2) a regional-level analysis of the markets for single-family, multifamily, commercial, and industrial construction, using partial equilibrium models of these markets. EPA also determines the net economic impacts in the overall U.S. economy. These analyses are incorporated into three modules that constitute EPA's C&D/PEqMMS. The first module, the National Housing Model, uses the total costs for the single-family sector, which is output from the Total Compliance Cost Model. The second module, the Regional Market Modeling Module, uses the state-by-state compliance costs per acre for each sector. State-by-state per-acre costs are calculated by dividing the total costs estimated for each state by the estimate of acreage developed annually in each state. These two items (costs per state and acres per state) are part of the engineering outputs described in Section 4.1.2 and the Technical Development Document (U.S. EPA, 2004). The last component of the C&D/PEqMMS is the Net Economic Impact Model. This module is discussed in more detail in Section 4.1.3.2.4.

The detailed market model methodologies are presented in Section 4.3.2. In addition, the section includes a description of data sources and assumptions used in the market models. The market modeling results are presented in Chapter Five, Section 5.6.

4.1.3.2.4 Net Economic Impact Model

Compliance costs have a ripple effect on the U.S. economy, resulting in both positive and negative impacts on production and employment in various sectors, both inside and outside of the C&D industry. The third module of the C&D/PEqMMS, the Net Economic Impact Model, uses the results of the partial equilibrium models described above. These results are expressed as changes in industry output, which are used with economic input-output multipliers developed by the Bureau of Economic Analysis (U.S. Department of Commerce, 1996) to estimate the broader effects in the U.S. economy. Where EPA has calculated results for both the national level and regional levels (housing sector only), it uses the national-level results, since the regional-level data are more limited in scope.

Economic multipliers indicate the degree to which declines in construction activity will have a ripple effect, causing declines in employment in the construction industry and declines in output and employment in other industry. Meanwhile, other parts of the economy (e.g., suppliers of ESCs) gain output and employment. The impacts of compliance are, therefore, measured as both gains and losses in output and gains and losses in employment across the national economy. These gains and losses generally balance, but some overall loss to the national economy does occur. This overall loss is called the deadweight loss, which contributes to the overall social cost of a regulation. The outputs of the Net Economic Impact Model are the change in employment and output in the national economy and an estimate of the deadweight loss.

Section 4.3.4 provides a detailed description of the methodology used to estimate the net economic impacts. In this section, EPA also discusses the approach for assessing regional impacts on the economy and explains why it did not develop a methodology for assessing impacts on international trade. The results of the national economic impact analysis are presented in Chapter Five, Section 5.7.

4.1.3.2.5 Government Impact Analysis

EPA estimates government impacts using costs that were derived separately from the costs discussed in Section 4.1.2. EPA develops government costs by estimating the costs associated with establishing or modifying permitting programs to reflect any requirements in the Final Action and new or increased costs related to permit processing. To these costs, EPA adds an estimate of the costs various levels of government will incur by complying with the options under consideration (governments at all levels undertake construction projects). See EPA's Technical Development Document for the proposal (U.S. EPA, 2002d) for more information. The total costs to government are the administrative costs of permitting and other activities and the compliance costs estimated to apply to government.

Section 4.3.4 presents the government impact analysis methodology. The results of the government cost impact analyses are presented in Chapter Five, Section 5.8.

4.1.3.2.6 Estimate of Social Costs

The final analysis EPA performs using the cost inputs calculates total social cost. The total social costs are derived by adding the total compliance costs to industry, the total costs to government, and the total deadweight loss (discussed in Section 4.1.3.2.4). The methodology for calculating total social cost and the results of this analysis are presented in Chapter Eight.

4.2 ANALYSIS OF IMPACTS ON THE C&D INDUSTRY

This section of Chapter Four presents, in detail, the methodologies EPA uses to assess impacts on the potentially affected C&D industry sectors. The analyses focus on two levels of impacts: the project level, where increased costs of construction could have the potential to affect either the asking price of construction or the profitability of that construction, and the firm level, where the aggregate effect of compliance costs on more than one project could affect the financial health of firms.

These analyses are performed under several different scenarios, reflecting differing assumptions about who ultimately bears the impacts of the compliance costs. In general, EPA believes that developers and builders faced with an increase in costs due to new ESC requirements would have an incentive and an ability to pass on all or some of the increased cost to the buyer. (This is referred to as cost passthrough). The extent to which the costs can be passed through in practice would depend on market conditions. The demand elasticity of the buyer (i.e., the sensitivity of the purchase decision to incremental changes in price) would be influenced by the magnitude of the cost increase relative to the overall cost of the project and the availability and price of substitutes. Evidence from the literature suggests that in residential construction, regulatory-related costs are usually passed on to consumers (e.g., Luger and Temkin, 2000). This general observation was echoed during EPA's focus group sessions with members of NAHB. Similarly, EPA believes demand to be relatively inelastic in the other sectors modeled (multifamily housing, commercial, industrial).

In the C&D/PrMS analyses, EPA has made two different assumptions concerning the extent of compliance cost passthrough to buyers. EPA analyzes results under the extreme conditions of zero and 100 percent cost passthrough. This bounding analysis enables EPA to examine the impacts under worst-case assumptions with respect to builders (zero cost passthrough) and buyers (100 percent cost passthrough) (see Section 4.2.1.3.2 for more detail). These bounding assumptions are not, however, expected to be accurate. They are used only to determine the maximum impacts to either industry or consumers, but cannot be used to determine the impacts to both simultaneously. EPA uses what it considers to be more realistic assumptions in Section 4.2.2 for the firm-level analysis, in which a large portion of costs are assumed to be passed on to consumers. The results of this analysis at the firm level are also compared to those estimated assuming zero cost passthrough. In Section 4.3.2, where the effects on construction markets are investigated using partial equilibrium models, EPA uses the analyses to determine the "share" of the compliance cost burdens falling simultaneously on industry and consumers. A more detailed discussion of cost passthrough assumptions can be found in the Economic Analysis of the proposed rule (U.S. EPA, 2002a).

4.2.1 Methodology for Estimating Impacts on C&D Projects

EPA has analyzed the impacts of the options considered for the Final Action by developing financial models of representative C&D projects. These models evaluate whether the additional costs of complying with the options would make the project unprofitable and vulnerable to abandonment or closure or, alternatively, determine the magnitude of price increases that consumers of construction products might face. In the absence of an industry survey, the economic models are based on EPA's best available data and assumptions concerning construction project characteristics. They are designed to depict, with reasonable accuracy, the change in cash flow for typical projects resulting from compliance with the requirements of the options considered. They also reflect the range of C&D projects generally undertaken by industry participants.

The following sections discuss

- The development of the basic structure of the C&D/PrMS, which comprises the project financial models (Section 4.2.1.1).

- The inputs to the C&D/PrMS and EPA's rationale for the selection of the component model projects (Section 4.2.1.2).

- A detailed discussion of the baseline financial conditions that are output by the C&D/PrMS, with an example of how the modeling system incorporates compliance costs and calculates impacts (Section 4.2.1.3). This latter presentation is based on a hypothetical compliance cost, not an actual compliance cost for the sample financial model. Actual compliance costs (and results) are only shown in Chapter Five (the results chapter).

4.2.1.1 Development of the Model Structure

The following sections describe the development of 24 model building projects (along with a simplified nonbuilding construction model). First, EPA discusses the choice of model project types and sizes. EPA then provides a general overview of how the model projects calculate the impacts of the options under two cost passthrough scenarios. The section then provides a detailed description of basic assumptions and data used to develop the general internal structure of each group of models by land use type.

4.2.1.1.1 Selection of Model Project Types and Sizes

Prior to developing either the engineering or economic models, EPA selected model project types by analyzing data on the output of the C&D industry. The industry output reflects both the diversity of the industry and the diversity of the U.S. economy. To illustrate this diversity, EPA notes that the Census of Construction (U.S. Census Bureau, 2000c) assigns construction projects to one of 17 building and 32 nonbuilding construction categories. In terms of economic value, building construction projects accounted for $371.4 billion (97.3 percent of total construction revenues) in 1997, while nonbuilding construction projects accounted for only $5.9 billion (1.5 percent).[3]

The largest single category of construction activity was single-family home construction, accounting for $150.5 billion (39.4 percent of the total). This category was followed by office buildings at $40.3 billion (10.6 percent of the total), all other commercial buildings at $36.5 billion (9.6 percent of the total), manufacturing and light industrial buildings at $26.2 billion (6.8 percent of the total), educational buildings at $25.1 billion (6.6 percent of the total), and multifamily housing at $19.6 billion (5.1 percent of the total). Based on this review, EPA developed engineering and economic models for four types of development projects that reflect the range of projects undertaken by the industry and that would fall within the scope of the Final Action. These projects included:

- A residential development of single-family homes
- A residential development of multifamily housing units
- A commercial development (enclosed shopping center)
- An industrial development (industrial park)

Furthermore, for each class of project, EPA developed engineering and economic models that correspond to a range of project sizes. In each case, there are versions of the model for projects constructed on 0.5 (labeled 1-acre in the model outputs, but not used), 3, 7.5, 25, 70, and 200 acres. The combination of four project types and six project size classes results in a total of 24 model projects. As noted in Section 4.1.2, the engineering costs per acre that are input to the economic models are also developed for these same 24 projects, although the smallest site size is not currently used in the economic analysis. Thus 20 active models are in use.

These models, however, account for building construction only. Nonbuilding construction projects are also potentially affected by the options under consideration. As noted earlier, an estimated $5.9 billion in nonbuilding construction is undertaken each year. This total represents the value of highway, road and street construction ($1.6 billion); sewage and water treatment facility construction ($1.7 billion); bridge, tunnel, and elevated highway construction ($587 million); sewer and water main

[3] In addition, $4.2 billion (1.1 percent of the total) was not specified by kind.

construction ($211 million); power and communication line and tower construction ($160 million); and private driveway and parking area construction ($100 million). While considerable in absolute value, such nonbuilding construction activity represents less than 2 percent of the total value of construction completed. Estimates of the land area developed as a result of nonbuilding construction activity are not available.

EPA has not developed engineering costs applicable to nonbuilding construction projects, due to the diversity of the activities covered under this category and the relatively small share of overall construction activity it constitutes.[4] EPA, however, has developed a reduced-form model project for highway construction that operates outside the C&D/PrMS and has analyzed the likely magnitude of the costs and impacts using this highway model. EPA believes impacts on other linear projects, such as those for power and gas line installations, would be of similar magnitude. A description of the highway model analysis is included with the descriptions of the four types of building construction model projects later in this section.

4.2.1.1.2 Overview of EPA's C&D/PrMS Approach

EPA's models for the 24 building projects that comprise the C&D/PrMS establish the baseline financial conditions for each representative project by type and size and assess the significance of the change in project cash flow that results from the incremental compliance costs. The two measures output by these models are changes in price (derived when EPA uses the assumption of 100 percent cost passthrough) and changes in profitability (derived when EPA uses the assumption of zero cost passthrough). EPA can also estimate the number of projects (if any) that become unprofitable under the latter scenario. Each project's financial characteristics are based on best available data and reasonable assumptions about development activities and project financing. Two other outputs calculated within each model project are multipliers that allow EPA to calculate costs per acre plus additional costs, such as interest and profit, that contribute to the increase in the price of a unit of construction.

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[4] The national costs of the Final Action, however, do account for the costs borne for these types of projects. See Section 4.4.

As explained in Section 4.2.1, the use of two cost passthrough scenarios allows EPA to show the impacts under worst-case conditions for builders (zero percent cost passthrough) and worst-case conditions for buyers (100 percent cost passthrough). Under the 100 percent cost passthrough scenario, a fixed percentage is assumed for the developer-builder's profit margin and the model calculates the final sales price that each buyer would be asked to pay after the compliance costs have been passed through. Under the zero cost passthrough scenario, the developer-builder's profit under baseline conditions is reduced by the compliance costs under each regulatory option. The sales price of each housing unit remains the same. Section 4.2.1.2 contains further details on the assumed profit levels and other inputs.

The nonbuilding project model, which represents a major highway project, is a simpler model. This model establishes an average cost per mile of construction. It also estimates the worst-case compliance costs. Worst-case compliance costs are calculated by multiplying the number of acres developed in a mile of highway construction—10.67 acres—by the worst-case cost per acre for a 7.5-acre project among the other construction industry sectors. The 7.5-acre size is the model size closest to the estimated acreage developed in a mile of highway construction. The model then compares these costs to the baseline cost of constructing that mile of highway. All impacts are assumed to fall on the project (zero cost passthrough).

The following section discusses each of the four building project models and the highway model in more detail.

4.2.1.1.3 Detailed Description of Model Projects

To develop the model projects, EPA focused first on the single-family residential model project. As noted above, single-family residential construction represents the highest value category of construction, and information about the C&D process for single-family homes is readily available.[5] EPA was able to develop a relatively detailed model for single-family development and then adjusted the model parameters as appropriate to reflect differences in the other project categories. In general, EPA

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[5] EPA was, for example, able to obtain input data for the single-family residential model from representative members of NAHB. Input from NAHB enabled EPA to identify cost elements associated with each stage of project development.

believes that projects in the other categories follow a similar development path and has, therefore, used the same general structure for all of the models.

Because many of the data elements and modeling assumptions are based on the single-family residential model, this model is discussed in detail below. Many of the assumptions and data elements defined for this model were applied directly to or modified only slightly for use in the other models. The discussion of the other three project types focuses primarily on those assumptions or methods that differ from assumptions or methods employed in the single-family residential model. EPA's simplified highway model project, which does not follow the form of the other four model types, is also briefly discussed.

Residential Single-Family Development

The model single-family residential project, or site, is assumed to be an undeveloped parcel zoned for single-family residential housing. The number of housing units built depends on the size of the model project. The location of the site is unspecified and, for this reason, EPA has used national-level data wherever possible. In this case, the site is assumed to be controlled by a developer-builder (sometimes referred to in the industry as a merchant builder or operative builder). The developer-builder is responsible for all aspects of the project, from land acquisition through permitting, subdivision of the parcel, installation of any ESCs, and construction and marketing of all completed housing units. EPA recognizes that there are many variations on how a particular site is developed, but believes this model is representative of a large number of the projects undertaken each year in the United States.[6] In effect, this assumption focuses the impacts of the action on a single business entity. The estimate of impacts is, therefore, somewhat higher than if EPA had assumed that compliance costs might be shared between a developer and a builder.

[6] Other common scenarios involve the developer selling all or some of the finished lots to builders. The developer will not necessarily retain lots in the development to complete and sell.

The starting point for the project is the acquisition of the parcel, which is assumed to be purchased or optioned from another landowner.[7] The C&D process, as modeled, is assumed to proceed through three phases, characterized as follows:

- **Land acquisition**—The developer-builder puts together the necessary financing to purchase the parcel. When lenders are involved, they may require certain documentation, such as financial statements, tax returns, appraisals, proof of the developer's ability to obtain necessary zoning, evaluations of project location, assessments of the capacity of existing infrastructure, letters of intent from the city/town to install infrastructure, and environmental approvals. To satisfy these factors, the developer might incur costs associated with compiling this data.

- **Land development**—The developer-builder obtains all necessary site approvals and prepares the site for the construction phase of the project. Costs incurred during this phase include *soft costs* for architectural and engineering services, legal work, permits, fees, and testing; and *hard costs*, such as land clearing, installing utilities and roads, and preparing foundations or pads. The result of this phase is a legally subdivided parcel with finished lots ready for construction.

- **Construction**—The developer-builder undertakes the actual construction of the housing units. A substantial portion of this work could be subcontracted to specialty subcontractors (e.g., foundation, framing, roofing, plumbing, electrical, and painting subcontractors). Marketing of the development generally begins before this phase, thus the developer-builder could also incur some marketing costs during the construction phase. Housing units can come under sales agreement at any time prior to, during, or after completion of construction.

While the length of each phase and the overall length of the project can vary considerably, EPA assumes, for modeling purposes, that 48 months are needed from acquisition of the parcel through development and construction. Focus groups arranged by NAHB in Dallas provided estimates that ranged from 13 to 63 months. EPA acknowledges there will be wide variation in the duration of each phase—land acquisition, development, and construction—and the duration of the whole project. Several commenters noted that the three-year timeline used in the EA for the proposed regulation was optimistic. NAHB felt that a four-year time frame was more typical, based on information they had collected. They also objected to the concept that a single developer-builder would be involved in all three phases, on different projects, at the same time. That assumption was invoked to avoid considering cash flows through the course of the project. Revenues from sales on one project were presumed to offset costs on

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[7] Options involve payments from the developer to a landowner to secure the rights to develop the land for a specified period of time, usually while a more complete assessment of project viability is undertaken.

another. Commenters noted that such cross-subsidy was unusual. The assumption that other projects are operating in each phase has been replaced in this analysis by the more general assumption that the builder has access to working capital sufficient to complete the project. The methods used in this analysis do not distinguish cash flows through time.

EPA currently lacks detailed data on the exact timing of ESC installation during project development. NAHB commented on timing, but EPA's model is simplified and shows all costs coming into the model in the first year (although opportunity and interest costs are calculated for a four-year period). In making this assumption, EPA is overstating the magnitude of the true costs incurred, since costs incurred in the future would have a lower present value. EPA assumes that ESCs installed to control runoff during the active phase of construction are put in place early in the development phase and are maintained throughout the construction phase. Thus, the capital costs for such ESCs would generally be incurred early in the project, and the structures would be maintained in place for the duration of the project.[8] The costs for removing the ESCs would be incurred at project completion. EPA has also used the simplifying assumption that the costs for all ESCs are incurred at the beginning of the project. EPA acknowledges that capital costs would actually be incurred after the start of the project and that, as a result, the costs would be discounted back to their present value. As noted, however, using the assumption that all costs are incurred in the first year results in costs being very slightly overstated.

Additional assumptions and sources for data used in the model project analysis are presented in this section. Each model project is developed using assumptions about the types and magnitude of costs incurred during various phases of the project, the sources for these funds (i.e., the amounts borrowed versus the amounts provided from the developer-builder's equity), and the expected developer-builder profit margins associated with each phase of the project.

Assumptions regarding the various cost elements incurred during each phase of the residential single-family development are described in detail in Section 4.2.1.2.

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[8]In practice, some ESCs installed to control runoff during the construction phase are then converted to permanent BMPs to control post-construction flows. These structures would not need to be removed.

Residential Multifamily Development

The model multifamily residential development is an apartment building or complex. The project is assumed to be developed in a similar fashion to the single-family model development described earlier. A single developer-builder is responsible for site acquisition, site preparation, construction, and marketing of the project, and the project proceeds through the same project phases. Comments received on the multifamily residential model for the proposed rule suggested that three years was too short a period for the average development. Commenters suggested using nine years. In response, EPA has extended the project timeline to nine years. As in the single-family residential model, EPA assumed that the developer had adequate access to working capital to support the project throughout its duration. Data sources and inputs specific to the model multifamily development are discussed in Section 4.2.1.2.

Commercial Development

The commercial development is assumed to be an enclosed retail shopping or office area. Depending on the size of the model project, it could range from a small, stand-alone retail outlet to a large, enclosed mall or office complex. As with the residential projects, a single developer-builder is assumed to be responsible for site acquisition, site preparation, construction, and marketing of the project. The project timeline is assumed to be three years from start to finish, and the project is assumed to proceed through the same project phases. EPA received no comments on this assumption. Similarly, the developer-builder is assumed to have several projects underway to help balance cash flows. This assumption makes it possible to examine the impacts of a three year project on a single year's cash flow for the affected business. No comments were received on this assumption. Again, the particular data sources used and inputs to this model project are discussed further in Section 4.2.1.2.

Industrial Development

The industrial development is assumed to be an industrial park or a stand-alone manufacturing facility. As with the residential and commercial projects, a single developer-builder is assumed to be responsible for site acquisition, site preparation, construction, and marketing of the project. The project timeline is assumed to be the same as for commercial projects (i.e., three years from start to finish), and the project is assumed to proceed through the same project phases. EPA received no comments on this assumption. Similarly, the developer-builder is assumed to have several projects underway to help balance cash flows. No comments were received on this assumption. This assumption makes it possible to examine the impacts of a three year project on a single year's cash flow for the affected business. A detailed discussion of data sources and inputs, which are similar to those used for the model commercial development, can be found in Section 4.2.1.2.

Nonbuilding Development

As noted earlier, nonbuilding construction, such as construction of roads, highways, and bridges, is a sizeable activity. Overall, however, construction of this type represents less than 2 percent of the total value of construction completed each year. To assess the potential impacts of the Final Action on such activities, EPA has developed a model highway construction project and used this model to assess the Final Action's costs and impacts. EPA believes the model captures and reflects the likely magnitude and significance of the impacts of the Final Action on the nonbuilding construction sector.

From the highway engineering literature, EPA assumed that the typical four-lane interstate roadway is configured as follows: two travel lanes of 24 feet each, one 20-foot median between the travel lanes, and a 10-foot buffer on each side of the highway (Wright, 1996). EPA assumed that the combined width of the road surface, median, and buffers, 88 feet, represents the typical developed area for new highway construction. One mile of new highway would, therefore, represent 10.67 acres in developed area.[9]

To develop representative baseline costs for the model highway project, EPA examined data from the Federal Highway Administration's (FHWA's) Highway Statistics publication (FHWA, 2001). Table FA-10 (Obligation of Federal-Aid Highway Funds for Highway Improvements) of the Highway Statistics series shows the number of miles, federal funds obligated, and total cost for approved projects

[9] The disturbed area is 88 feet or 0.0167 miles wide (88 divided by 5,280 feet). One mile of roadway, therefore, disturbs 0.0167 square miles, or 10.67 acres (0.0167 multiplied by 640 acres per square mile).

in a number of highway improvement categories and roadway functional classifications. EPA aggregated the mileage and cost for new construction, relocation, reconstruction with added capacity, and major widening for urban interstates and other freeways and expressways. Since highway and road funding can fluctuate from year to year, EPA estimated the average miles and average cost for the period 1995 to 2000. EPA generated a weighted average cost of $5.4 million per mile (1997 dollars) across all relevant improvement types and functional classifications.[10] EPA related option costs to miles using the maximum per-acre costs associated with 7.5-acre sites among the other construction sectors. The 7.5-acre site size is closest to the size of the estimated developed area for a mile of highway. Results are presented as a ratio of compliance costs to total construction costs for that mile of highway. Further detail on heavy construction appears in the EA for the proposed rule (U.S. EPA, 2002a). The results of this analysis are presented in Chapter Five, Sections 5.2 and 5.4.

4.2.1.2 Inputs to the Model Projects

Numerous inputs to the model projects are helpful in constructing baseline financial conditions. As noted above, the representative model building projects take place in three phases: land acquisition, site development, and construction. The process of obtaining options on land to be developed (a common, but not universal step that occurs in the early stages of development) has been combined with the land acquisition activities for simplicity. Assumptions regarding the various costs that are incurred during each phase of the project are summarized in Table 4-1.

Overall, EPA has used more than two dozen different modeling parameters, although not all project types encompass all of these parameters. Because the project location is not specified, national estimates are used where possible.

For the residential single-family models, EPA turned to data provided by industry. During focus group meetings in Chicago, participants assisted EPA with identifying ranges for various cost elements for the hypothetical residential construction project. They also assisted in developing estimates for cost

[10] Values were converted to 1997 equivalents using data from Table PT-1 of the *Highway Statistics* publication, “Price Trends for Federal-Aid Highway Construction” (FHA, 2001a).

items such as raw land, engineering, and construction. Some of the estimates proposed during the Chicago meetings are used in the model projects, particularly where actual national-level data was not identified. These costs could, therefore, reflect market conditions more prevalent in the Midwest. Table 4-2 presents the assumptions used in the single-family residential model and data sources used. Many of these parameters remain the same in the other three building project model types. Where alternative assumptions are used for multifamily, commercial, and industrial model projects, they are also shown in the table. The EA for the proposed rule contains a similar table outlining the data parameters and sources for all four model project types (U.S. EPA, 2002a). Although NAHB commented on the anecdotal nature of the focus group data, with the exception of a few parameters, NAHB did not offer alternative data. EPA acknowledges the data limitations, but believes it has developed reasonable models with the only data available.

Table 4-1. Costs Incurred at Various Stages of a Residential Construction Project

Project Phase	Cost Elements
Land Acquisition	• Raw land (purchase or option) • Interest on land acquisition loan • Opportunity cost of capital
Development	• Engineering • Due diligence • Land development • Stormwater controls • Contingency • Impact fees • Interest on development loan • Opportunity cost of capital • Overhead
Building Construction	• Lot cost (if sold to a builder; includes land acquisition and development costs and profit to the developer) • Construction cost • Builder overhead • Interest on construction loan • Opportunity cost of capital • Real estate and marketing fees

Table 4-2. Model Parameters and Data Sources

Model Parameter		Source
1, 3, 7.5, 25, 70, and 200	size of parcel, in acres	EPA assumption
$40,000	cost of raw land, per acre	Estimate from Chicago focus groups, based on experience of the Chicago-area participants.
0.33	size of lot, in acres	Census Report C25 (Characteristics of New Housing, 1999) reports a mean lot size for new single-family homes sold of 12,910 square feet, which represents a density of close to three lots per acre (evenly distributed with 1/3 acre lots). (The *median* lot size is 8,750 square feet, which implies a density of nearly five lots per acre.)
2.67	approximate density (number of lots per acre)	Calculated based on impervious surface ratios from "Chesapeake Bay Watershed Impervious Cover Results by Land Use Polygons" to account for impervious surface area. The total number of lots (density x site size) is rounded to the nearest whole number.
$2,500	due diligence costs, per acre	Based on $100,000 in total due diligence costs for a hypothetical 40-acre development discussed by the Chicago focus group participants. Participants considered the costs associated with all necessary environmental and engineering assessments, usually completed prior to land acquisition. During these assessments, the developer works to identify any potential future problems or liabilities.
$25,000	land development costs, per lot	Estimate from Chicago focus groups. This figure includes any construction activities related to land development (e.g., infrastructure costs).
6%	engineering costs, as percent of land development costs	Estimate from Chicago focus groups.
10%	overhead costs, as percent of development costs	Estimate from Chicago focus groups.
10%	contingency, as percent of land development costs (before impact fees)	Estimate from Chicago focus groups.
$15,000	impact fees, per lot	Estimate from Chicago focus groups.
7%	real estate and marketing fees, as percent of house sales price	Estimate from Chicago focus groups.
2,310	average square footage of new house	From Census Report C25, which states that the average size of new single-family homes sold in 1999 and conventionally financed was 2,310 square feet
$53.80	cost of house construction, per square foot	From NAHB's web site, which shows construction costs for a generic single-family house are $124,276. $124,276 ÷ 2,310 sq. ft. = $53.80 per sq. ft. (NAHB, 2001a).
65%	percent of total land cost that a developer can finance for land acquisition	Loan-to-value ratio as written in the Real Estate Lending Rules.

Table 4-2. Model Parameters and Data Sources

Model Parameter		Source
75%	percent of total development costs that a developer can finance for this stage	Loan-to-value ratio as written in the Real Estate Lending Rules.
80%	percent of total building construction cost that a builder can finance	Loan-to-value ratio as written in the Real Estate Lending Rules.
7.5%	loan interest rate for builder/developer	EPA estimate.
4	term of land acquisition loan, years (nine years for multifamily; three years for commercial and industrial)	EPA assumption, based on comments received on the EA for the proposal. Assumes that the land acquisition loan is paid off during the life of the project.
1	term of development loan, years (two years for multifamily; one year for commercial and industrial)	EPA assumption. EPA assumes that the land development loan term is equal to the length of the development phase of the project.
2	term of construction loan, years (six years for multifamily; one year for commercial and industrial)	EPA assumption. EPA assumes that the construction loan term is equal to the length of the construction phase of the project.
10%	assumed baseline profit on land development	Chicago focus group estimated 12 to 14 percent; 10 percent is an EPA assumption.
10%	assumed baseline pre-tax profit on construction	Chicago focus groups estimated 8 to 12 percent pre-tax at time of sale. R.S. Means also uses 10 percent as a profit assumption in their Cost Data series.

4.2.1.3 C&D/PrMS Analysis Approach

This section presents an example of the calculation of baseline financial conditions, using the residential single-family project encompassing a 7.5-acre site. It also presents the results of a sample analysis using a hypothetical option cost, showing the impact of this cost on the final price of a single-family house. In the baseline example, the model project shown defines the baseline financial performance of the residential subdivision project prior to the promulgation of the Final Action. The baseline case is assumed to incorporate the costs of full compliance with the existing Phase I and Phase II NPDES stormwater regulations. The same sample model is then used to assess the incremental impact of additional requirements imposed under a hypothetical option. Results using actual option costs for all 20 active baseline models[11] can be seen in the Rulemaking Record (DCN 45023). The results using actual compliance costs for the options under consideration are not presented here. Summaries of the outputs of the 20 model projects are provided in Chapter Five. The detailed post-compliance results for each model project, similar to those shown in the example, can be found in the Rulemaking Record (DCN 45023).

4.2.1.3.1 Baseline Model Project Performance

Table 4-3 presents an example of the model project analysis under baseline conditions in the column labeled "baseline." This column represents the financial conditions for the sample model project before compliance costs associated with option requirements are added. The example of a single-family construction project on a 7.5-acre site is used. This baseline example works similarly to the other 19 project models, as shown in DCN 45023. The sample model estimates the final sales price per housing unit using the assumptions discussed in Sections 4.2.1.1 and 4.2.1.2. The model incorporates built-in targets for profit margins for both the development and construction portions of the project. The model also incorporates other assumptions that affect the target sales price for each unit. Using the assumptions discussed here, EPA calculates the sales price ($316,628) for each unit.

EPA notes that this price is higher than the national mean sales price for a conventionally financed new single-family housing unit, which was $234,900 in 2000 (FHFB, 2001). EPA attributes the difference to assumptions in the model that could reflect higher-priced housing markets. It also reflects the four-year time frame during which opportunity and interest costs accrue (a shorter assumed time frame leads to lower prices). Despite the potential bias, EPA believes that the model is sufficiently well-calibrated to allow comparison of the impacts of alternative stormwater control costs on the model project financials. This sales price is also higher than that calculated by the sample model shown in the EA for the proposal (U.S. EPA, 2002a). The change in the assumption about length of project (three years was assumed in the proposal EA and four years is assumed here, based on NAHB comments) causes this increase in the calculated baseline sales price from that shown at proposal.

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[11] Excluding the results models representing sites of less than 1 acre.

Table 4-3. Baseline Model and Illustration of Impact of Incremental Option Requirements on Model Project Under a Hypothetical Option—100 Percent Cost Passthrough Scenario (Engineering costs and results are only examples)

Project Cost Element	Baseline	Hypothetical Option
Land Acquisition (7.5-acre parcel)		
Raw land	$300,000	$300,000
Interest on land acquisition	$29,955	$29,955
Opportunity cost of capital	$16,129	$16,129
Land acquisition costs	*$346,084*	*$346,084*
Land Development (7.5-acre parcel)		
Engineering	$30,000	$30,000
Due diligence	$18,750	$18,750
Land development	$500,000	$500,000
ESC engineering costs	$0	$4,928
Contingency	$50,000	$50,000
Impact fees	$300,000	$300,000
Interest on development loan	$130,950	$130,950
Opportunity cost of capital	$43,650	$43,889
Overhead[a]	$59,320	$59,645
Land development costs	*$1,132,670*	*$1,138,880*
Land acquisition + land development costs	$1,478,754	$1,484,964
Profit on land acquisition and development	$164,306	$164,996
Total—Land acquisition and development	*$1,643,060*	*$1,649,960*
Construction Costs (per lot)		
Finished lot cost	$82,153	$82,498
Construction cost	$124,276	$124,276
Interest on construction loan	$32,082	$32,136
Opportunity cost of capital	$8,021	$8,034
Builder overhead[a]	$15,831	$15,857
Total costs to builder	$262,363	$262,801
Marketing fees	$22,127	$22,164
Profit	$31,610	$31,663
House sales price (calculated)	$316,099	$316,628
Incremental Regulatory Impacts		
Change in sales price per lot	$0	$528
Costs per lot as % of baseline sales price	0.00%	0.17%
Multiplier[b]	0.000	2.144

[a] Overhead in the development and construction stages is total overhead (based on 10 percent of development or construction costs) minus the opportunity cost of capital. This calculation was performed to avoid double-counting of the opportunity cost.
[b] [Incremental regulatory costs per lot x number of lots] ÷ [engineering costs]
Source: EPA estimates. Also see Table 4-2 for model parameters and data sources.

It is important to note again that while the model recognizes that projects are developed over time, the model does not fully account for the time value of money. Assumptions have been made regarding the duration of each stage of development to determine the period for any loans taken on by the developer (to develop the costs associated with opportunity costs and interest). The durations assumed are: three years for the land acquisition loan, four years for the development loan, and four years for the construction loan. These assumptions influence the debt-carrying costs incurred by the developer. What the model does not account for, however, is the fact that some costs are incurred in years two and three (e.g., construction costs are incurred in year three). These costs should be discounted back to the base year, which is the year the project starts. The discount factors for costs incurred two and three years in the future are 0.873 and 0.816, respectively, assuming a 7 percent discount rate. Any adjustments made to reflect the time value of money, therefore, would reduce the overall project costs, but only to a limited degree.

4.2.1.3.2 Results of a Sample Model Project Analysis Assuming a Hypothetical Compliance Cost

Each of the project models incorporates incremental regulatory costs as illustrated in the sample model within the shaded lines of the column labeled “hypothetical option” in Table 4-3. As these costs are added to the other costs incurred during development, the financing requirements in the development stage increase. Table 4-3 shows the sample baseline project data and illustrates how the project financials change in response to the hypothetical regulatory costs associated with Option 1. Note, again, that although the baseline parameters shown in Table 4-3 are those used to generate the model project results shown in Chapter Five, the engineering costs and results in these tables are included only as examples. They do not reflect EPA’s actual estimated costs and impacts. Summaries of these actual estimated costs and impacts can be found in Chapter Five. The actual result spreadsheets (formatted similarly to Table 4-3 for each of the models) are based on the compliance costs for Options 1, 2, and 4 and are provided in the Rulemaking Record (DCN 45023).

The incremental controls for the 7.5-acre, 20-unit project under the hypothetical option shown in the example, at a hypothetical cost of $4,928, would raise the calculated sales price for each housing unit from $316,099 to $316,628, a difference of $528. This represents 0.167 percent of the baseline sales price. This price differential is higher than the cost of the option requirements to the builder by a cost "multiplier" factor. EPA can estimate this multiplier by dividing the calculated increase in house sales price (from baseline) by the actual per-lot cost of stormwater controls incurred by the builder. Comparing the $528 per-lot cost passed on to the buyer in this example with the contractor's per-lot cost of controls (i.e., $4,928 divided by 20 lots equals $246.40), EPA estimates a total cost multiplier of 2.144. EPA uses a similar approach to calculate a multiplier that accounts for the opportunity and interest cost components contributing to the price increase. In the example presented in Table 4-3, all costs are passed through to the buyer (100 percent cost passthrough). These multipliers are used to add other cost components to the compliance costs per acre, as needed, in the national-level analyses discussed in Section 4.3.

In Chapter Five, EPA presents a summary of actual results for all regulatory options considered under both the 100 percent and zero cost passthrough assumptions. Under the zero cost passthrough assumption, the builder absorbs all of the compliance costs for each lot. This impact is reflected in a decrease in the builder profit. The asking price of the housing unit remains the same as the asking price in the baseline.

4.2.2 Methodology for Estimating Impacts on C&D Firms

In this section, EPA presents the methodology used to analyze firm-level impacts based on modeled financial conditions at representative firms in the various C&D industry groups. Section 4.2.2.1 discusses how EPA's system of model firms (C&D/FrMS) was developed, detailing the types and sizes of model firms EPA selected for use in the C&D/FrMS. Additionally, this section presents an overview of how the models are used to estimate impacts and describes the data and methods used to construct the models. Section 4.2.2.2 explains the integration of the compliance costs into the firm models. This section also discusses EPA's methodology for determining impacts on the financial health of firms. These impacts include firm financial stress, potential employment effects, and possible barriers to the entrance of new firms into the industry. Generally, EPA uses establishment data to construct firm-level data because EPA's data show that in the vast majority of cases, construction firms own only one establishment (see Chapter Six). For the firm-level analysis discussed in Chapter Four, establishments and firms are considered essentially the same.

4.2.2.1 Development of the C&D/FrMS Structure

EPA's C&D/FrMS comprises 14 model firms—six single-family construction firms, five multifamily construction firms, one commercial construction firm, one industrial construction firm, and one highway construction firm (the highway sector model is included within the C&D/FrMS). These model firms are represented financially using simulated income statements and balance sheets for firms categorized by size and type of construction. The C&D/FrMS uses these model firms and performs an iterative calculation with the costs for each of the project sizes affected under the options analyzed. The following sections 1) discuss the selection of each of the model firms by construction type and size, 2) present a general overview of how these firm models fit into the overall C&D/FrMS structure and what analyses are performed by the modeling system, and 3) summarize how each model firm's financial statements are constructed.

4.2.2.1.1 Selection of Model Firm Types and Sizes

EPA selected model firm types and sizes that correspond with the four major building construction industry groups (residential single-family, residential multifamily, commercial, and industrial construction) along with the highway construction industry group. The sizes of model firms that could be constructed were based on either 1) the numbers of houses (starts) or units built by firms in the single-family and multifamily construction industries, or 2) employment at firms in the commercial, industrial, and highway construction industry groups. The difference in the basis for developing model firm sizes is due to the different types of data available for each industry.

For the single-family and multifamily construction industry groups, EPA used data from the Bureau of the Census (Rappaport and Cole, 2000), which has financial data available for several ranges of number of starts or units. Using these data, EPA developed six firm sizes in the single-family sector and five firm sizes in the multifamily sector. For the single-family sector, EPA developed firm models of the following sizes: one to four starts, five to nine starts, 10 to 24 starts, 25 to 99 starts, 100 to 499 starts, and more than 500 starts. For the multifamily industry, EPA developed firm models of the following sizes: two to nine units, 10 to 29 units, 25 to 99 units, 100 to 499 units, and more than 500 units.

Data of similar detail were not available for the commercial, industrial, or highway construction sectors. These latter sectors are represented by one model firm each, based on a median employment size of 50 to 99 employees (U.S. Bureau of the Census, 2000c).

4.2.2.1.2 Overview of the Approach Within the C&D/FrMS

This section provides a general overview of how the C&D/FrMS incorporates the 14 model firms and how the modeling system uses these model firms to estimate impacts on C&D firms. Further detail on the construction and operation of the model firms is provided in later sections.

EPA's model firms for each size category are constructed with income statements and balance sheets that EPA believes are representative of typical firms in the affected industry groups. These income statement and balance sheet financials include the data that are helpful in calculating key financial ratios.

Financial ratio analysis is the core of EPA's firm-level impact analysis. Financial ratios are used by analysts to provide insight into the general financial health of firms. These ratios could, for example, reveal whether the firm is overburdened with debt, providing inadequate return on investment, or suffering from insufficient liquidity. Typical financial ratios use two or more line items from the income statement, the balance sheet, or both. The net profit (income) after-tax line item from the income statement, for example, can be used with the net worth (equity) line item from the balance sheet to develop a ratio called return on net worth, a measure of whether investment held in the firm (its net worth) is providing a reasonable return (profit) to the owners or stockholders.

EPA inputs compliance costs to the C&D/FrMS, which changes the values of the financial ratios calculated from the model firm balance sheets and income statements. In ratios looking at returns, for example, profits are assumed to decline (due to the imposition of compliance costs), which affects ratios using profits as a component. The relationships between debt and assets and between total assets and current assets also change, assuming the firm takes on greater debt to meet option requirements. All of these types of changes affect the financial ratios that EPA uses to determine impacts.

The changes that occur in the financial ratios form the basis for three analyses:

- An analysis of the change in financial ratios measured before and after the incorporation of option costs into each model firm's financial statements.

- An industry-based benchmark approach that EPA uses to estimate the number of firms incurring a change in financial health that might make them vulnerable to financial stress. EPA uses this result, in turn, to identify the potential for employment effects. Note, however, that in this analysis, financial stress does not directly imply closure, which is the most extreme response to financial stress. It indicates only that the firm is likelier to need to make changes to its operations to accommodate changing business conditions than a firm not estimated to experience financial stress. Effects on employment will only occur to the extent that firms downsize or close. Even in the case of downsizing or firm closure, however, employment effects are likely to result in a relatively rapid shift of work from one firm to another. Employees in the C&D industry are quite mobile and have transferable skills. Firms that remain open might need to add labor to install and operate ESCs (see Section 4.3.3).

- An analysis comparing compliance costs to assets, allowing EPA to determine if new construction firms might face barriers to entry.

The first two analyses are undertaken for two cost passthrough scenarios. The focus of the firm analysis is on the firm alone (impacts on consumers were explored using the C&D/PrMS and will be further explored in the national-level analyses discussed in Section 4.3). EPA is, therefore, investigating a cost passthrough scenario in which the firms absorb all of the compliance costs of the options considered (the zero cost passthrough scenario). EPA is also using a scenario in which the firms absorb a portion of the compliance costs (partial cost passthrough scenario). In this way, EPA models a worst-case scenario (zero cost passthrough) and a more likely scenario (partial cost passthrough). The 100 percent cost passthrough scenario is not analyzed because complete, or 100 percent, cost passthrough implies no direct impacts on the firm.

EPA's partial cost passthrough scenario is based on literature reviews, industry focus group input, and econometric evidence, which indicate that the level of cost passthrough from firms to customers is high in the construction industry. EPA used a market model approach to estimate cost passthrough (i.e., the ratio of the increase in market price to incremental compliance costs) for each of the four construction sectors analyzed (see Section 4.3.2). EPA's estimates of cost passthrough using these market models, range from a low of 84 percent for the industrial construction sector to a high of 91 percent for the commercial construction sector. The single-family and multifamily construction sectors are both estimated to pass through approximately 86 percent of costs (see DCN 45029 in the Rulemaking Record, which shows the calculation of these results). Assuming positive cost passthrough, builders incur compliance costs multiplied by one minus the cost passthrough percentage; the remaining costs are passed through to customers in the form of higher prices.[12]

4.2.2.1.3 Construction of the Model Firm Balance Sheets and Income Statements

This section presents the data used to construct the model firms and discusses the development of balance sheet and income statement information that characterize the financial conditions of model firms.

Sources of Data for Constructing Model Firms

EPA began the construction of the model firms by identifying data to characterize the typical financial conditions of model businesses in the C&D industry. These data are used to develop financial models of a number of representative firms, which in turn are used to analyze the impacts of the regulatory options on firm financial conditions.

For the residential construction sector, the Bureau of the Census recently published a profile of the residential homebuilding industry that allows analysts and others to examine firm financial data in new ways (Rappaport and Cole, 2000). In particular, the study presents firm financial data by size of builder, where the builder's size is defined in terms of the number of housing units completed (previously such breakdowns were available only on the basis of employment size or revenue size). EPA also obtained the average value of construction work (revenues) completed by builders of various sizes, based on the number of housing units started in 1997 (U.S. Bureau of the Census, 2000c). EPA used these profiles as a first step in developing financial snapshots of typical residential home builders, both single-family and multifamily.

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[12] Assume, for example, that the market analysis shows that housing prices increase by $0.80 of every dollar in increased construction costs per unit built. In this case, the cost passthrough is 80 percent. If the Final Action adds $200 in construction costs per house, the builder incurs impacts from $40 in increased costs not offset by increased revenues [(1 - 0.8)*$200], while the buyer pays an additional $160 (0.8*$200) for the house.

The Bureau of the Census' special study (Rappaport and Cole, 2000) does not cover the commercial and industrial building construction sectors or highway construction. EPA, therefore, used 1997 Census of Construction data (U.S. Bureau of the Census, 2002b) to provide revenues by employment size class, the first step in building model firms for these sectors.

The next step involved combining the average construction revenue data for builders with more detailed financial data on the homebuilding industry from Dun and Bradstreet's 1999- 2000 Industry Norms and Key Business Ratios (D&B, 2000). This document provided data on the balance sheet and income statement for a typical firm in the following four-digit SIC industry group:[13]

- Single-family residential construction (SIC 1531).
- Multifamily residential construction (SIC 1522).
- Manufacturing and industrial building construction (SIC 1541).
- Commercial and institutional building construction (SIC 1542).
- Highway and street construction (SIC 1611).

The D&B balance sheet and income statement for the typical firm in each industry group were scaled to the size of each builder in the census profile (for the residential construction sectors) or the 1997 Census of Construction median firm (for the commercial, industrial, and highways sectors).

Development of Balance Sheet and Income Statements for Model Firms

EPA used two distinct methodologies for constructing balance sheets and income statements for model firms: one for single-family and multifamily construction firm models and one for commercial, industrial, and highway construction firm models.

Table 4-4 illustrates the methodology used to construct the single-family and multifamily firm models. It presents a sample balance sheet and income statement for a model firm EPA developed to

[13] Although most of the data used in this EA is reported on a NAICS basis, the most recent D&B report still uses the SIC system. EPA believes the SIC-based data from D&B can be applied to the corresponding NAICS industries groups, as there is a high degree of overlap in the industry definitions.

represent a firm in the single-family residential construction sector that builds 10 to 24 houses per year, one of 14 such model firms within the C&D/FrMS.

Table 4-4. Model Single-Family Residential Construction Firm Financial Data

Line Item		Dollars	Percent
Assets			
1	Cash	$163,390	11.9%
2	Accounts Receivable	$122,199	8.9%
3	Notes Receivable	$9,611	0.7%
4	Inventory	$417,399	30.4%
5	Other Current	$303,438	22.1%
6	**Total Current Assets**	**$1,016,037**	**74.0%**
7	Fixed Assets	$216,938	15.8%
8	Other Non-current	$140,049	10.2%
9	**Total Assets**	**$1,373,023**	**100.0%**
Liabilities			
10	Accounts Payable	$112,588	8.2%
11	Bank Loans	$23,341	1.7%
12	Notes Payable	$201,834	14.7%
13	Other Current	$391,312	28.5%
14	**Total Current Liabilities**	**$729,075**	**53.1%**
15	Other Long Term	$162,017	11.8%
16	Deferred Credits	$10,984	0.8%
17	Net Worth	$470,947	34.3%
18	**Total Liabilities & Net Worth**	**$1,373,023**	**100.0%**
Operating Income			
19	**Net Sales**	**$1,987,009**	**100.0%**
20	Gross Profit	$453,038	22.8%
21	Net Profit After Tax	$23,844	1.2%
22	Working Capital	$286,962	--

Sources: D&B (2000); U.S. Census Bureau (200c); CCH (1999)

To construct these data, EPA first obtained the revenue figure (shown as $1.987 million in net sales) directly from the census profile data for a firm in the 10 to 24 starts grouping. Next, EPA calculated the ratio of total assets to revenues (net sales) for the D&B typical firm's balance sheet for SIC

1531. This ratio was used to determine total assets (and therefore total liabilities and net worth), using the census profile value for revenues. The dollar value of the remaining line items were based on their relationship to total assets, total liabilities, and net worth or net sales, using the percentages in the right hand column of the table. These percentages were derived from the D&B data for typical firms in each of the industry sectors.

In the example shown, the D&B ratio of total assets to net sales is 0.691. Thus, if net sales for D&B's typical firm is $1.987 million, then total assets are $1.373 million ($1.373 million equals $1.987 million multiplied by 0.691). After total assets are estimated, all other asset and liability line items can be calculated using each line item's percentage to total assets, liabilities, or net sales. These percentages were calculated using the D&B data. In this example, the model firm holds $163,000 in cash, based on the fact that cash constitutes 11.9 percent of total assets in the D&B data. This same method was used to create the balance sheets and income statements for the other firms in the single-family and multifamily residential construction sectors. See DCN 45031 for the balance sheets and income statements for all 11 of the residential building construction firm models EPA developed.

EPA conducted an alternative analysis to construct models for the commercial, industrial, and highway construction sectors because available data was limited for these sectors. For each of these sectors, EPA first determined the employment class corresponding to the median-sized firm in terms of revenues (U.S. Bureau of the Census, 2000c). This employment class became the basis for a single model facility for each sector. For each sector, EPA also identified the aggregate total revenues, employment, and costs associated with the 50 to 99 employee class of establishments. EPA then divided census total revenues, employment, and costs by the number of establishments in that class, by sector, to characterize the model firm. Average firm net sales (revenues), calculated in this manner, are used as the starting point for developing the D&B typical firm balance sheet and income statement. Average revenues and employment are also used to project the impacts of the options. See DCN 45031 for the balance sheet and income statements EPA constructed for commercial, industrial, and highway construction model firms. EPA solicited comments on its use of these median firms for modeling purposes. Although commenters would have preferred to see impacts on a range of different sized firms, they generally agreed that the median firm was more representative of existing conditions than the mean firm.

4.2.2.2 C&D/FrMS Analysis Approach

This section explains the methodologies for inputting compliance costs into the C&D/FrMS, assessing potential regulatory impacts in terms of changes in model firm financial ratios, extending these measures to the assessment of firm financial stress and any potential employment effects, and determining the potential for the various regulatory options to create barriers to entry for new firms.

4.2.2.2.1 Incorporation of Compliance Costs

EPA estimated engineering compliance costs, based on project size, type of construction, climatic region, state, and other characteristics (see Section 4.1.2). These costs were provided to EPA economics staff by EPA engineers and converted to weighted average costs per acre by type of construction (e.g., single-family) and size of project (acreage). To determine the costs for each model firm in each construction sector, EPA converted the costs per acre to costs per firm based on the following formula:

$$\text{costs per establishment} = (\text{costs per acre}) \times (\text{acres per start}) \times (\text{starts per establishment})$$

The C&D/FrMS applies an interactive process to progress all model firms through a series of assumptions about project size. This process enables EPA to address each project size for a particular land use type within each firm model for that particular land use type. In one such iteration, for example, the C&D/FrMS applies the cost per acre for a 7.5-acre project, multiplying this cost by 0.3 acres per house and the number of starts (houses) assumed for each specific single-family construction firm model (the midpoints of the size ranges). In the next iteration, 25-acre project costs are applied. Other iterations follow accordingly. Once impacts are tallied for each iteration, the C&D/FrMS makes adjustments to account for the proportion of projects of any one size that are undertaken annually. These adjustments are discussed in Section 4.2.2.2.3.

For the single-family residential, commercial, and industrial construction sectors, the estimated number of units started per firm is essentially identical to the number of buildings started. For the multifamily residential construction sector, however, the Census Bureau reports the number of units started, but each building contains a number of units. EPA used the estimate that the average multifamily building contains 10.8 units, therefore, to convert units started to buildings started (see Section 4.3.1.2 for a description of the number of units per building calculation). EPA used the midpoint of each range with the 10.8 units to estimate the number of buildings. In the 2 to 9 unit size group, for example, EPA assumed that one building would be constructed, and for the 25 to 99 unit group (midpoint 62), EPA assumed six buildings would be constructed.

EPA used a variety of sources to estimate average acres per start. For single-family residential construction, EPA based its estimate of acres per start on the median lot size from the Census Bureau's Characteristics of New Housing report (U.S. Census Bureau, 2000a). For the multifamily residential, commercial, and industrial sectors, EPA combined data on the typical "building" footprint from R.S. Means (2000) with the ratio of building footprint to site size from the Center for Watershed Protection (CWP, 2001) to estimate average acres per start (see Section 4.3.1.2).

For the model highway and street construction contractor, EPA used data on highway construction costs from the 1995 through 2000 editions of the Federal Highway Administration's (FHWA's) Highway Statistics publication. EPA also used 1997 Census data (U.S. Census Bureau, 2000c) to construct a model highway and street construction firm based on median revenues for firms in NAICS 234110. To estimate the number of acres developed and, hence, total firm compliance costs, EPA estimated miles of highway constructed per year. It did so by dividing model firm revenues by the estimated cost per mile constructed, $5.4 million, which was derived in Section 4.2.1.1.3. EPA estimated that one mile of highway construction involves, on average, 10.67 acres of land (calculated from Wright, 1996).

The compliance costs developed for each model firm were then used to alter the baseline financial information in the model balance sheets and income statements. The next section discusses financial line items changes that occurred as a result of the input of compliance costs.

4.2.2.2.2 Financial Ratio Analysis

For each model firm, EPA examined the economic impacts of each regulatory option on four different financial ratios: 1) gross profit, 2) current ratio, 3) debt to equity, and 4) return on net worth. Industry publications cite these financial ratios as particularly relevant to the construction industry (Kone, 2000; Benshoof, 2001). Two of the ratios are based on operating income (gross profit and return on net worth) and two are based on the balance sheet statement (current ratio and debt to equity).

Few financial ratios, however, have clearly defined critical values that indicate whether a firm is performing well or poorly. Furthermore, analysts often find that a firm can perform well in one financial category (e.g., debt management), yet poorly in another (e.g., rate of return). Lacking such hard and fast rules for interpreting financial ratios, analysts tend to emphasize trends over time, comparisons among competitors, or comparisons between industries, rather than a single critical value for any particular ratio.

An approach EPA has used in the past to analyze impacts from other ELGs employs Altman's Z-score (Z′ or Z″) (Altman, 1993). Altman's Z-score is a multidiscriminant analysis (similar to a regression analysis) used to assess bankruptcy potential. The Z-score equation analyzes a number of financial ratios, simultaneously, to arrive at a single number to predict the overall financial health of a firm. In effect, it applies empirically derived weights to several financial ratios. Unfortunately, Altman derived the equation for Altman's Z using specific data from the manufacturing sector. Altman developed two modified versions of the original model to evaluate privately held firms in the manufacturing sector (Z′) and the service industry sector (Z″). After careful evaluation, EPA determined that Altman's Z, Z′, or Z″ should not be used with the construction industry, because the equations Altman developed are based on empirical data specific to the manufacturing and service sectors (Altman, 1993). There many differences between the ratios and weights used in the manufacturing sector equation and those in the service sector equation, indicating that the ratios and their weights might be very different for construction sector equations.

To contend with the difficulty of judging financial health from several ratios, EPA has chosen two approaches to assessing impacts on existing firms. The first approach presents the post-compliance changes in four financial ratios, each considered separately from the others. This method does not attempt to identify firms that might face financial stress due to the regulatory options considered. The second approach compares the changes in the four ratios against ratios considered "low" for each affected industry sector to determine whether firms might experience financial stress. In this analysis, lacking data on the relative weights of the ratios used, EPA gives each ratio equal weight. EPA averages together the probability of financial stress, estimated separately for each ratio, at the end of the process. See Section 4.2.2.2.3 for more information on the averaging of probabilities.

Table 4-5 presents the four ratios examined for this analysis and a brief description of each one. More detailed information on the financial ratio analysis can be found in the EA of the proposed rule (U.S. EPA, 2002a).

The changes in the financial ratios triggered by compliance costs are also shown in Table 4-5. Compliance costs reduce gross profit and net profit after taxes. Compliance costs also have an effect on balance sheet items, but these effects are more complex. EPA assumes that construction costs, including compliance costs, are typically financed with a short-term construction loan. The value of the loan tends to be approximately 80 percent of the value of the project, with the developer providing the remainder of the capital. The loan reduces current assets by the amount of capital the builder is required to pay, but increases noncurrent assets by the total value of the project; total debt is increased by the amount of the loan.

EPA provides an example of how a model's financial ratios change from baseline to the post-compliance scenario. Table 4-6 shows sample results for a firm in the single-family residential construction industry (SIC 1531) completing between 10 and 24 housing starts per year, based on costs for 7.5-acre projects. The results are generated under an assumption of zero cost passthrough. Thus, this table only presents one of the many model results generated by the C&D/FrMS, as it shows only one size firm and one project size assumption (7.5-acre). Detailed results of each model firm with all project size assumptions are provided in the Rulemaking Record (DCN 45029). In this example, impacts are most severe on the return on net worth ratio, a recurring outcome throughout EPA's firm-level analysis. Return on net worth is the most sensitive ratio because it is based on net profit after taxes, which makes up only 1.2 percent of gross revenues for the typical establishment in SIC 1531 (according to D&B data). Impacts are much lower on the other financial ratios.

Table 4-5. Financial Ratios — Baseline and Post-compliance Equations

Financial Ratio	Baseline Equation	Post-compliance Equation
Gross Profit	$\text{gross profit ratio} = \frac{\text{gross profit}}{\text{net sales}} = \frac{(\text{net sales} - \text{operating costs})}{\text{net sales}}$	$\text{gross profit ratio} = \frac{(\text{net sales} - \text{operating costs})}{\text{net sales}}$
Return on Net Worth	$\text{return on net worth} = \frac{\text{net profit after tax}}{\text{net worth}}$	$\text{return on net worth} = \frac{(\text{net profit after tax} - \text{post-tax compliance costs})}{\text{net worth}}$
Current Ratio	$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}}$	$\text{current ratio} = \frac{(\text{current assets} - 0.20 \times \text{pretax compliance costs})}{\text{current liabilities}}$
Debt Management	$\text{debt to equity ratio} = \frac{\text{total debt}}{\text{owner equity}}$	$\text{debt to equity ratio} = \frac{(\text{total debt} + 0.80 \times \text{pretax compliance costs})}{\text{net worth}}$

Table 4-6. Sample Results Showing Impact of Regulatory Options on Financial Performance for a Single-family Residential Construction Model Firm, with 7.5-Acre Costs, in the 10 to 24 Housing Units Starts Class

Impact	Regulatory Option			
	Option 1	**Option 2**	**Option 3**	**Option 4**
Cost Impact				
Incremental Cost per Acre per Year	$113	$616	$0	$505
Incremental Costs per Establishment per Year	$14,408	$78,540	$0	$64,388
Impact on Financial Performance				
Gross Profit Ratio	0.23%	0.23%	0.23%	0.23%
Percent change from baseline	-0.14%	-0.75%	–	-0.61%
Return on Net Worth	0.05%	0.05%	0.05%	0.05%
Percent change from baseline	-1.55%	-8.43%	–	-6.91%
Current Ratio	1.39%	1.39%	1.39%	1.39%
Percent change from baseline	0.01%	-0.07%	–	-0.05%
Debt to Equity Ratio	1.92%	1.92%	1.92%	1.92%
Percent change from baseline	0.06%	0.30%	–	0.25%

Note: Stormwater control costs reflect a 7.5-acre site.
Source: EPA estimates based on the methodologies presented in Chapter Four.

EPA presents the changes in ratios from baseline to post-compliance for the regulatory options under consideration in Chapter Five, Section 5.4. EPA's method for comparing the changes in ratios with industry "benchmarks" to determine financial stress is discussed in the following section.

4.2.2.2.3 Analysis of Firm Financial Stress and Potential Employment Effects

EPA extended the model firm framework described above to estimate firm financial stress and the employment effects that might result from the Final Action.[14] This section discusses EPA's

[14]For the proposed rule, EPA also developed a cash flow model and constructed a statistical distribution of establishments around each representative model as a check on the financial ratio-based approach to projecting establishment closure impacts. This cash flow model allowed EPA to estimate the probability that establishments would have insufficient cash flow to afford the estimated compliance costs. The methods for this confirmatory

methodology, which is also based on analysis of financial ratios. Results are reported in Chapter Five, Section 5.4. First, EPA presents information on how it determined the number of affected firms and employees for this analysis. Then the Agency discusses the methodology used to determine financial stress and potential employment effects.

The options analyzed apply to sites of varying sizes. Option 1 applies to sites 1 acre or larger, while Options 2 and 4 apply to sites of 5 acres or larger and Option 3 (no-action option) applies to all sites. To accurately reflect the number of entities affected under each option, EPA has adjusted the closure and employment loss methodology to account for the number of firms affected.

In its special study of the home building industry (Rappaport and Cole, 2000), the Census Bureau estimates that 50,661 single-family builders start between one and four housing units per year, while 12,708 builders start between five and nine units per year. EPA concluded that builders starting fewer than five units per year were unlikely to disturb an acre of land in only one project. Some commenters seemed confused by the difference between total land development and disturbed acreage. Generally, the disturbed acreage will be much less than the total acreage developed. Those who build one to four houses per year generally build one house at a time, often on nonadjacent lots. Even if they build four houses as part of one development, four houses are unlikely to disturb an entire acre. Those starting fewer than 10 units are considered unlikely to disturb 5 acres. EPA further concluded that 1,904 multifamily builders starting between two and nine multifamily units per year are unlikely to disturb more than 5 acres during a given project. EA excluded these builders from the universe of firms potentially affected under Options 2 and 4.

EPA also adjusted the number of firms to account for equivalent state programs under the CGP component of Option 2 and Option 4. In the EA of the proposed C&D regulation, the number of acres affected by each alternative option differed only by the site size. Proposed Option 1 applied to all sites and proposed Option 2 applied to sites larger than 5 acres. Costs were reduced by the proportion of

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analysis are presented in Section 4.3.2.3 of the EA of the proposed rule and the results are presented in Appendix 5A (U.S. EPA, 2002a). EPA did not run this sensitivity analysis for the Final Action because the results of the sensitivity analysis upheld the results of the ratio analysis and because the average per-acre costs are similar to those estimated at proposal.

development sites in states with equivalent regulations. But costs per acre affected used in the firm impact models were calculated to be the same throughout the country.

There are significant differences in the number of acres incrementally affected by Option 1, the CGP component of Option 2, the inspection and certification component of Option 2, and Option 4. Option 1 affects 2.2 million acres, the inspection and certification component of Option 2 affects 1.8 million acres, and the CGP component of Option 2 affects only 1.2 million acres. Option 4 also affects 1.2 million acres. This difference is the result of excluding sites of less than 5 acres and excluding states that have equivalent state regulations. Few states have provisions analogous to inspection and certification requirements, while many have requirements similar to the CGP component of Option 2 and the requirements of Option 4. Thus, the Option 1 costs are spread across more acres than the Option 4 costs, resulting in divergent costs per acre. Option 2, in a sense, combines Option 1 (at sites of 5 acres or more) and Option 4. Of the 1.8 million acres affected by Option 2, about 0.6 million acres of this total are affected only by the inspection and certification component of Option 2. Spreading the total costs of Option 2 across 1.8 million acres makes the costs per acre appear lower than those for Option 4, although Option 4 is identical to the CGP component of Option 2.

Ideally, the firm impact models would be adapted to account for each state's unique situation, but financial information was not available to develop state-specific model firms. EPA was, however, able to accommodate some of the differences in costs among states. Total counts of construction firms by state were available (U.S. Census Bureau, 2000). EPA used these data to calculate the number of firms in states affected by the CGP component and calculate the nationwide proportion of firms by land use type. This step further reduced the universe of affected firms from the count of firms that only complete renovations and disturb less than 1 acre or less than 5 acres. EPA used this smaller universe of firms in CGP-affected states to calculate the impacts of Option 4.

Clearly, Option 2 includes the impacts of Option 4. In addition, in-scope sites in all states would be affected by the inspection and certification component under Option 2. EPA estimated the costs associated with the inspection and certification component by subtracting Option 4 costs from Option 2 costs. As there are some efficiencies created by implementing inspection and certification and the CGP components together, this difference was not equal to Option 1 costs. EPA then converted the inspection and certification component costs to costs per acre, using the total acreage affected by Option 2. The

Option 2 impacts were calculated in two parts and added together. In one part, EPA tallied firms that were estimated to experience financial stress under Option 4. These numbers were then added to the results of the run that incorporated the additional inspection and certification component costs of Option 2. Those firms affected by Option 2, but not Option 4, were affected only by the inspection and certification component costs per acre of Option 2. The results of these two model runs were added together to estimate the total impact of Option 2.

Affected employment is determined in the same manner as affected firms. The Census Bureau's study reports the number of employees in each housing unit start category, and these numbers are used to estimate the numbers of employees affected under each option by subtracting the numbers of employees in the smaller housing unit start categories to eliminate sites not in scope.

The site size adjustment, used to remove sites less than 1 acre and less than 5 acres, was only made for the residential construction industry groups for two reasons. First, the Census Bureau's special study, from which EPA identified firms and employment by the number of starts or units, only covers single-family and multifamily residential construction establishments. Second, EPA believes that commercial and industrial building establishments are, overall, more likely to disturb 5 acres or more during the course of each project. Thus, no adjustments were made to the nonresidential building firm and employment counts on the basis of acreage covered by the options' scopes. Adjustments, however, were made to account for equivalent state programs. These adjustments were similar to the adjustments made for residential builders.

Table 4-7 shows the firm count adjustment for each option, based on acres excluded. The first column in this table is identical to the third column of Table 2-14 in Chapter Two. Table 4-7, however, removes the special trades sector before EPA makes adjustments to firm numbers on the basis of option scope. In Table 2-14, the option scopes are shown with and without special trades removed. Special trade contractors are not analyzed in this EA because EPA believes they will not be affected by any of the options. First, most of the special trade professionals (such as plumbers and electricians) are unlikely to disturb 1 or more acres of land. These trades were omitted prior to Table 2-14. Second, the 19,771 firms in the excavation and demolition sectors (shown in Table 4-7), usually act as subcontractors. EPA believes that if they do incur compliance costs, they will pass these costs to the general contractor because subcontractors will note any such requirements while making their bids. If an excavation subcontractor, for example, is told to excavate for a swimming pool, this task is accounted for in the bid. If the subcontractor is told to excavate a sediment pond, the same reasoning applies.

Table 4-7. Number of Firms in the C&D Industry, Adjusted for Regulatory Option Coverage

Industry	Number of Firms[a]	Number of Firms in Analysis Before Site Size Exclusions	Option 1		Options 2 and 4	
			Adjustment for 1 acre exclusion	Adjusted Number	Adjust-ment for 5 acre exclusion	Adjusted Number
Single-family housing construction	84,731	84,731	(50,661)	34,070	(12,708)	21,362
Multifamily housing construction	4,603	4,603	--	4,603	(1,904)	2,699
Commercial construction	39,810	39,810	--	39,810	--	39,810
Industrial building construction	7,742	7,742	--	7,742	--	7,742
Heavy construction	42,557	11,270	--	11,270	--	11,270
Special trade	19,771	--	--	--	--	--
Total Firms	**199,217**	**148,156**		**97,495**		**82,883**

[a] Previously adjusted to remove remodeling establishments and to reallocate land development establishments to the four building construction sectors. See Chapter Two, Section 2.3.5 for discussion of this adjustment. Also, see Table 2-14.
Figures do not necessarily add to totals due to rounding.
Source: Rappaport and Cole, 2000; EPA estimates.

Table 4-7 also adjusts the number of firms in the heavy construction sector. The adjusted number represents the number of firms in the highway construction portion of this sector, which is the only sector with enough data for analysis. Although commenters noted that this sector was not analyzed in detail, they did not submit usable financial data. EPA discusses potential impacts on the rest of this sector qualitatively in Chapter Five.

Table 4-8 displays the firm count after adjustments are made for state equivalency. The number of firms that are subject to the CGP component of Option 2 and the requirements of Option 4 is smaller than the total number of firms in each industry sector.

Table 4-8. Number of Firms in the Construction and Development Industry Adjusted for State Equivalency for the CGP Component of Option 2 and for Option 4

Industry	Number of Firms in Analysis[a]	Option 2 (CGP Component) and Option 4	
		Adjustment for State Equivalency	Adjusted Number
Single-family housing construction	21,362	(5,212)	16,150
Multifamily housing construction	2,699	(619)	2,080
Commercial Construction	39,810	(11,103)	28,707
Industrial building construction	7,742	(1,947)	5,795
Heavy construction (highway)	11,270	(2,834)	8,436
Potentially affected firms	**82,883**		**61,168**

[a] From Table 4-7.
Figures do not necessarily add to totals due to rounding.
Source: EPA estimates.

To project firm financial stress due to the options, EPA first selected a criterion for determining when a facility is considered "impacted" by an option under consideration. As discussed earlier, financial ratios rarely have well-defined thresholds that correlate with financial health or stress. In analyzing previous ELGs (e.g., U.S. EPA, 2003), EPA has defined the critical value for financial stress as the value of a financial ratio that defines the lowest quartile of firms (i.e., the poorest performing 25 percent of firms). EPA assumes that a facility is financially stressed if its preregulatory financial ratio lies above the lowest quartile value, but its post-regulatory ratio falls below the lowest quartile value. According to D&B, for example, 25 percent of establishments in SIC 1531 have a current ratio less than 1.1, which is it the lowest quartile value. If a firm's preregulatory current ratio is greater than 1.1, but its post-regulatory current ratio is less than 1.1, EPA would classify the firm as potentially financially stressed, subject to consideration of the other financial ratios, discussed in the next paragraph.

EPA approximated a cumulative distribution function for each financial ratio, using the lower quartile, median, and upper quartile values from D&B. Figure 4-2 illustrates the current ratio cumulative distribution function for SIC 1531 (single-family residential construction). The baseline curve represents the preregulatory cumulative distribution function. This curve indicates that 25 percent of establishments have a current ratio below 1.1 (1.1 thus becomes the critical value for determining financial stress), 25 percent of establishments have a current ratio greater than 1.1 but less 1.4 (the median), 25 percent have a current ratio greater than 1.4 but less than 2.9, and 25 percent have a current ratio greater than 2.9. The cumulative distribution function is assumed to be identical for each size model firm in the single-family and multifamily housing sectors, although the values of the balance sheet and income statement line items, used to calculate the financial ratios, increase with model firm size. EPA also constructed cumulative distribution functions for the debt to equity and return on net worth ratios. D&B does not provide quartile values for the gross profit ratio. EPA, therefore, could not use the gross profit ratio in the firm financial analysis.

EPA then estimated the post-compliance cumulative distribution function by calculating the post-compliance quartile values for each financial ratio, using the post-compliance equations in Table 4-5 and the estimated compliance costs for the model firm. To estimate the post-compliance financial ratios, EPA combined relevant model firm line items and each quartile financial ratio values, calculating the value of other balance sheet line items that would be consistent with each financial ratio value. The current ratio, for example, is:

$$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}}$$

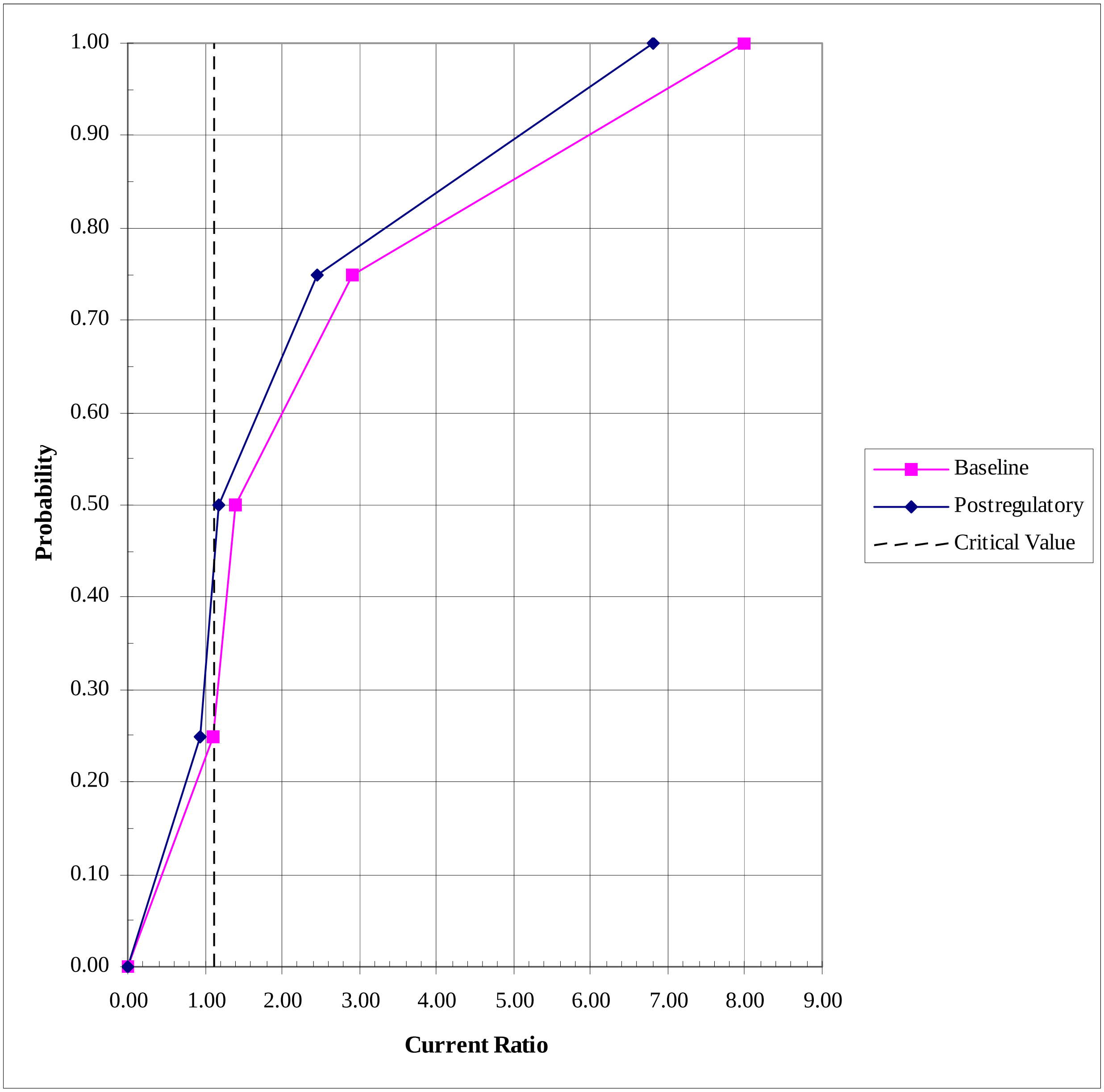

Figure 4-2. Hypothetical Pre- and Post-regulatory Cumulative Distribution Function for Current Current Ratio, SIC 1531: Operative Builders

EPA calculated the value of current liabilities, consistent with upper and lower quartile values of the current ratio, using the following equation:

$$\text{estimated current liabilities} = \frac{\text{model firm current assets}}{\text{quartile value of current ratio}}$$

For the model firm represented in Table 4-4, current assets are $1.016 million. If the lower quartile value of the current ratio is 1.1, then current liabilities of $923,600 are consistent with the current ratio of 1.1 and the current assets value of $1.016 million. The post-compliance value of the current ratio for this firm would then be calculated by subtracting 20 percent of pre-tax compliance costs from current assets ($1,016 million) and dividing the resulting value by current liabilities ($923,600).

In the example shown in Figure 4-2, compliance costs decrease the value of the current ratio, shifting the post-compliance cumulative distribution function to the left. The post-regulatory scenario in Figure 4-2 is hypothetical and does not reflect actual impacts, which are presented in Chapter Five. DCN 45028 in the Rulemaking Record presents the results of all iterative runs for all models. Using the post-compliance curve in this example, EPA estimates that approximately 40 percent of establishments now have current ratios less than or equal to the critical value of 1.1. In this hypothetical example, therefore, approximately 15 percent of firms in this sector might incur incremental financial stress due to compliance costs (i.e., 40 percent below 1.1 on the post-regulatory curve minus 25 percent below 1.1 in the baseline scenario).

Under each regulatory option considered, compliance costs vary with project size (acreage). Furthermore, even when project size is held constant, financial stress will vary with model firm size because the average number of projects undertaken in a year differs among model firms. Financial stress also varies with model firm size because different size model firms have different levels of resources available to absorb compliance costs. To estimate the number of firms in each sector that would be financially stressed by an option under consideration for the Final Action, therefore, EPA examined all combinations of model facility size and project size for each financial ratio.

A firm with a financial ratio that does not meet the “financially healthy” benchmark for a single measure of financial performance, however, will not necessarily experience financial stress. To assess the impacts of the options analyzed, therefore, EPA assumes that the probability of firm stress due to incremental compliance costs is equal to the average probability of incremental financial stress under each of the three financial ratios: current, debt to equity, and return on net worth. If the probability of incurring incremental financial stress, for example, is 15 percent when observing the change in the current ratio, 10 percent when observing the change in debt to equity, and 5 percent when observing the change in return on net worth, EPA calculates that the overall average probability of financial stress is 10 percent for the sector (the average of 10, 5, and 15). In effect, EPA is giving each ratio equal predictive weight. Multiplying this probability by the number of firms represented by the model firm used for the analysis, EPA obtains an estimate of the number of firms projected to experience financial stress due to the option under consideration for that size project and that size model firm. Intuitively, EPA is making an implicit assumption that a firm that does not meet a benchmark under one ratio also does not meet benchmarks under the other two ratios. If a firm is not meeting benchmarks under multiple measures of financial health, it is highly likely that the firm will experience financial stress.[15] The potential for employment effects are estimated by multiplying the number of firms projected to experience financial stress by the average number of employees per firm. As noted earlier, however, any effects on the group of employees identified in this manner are likely to 1) not occur at all or 2) involve fairly quick transfer of workers to projects managed by other, nearby firms. These firms might need to hire additional labor to comply with ESC installation and maintenance requirements (see Section 4.3.3).

Finally, to project sector-wide impacts under a specific regulatory option, EPA aggregated the number of firms expected to experience financial stress and the potential employment effects for all combinations of model firms and project sizes affected by that option. Numbers of firms estimated to experience financial stress in a single sector were calculated as a sum of the projected numbers of such firms under each combination of model firm and project size. The numbers of firms are weighted by the relative frequency of a particular project size among all projects constructed by the sector. Suppose that

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[15] A strict interpretation of this implicit assumption would result in EPA always selecting the smallest probability of incremental financial stress from among the three measures. EPA determined, however, that this method was not analytically desirable because the results would always be determined by the least sensitive measure of stress. EPA, therefore, selected an average of the three probabilities to measure financial stress rates. Note that, in reality, a firm might not meet a benchmark under one ratio, but meet one under another ratio. This firm would be less likely to experience financial stress. It is possible that the set of firms that do not meet the benchmark for the current ratio, for example, is completely separate from the set of firms that do not meet the benchmark for the debt to equity ratio. EPA, however, has no information on which to base an estimate of such joint probabilities. Assuming the sets of firms that do not meet benchmarks are identical under each type of benchmark results in a more conservative estimate of stress.

in the single-family housing construction sector, for example, the C&D/FrMS estimates that the incremental probability of financial stress for firms in the 25 to 99 start class is 0.8 percent for a 3-acre project under Option 1. Because there are approximately 3,000 firms in this start class, approximately 24 firms are expected to incur financial stress. Three-acre projects, however, account for only about 6 percent of single-family construction. Thus, the weighted number of firms in the 25 to 99 model firm start class estimated to experience financial stress as a result of undertaking 3-acre projects under Option 1 is 1.4. Similar calculations are performed for all other size model firms for 3-acre projects, and for all size model firms for 7.5-acre, 25-acre, 70-acre, and 200-acre projects. The weighted number of firms experiencing financial stress for each combination is summed to project total numbers of firms estimated to experience financial stress under Option 1. In this calculation, EPA also adjusted the universe of affected firms to reflect the regulatory coverage of each option, as shown in Tables 4-7 and 4-8.

4.2.2.2.4 Barriers to Entry Analysis

In addition to having impacts on existing firms, EPA regulations can have impacts on new firms. In some cases, regulations can have an adverse affect on the ability of new firms to compete with existing firms in an industry, reducing the likelihood that new firms will enter the market. These effects are known as barriers to entry. Barriers to entry are typically assumed to occur if the cost of complying with a regulation substantially increases the firm start-up costs.   If a rulemaking requires that all facilities invest substantially in a wastewater treatment system, for example, then an entrepreneur might be discouraged from starting an enterprise. The increased capital cost serves as a barrier to new entry to the industry.

The situation in the construction industry is somewhat different. In terms of the capital required to start a firm, the final action has little direct impact. The final action does not require a firm to purchase and install any capital equipment, and thus the level of capital expenditures required to start up a firm are not directly affected by the final action.

Landis (1986; see Section 2.4.1.4.2 for details) identifies two significant barrier to entry classes, specific to the construction industry, that are not related to capital equipment: 1) entry costs to participate in a given market (e.g., local development fees or abnormally high land costs) and 2) input cost differentials (e.g., the new entrant must pay a higher price for inputs than existing firms). These barriers to entry, however, also appear to be unaffected by any of the options under consideration. To the extent that either of these barriers already exist in any given market, they would not be differentially affected by any of the options considered in EPA's Final Action.

As the model establishment analysis indicates, the options considered might increase borrowing as firms finance building projects. This could affect a potential industry entrant indirectly, as the new firm might need marginally more startup capital to obtain the somewhat larger short-term construction loan required to undertake a project. Once again, however, the new entrant would still face essentially the same requirements that existing firms face to secure a loan. Thus, new entrants should not be differentially affected by the options considered in such a way that they would be unable to compete effectively with existing firms.

To examine the potential for barriers to entry, EPA calculated the ratio of estimated compliance costs to each model firms's current assets and total assets. If these ratios are small, then EPA concludes that the option considered would have little effect on the ability of a new entrant to secure financing for a project. Note that in this analysis, EPA compares total compliance costs to assets. This step probably overestimates impacts. It is more likely that a new entrant would need to provide only 20 percent of the incremental compliance costs and would obtain the remaining 80 percent from conventional construction loan financing sources (see Section 4.2.2.2.2), as would an existing firm.

4.3 NATIONAL-LEVEL COSTS AND IMPACTS

This section presents EPA's methodologies for calculating national-level costs and impacts. Section 4.3.1 discusses the methodology for computing national compliance costs. Section 4.3.2 presents EPA's methodologies for using partial equilibrium market modeling to measure impacts on the U.S. economy. The section also presents EPA's methodologies for 1) measuring impacts on consumers who purchase single-family housing, 2) determining changes in price and quantity of single-family housing at the national level due to the options considered, and 3) undertaking a regional market analysis. This last analysis focuses on all four major construction sectors (single-family, multifamily, commercial, and industrial) to determine changes in price and quantity for each sector. Section 4.3.3 presents EPA's approach for calculating net economic impacts on the U.S. economy. This calculation uses the results of the partial equilibrium models to identify changes in output and employment and to compute a deadweight loss to society. Finally, Section 4.3.4 presents EPA's method for calculating impacts on government agencies. The relationships among these analyses can be seen earlier in this chapter in Figure 4-1b.

4.3.1 Methodology for Computing National Compliance Costs

EPA developed per-acre engineering costs (across all acres developed for Options 1, 2, and 4)[16] for four categories of land use (single-family residential, multifamily residential, commercial, and industrial). Each land use category was also broken into the various project size categories, as discussed in Section 4.1.1. To estimate the total national costs of the options to the affected C&D industry groups, EPA first adjusted the per-acre costs to include opportunity and interest costs, because these are additional costs industry will bear implicitly or explicitly (see Section 4.3.1.1). These costs arise out of the need for firms to self-finance the incremental project costs (using, for example, working capital) and/or borrow additional money to cover the added compliance costs. EPA then estimated the numbers of acres of land developed annually by type of land use and project size (see Section 4.3.1.2). Finally, EPA aggregated the adjusted per-acre costs for each option across all acres developed annually by land use type and project size. These costs were summed to produce the total national compliance costs to industry of each of the options considered (see Section 4.3.1.3).

4.3.1.1 Calculation of Adjusted Per-Acre Costs That Are Used to Compute National Compliance Costs

As noted in Section 4.1.1.2, the compliance costs developed by EPA's engineers do not include a variety of costs or items that arise during the C&D process. These costs or items include profit and overhead, and opportunity costs and interest, all of which can add to the price of construction if costs are passed through to consumers. The latter two costs are costs that industry bears and should be included in

[16]Option 3 is the no-action option. In general, the analysis of this option is not discussed, as it is identical to the baseline analysis.

an estimate of national compliance costs. Profit, however, does not affect costs to industry. Additionally, as discussed in Section 4.1, overhead is not affected measurably by the very small, per-project incremental option costs because most overhead cost items do not change with small, marginal changes in project costs.

Section 4.2.1 discussed two multipliers that are calculated within EPA's C&D/PrMS. These multipliers allow EPA to compute a cost per acre for each combination of project size and land use. EPA can use either a total cost multiplier, which includes all components that contribute to a price increase, or an opportunity and interest cost multiplier, which only includes the opportunity and interest cost components. EPA uses the project-specific opportunity and interest cost multiplier with the project-specific, per-acre engineering costs developed for each model to produce per-acre adjusted costs (by size and type of project), which are entered into the National Cost Model.

4.3.1.2 Calculation of Number of Acres by Land Use Type and Size

Aggregate costs to the industry are obtained by multiplying the adjusted per-acre costs (see Section 4.3.1.1) for each land use type and site size by the number of acres estimated to be developed each year for each type and size.[17] A major step of the national-level cost methodology, therefore, is estimating the numbers of acres developed by land use type and site size. EPA obtained estimates of the annual, nationwide number of acres developed from the U.S. Department of Agriculture's (USDA's) National Resources Inventory (NRI). This source does not, however, identify the type of development, subsequent nature of the land use, or the distribution of acreage by site size.

The following sections describe the four steps EPA undertook to break out the numbers of acres developed annually by land use type and site size:

[17]In actuality, these estimates of acreage by land use and size were used first to create the per-acre costs, using the total costs by site and size that are output by the engineering cost models (see Section 4.1.1). Their use, as described here, allows EPA to return to total costs after the adjustments to per-acre costs are made using the multipliers. Note that using costs per acre developed and numbers of developed acres would produce the same result as using costs per acre affected by CGP codification requirements and numbers of CGP-affected acres. For simplicity, EPA uses the former to compute total costs for all options.

- Step One—Identifying the nationwide number of acres developed annually, based on NRI estimates.

- Step Two—Distributing the developed acreage estimated in Step One across land use type.

- Step Three—Distributing the acres in each land use type estimated in Step Two across site size classes.

- Step Four—Adjusting the numbers of acres downwards to account for the regulatory scope of Options 2 and 4. This section also presents the numbers of CGP-affected acres under Options 2 and 4, although they are not used for computing total compliance costs.

4.3.1.2.1 Step One—Identifying Annual, Nationwide Numbers of Acres Developed

The NRI, a program of the USDA's Natural Resources Conservation Service, is designed to track changes in land cover and land use through time. The inventory, conducted every five years, covers all non-federal land in the United States (75 percent of the U.S. total). The program captures land use data from approximately 800,000 statistically selected locations. From 1992 to 1997, an average of 2.24 million acres per year was converted from nondeveloped to developed status (USDA, 2000).

EPA assumes that some of the 2.22 million acres converted from an undeveloped to developed status each year would be exempt from the requirements of any of the options considered, due to the site size being less than 1 acre. Based on the engineering analysis of sites of that size, EPA has reduced the amount of land subject to active construction controls to 2.18 million acres (U.S. EPA, 2004). Thus, the 2.18 million acres represents EPA's estimate of the number of acres that would be subject to Option 1. EPA made further adjustments, limiting the acreage to land affected under Options 2 and 4, by removing the acreage associated with sites smaller than 5 acres.

4.3.1.2.2 Step Two—Distributing Acreage by Land Use Type

The NRI data are not allocated among the land use types used in EPA's analysis. To allocate the NRI acreage by land use type, EPA estimated the distribution of acres developed by land use type as follows:

- EPA obtained data relating to numbers of permits issued annually for the various land use types. EPA was able to obtain data on the number of building permits issued per year for single-family homes and multifamily projects directly from 1995 through 1997 census data. Estimates of the number of permits for other types of construction were based on extrapolations of the number of permits derived from older census permit data.

- EPA multiplied the number of building permits issued annually by estimates of the average site size for each land use type. This calculation produced an estimate of the number of acres developed annually by land use type.

- EPA compared the sum of these estimates of acres developed to the NRI estimates of land developed annually in the United States and adjusted the estimates of acres by land use type to reconcile any differences. Finally, EPA allocated the total by type of construction, site size, and region and adjusted each regional value to an integer to ensure that only whole sites were considered.

Detailed methodologies for deriving acreage estimates for each of the major land use types–single-family residential, multifamily residential, and nonresidential construction–are described in more detail in the subsections below.[18] This section concludes with a discussion of how EPA adjusted the estimate of acres by land use type to match the total acreage developed according to the NRI data.

Single-Family Residential

Census data from 1995 through 1997 indicate that the number of new single-family housing units authorized has averaged 1.04 million units per year (see Table 4-9). As seen in Table 4-10, the average lot size for new single-family housing units is 13,553 square feet, or 0.31 acres (1 acre = 43,560 square feet). If EPA had used the average lot size, however, the total acreage converted for single-family residential projects could have been underestimated because this acreage does not include housing development common areas that are not considered part of the owner's lot—streets, sidewalks, parking areas, stormwater management structures, and open spaces.

[18] EPA also estimates acres developed for highway and other nonbuilding construction. EPA, however, includes these acres in the other land use types because no distinct engineering costs were developed for these types of construction. This approach leads to the implicit conclusion that compliance costs to nonbuilding construction will be similar to those for building construction.

Table 4-9. New Single-Family and Multifamily Housing Units Authorized, 1995-1997

Year	All Housing Units	Single-Family Housing Units	Multifamily Housing Units
1995	1,332,549	997,268	335,281
1996	1,425,616	1,069,472	356,144
1997	1,441,136	1,062,396	378,740
1995-1997 avg	**1,399,767**	**1,043,045**	**356,722**

Source: U.S. Census Bureau, 2000b. Series C40 New Privately Owned Housing Units Authorized.

Table 4-10. Average and Median Lot Size for New Single-Family Housing Units Sold, 1995-1997

Year	Average Lot Size (Square Feet)	Median Lot Size (Square Feet)
1995	13,290	9,000
1996	13,705	9,100
1997	13,665	9,375
1995-1997 avg	**13,553**	**9,158**

Source: U.S. Census Bureau, 2000a. Series C25 Characteristics of New Housing.

To account for this additional acreage, EPA examined data obtained from a survey of municipalities conducted in support of the Phase II NPDES stormwater rule (U.S. EPA, 1999). This survey identified 14 communities that consistently collected project type and size data as part of their construction permitting programs.[19] EPA reviewed the permitting data from these communities, which indicated that 855 single-family developments, encompassing 18,134 housing units, were constructed. The combined area of these developments was 11,460 acres, which means that each housing unit accounted for 0.63 acres (11,460 acres ÷ 18,134 units = 0.63 acres per unit). This estimate (essentially double the average lot size) appears high and could more than account for the common areas and

[19] The communities were Austin, TX; Baltimore County, MD; Cary, NC; Ft. Collins, CO; Lacey, WA; Loudoun County, VA; New Britain, CT; Olympia, WA; Prince George's County, MD; Raleigh, NC; South Bend, IN; Tallahassee, FL; Tuscon, AZ; and Waukesha, WI.

developed areas in a typical single-family residential development. On the other hand, the average lot size alone clearly understates size relative to developed area. To address these issues, EPA averaged the census national average lot size estimate of 0.31 acres and the Phase II NPDES stormwater estimate of 0.63 acres per unit to arrive at an estimate of 0.47 acres per unit. EPA then multiplied the 0.47 acres per unit by the average annual number of single-family housing units authorized by building permits (1.04 million), arriving at an estimate of 490,231 acres developed annually for single-family housing.

Multifamily Residential

EPA's calculation of acreage for the multifamily sector required several steps. First, the Agency calculated the average number of units per new multifamily building. Then, EPA divided the average number of units authorized between 1995 and 1997 (356,722, from Table 4-9) by the average number of units per new multifamily building to estimate the number of sites developed annually. Finally, EPA estimated the number of acres likely to be developed at these sites.

EPA estimated the average number of units per multifamily building by examining the distribution of units by unit size class in census data (U.S. Census Bureau, 2000b). The Census Bureau's report shows the number of units built annually by building size class (2 to 4 units, 5 to 9 units, 10 to 19 units, and 20 or more units).[20] EPA estimated the number of buildings in each size class by dividing the total number of units in each class by the average number of units per building for that size class. In the 10 to 19 unit size class for 1999, for example, the total number of units was approximately 94,000 and the average number of units per building was 14.5, so EPA calculated 6,483 buildings associated with this size class. After EPA calculated the number of buildings associated with each size class, the number of buildings estimated in each size class were summed to estimate a total number of buildings built on average annually (31,405 buildings). EPA also summed the number of units in each size class to obtain a total number of units associated with all multifamily buildings estimated to be built annually (338,000 units). EPA then divided the total number of units built annually by the total number of buildings built annually to estimate the average number of units per multifamily building constructed (338,000 units ÷

[20] The average number of units was derived using data for 1999 and 2000 because data for prior years was not available at this level of building size detail.

31,400 buildings = roughly 10 units/building).[21] EPA divided the average number of units estimated to be built annually from 1995 to 1997 (356,722 units) by the average number of units per building (10 units), yielding an estimated of 35,672 sites.

EPA's next step was to estimate the number of acres per site associated with the 35,672 sites developed per year. EPA identified two methods for calculating site size for multifamily developments. The first method allows EPA to extrapolate from living space estimates to footprint size and then to total site size. The second approach uses data from the 14-community study, cited earlier.

In the first approach, EPA used data from a report by The Center for Watershed Protection (CWP), which estimated that multifamily buildings occupy an average of 15.6 percent of the total site (CWP, 2001). EPA assumed that the average-sized multifamily building (10.8 units) has two floors and that each unit occupies the national average of 1,095 square feet (NAHB, 2002). EPA thus estimated that the total square footage accounted for by living space is 11,826 square feet. EPA assumed an additional amount of space would be required for common areas. EPA selected a factor of 1.2 to account for common areas and other non-living space (e.g., utility rooms, hallways, stairways). When EPA multiplied the living space square footage by the 1.2 factor and divided this number by 2, to reflect the assumption of a two-story structure, an estimate of 7,096 square feet (11,826 x 1.2 ÷ 2 = 7,096) was obtained for a typical building footprint. EPA combined this number with the CWP estimate of the building footprint share of total site size (15.6 percent) to estimate an average site size of 42,485 square feet (7,096 ÷ 0.156 = 45,485), slightly more than 1 acre (1.04 acres).

In the second approach, using data from the 14-community study, EPA identified 286 multifamily developments covering a total of 3,476 acres. The average site size, 12.1 acres, is considerably higher than that obtained above. EPA had no indication that the permits reviewed in these communities were for projects of a larger than average size. Lacking a clear indication of how to resolve the wide variation between the two approaches, EPA decided to select the midpoint of the results obtained using the two methods. EPA has thus assumed that 6.5 acres is the average site size of multifamily projects. EPA

[21]EPA uses 10 in this calculation to match the rounding used in the Technical Development Document (U.S. EPA, 2004). Elsewhere in this EA, EPA uses the more precise 10.8 units per building.

multiplied this number by the average number of multifamily housing developments authorized by building permit, 35,672, to arrive at an estimate of 231,868 acres.

Nonresidential Construction

For nonresidential construction, EPA again used estimates of numbers of permits issued annually and estimates of average site sizes to calculate the number of acres of land developed annually for nonresidential purposes. EPA, however, lacked current data on the number of nonresidential C&D projects authorized annually because the Census Bureau ceased collecting data on the number of permits issued for such projects in 1995. EPA, therefore, used regression analysis to forecast the number of nonresidential building permits issued in 1997, based on the historical relationship between residential and nonresidential construction activity (see Section 4.3.1.2). Using this approach, EPA estimates that a total of 426,024 nonresidential permits were issued in 1997.

In the original census data (U.S. Bureau of the Census, 2000b), the numbers of permits are broken down by a variety of project types, including commercial and industrial, institutional, recreational, nonresidential, and nonbuilding, which includes parks and road and highway projects. EPA allocated the total nonresidential permits to land use categories based on the proportions of such projects in the1997 Census. EPA divided project types into commercial and industrial categories because stormwater management practices for commercial sites generally differ from those for industrial sites. The commercial category required EPA to combine several census categories. The census categories included hotels and motels, retail and office projects, and religious, public works, and educational projects, each with a count of permits.[22] EPA combined these categories into a "commercial construction" category based on engineering judgment that stormwater management practices would be similar across these project types. When the commercial categories were combined, EPA estimated that 254,566 commercial permits (59.7 percent of the nonresidential total) were issued in 1997.

[22] The commercial category included the following: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, and other nonresidential buildings.

EPA did not adjust the Census Bureau's industrial category. Census Bureau data indicated that, on average, 12,140 permits (2.8 percent of the total nonresidential construction category) were issued for this group. The remaining 159,318 permits (37.4 percent) covered nonbuilding, nonresidential projects that include parks, bridges, roads, and highways. EPA accounts for the costs of these latter projects when it reconciles acreage estimates by land use type with the total NRI estimates of land developed annually (see later in this section).

EPA used two approaches to estimate the average acreage developed by commercial and industrial construction projects. First, EPA reviewed the project size data collected from the 14-community study referenced earlier (U.S. EPA, 1999). This study identified 817 commercial sites, occupying 5,514 acres, and 115 industrial sites, occupying 689 acres. The average site sizes, according to these data, are 6.75 and 5.99 acres, respectively.

Second, EPA reviewed estimates from CWP (2001) on the average percentage of commercial and industrial sites taken up by the building footprint. These percentages were 19.1 and 19.6 respectively. EPA then turned to R.S. Means (2000), which identifies the typical range of building sizes based on a database of actual projects. Table 4-11 shows the typical size and size range for a variety of building types in commercial or industrial categories, according to the R.S. Means data. Based on the data shown in Table 4-11, EPA believes, generally, that there are more small projects than large ones because the "typical" sizes are smaller than the average of the low and high ranges. As a result, using the data in Table 4-11, EPA inferred that an assumption of an average building size of 25,000 square feet is reasonable. This building size, combined with the CWP percentages of footprint to site (which are slightly more than 19 percent for both commercial and industrial sites), implies an average site size of approximately 3 acres for both commercial and industrial construction.

EPA again found that the data provided in the 14-community study led to a higher estimate of site size than a method using the CWP data. To reconcile the estimates obtained from the two approaches, EPA has taken the midpoint of the estimates. For commercial development, EPA assumed an average site size of 4.9 acres (the midpoint of 6.75 and 3.0 acres) and for industrial development, EPA assumed an average site size of 4.5 acres (the midpoint of 5.99 and 3.0 acres).

Table 4-11. Typical Building Sizes and Size Ranges by Type of Building

Building Category/Type	Typical Size (Gross Square Feet)	Typical Range (Gross Square Feet)	
		Low	High
Commercial - Supermarkets	20,000	12,000	30,000
Commercial - Department Store	90,000	44,000	122,000
Commercial - Low-Rise Office	8,600	4,700	19,000
Commercial - Mid-Rise Office	52,000	31,300	83,100
Commercial - Elementary[a]	41,000	24,500	55,000
Industrial - Warehouse	25,000	8,000	72,000

[a] For purposes of this analysis, EPA combines a number of building types, including educational, under the commercial category.
Source: R.S. Means, 2000.

EPA multiplied the resulting average project sizes by the estimated number of commercial and industrial permits to obtain an estimate of the total acreage developed for these project categories. For commercial projects, EPA estimated that 1.2 million acres are developed annually (254,566 permits x 4.9 acres). For industrial projects, EPA estimated that 54,630 acres are developed annually (12,140 permits x 4.5 acres).

Final Allocation of Acres Across All Project Types Using NRI Estimates of Developed Acres

Table 4-12 summarizes the results of EPA's bottom-up approach to estimating the number of acres of land developed across all categories. The overall estimate of the amount of land developed is 2.01 million acres per year. Residential single-family development accounts for 24.4 percent of the total, multifamily development for 11.5 percent of the total, commercial for 61.4 percent, and industrial for 2.7 percent.

Table 4-12. National Estimates of Land Area Developed Per Year, Based on Building Permit Data

Type of Construction		Permits: Number	Permits: Pct. of Total	Average Site Size[a] (Acres)	Acres Developed: Number	Acres Developed: Percent of Total
Residential	Single-family	1,043,045	77.5%	0.47	490,231	24.4%
	Multifamily	35,672	2.7%	6.5	231,868	11.5%
Nonresidential	Commercial[b]	254,566	18.9%	4.9	1,234,645	61.4%
	Industrial	12,140	0.9%	4.5	54,630	2.7%
Total		**1,345,423**	**100.0%**	**--**	**2,011,374**	**100.0%**

[a] For single-family residential construction, this is the average of the average lot size for new construction in 1999 (U.S. Census Bureau, 1999) and the average obtained by EPA (1999). For all other categories, the site sizes are EPA assumptions based on representative project profiles contained in R.S. Means (2000) and the 14-community survey conducted in support of the Phase II NPDES stormwater rule (U.S. EPA, 1999). See Tables 4-10 and 4-11.
[b] A number of project types were grouped together to form the commercial category, including: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, and other nonresidential buildings.

The estimate of total acreage developed, 2.01 million acres (shown in Table 4-12), can be compared with the estimate provided by NRI. NRI estimates that a total of 2.24 million acres are converted from undeveloped to developed status each year. As noted above, some acreage would not be covered by the options analyzed in this EA because of site size or other waivers. The estimated acreage subject to Option 1 (the widest scope option analyzed), based on NRI data, is 2.18 million acres (see Section 4.3.1.2.1).[23]

EPA considers the estimate of 2.01 million acres, derived on the basis of the site size calculations that are summarized in Table 4-12, to be close to the 2.18 million acre estimate derived from NRI data. Areas not accounted for in EPA's estimates include those converted as a result of road, highway, bridge, park, monument, and other nonbuilding construction projects.[24] EPA generally assumes that the

[23] This is the acreage covered under Option 1, which affects sites of 1 acre or more in size. Estimates of the acreage covered under Options 2 and 4, which affect sites of 5 acres or more, are made in Section 4.3.1.2.4.

[24] As noted above, EPA estimates there are approximately 159,000 such projects permitted each year.

difference between EPA's estimate and the NRI estimate can be accounted for by acres of nonbuilding construction. For the purpose of developing national compliance costs that include costs for nonbuilding construction, EPA has allocated the entire NRI acreage according to the distribution shown in the final column of Table 4-13.[25]

Table 4-13. National Estimates of Land Area Developed Based on NRI Totals

Type of Construction		Acres Based on Permits Data		Allocated NRI Acreage,[b] Technical Development Document[c]	Acreage Developed on Sites of more than 1 acre, Option 1
		Number[a]	Pct. of Total		
Residential	Single-family	490,231	24.4%	540,800	533,781
	Multifamily	231,868	11.5%	253,358	250,937
Nonresidential	Commercial[d]	1,234,645	61.4%	1,366,387	1,332,622
	Industrial	54,630	2.7%	59,009	57,379
Total		**2,011,374**	**100.0%**	**2,219,553**	**2,174,719**

[a] From Table 4-12.
[b] This column distributes the total acreage (estimated by NRI) to be converted on an annual basis (adjusted for waivers), according to the distribution by type of development estimated through analysis of permits data.
[c] U.S. EPA, 2004, Section 4.2.2.2, Table 4-8.
[d] A number of project types were grouped together to form the commercial category, including: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, and other nonresidential buildings.

At each progressively more detailed level of analysis, EPA engineers adjusted the number of sites so that no fractional sites would be considered. Thus, if EPA allocated 537.7 sites to a state, the number of sites was rounded to 538 and acreage was adjusted accordingly. EPA's cost analysis included a number of disaggregations by site size, land use category, state, ecoregion, and hydrologic units. EPA also rounded numbers of units at each step. Thus, the total acreage differs slightly when different breakouts are presented. Table 4-13 presents the total acreage estimates that are presented in the Technical Development Document (U.S. EPA, 2004). In all cases, the acreage estimates shown in the

[25] This distribution implies that the acres not accounted for by NRI (see Table 4-13) will be costed at the weighted average cost across the single-family residential, multifamily residential, commercial, and industrial categories. EPA generally recognizes that this approach implies an assumption that incremental costs for nonbuilding construction are similar to incremental costs for building construction.

Technical Development Document are slightly higher than those estimated on the basis of NRI data. See the Technical Development Document, Section 4.2.2.3 for more details.

4.3.1.2.3 Step Three—Distributing Acreage by Project Size

The third step in estimating the national compliance costs is to allocate the number of acres in each of the four land use categories according to project size. The starting point for this step is the 14-community study (U.S. EPA, 1999), which collected project type and size data. Table 4-14 shows the distribution by project size for each land use category. (The information corresponding to site sizes of less than 1 acre has been omitted). Using this information, EPA calculated the total number of acres by project type and by project size.

4.3.1.2.4 Step Four—Adjusting the Numbers of Acres Downward to Account for the Regulatory Scope of Options 2 and 4.

EPA made further adjustments to the acreage by type and size to account for the differences between the scopes of Option 1 and Options 2 and 4. The distributions of acreage by project type presented in Table 4-14 account for all sites greater than 1 acre. The acreage distributions accounted for at this point, therefore, only apply under Option 1, which covers sites of 1 acre or larger. EPA estimated the numbers of acres that would be excluded under the site size limitations of Options 2 and 4, which cover sites of 5 acres or more.

EPA calculated the numbers of acres excluded by project type under Options 2 and 4 by estimating the acreage in sites more than 1 acre and less than 5 acres in size. The 3-acre size class represents projects on sites greater than 1 acre and less than 5 acres. The acreage associated with this size class category was subtracted from the matrix of acreage by region, type, and size class. EPA examined, for example, the 14-community study (U.S. EPA, 1999) and found that 6.1 percent of acreage developed for single-family housing was assigned to sites in the 3-acre size class (see Table 4-14). Thus 6.1 percent of the acreage associated with single-family construction is not considered to be covered under Options 2 or 4. EPA made similar estimates of the acreage converted to multifamily, commercial, and industrial

Table 4-14. Distribution of Permits by Site Size

Site Size (Acres)	No. of Permits	Acres by Size	Percent Acres Occupied by Size
Single-Family Residential			
3	228	684	6.1%
7.5	138	1,035	9.2%
25	175	4,375	39.1%
70	30	2,100	18.8%
200	15	3,000	26.8%
Total	586	11,194	100.0%
Multifamily Residential			
3	100	300	8.7%
7.5	61	458	13.3%
25	71	1,775	51.7%
70	10	700	20.4%
200	1	200	5.8%
Total	243	3,433	100.0%
Commercial			
3	356	1,068	20.4%
7.5	86	645	12.3%
25	91	2,275	43.4%
70	16	1,260	24.0%
200	0	0	0.0%
Total	549	5,248	100.0%
Industrial			
3	55	165	25.4%
7.5	10	75	11.5%
25	8	200	30.8%
70	3	210	32.3%
200	0	0	0.0%

Table 4-14. Distribution of Permits by Site Size

Site Size (Acres)	No. of Permits	Acres by Size	Percent Acres Occupied by Size
Total	76	650	100.0%
Total			
3	739	2,217	10.8%
7.5	295	2,213	10.8%
25	345	8,625	42.0%
70	59	4,270	20.8%
200	16	3,200	15.6%
Total	1,454	20,525	100.0%

Based on permitting data from the following municipalities or counties: Austin, TX; Baltimore County, MD; Cary, NC; Ft. Collins, CO; Lacey, WA; Loudoun County, VA; New Britain, CT; Olympia, WA; Prince George's County, MD; Raleigh, NC; South Bend, IN; Tallahassee, FL; Tuscon, AZ; and Waukesha, WI (U.S. EPA, 1999).
Source: EPA estimates.

uses that would be excluded under Options 2 and 4. Table 4-15 compares the distribution of acreage by land use type covered under Option 1 with the acreage covered under Options 2 or 4. The table also presents the distribution of CGP-affected acreage by land use type under Options 2 or 4. This affected acreage, under the CGP component of Option 2 and under Option 4, is approximately two-thirds of the total developed acreage. To simplify the calculation for total compliance costs, EPA multiplies costs per acre developed by the number of acres developed. Multiplying costs per affected acre by the number of affected acres would yield the same result.

The reason that CGP-affected acreage is so much smaller than the total acreage estimated to be developed annually is that many states already enforce ESC provisions as stringent or more stringent than the current CGP. Codifying the provisions of the CGP, under the CGP component of Option 2 and under Option 4, will have no effect on costs in these states. See Section 4.1.2 for a discussion of how state equivalency was determined. The Technical Development Document (U.S. EPA, 2004) provides additional information on the acreage estimates for each state.

Table 4-15. Estimates of Acreage Affected Under Final Action Options 2 and 4

Type of Construction		Acreage Affected Under Option 1[a]	Percent Excluded Under Options 2 and 4[b,c]	Acreage Developed Subject to Options 2 and 4[c]	Acreage Affected Under CGP Component of Option 2 and Option 4[c]
Residential	Single-family	533,781	6.1%	500,985	324,158
	Multifamily	250,937	8.9%	228,713	147,810
Nonresidential	Commercial[d]	1,332,622	20.4%	1,061,245	686,563
	Industrial	57,379	25.8%	42,583	27,545
Total		**2,174,719**	**--**	**1,833,526**	**1,186,076**

[a] From Table 4-13.
[b] Based on analysis of site size distributions found in EPA (1999). Due to rounding to whole acres at various parts of the engineering cost analysis, there are slight differences in the percentage of acreage excluded for multifamily and industrial construction; see Table 4-14.
[c] U.S. EPA, 2004.
[d] A number of project types were grouped together to form the commercial category, including: hotels/motels, amusement, religious, parking garages, service stations, hospitals, offices, public works, educational, stores, and other nonresidential buildings.
Source: EPA estimates.

4.3.1.3 Estimating Total National Costs

To calculate the total national costs of compliance to industry, EPA's last step was to multiply the number of acres by adjusted costs per acre for each of the four land use categories and the size categories covered by each option (e.g., the 3-, 7.5-, 25-, 70-, and 200-acre site sizes under Option 1 and the 7.5-, 25-, 70-, and 200-acres site sizes under Options 2 and 4). Costs for each size and type were added, producing a total compliance cost for each option. Costs are also presented by size and by land use type for each option in Chapter Five, Section 5.1. The spreadsheet that calculates all of these costs is presented in the Rulemaking Record (DCN 45020).

4.3.2 Methodologies for Measuring Impacts on Markets

EPA uses three complementary approaches to estimate the market impacts of the Final Action. These approaches are used to evaluate somewhat different measures of impact and are not necessarily consistent with each other, the C&D/FrMS analysis, or the C&D/PrMS analysis. Two of the analyses treat the nation as a single market; the third treats each city as a distinct market for C&D products. These three market models comprise the Consumer Impact Model, the National Housing Market Model, and the Regional Market Model. Detailed mathematical equations and data supporting the construction of these models can be found in the EA of the proposed rule (U.S. EPA, 2002a). Summaries of the results can be found in the current EA (Chapter Five, Section 5.6), while detailed results are presented in the Rulemaking Record (DCN 45024).

The first approach, embodied in EPA's Consumer Impact Model, assumes all of the costs of compliance with the regulation are passed through to the home buyer. When a home is more costly, fewer households are able to qualify for a mortgage to purchase it. This change in market size is an indicator of the impact of the final action (see Section 4.3.2.1).

In the second approach, EPA uses a linear partial equilibrium market model (the National Housing Market Model module of EPA's C&D/PEqMMS), in which the costs of compliance shift the national single-family housing supply curve. A portion of the increased costs raises the price of new housing, while the balance is absorbed by the builder (see Section 4.3.2.2).

The third approach (the Regional Market Modeling Module of the C&D/PEqMMS) also uses linear partial equilibrium models, and EPA developed four such models for the single-family, multifamily, commercial, and industrial sectors. For the residential construction sectors (single-family and multifamily), the Regional Market Modeling Module analyzes 215 metropolitan statistical areas (MSAs), based on local measures of residential construction activity, to determine changes in prices and quantities. For the single-family housing market, this model also measures changes in affordability in terms of a rough Housing Opportunity Index (HOI). HOI is a well publicized measure of housing availability. For the commercial and industrial construction markets, the model predicts changes in price and quantity based on the analysis of 52 and 35 MSAs, respectively, due to the more limited data available for these sectors (see Section 4.3.2.3).

Each of the three approaches offers a different perspective on the impact of the action on the various markets for C&D products. The outputs of the National Housing Model and the Regional Market Modeling modules are also used to determine the net economic impacts on the U.S. economy. See Section 4.3.3 for a discussion of the Net Economic Impact Model (the final module of the C&D/PEqMMS) and its use of the various market model outputs to determine economic output and employment effects in the U.S. economy.

4.3.2.1 Methodology for Measuring Impact on Consumers (Single-Family Housing)

EPA's Consumer Impact Model uses the total price multiplier from the previously described C&D/PrMS. As discussed in Section 4.2.1, cost increases at a residential housing project can translate into an increase in the asking price of a new home by more than the original cost increase, due to the builders' interest and opportunity costs and a fixed percentage expectation for profit and overhead that drive an asking price increase under a 100 percent cost passthrough scenario. These simple assumptions about expected proportionate profit margins, borrowing, and contingencies (discussed in Section 4.1.2) indicate that added incremental compliance costs are multiplied by a factor of 1.5 to 2.1 in the final consumer price. The existence of these multipliers is supported by census data and the housing economics literature. Luger and Temkin (2000), for example, report a compliance cost multiplier of 2 to 6 times actual compliance costs. The higher multiplier range reported by Luger and Temkin (2000) could reflect a tight housing market in high growth regions.

In using a cost multiplier in the Consumer Impact Model, EPA is assuming that the entire costs of compliance are borne by consumers (unlike later sections, in which at least a portion of the costs are assumed to be borne by the C&D industry). This assumption reflects Landis' (1986) and Luger and Temkin's (2000) surveys that suggest all of the additional costs of compliance with new stormwater regulations would be passed through to new home buyers in the form of higher prices for a unit of a given quality. This assumptions implies that the quantity of new housing built would not change because demand is driven by demographics more than marginal price considerations (i.e., demand is inelastic), and competition in supply is limited because of oligopolistic markets in many areas and infinitely elastic supply in others. This portion of the analysis is motivated by the observation that an increase in the price of a home increases the income necessary to qualify for a home mortgage to purchase the home and, therefore, reduces the number of households able to afford it. One measure of the impact of the regulation is the change in the size of the market (i.e., the number of households that can afford the new home). This is the basis of EPA's Consumer Impact Model.

The Consumer Impact Model uses the median house price from the baseline model project for a 7.5-acre single-family development as the baseline price.[26] First, the monthly principal, interest, taxes, and insurance (PITI) payment for the new home is calculated, using the baseline price as a starting point. In 2000, buyers financed an average of 77.4 percent of the home purchase price at an interest rate of 7.52 percent (FHFB, 2001). EPA assumes a 30-year conventional fixed rate mortgage for ease of calculation. EPA also assumes a monthly real estate tax rate of $1 per $1,000 of home value and an insurance payment of $0.25 per $1,000 of home value (Savage, 1999). These assumptions are applied to the home price calculated for the baseline to derive an estimate of the monthly PITI payment required to purchase a new home. This monthly payment is then recalculated for each of the regulatory options, based on the new price derived by multiplying compliance costs per acre by the total price multiplier and adding the resulting value to the baseline price.

EPA then estimates the difference in the income level necessary for a homebuyer to qualify to purchase a house of the price estimated under each of the options. Subsequently, EPA estimates the number of households that no longer qualify for a mortgage of the size assumed necessary to cover the new price, using the standard lending practices discussed earlier. This analysis is based on Census Bureau statistics of household income, from which EPA calculated the number of households represented at the income qualifying level in the baseline and under each option. EPA calculates the number of households that no longer qualify for a mortgage at the higher option prices by noting the number of households at the baseline required income level and each option's required income level and then computing the difference in the number of households. This result is conservative because consumers have alternatives, such as selecting lower quality features or forgoing other expenditures, to increase their down payment, thus lowering the amount borrowed. More detailed discussion of the methodology is provided in the EA for the proposed rule (U.S. EPA, 2002a). EPA received no comments directly affecting this methodology.

[26]Other project sizes' baseline prices vary from this price by less than $2,000.

Table 4-16 illustrates the calculations performed in the Consumer Impact Model using hypothetical option costs. These costs are only included as examples. EPA uses the costs of the actual regulatory options in Chapter Five to estimate the number of households priced out of the new housing market as a result of each regulatory option.

Table 4-16. Change in Housing Affordability—Sample Calculation

Data Element	Baseline	Hypothetical Option
Average per lot cost difference from baseline	$0	$111[a]
Difference in cost per lot X multiplier	$0	$238[a]
Home price	$316,099	$316,337
Monthly Mortgage Payment Calculation: Principal and interest (30-year fixed at 7.52%; 77.4 loan-to-value)	$1,714	$1,715
Real estate taxes	$316	$316
Homeowner's insurance	$79	$79
Total principal, interest, taxes, and insurance	$2,109	$2,111
Income Criterion: Income necessary to qualify for mortgage	$90,393	$90,461
Change in income necessary	$0	$68
Number of households shifted (thousands)	0	-24
Percent change in number of qualified households	0.0%	-0.15%

[a] Hypothetical cost difference. Estimated actual costs are used in Chapter Five.
Source: EPA estimates.

4.3.2.2 Methodology for Measuring Impact on the National Housing Market

Another approach to evaluating the impact of the Final Action on housing markets is to use the market based approach underlying EPA's National Housing Model Module of the C&D/PEqMMS. This and other partial equilibrium market models use data on elasticities of market supply and demand to predict the changes to price and quantity that will occur given a producer cost increase of a particular magnitude. The economic theory that supports this approach and the detailed equations used to calculate the market impacts are documented in the EA to the proposal (U.S. EPA, 2002a). EPA received no comments on the approach or data used to construct the National Housing Model module of the C&D/PEqMMS.

EPA's first step in constructing the National Housing Model was to identify the appropriate data to specify the elasticities of supply and demand in this market. Empirical studies find a highly elastic supply and a somewhat inelastic demand for new housing (DiPasquale, 1999). To indicate highly elastic supply, EPA assumes a price elasticity of supply of 4.0. DiPasquale (1999) cites studies with estimates for new housing supply elasticity from 0.5 to infinity, but the majority of the long run estimates are in the 3 to 13 range. Housing demand elasticity is equally controversial. EPA assumes a price elasticity of demand of -0.7 to indicate a somewhat inelastic demand function. Using the supply and demand elasticities (which are representative of the literature: $E_s = 4$ and $E_d = -0.7$), EPA calculates that some of the costs of compliance in the partial equilibrium model might be absorbed by the builder, unlike the complete cost passthrough assumption used in the Consumer Impact Model. The proportions flowing to consumers and builders depend on the relative elasticities of supply and demand, which in this case, indicate that the cost passthrough is 85 percent. In this model, therefore, the industry absorbs 15 percent of the costs of compliance and passes the remainder on to homebuyers as a price increase. Sensitivity tests of these assumptions are shown in Appendix 5B of the proposal EA (U.S. EPA, 2002a). Since the magnitudes of compliance costs per house in the Final Action are similar to those estimated at proposal, the results of the sensitivity analyses are still valid. These results indicate that moderate changes in elasticity assumptions do not appreciably alter the results.

EPA then made assumptions about the shape of the curves associated with the elasticities in the published literature. The assumption that compliance costs of new environmental regulations result in only small marginal changes in prices and quantities provides the basis for EPA's modeling of the market using supply and demand curves that are assumed to be linear in the relevant range. This type of simple linear partial equilibrium market model is similar to those used in other recent EPA regulations (U.S. EPA, 2001). See the EA for the proposal (U.S. EPA, 2002a) for additional supporting information.

EPA then established the baseline conditions of the national housing market. National statistics of residential housing starts from the Census of Construction are used as the baseline quantity for the model. The baseline price is the median new home price (based on the 7.5-acre project from the C&D/PrMS described in Section 4.2.1). This combination of quantity and price provides the basis for EPA to describe the baseline market equilibrium, where supply equals demand.

Given this baseline equilibrium point, the elasticities estimated, and EPA's assumptions about curve shape, EPA identified a linear supply curve and linear demand curve. The increased costs of compliance under each option raise builders' costs and shift the supply curve upward to the left. The change in prices and quantities depends on the relative slopes of the supply and demand curves.[27] The new intercept is calculated using the per unit costs of complying with the Final Action. Equilibrium prices and quantities are then recalculated, using the new post-compliance price and intercept, to estimate the changes in price and quantity associated with each option. Detailed results are provided in the Rulemaking Record (DCN 45026). Results are summarized in Chapter Five, Section 5.6.

The model also outputs welfare effects, which are discussed in more detail in Section 4.3.3, which discusses the methodology for determining net economic impacts.

4.3.2.3 Methodology for Measuring Regional Market Impacts

The approaches described in the previous sections treat housing as a single, national market with the same demand elasticities applying across the country. In reality, however, market conditions can vary widely among regions, states, and cities. Markets vary both in the level of activity and the structure of the industry. It would, undoubtedly, be easier to pass through compliance costs to consumers in a hot housing market than in a depressed market. EPA's third modeling approach, embodied in the Regional Market Model module of the C&D/PEqMMS, captures such regional variation by setting up a partial equilibrium model for housing markets for each MSA, using statistics of the level of activity in the MSA

[27]EPA chose to model the increased costs as a slope-preserving change in the supply curve intercept rather than an elasticity-preserving change in slope. A change in the cost to the producer is assumed to raise the supply curve parallel to the baseline curve. If the elasticity were preserved, the slope of the supply curve would change, leading to one part of the curve appearing to shift more than another part of the curve.

to select the parameters of the model. Using this approach, EPA is also able to perform a consumer affordability analysis at the regional level, similar to the analysis discussed in Section 4.3.2.1 for the national level.

At proposal, the partial equilibrium models used a weighted average of ecoregion costs per acre, based on populations in each ecoregion within the state. For the Final Action, EPA conducted a more extensive analysis of the equivalency of state regulations to provisions of the options. From this analysis, costs were calculated for each state, based on the specific BMPs that would have been required under state law and the new ones that would be required by each option. Thus, each state could have different average costs per acre. This difference is particularly notable for Options 2 and 4, in which some states have relatively low costs per acre and other states, where EPA deemed the state did not have requirements equivalent to option requirements, have higher costs per acre. EPA used these individualized state costs in the partial equilibrium modeling of state-by-state impacts.

EPA was not able to locate data sufficient to conduct a national market analysis of the multifamily, commercial, and industrial sectors. EPA found no studies analogous to Montgomery (1996) for modeling the commercial or industrial construction sectors as single, national markets. The Agency, therefore, conducted a regional-level analysis of these sectors, using the Regional Market Model Module and state-specific per-acre costs. The following subsections discuss the regional-level model for the single-family housing sector (Section 4.3.2.3.1) and explain how this model was adapted to create models to analyze the other three sectors (Section 4.3.2.3.2).

4.3.2.3.1 Single-Family Housing

The Census Bureau collects information about housing starts and the size of the existing housing stock at the MSA level. EPA infers that the new housing market is active in areas where a large proportion of the total current housing stock comprises housing built during the 1990s. EPA expects that demand is less elastic in these areas than in areas with slower growth. As discussed in Section 4.3.2.2, the long-run supply of new housing is, overall, assumed to be quite elastic. These facts provide the basis for selecting elasticities to represent housing markets at the MSA level.

EPA developed separate partial equilibrium models for each MSA. Similarly to EPA's development of the National Housing Model described earlier, EPA used building permit data from the Census Bureau and median new home price data from the C&D/PrMS to establish the baseline equilibrium point for each MSA. Demand elasticities were selected based on the ratio of new housing units authorized, calculated for each year during the period 1990 to 1996, to total 1997 housing stock (U.S. Census Bureau, 1998). EPA mapped regions where this ratio is very low to the most elastic estimates of demand found in the literature and those regions where the ratio is very high to the least elastic demand elasticity estimates. EPA believes this approach captures the relative differences in demand elasticity between active and depressed housing markets around the country (see DCN 45027 for EPA's mapping results).

Each MSA model is shocked with the average estimated compliance costs for a new home in the state, as in the National Housing Model. EPA then uses each MSA model to estimate changes in prices, quantities, and welfare measures. As there are more than 200 MSAs, it is not practical to report all of the individual results. Instead, all of the MSAs in a census division are averaged together to give a sense of the effect of compliance costs on each region of the nation. Chapter Five, Section 5.6 reports the results of this analysis on a state-by-state basis. The spreadsheets used to create these outputs appear in the Rulemaking Record (DCN 45026).

Affordability is a significant concern for some stakeholders, so another analysis performed using the MSA models investigates changes in housing affordability in major U.S. regions. NAHB publishes the HOI for 180 MSAs. The HOI measures the proportion of the housing stock a family with the median income in the MSA can afford. NAHB compares the median family income to the actual distribution of homes by price in the MSA. EPA uses a similar, but simplified approach to measure affordability by MSA.

The Agency considered the cost of acquiring and managing the more detailed HOI information disproportionate to an improvement in the accuracy of the results. EPA, therefore, assumed home prices are normally distributed about the median price to create an analysis termed "rough" HOI (RHOI) Thus, RHOI is the cumulative probability of homes with prices less than the maximum PITI that a household with the median income can afford. For MSAs with HOIs reported by NAHB, EPA adjusts the variance of the normal curve so that RHOI yields the NAHB baseline HOI index (NAHBHOI). In those MSAs where NAHB does not calculate HOI, unadjusted RHOI is reported.[28] To assess the impact of the regulatory options, the adjusted RHOI is calculated with the new sales price from the market model. The percent change in adjusted RHOI is an indicator of the added stress on the housing market associated with compliance costs.

A baseline RHOI of 41.6, for example, indicates that a median income family can afford 41.6 percent of the homes on the market in an MSA. If compliance costs raise the price of homes and the RHOI falls to 41.5, then 0.24 percent of the homes the family could have bought, absent the regulation, are now out of reach ([0.416 - 0.415]/0.416 = 0.0024).

Both the Consumer Impact Model and the RHOI component of the C&D/PEqMMS show how changes in costs affect home buyers. The RHOI approach, however, has the advantage of recognizing local market differences and applying them within the model. Average RHOI among MSAs in census divisions before and after compliance costs are applied are reported in Chapter Five, Section 5.6. The changes in RHOI can also be used to calculate the number of households priced out of the housing market, using the same assumptions about how to compute levels of required income, given a particular house price used in the Consumer Impact Model. Chapter Five, Section 5.6, also reports the results of this analysis. Also, see DCN 45027 in the Rulemaking Record for more information.

EPA received comments on its use of the RHOI to compute housing affordability changes. NAHB asked EPA to distinguish the Agency's HOI approach, which is an approximation, from more precise HOI analyses. NAHB also stated it would provide information for EPA to calculate a more precise HOI, but did not include that information in their comments. EPA has distinguished the Agency's method by labeling it "rough" HOI, or RHOI. EPA believes that the use of RHOI does not bias the impact estimates in any consistent direction.

[28] In 13 MSAs, the distribution of home prices is so different from normal that RHOI cannot approximate NAHBHOI with the variance adjustment. These MSAs were deleted from the results.

4.3.2.3.2 Multifamily and Nonresidential Construction

As another part of the Regional Market Modeling Module, EPA developed three market models of the multifamily and nonresidential (commercial and industrial) construction industries. All three are similar to the residential regional partial equilibrium model for single-family housing discussed earlier. They treat each state as a separate market using adjusted demand elasticities. Each model produces estimates of changes in prices, quantities, and welfare measures.

All three models require information on baseline equilibrium price and quantity, where quantity is estimated on the basis of permit information (as EPA did for single-family housing). Numbers of permits for multifamily housing were derived as discussed in Section 4.3.1. As noted earlier in Section 4.3.1, however, the Census Bureau discontinued collection of nonresidential building permit information in 1994. To estimate nonresidential building permits issued in later years, EPA regressed nonresidential building permits on residential building permits. This regression was undertaken in the calculation of national-level costs (see Section 4.3.1). The relationship among these variables differs from state to state. Regressions therefore, were estimated at the state level. For more information, see ERG (2001a) in the Rulemaking Record.

EPA allocated the nonresidential building permits estimated for each state to commercial, industrial, and other projects, based on the number of permits issued for each type of project in the 1994 building permit data. The number of permits was estimated in Section 4.3.1. For more information, see ERG (2001a) in the Rulemaking Record.

The multifamily and nonresidential models apply equations from the EA of the proposed rule to estimate supply and demand curves (U.S. EPA, 2002a). Compliance costs are converted to the same units as the rental rates. The increase in costs shifts the supply curve to the left and upward. Market results are reported in terms of changes in rents and building permits and changes in consumer and producer surplus. Market results can be converted to changes in indirect employment using an appropriate input-output multiplier (see Section 4.3.3).

The following sections describe the assumptions for the multifamily and nonresidential construction sector models that differ from those used for the single-family sector model.

Multifamily Housing

Within the Regional Market Modeling Module for multifamily housing, EPA developed separate partial equilibrium models (as it did for single-family housing) with demand elasticities for each of the 215 MSAs used to characterize the single-family component of the module. The activity measure was the proportion of housing stock built during the 1990 to 1996 time period, with multifamily building permits as the basis for determining baseline quantities (see Section 4.3.1). Separate price series or rental rates for multifamily housing are not reported, so EPA used single-family housing prices as a near substitute. EPA converted the compliance costs, including multipliers, to the same units as the rental rates. The increase in costs shifts the supply curve to the left and upward (see the EA of the proposed rule for equations and detailed discussions [U.S. EPA, 2002a]). The results are reported in terms of changes in rents, building permits, consumer surplus, and producer surplus. These results become inputs to calculations used to estimate changes in net economic impacts (see Section 4.3.3). Results are summarized in Chapter Five, Section 5.6. Spreadsheets calculating these changes can be found in the Rulemaking Record (DCN 45027).

Commercial Construction

The commercial market is highly disaggregated into regional markets. Office rents for similar buildings (Class A space) range from $17 per square foot per year in Wichita to more than $60 per square foot per year in San Francisco (Grubb & Ellis, 2001). This disparity shows that arbitrage among markets is not possible and space in each area should be considered a different commodity. Many real estate companies maintain data on conditions in regional markets. Typically, activity in the market is measured in terms of the vacancy rate and asking rents. EPA developed a market model for office space similar to the regional partial equilibrium models developed for residential construction to indicate the effects on commercial construction.

In the partial equilibrium model, the quantity of construction in each category is measured by the number of building permits issued. Rental rates, in dollars per square foot per year, are closely watched indicators of demand for commercial space and serve as our price. Rents and activity reports for 35 retail space markets around the country, from a recent real estate marketing firm report (Grubb & Ellis, 2001), provide the baseline information for the market model. As EPA used the ratio of new building permits to housing stock in the residential model, EPA used the activity reports to create a scale of demand intensity in the commercial model. The activity reports provided only descriptive assessments of market activity. EPA rated the level of activity described on a scale of 1 to 5. EPA then used this scale to map an appropriate demand elasticity, from a range of possible market elasticities, to each market. See ERG (2001b) in the Rulemaking Record for more information on this process.

The number of nonresidential building permits was projected at the state level, while the Grubb & Ellis commercial data are from 35 selected cities. Building permit data are insufficient to model each city. Thus, EPA models each state as a separate market, using the average rent and activity rate for the cities within the state to represent the state market. This approach is reasonable where state office and retail markets are concentrated in one city or one city is representative of general, statewide market conditions. The approach is less defensible in large states with many population centers because market conditions can vary from city to city within such states. Nearly half of the states were not represented by cities in the Grubb & Ellis data. For these states, the average rent and activity values for cities within the census division containing the state were used to indicate state market conditions.

Demand for office and retail space is relatively insensitive to small changes in price. Since nonresidential construction activity tends to be driven by interest rates, job growth, and location-specific factors rather than building costs, cost passthrough is very high. Huffman (1988), for example, found that impact fees were largely passed on to end users in the long run. EPA, therefore, applies a range of elasticities, from -0.01 to -0.80, to represent relatively inelastic demand for commercial space. In regions with many vacancies, lessees can be more sensitive to price, so a more elastic demand curve is used. In regions with tight markets, lessees have fewer options and, generally, have little choice but to pay the asking price, so demand is less elastic. Builders can pass on a higher proportion of their costs in tight markets than in soft markets. Even in the softest market, however, 83 percent of costs are passed through to consumers under these assumptions.

Similarly to the National Housing Model, this model outputs the changes in price and quantity expected given the baseline price conditions for commercial properties from the C&D/PrMS, the cost increases adjusted by the total cost multiplier, and the elasticities assumed for the MSAs modeled. It also outputs changes in welfare resulting from the cost increases associated with the various regulatory options. Chapter Five, Section 5.6 summarizes these results, which can also found in the Rulemaking Record (DCN 45025).

Industrial Construction

The industrial space market model is similar to the commercial model. It uses the rental rate for warehouse space as the baseline price, and the vacancy rate for industrial space serves as an indicator of market activity. Industrial space users are considerably more mobile and price sensitive than commercial or residential space consumers, so demand for industrial space is more elastic. The range used in this analysis is -0.2 to -1.5. The outputs discussed for the commercial space model are also generated by the Regional Market Modeling Module for industrial space. See Chapter Five, Section 5.6 for a summary of the results and DCN 45038 in the Rulemaking Record for more detailed information.

4.3.3 Methodology for Modeling Net Economic Impacts

The last module of the C&D/PEqMMS is the Net Economic Impact Model. This model embodies EPA's analysis of net economic impacts on output (industry revenues and GDP) and employment. The discussion of the analyses undertaken through this model is divided into four sections. Section 4.3.3.1 presents EPA's methodology for estimating the net economic impacts on the U.S. economy in terms of changes in employment (measured as full-time equivalents)[29] and output (measured as revenues within the industry and as GDP in the U.S. economy as a whole). Section 4.3.3.2 presents the calculation of consumer and producer surplus losses and deadweight losses to the economy. Deadweight losses are losses that are not compensated for by gains elsewhere in the economy. Section 4.3.3.3 investigates the potential for any important regional or community-level impacts. Finally, Section 4.3.3.4 presents EPA's reason for assuming that international trade effects are minimal.

[29] 1 FTE = 2,080 hours.

4.3.3.1 Calculation of Output and Employment Effects in the U.S. Economy

EPA conducted an output and employment analysis to account for the fact that changing the costs of production in one industry has a direct effect on that industry's output and a proportionate impact on employment. This change also has a ripple effect in all other sectors of the economy (contributing to changes in output and employment in these other sectors). These additional, ripple effects are considered indirect effects (e.g., when they affect suppliers to the regulated industry) or induced effects (i.e., when they affect the economy through changes in consumer spending induced by the direct and indirect effects). Induced effects, for example, occur when reductions in the labor force induce a decline in overall consumer spending. The direct effects on output can be measured using market models. Indirect and induced effects on output and direct, indirect, and induced effects on employment can be measured using input-output analysis.

To compute total output and employment effects on the U.S. economy, EPA used established input-output multipliers developed by the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). Multipliers generated by BEA's Regional Input Output Modeling System (RIMS II) provide a means of estimating the full scope of output and employment changes within the U.S. economy, given a direct change in the output of one or more industries. These multipliers are termed the final demand multipliers for output and employment. EPA also uses a direct effect multiplier for employment, which allow it to calculate the employment effect within the C&D industry groups, given the direct output effect in those groups. EPA only uses the national-level multipliers for the construction industry, because they are the best indicators of economy-wide effects.

It is important to note that the changes in output and employment are not unidirectional. Losses in output and employment will occur in the C&D industry, but environmental regulations generally induce increased output from firms that make or install environmental controls or provide other services related to regulatory compliance. The output and jobs created by new spending in the environmental industry offsets, to some extent, the loss of output in the affected industry. In the case of the C&D industry, the same firms that now do much of the site preparation work would also be charged with implementing ESCs and, most likely, conducting ESC certification and inspection. Contractors would be hired to build sedimentation ponds, improve grades, and construct any incremental ESCs triggered by the

Final Action. While the regulation is costly in one sense, much of that cost flows directly back into the industry, stimulating more activity, output, and employment.

EPA calculates the direct output effects of the options using the results of the two C&D/PEqMMS modules discussed in Section 4.3.2. EPA uses the results of the National Housing Model to estimate the change in revenues expected for the single-family housing sector as a result of the options considered, and the Agency uses the results of the regional models for the commercial, industrial, and multifamily sectors to estimate the change in revenues expected for these sectors. The outputs of these models provide EPA with a new price and quantity for each of the four industry sectors. Multiplying the new price by the new quantity provides the post-regulatory revenues, which can be compared to the baseline revenues (baseline price multiplied by baseline quantity) to calculate the change (decline) in revenues associated with the increase in compliance costs.

EPA then applies the final demand output multiplier for the construction industry to the revenue changes calculated for each industry sector to obtain the full estimate of the total output effects on the U.S. economy. EPA uses the direct effect employment multiplier to calculate the employment changes within the industry, then uses the final demand employment multiplier to estimate the broader employment changes throughout the economy.

These calculations address the declines in output and employment in the economy that are estimated to occur as a result of incremental compliance costs. As noted earlier, however, there are also economic gains to the economy, as construction firms and others take on the additional work to install and maintain ESCs and/or inspect and certify sites. These gains are measured in terms of the total national compliance costs. These costs become the direct (and positive) revenue effects on the C&D industry. EPA uses the same approach to calculate total output and employment effects resulting from this direct gain of revenues. The Agency uses final demand output multipliers and direct effect and final demand employment multipliers to calculate the gains in output and employment associated with the implementation of the options considered. Chapter Five, Section 5.7, presents the output and employment effects calculated for each of the options considered for the Final Action. Additional supporting materials and spreadsheets are located in the Rulemaking Record (DCNs 45024 and 45026).

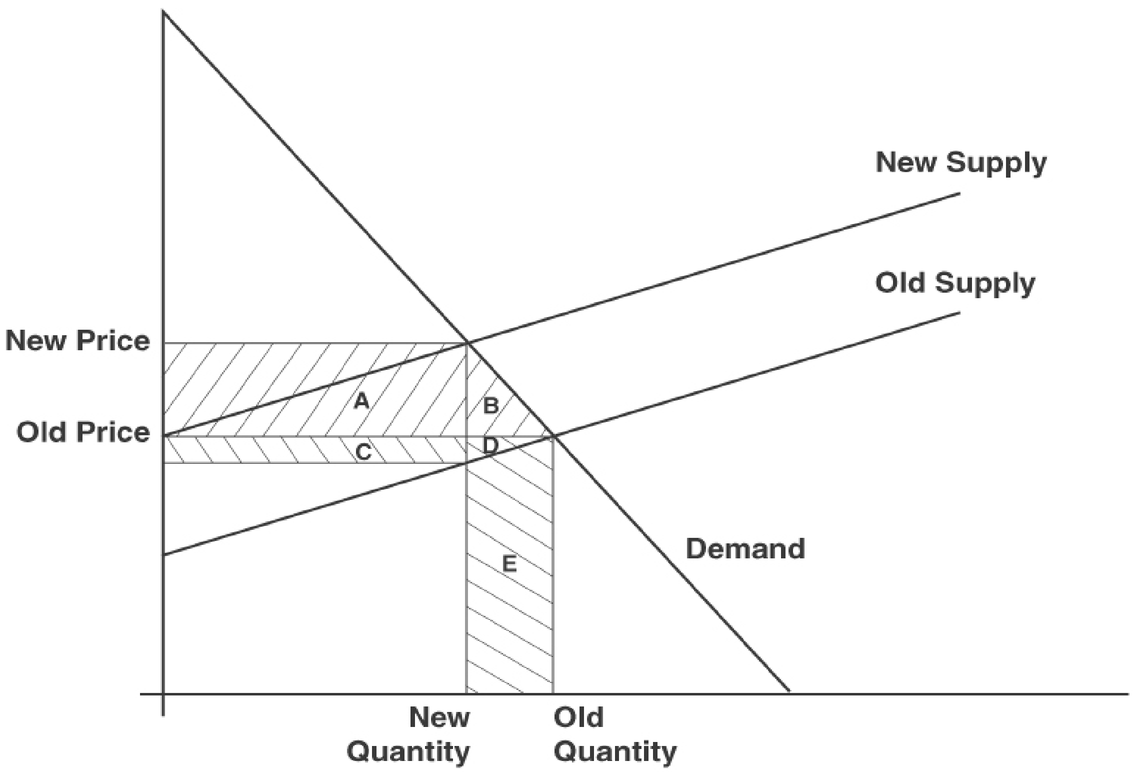
4.3.3.2 Calculation of Welfare Effects

The regulatory options considered for the Final Action also have a number of implications for the welfare of society. Welfare losses occur when the supply curve shifts, following introduction of incremental compliance costs. These losses can be measured as losses of consumer surplus, losses of producer surplus, and deadweight losses.

Consumers gain utility from products when the market price is lower than the value they derive from the product. This difference between market price and value to the consumer is termed “consumer surplus.” Producers also gain a surplus, or profit, when they can sell a product for more than the cost of production. The incremental C&D options will shift the supply curve of producers upward and to the left. As a result, consumers lose some of their surplus. The means by which the consumer surplus is lost is irrelevant from a welfare economics perspective. Consumers might choose cheaper options, such as lower quality carpets or cabinets, in the construction of their new homes. They might accept less expensive, smaller homes, or might pay the higher price and forego other spending. In any case, the home represents less utility than it would have without the ESC costs.

Most of this lost surplus is simply transferred to producers, as buyers are expected to pay more to builders for the added stormwater measures. There is also some loss of producer surplus, however. A higher price will discourage some buyers, so the number of homes or buildings sold will fall slightly. Such reductions in sales result in losses of both consumer and producer surplus without any offsetting gains. These losses are termed “deadweight losses,” and they are losses to society as a whole.

The consumer and producer surplus losses and the deadweight losses are calculated within the market models. The deadweight losses are included in the direct output losses calculated by the models for each industry sector. The calculation of these losses is straightforward because the market models assume linear supply and demand curves. Figure 4-3 shows how these calculations are performed. In the figure, Area A is part of consumer surplus in the baseline scenario. It is lost to consumers, but is transferred to producers and becomes a part of the producer surplus in the post-compliance scenario. Area B is also part of consumer surplus in the baseline scenario. This area becomes the consumer portion of the deadweight loss. Area C is producer surplus in the baseline scenario. It becomes producer surplus lost absorbing new costs, but also becomes a stimulus to construction output. Area D is producer surplus in the baseline scenario. It becomes the producer portion of deadweight loss. Area E is part of production output in the baseline scenario. It becomes lost sales and a loss in producer surplus. To calculate the deadweight loss, the sum of Area B and D is calculated as one-half of the change in quantity (the old quantity minus the new quantity) multiplied by the total compliance cost, using the area formula for triangles (½ base x height). In this case, the base is the line showing the vertical shift of the supply curve, which is equal to the total compliance costs, and the height is the change in quantity.



A = Consumer surplus transferred to producer
B = Consumer surplus that becomes deadweight loss
C = Producer surplus lost absorbing new costs but adds to construction output
D = Producer surplus that becomes deadweight loss
E = Production output that becomes lost sales

Figure 4-3. Consumer Surplus Loss, Producer Surplus Loss, and Deadweight Loss

Chapter Five, Section 5.7, presents the losses in consumer surplus, losses in producer surplus, and deadweight losses. For more detailed information, see also DCN 45024 in the Rulemaking Record. Deadweight loss calculations are also discussed in Chapter Eight, where total social costs are presented.

4.3.3.3 Regional Impacts

For this analysis, EPA assesses whether the Final Action could have community- or regional-level impacts and examines the potential impacts on specific regions. Such impacts could alter the competitive position of the C&D industry across the nation or lead to growth or reductions in C&D activity (in- or out-migration) in different regions and communities.

Traditionally, the distribution of C&D establishments has echoed the general regional distribution of U.S. population, with some parts of the industry responding to short- or long-term shifts in population distribution. EPA does not expect that the Final Action, regardless of option choice, will have a significant impact on where C&D takes place or the regional distribution of C&D activity. On the one hand, regulatory costs are estimated to be lower in regions with lower rainfall and reduced soil erodability. These factors favor projects being developed in such regions. At the same time, however, a project located in a low rainfall region would rarely be a perfect substitute for the same project in a high rainfall region. So many factors go into a decision on location that the relative costs of stormwater controls are unlikely to exercise a strong influence on project location. Thus EPA does not expect the Final Action to significantly influence the prevailing pattern of C&D activity, regardless of option choice.

EPA's market model accounts for regional market influences by creating state and MSA level partial equilibrium models for each sector. These models are used to quantify the regional impacts in terms of output and employment. As for the national employment effects, state employment changes are calculated using RIMS II multipliers. Regional multipliers were not available for this analysis, so EPA used the national multipliers. The results, therefore, overstate the employment impacts within the region, but indicate the effect of changes within the region on the nation as a whole. Chapter Five, Section 5.6, includes tables summarizing state impacts.

4.3.3.4 International Trade

As part of its economic analysis, EPA has evaluated the potential for changes in U.S. trade (imports, exports) of C&D-related goods and services. A significant component of the U.S. C&D industry operates internationally, and numerous foreign firms operate in the United States. EPA judged, however, that the potential for U.S. C&D firms to be differentially affected by the Final Action is negligible. The Final Action will be implemented at the project level, not the firm level, and will only affect projects within the United States. All firms undertaking such projects, domestic or foreign, will be subject to the Final Action. U.S. firms doing business outside the United States will not be differentially affected compared to foreign firms, regardless of option chosen. Similarly, foreign firms doing business in the United States will not be differentially affected.

The Final Action could stimulate or depress demand for some construction-related goods. To the extent that the Final Action acts to depress the overall construction market, demand for conventional construction-related products could decline. This decline could be offset by the purchase of goods and services related to stormwater management. Overall, EPA does not anticipate that any shifts in demand for such goods and services resulting from the Final Action will have significant implications for U.S. or foreign trade.

4.3.4 Government Impacts

Government impacts are measured as the costs associated with changes to state regulations that might be necessitated by the Final Action. These administrative costs are incurred when states bring their own regulations into line with option requirements. In addition, governments build or hire contractors to build a large fraction of developed space in any given year. For these projects, EPA assumes that a portion of the costs associated with meeting the Final Action requirements, if any, would be passed through to local, state, and federal governments. The following sections discuss EPA's methodology for assessing these costs to governments.

4.3.4.1 Administrative Costs

EPA has analyzed the administrative costs to governments associated with the Final Action. EPA assumes that the majority of construction-related regulatory costs would be associated with processing general permits. As noted previously, EPA assumes that the NPDES Phase I and Phase II stormwater permit programs are fully implemented and that any new regulatory requirements would be superimposed on these programs.

Under Option 1, EPA assumes that no incremental costs would be imposed on governments. Under Options 2 and 4, EPA estimates that each state would incur costs to revise existing regulations to reflect the shift of regulatory coverage from Part 122 to Part 450. EPA assumed that all states would change their stormwater programs to include certification of sedimentation basins and other aspects of the options considered, and EPA estimated the costs associated with making these changes. The costs are based on assumptions about the number of labor hours states would allocate to amending such programs and the applicable labor rate. The methodology remains the same as that for the proposal. Further details on these assumptions and costs can be found in the Technical Development Document for the proposal (U.S. EPA, 2002d).

4.3.4.2 Compliance Costs

EPA estimates that government entities (federal, state, and local) commission as much as one quarter of the total value of construction work completed in the United States each year. As final owner of a substantial amount of the industry output, governments will bear some of the compliance costs associated with the Final Action, unless Option 3 is chosen, assuming that these costs are passed on from developers and builders. In Chapter Five, Section 5.8, EPA allocates the government share of compliance costs, based on the government share of industry output. Further details about government costs can also be found in Chapters Eight and Nine.

4.3.4.3 Impacts Associated With NSPS

Under Options 2 and 4, EPA is defining a "new source" (under Part 450) as: "any source of stormwater discharge associated with construction activity that results in the disturbance of at least 5 acres total land area that itself will produce an industrial source from which there may be a discharge of pollutants regulated by some other new source performance standard in Subchapter N"[30] (33 U.S.C. sec. 1316(a)(2)). This definition means that the land-disturbing activity associated with constructing a particular facility would not constitute a "new source" unless the results of that construction yield a "new source" regulated by other new source performance standards. Construction activity that is associated with building a new pharmaceutical plant covered by 40 CFR 439.15, for example, would be subject to new source performance standards under §450.24. EPA has sought comment on whether no sources regulated under Option 2 should be deemed "new sources,", as construction activity itself is outside the scope of section 306 of the Clean Water Act (CWA).[31] Several commenters indicated that the language in this section specifically excludes construction activities from being considered new sources. For the purpose of this analysis, EPA continues to assume that construction activities can be considered new sources.

Under the new definition, EPA believes that the NSPS standards could trigger a National Environmental Policy Act (NEPA) review process for those C&D activities permitted by EPA. To assess the potential impact of such a result, EPA examined NPDES construction permitting data for 19 states with permitting systems fully or partially administered by EPA. In 2000, the number of permits administered by EPA was 8,563. EPA believes, however, that by the time EPA implements the Final Action, the states of Florida, Maine, and Texas (currently fully administered by EPA) will have assumed permitting authority for construction activities. In 2000, the number of permits administered by EPA, *excluding these three states*, was 1,454.

The NPDES permitting data does not include sufficient detail to indicate the number of sources that could be new sources covered by CWA section 306. EPA notes, however, that in a 1999 study of 14

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[30] All new source performance standards promulgated by EPA for categories of point sources are codified in Subchapter N.

[31] "The term 'new source' means any source, the construction of which is commenced . . ." 33 U.S.C. sec. 1316(a)(2)(emphasis added).

communities, slightly less than 1 percent of construction permits were for industrial facilities (U.S. EPA, 1999; see Table 4-13). Based on this statistic, EPA believes that the number of construction permits for new sources (regulated under Subchapter N) that would be administered by EPA is likely to be small. EPA has not, therefore, estimated any potential costs for NEPA review as part of this economic analysis.

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