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Environmental Protection
Agency

Economic Analysis of Final Effluent Limitation Guidelines and Standards for the Construction and Development Industry

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Abt Associates, Inc.

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Abbreviations and Acronyms

ACS – American Community Survey

AHS – American Housing Survey

AIA – American Institute of Architects

ATS – Active Treatment Systems

BAT – Best Available Technology Economically Achieveable

BEA – Bureau of Economic Analysis

BMP – Best Management Practice

C&D – Construction and Development

CAPM – Capital Asset Pricing Model

CGP – Construction General Permit

CWA – Clean Water Act

DMR – Discharge Monitoring Reports

DOL – Department of Labor

EA – Economic Analysis

EBIT – Earnings Before Interest and Taxes

ELG – Effluent Limitation Guideline

EPA – Environmental Protection Agency

FDIC – Federal Deposit Insurance Corporation

FHA – Federal Housing Administration

FHFB – Federal Housing Finance Board

FHWA – Federal Highway Administration

GDP – Gross Domestic Product

HAI – Housing Affordability Index

HUD – U.S. Department of Housing and Urban Development

III – Insurance Information Institute

IO – Input Output

MBA – Mortgage Bankers Association

MSA – Metropolitan Statistical Area

NAHB – National Association of Home Builders

NAICS – North American Industrial Classification System

NAR – National Association of Realtors

NBER – National Bureau of Economic Research

NOI – Notice of Intent

NPDES – National Pollutant Discharge Elimination System

NRDC – Natural Resources Defense Council

NSPS – New Source Performance Standards

NTU – Numeric Turbidity Limit

RFA – Regulatory Flexibility Act

RIMS II – Regional Input–Output Modeling System

RMA – Risk Management Association

SBA – Small Business Adminstration

SBREFA – Small Business Regulatory Enforcement Fairness Act

SIC – Standard Industrial Classification

SISNOSE – Significant Economic Impact on a Substantial Number of Small Entities

SPARROW – Spatially Referenced Regressions On Watershed Attributes

SUSB – Statistics of U.S. Businesses

SWPPP – Storm Water Pollution Prevention Plan

TDD – Technical Development Document

TN – Total Nitrogen

TP – Total Phosphorus

UMRA – Unfunded Mandates Reform Act

USGS – United States Geological Survey

VL – Value Line Investment Survey

WQI – Water Quality Index

1 Introduction to the Economic Analysis

EPA is establishing effluent limitations guidelines (ELGs) and new source performance standards (NSPS) for stormwater discharges from the Construction and Development (C&D) industry. These guidelines and standards would require discharges from certain construction sites to meet a numeric turbidity limit (NTU). The guidelines and standards would also require all construction sites currently required to obtain a National Pollutant Discharge Elimination System (NPDES) to implement a variety of best management practices (BMPs) designed to limit erosion and control sediment discharges from construction sites. This Economic Analysis (EA) report assesses the overall cost and impact of four regulatory options, which are described below:

- *Option 1*, which requires non-numeric effluent limitations for all sites, is EPA's least stringent policy option;
- *Option 2* requires active treatment systems (ATS) on sites disturbing 30 or more acres at one time and imposes a 13 NTU turbidity standard while requiring non-numeric effluent limitations on all sites and is similar to an option EPA proposed previously;
- *Option* 3, EPA's most stringent policy option, requires ATS on sites disturbing 10 or more acres at one time, imposes a 13 NTU turbidity standard on these sites, and requires non-numeric effluent limitations on all sites; and,
- *Option 4*, the option EPA has selected for the final rule, requires passive treatment systems on all sites disturbing 10 or more acres disturbed, and establishes a numeric turbidity standard of 280 NTU (based on passive treatment and expressed as a daily maximum value). In addition, all sites will be required to meet non-numeric effluent limitations.

EPA estimates that Option 1 would cost approximately $180 million dollars per year, reduce sediment discharges from construction sites by approximately 18.4 million cubic yards per year, and result in monetized benefits of $214 million per year. EPA estimates that Option 2 would cost approximately $4.8 billion dollars per year, reduce sediment discharges from construction sites by approximately 38.3 million cubic yards per year, and result in monetized benefits of $360 million per year. EPA estimates that Option 3 would cost approximately $9.1 billion dollars per year, reduce sediment discharges from construction sites by approximately 47.8 million cubic yards per year, and result in monetized benefits of $422 million per year. EPA estimates that Option 4 would cost approximately $960 million dollars per year, reduce sediment discharges from construction sites by approximately 44.1 million cubic yards per year, and result in monetized benefits of $369 million per year.

This EA presents analyses and findings pertaining to:

- Baseline business performance and condition of the C&D industry sectors and firms that would be affected by the regulation;
- Cost and economic/financial impact of the regulation to these firms and to the C&D industry as a whole;
- Potential impact on the price and affordability of new single-family housing expected to be affected by the regulation;
- Total cost to society, accounting both for the cost of meeting compliance requirements and for potential changes in C&D industry output and the associated loss in societal economic welfare;
- Economy wide effects, accounting for inter-industry linkages, in terms of net change in economic output and employment;

- Potential impact on small businesses and governments in accordance with requirements of the Regulatory Flexibility Act (RFA) and the Unfunded Mandates Reform Act (UMRA); and,
- Comparison of total social costs and estimated benefits.

This chapter provides a general overview of the final rule economic analysis. *Section 1.1* describes the background and the purpose of the rule, highlighting requirements of the effluent limitation guidelines. *Section 1.2* reviews the sectors within the C&D industry that are expected to be affected by the regulatory requirements. *Section 1.3* summarizes the analyses undertaken for assessing the costs and impacts of the regulation. *Section 1.4* summarizes the approach for estimating the benefits of the regulation.

1.1 Background and Purpose of the Final Rule

The U.S. Environmental Protection Agency (EPA) is finalizing Effluent Limitation Guidelines for discharges associated with construction and development activities under the authority of Sections 301, 304, 306, 308, 402, and 501 of the Clean Water Act (CWA) (the Federal Water Pollution Control Act), 33 United States Code (U.S.C.) 1311, 1314, 1316, 1318, 1342, and 1361.

Effluent Limitation Guidelines Schedule and Previous Actions Related to Construction and Development

CWA section 304(m) requires EPA to publish a plan every 2 years that consists of three elements. First, under section 304(m)(1)(A), EPA is required to establish a schedule for the annual review and revision of existing effluent guidelines in accordance with section 304(b). Section 304(b) applies to ELGs for direct dischargers and requires EPA to revise such regulations as appropriate. Second, under section 304(m)(1)(B), EPA must identify categories of sources discharging toxic or nonconventional pollutants for which EPA has not published best available technology economically achieveable (BAT) ELGs under section 304(b)(2) or new source performance standards under section 306. Finally, under section 304(m)(1)(C), EPA must establish a schedule for the promulgation of BAT and New Source Performance Standards (NSPS) for the categories identified under subparagraph (B) not later than three years after being identified in the 304(m) plan. Section 304(m) does not apply to pretreatment standards for indirect dischargers, which EPA promulgates pursuant to sections 307(b) and 307(c) of the Act.

On October 30, 1989, Natural Resources Defense Council, Inc. (NRDC), and Public Citizen, Inc., filed an action against EPA in which they alleged, among other things, that EPA had failed to comply with section 304(m). Plaintiffs and EPA agreed to a settlement of that action in a consent decree entered on January 31, 1992 (*Natural Resources Defense Council et al v. Whitman, D.D.C.* Civil Action No. 89-2980). The consent decree, which was modified several times, established a schedule by which EPA is to propose and take final action for 11 point source categories identified by name in the decree and for eight other point source categories identified only as new or revised rules, numbered 5 through 12. EPA selected the Construction and Development (C&D) category as the subject for new or revised rule #10. The modified decree called for the Administrator to sign a proposed ELG for the C&D category no later than May 15, 2002, and to take final action on that proposal no later than March 31, 2004. A settlement agreement between the parties, signed on June 28, 2000, required that EPA develop regulatory options applicable to discharges from construction, development and redevelopment, covering site sizes included in the Phase I and Phase II NPDES storm water rules (i.e., 1 acre or greater). EPA is required to develop options including numeric effluent limitations for sedimentation and turbidity; control of construction site pollutants other than sedimentation and turbidity (e.g., discarded building materials, concrete truck washout, trash); best management practices (BMPs) for controlling post-construction runoff; BMPs for construction sites; and requirements to design storm water controls to maintain pre-development runoff conditions where practicable.

EPA identified the C&D point source category in its CWA section 304(m) plan in 2000 as an industrial point source category for which EPA intended to conduct rulemaking (65 FR at 53008 and 53011, August 31, 2000). On June 24, 2002, EPA published a proposed rule that contained several options for the control of stormwater discharges from construction sites, including ELGs and NSPSs. (67 FR 42644; June 24, 2002). On April 26, 2004, EPA chose to rely on the range of existing programs, regulations, and initiatives that already existed at the federal, state and local level and withdrew the proposed EPGs and NSPSs (69 FR 22472; April 26, 2004).

On October 6, 2004, NRDC and Waterkeeper Alliance, as well as the States of New York and Connecticut filed a motion against EPA alleging that EPA failed to promulgate ELGs and NSPSs as required by the Clean Water Act. On December 1, 2006 the district court, in *Natural Resources Defense Council, et al. v. U.S. Environmental Protection Agency, et al.*, C.D. Cal. 2006, Case No. CV 04-8307-GHK (RCx), held that CWA section 304(m), read together with CWA section 304(b), imposes on EPA a mandatory duty to promulgate effluent limitations guidelines and new source performance standards for industrial point source categories named in a CWA section 304(m) plan. The court ordered EPA to publish proposed regulations in the *Federal Register* by December 1, 2008 and to promulgate ELGs and NSPSs for the C&D category as soon as practicable, but no later than December 1, 2009. This final rule addresses the court order.

NPDES Phase I and II Storm Water Rules

As authorized by the CWA, the National Pollutant Discharge Elimination System (NPDES) permit program was established to control water pollution by regulating point sources that discharge pollutants into waters of the United States. The Phase I and II storm water rules established the construction category as a point source for discharges. Storm water runoff from construction activities can have a significant impact on water quality. The NPDES storm water program requires operators of construction sites to apply for either a general permit or an individual permit under the NPDES Phase I and II storm water rules. Phase I of EPA’s storm water program was promulgated in 1990 under the CWA and addresses, among other things, discharges from construction activities disturbing 5 acres or more of land. Phase II of the NPDES storm water program, promulgated in 1999, expands the Phase I Rule by addressing storm water discharges from small construction sites disturbing between 1 and 5 acres. In addition, operators of small construction sites are also required to develop and implement a storm water pollution prevention plan (SWPPP), which includes implementation of the appropriate erosion and sediment control BMPs. The BMP selection and design are at the discretion of permittees (in conformance with applicable state or local requirements). Moreover, construction activities disturbing less than 1 acre are also included in Phase II of the NPDES storm water program if they are part of a larger common plan of development or sale with a planned disturbance of greater than or equal to 1 acre and less than 5 acres, or if they are designated by the NPDES permitting authority.

Most states are authorized to implement the storm water NPDES permitting program. However, EPA remains the permitting authority in a few states, territories, and on most land in Indian Country. For construction (and other land disturbing activities) in areas where EPA is the permitting authority, operators must meet the requirements of the EPA Construction General Permit (CGP).

1.2 Industries and Activity Affected by the Final Regulation

Table 1-1 presents the C&D industry sectors that are expected to be affected by the regulation. These industries are reported in the current North American Industrial Classification System (NAICS) framework. A detailed characterization of the industry sectors and of those sectors included within this EA is provided in the Economic Profile of the Construction and Development Industry (*Chapter 3*).

Table 1-1: Industries Potentially Affected by the Final Rulemaking

NAICS Code	Sector Name	Sector Description
236	**Construction of buildings**	
2361	Residential building construction	
236115	New Single-Family Housing Construction (except Operative Builders)	General contractor establishments primarily responsible for the entire construction of new single-family housing, such as single-family detached houses and town houses or row houses where each housing unit is either separated from its neighbors by a ground-to-roof wall or has no housing units constructed above or below. This industry includes general contractors responsible for the on-site assembly of modular and prefabricated houses. Single-family housing design-build firms and single-family construction management firms acting as general contractors are included in this industry.
236116	New Multifamily Housing Construction (except Operative Builders)	General contractor establishments responsible for the construction of new multifamily residential housing units (e.g., high-rise, garden, and town house apartments and condominiums where each unit is not separated from its neighbors by a ground-to-roof wall). Multifamily design-build firms and multifamily housing construction management firms acting as general contractors are included in this industry.
236117	New Housing Operative Builders	Operative builders primarily responsible for the entire construction of new houses and other residential buildings, single-family and multifamily, on their own account for sale. Operative builders are also known as speculative or merchant builders.
2362	Nonresidential building construction	
236210	Industrial Building Construction	Establishments primarily responsible for the construction (including new work, additions, alterations, maintenance, and repairs) of industrial buildings (except warehouses). The construction of selected additional structures, whose production processes are similar to those for industrial buildings (e.g., incinerators, cement plants, blast furnaces, and similar nonbuilding structures), is included in this industry. Also included in this industry are industrial building general contractors, industrial building operative builders, industrial building design-build firms, and industrial building construction management firms.
236220	Commercial and Institutional Building Construction	Establishments primarily responsible for the construction (including new work, additions, alterations, maintenance, and repairs) of commercial and institutional buildings and related structures, such as stadiums, grain elevators, and indoor swimming pools. This industry includes establishments responsible for the on-site assembly of modular or prefabricated commercial and institutional buildings. Included in this industry are commercial and institutional building general contractors, commercial and institutional building operative builders, commercial and institutional building design-build firms, and commercial and institutional building project construction management firms.
237	**Heavy and civil engineering construction**	
2371	Utility system construction	
237110	Water and Sewer Line and Related Structures Construction	Establishments primarily engaged in the construction of water and sewer lines, mains, pumping stations, treatment plants, and storage tanks. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to water and sewer line and related structures construction. All structures (including buildings) that are integral parts of water and sewer networks (e.g., storage tanks, pumping stations, water treatment plants, and sewage treatment plants) are included in this industry.
237120	Oil and Gas Pipeline and Related Structures Construction	Establishments primarily engaged in the construction of oil and gas lines, mains, refineries, and storage tanks. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to oil and gas pipeline and related structures construction. All structures (including buildings) that are integral parts of oil and gas networks (e.g., storage tanks, pumping stations, and refineries) are included in this industry.
237130	Power and Communication Line and Related Structures Construction	Establishments primarily engaged in the construction of power lines and towers, power plants, and radio, television, and telecommunications transmitting/receiving towers. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to power and communication line and related structures construction. All structures (including buildings) that are integral parts of power and communication networks (e.g., transmitting towers, substations, and power plants) are included.
2372	Land Subdivision	
237210	Land Subdivision	Establishments primarily engaged in servicing land and subdividing real property into lots, for subsequent sale to builders. Servicing of land may include excavation work for the installation of roads and utility lines. The extent of work may vary from project to project. Land subdivision precedes building activity and the subsequent building is often residential, but may also be commercial tracts and industrial parks. These establishments may do all the work themselves or subcontract the work to others. Establishments that perform only the legal subdivision of land are not included in this industry.
2373	Highway, Street, and Bridge Construction	
237310	Highway, Street, and Bridge Construction	Establishments primarily engaged in the construction of highways (including elevated), streets, roads, airport runways, public sidewalks, or bridges. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to highway, street, and bridge construction (e.g., installing guardrails on highways).
2379	Other Heavy and Civil Engineering Construction	
237990	Other Heavy and Civil Engineering Construction	Establishments primarily engaged in heavy and engineering construction projects (excluding highway, street, bridge, and distribution line construction). The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to engineering construction projects (excluding highway, street, bridge, distribution line, oil and gas structure, and utilities building and structure construction). Construction projects involving water resources (e.g., dredging and land drainage), development of marine facilities, and projects involving open space improvement (e.g., parks and trails) are included in this industry.
238	**Specialty Trade Contractors**	

Table 1-1: Industries Potentially Affected by the Final Rulemaking

NAICS Code	Sector Name	Sector Description
2389	Other Specialty Trade Contractors	
238910	Site preparation contractors	Establishments primarily engaged in site preparation activities, such as excavating and grading, demolition of buildings and other structures, septic system installation, and house moving. Earth moving and land clearing for all types of sites (e.g., building, nonbuilding, mining) is included in this industry. Establishments primarily engaged in construction equipment rental with operator (except cranes) are also included.

Source: U.S. Census Bureau's Economic Census (2005a)

EPA anticipates that some businesses and activities in the *Heavy Construction* sector (NAICS 237) will be affected by the Construction rule. However, with the exception of NAICS 237310 (*Highway, street, and bridge construction*), data are not available to support an assessment of the number and character of projects performed by NAICS 237 sector businesses that would be subject to compliance requirements and incur compliance costs. For this reason, of the sectors in NAICS 237, only NAICS 237310 (*Highway, street, and bridge construction*) is considered in the cost and impact analysis for the Construction rule. In addition, the establishments included under NAICS 238910 (*Site preparation contractors)* are expected to be involved in land disturbance. However, since the establishments in this sector are not expected to be the NPDES permitees this sector was therefore excluded from this regulatory analysis. For ease, EPA describes the regulated sector by three main subsectors, residential, non-residential and transportation.

1.3 Overview of Approach for Assessing the Economic Effects of the Final Rule

For each of the regulatory options, EPA estimated total affected acreage and compliance cost from an engineering assessment of compliance requirements and construction activity that is likely to be affected by the specific requirements of a regulatory option. The costs were broken out by state, general industry sector (i.e., residential, non-residential, and transportation), project size, and project duration. To analyze the costs and impacts of the final C&D industry regulation, EPA first identified and described the baseline condition of the economic entities expected to be subject to the regulation. EPA assessed the incremental changes in the baseline conditions of the affected entities and industries incurring compliance costs. *Chapter 3*, *Economic Profile of the Construction and Development Industry* identifies and characterizes the establishments, firms, employees, and revenue by the specific industry segments at the establishment- and firm-level. The profile also presents recent industry trends, industry characteristics, industry dynamics and an industry forecast. This information is important for establishing and understanding C&D industry analysis baseline, which is detailed in *Chapter 4, Developing the Analysis Baseline.*

EPA used a number of methods to assess the economic impacts of the regulatory options on C&D businesses and consumers at the project-level, firm- and industry-level, regional-level, and at the state- and national-level. EPA undertook five main analyses to examine the costs and impacts of the final rule. Additional analyses describing small business impacts and government-level impacts are also included within this EA. Most of these analyses, including the primary *Firm- and Industry-Level Analysis* and *Housing Affordability Analysis*, are based on assumptions that reflect the long-term steady-state condition of the industry and the level of compliance activity subject to the final regulation. Because of the current economic downturn in the C&D industry and the U.S. economy generally, this level of activity exceeds the activity actually occurring in 2008 and anticipated for the near future. In view of the current economic downturn, EPA also undertook an *Adverse Business Conditions* case analysis and a *Projection of Cost and Impacts* analysis. Both of these analyses diverge from the long-term steady-state model and instead examine the rule's effects under approximately current and near-term future conditions, respectively. EPA judges the *Project of Cost and Impacts* to be of particular significance because it provides detailed insight into the rule's likely effects as the industry begins to resume growth. Brief summaries of the five analyses conducted by EPA are below. More detailed descriptions of the methodologies for each of these analyses can be found in their respective chapters.

- ***Chapter 6 – Analysis of Firm- and Industry-Level Economic Impacts.*** Assessment of the cost and economic/financial impact of regulatory requirements on C&D industry firms, and the potential industry-level effects in terms of numbers of firms that may be adversely affected, potential employment at risk, and total costs to the C&D industry for regulation compliance;
- ***Chapter 7 – Projection of Cost and Impacts.*** Analysis that simulates the rule's phase-in over the period 2010 – 2014 and projects the estimated total cost out to the year 2025. This analysis accounts for the expected phase-in of compliance over the first five years as states renew their Construction General Permits, the expected phase-in of the rule's requirements during that period, and estimated levels of C&D activity for the years 2010 – 2014;
- ***Chapter 8 – Analysis of Single-Family Housing Affordability Impacts.*** An assessment of housing affordability, where impacts are measured in terms of the expected change in price for median- and lower-quartile priced new single-family homes and the associated number of prospective home buyers that may experience an affordability effect due to the price change;
- ***Chapter 9 – Analysis of Social Cost.*** An analysis of the costs of the rule from the viewpoint of society as a whole. The social cost of the rule includes the total resource costs accounting for C&D market effects, the social welfare loss to society arising from the change in each market's output level, and administrative costs to implement the regulation; and,
- ***Chapter 10 – Analysis of Economy-Wide Output and Employment Impacts.*** An input-output multiplier analysis that considers total economy effects – in terms of output and employment – based on the total change in demand for society's resources arising from (1) compliance outlays, and (2) the reduction in C&D industry output. The analysis also estimates the *net* change in demand for society's resources arising from these two effect mechanisms.

1.4 Overview of Approach for Assessing the Benefits of the Final Rule

Chapter 11 - Benefits Assessment Methodology and Results presents EPA's analysis of benefits for the final regulation. EPA analyzed four categories of quantifiable and monetizeable benefits from the final C&D regulation:

- ***Benefits to Navigation***. Navigable waterways are often dredged to maintain their navigable depth and width. Reduced sediment settling in navigable channels is expected to reduce the frequency and therefore cost of dredging in these channels, as frequency and cost are related to the amount of sediment accumulated over time and therefore needed to be dredged;
- ***Benefits to Water Storage***. Water storage facilities, commonly called reservoirs, may also be dredged in order to regain capacity lost to sediment build-up. Reduced sediment settling in reservoirs is also expected to reduce the frequency and cost of dredging in reservoirs that are dredged;
- ***Benefits to Drinking Water Treatment***. Drinking water must be treated for sediment in turbidity, among other things, and treatment costs are related to the sediment and turbidity levels of the influent water. Reducing sediment and subsequently the turbidity that must be treated by drinking water treatment plants reduces the amount of chemicals needed for treatment, and also the amount of sludge generated from this treatment that must be disposed; and,
- ***Water Quality Benefits.*** Reducing sediment levels in waterways has the general effect of improving water quality, as suspended sediment is one of the determinants of water quality. Increased water quality

increases both the use and non-use value of waterbodies. EPA quantified the increased use value using willingness-to-pay estimates based on a meta-analysis of existing willingness-to-pay studies for improved water quality.

The analysis methodology and findings for these benefit categories are presented in *Chapter 11*. The total benefit resulting from the reduced sediment and turbidity levels in U.S. waters induced by this regulation is estimated as the sum of the four mutually exclusive categories of monetary benefits.

2 Summary of Results from the Economic Analysis

This chapter presents a concise summary of key analysis results. Complete details about the methodologies supporting these analyses can be found in their respective chapters.

2.1 Firm- and Industry-Level Effects

The estimated levels of cost, affected acreage, and resulting firm and industry impacts reported in *Table 2-1* vary substantially over the four primary regulatory options analyzed. Please refer to Chapter 6 for complete details regarding these results and the supporting analysis methodology.

- For *Option 1*, the least costly of the four options, EPA estimates total annual costs of $176 million. A total of 30,508 firms are estimated to incur compliance costs under this option. Out of these 30,500 firms, none are estimated to incur costs exceeding 1 or 3 percent of revenue, while 31 firms are estimated to incur financial stress. These 31 firms represent 0.1 percent of all firms incurring cost, and essentially zero percent of all firms in the affected industry sectors. A total of 30 firms are estimated to experience negative business value[1] as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.
- For *Option 2*, EPA estimates total annual costs of $4,866 million. Out of the 30,500 firms estimated to incur costs, 4,717 are estimated to incur costs exceeding 1 percent of revenue, and 2,399 are estimated to incur costs exceeding 3 percent of revenue. The 4,717 firms incurring cost exceeding 1 percent of revenue represent about 15.5 percent of the firms that are estimated to incur costs, 5.8 percent of in-scope firms (i.e. firms that perform sufficient quantity and character of projects to be directly subject to the regulation), and less than 3 percent of all firms in the affected industry sectors. When the effect of cost pass-through is accounted for in the cost-to-revenue analysis – i.e., costs are reduced by the amount of estimated offsetting revenue increase – 873 firms are estimated to incur costs exceeding 1 percent of revenue. A total of 1,181 firms are estimated to incur financial stress as a result of regulatory requirements. A total of 430 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact are not additive.
- For *Option 3*, the most costly option, EPA estimates total annual costs of $9,090 million. Out of these 30,500 firms estimated to incur costs, 14,021 are estimated to incur costs exceeding 1 percent of revenue, and 9,126 are estimated to incur costs exceeding 3 percent of revenue. The 14,021 firms with cost greater than 1 percent of revenue represent 46 percent of firms estimated to incur costs, 17 percent of in-scope firms, and 7.5 percent of all firms in the affected industry sectors. The 9,126 firms incurring cost greater than 3 percent of revenue represent 30 percent of firms estimated to incur costs and 11 percent of in-scope firms. When the effect of cost pass-through is accounted for in the cost-to-revenue analysis – i.e., costs are reduced by the amount of estimated offsetting revenue increase – 3.573 firms are estimated to incur (*net*) costs exceeding 1 percent of revenue. A total of 5,398 firms are estimated to incur financial stress as a result of regulatory requirements. These 5,398 firms represent 17.7 percent of all firms incurring cost,

[1] The equity value of the business as a going-concern, based on discounting of the business' free cash flow from operations at the business' estimated cost of capital, and subtracting the value of liabilities recorded on the balance sheet.

6.6 percent of in-scope firms, and 2.8 percent of all firms in the affected industry sectors. A total of 1,254 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact are not additive.

- For *Option 4*, EPA estimates total costs of $953 million. Out of the 30,500 firms estimated to incur costs, 276 are estimated to incur costs exceeding 1 percent of revenue, and zero are estimated to incur costs exceeding 3 percent of revenue. The 276 firms incurring cost exceeding 1 percent of revenue represent about 0.9 percent of the firms that are estimated to incur costs, 0.3 percent of in-scope firms, and about 0.1 percent of all firms in the affected industry sectors. When the effect of cost pass-through is accounted for in the cost-to-revenue analysis – i.e., costs are reduced by the amount of estimated offsetting revenue increase – zero firms are estimated to incur (*net*) costs exceeding 1 percent of revenue. A total of 169 firms are estimated to incur financial stress as a result of regulatory requirements. These 169 firms represent 0.5 percent of all firms incurring cost, 0.2 percent of in-scope firms, and less than 0.1 percent of all firms in the affected industry sectors. A total of 147 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

Table 2-1: Summary of Cost and Economic Impact Analysis for Final Rule Options

Impact Analysis Concept		Option 1	Option 2	Option 3	Option 4
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)					
Total Costs ($millions)		$176	$4,866	$9,090	$953
Total Acreage Incurring Cost		852,649	852,649	852,649	852,649
Number of Firms	All Firms	187,100	187,100	187,100	187,100
	Firms In-Scope	81,665	81,665	81,665	81,665
	Firms Incurring Cost	30,508	30,508	30,508	30,508
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact					
Costs Unadjusted for Effect of Cost Pass-Through					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	4,717	14,021	276
	% of All Firms	0.0%	2.5%	7.5%	0.1%
	% of Firms In-Scope	0.0%	5.8%	17.2%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	2,399	9,126	0
	% of All Firms	0.0%	1.3%	4.9%	0.0%
	% of Firms In-Scope	0.0%	2.9%	11.2%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	873	3,573	0
	% of All Firms	0.0%	0.5%	1.9%	0.0%
	% of Firms In-Scope	0.0%	1.1%	4.4%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	81	225	0
	% of All Firms	0.0%	0.0%	0.1%	0.0%
	% of Firms In-Scope	0.0%	0.1%	0.3%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance					
Firms Incurring Financial Stress	Number Incurring Effect	31	1,181	5,398	169
	% of All Firms	0.0%	0.6%	2.9%	0.1%
	% of Firms In-Scope	0.0%	1.4%	6.6%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)					
Firms with Negative Business Value (Potential Closures)	Number Incurring Effect	30	430	1,254	147
	% of All Firms	0.0%	0.2%	0.7%	0.1%
	% of Firms In-Scope	0.0%	0.5%	1.5%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

EPA Estimates

2.2 Projections of Future Regulatory Cost and Economic Effects

EPA projected the cost and economic effects of the final rule through the year 2025, accounting for: (1) the expected levels of in-scope activity during the years in which the regulation will begin to be implemented, (2) the phase-in of the rule's requirements during the initial years following promulgation, and (3) the phase-in of rule applicability as states renew their Construction General Permits. This projection relies primarily on a recent forecast of total construction industry activity over the next several years developed by Global Insight. Unlike the other cost and impact analyses described in this document, this projection analysis is presented only for the final rule option, *Option 4*.

As reported in Chapter 6, *Table 6-3*, the primary estimate of total compliance cost of Option 4, is $953 million. The results – cost and impacts – presented below differ from this estimate in three important ways:

- The projection analysis accounts for the anticipated activity levels in each year from 2010 – 2014;
- The projection analysis accounts for the phase-in of the rule's requirements from 2010 – 2014; and,
- The projection analysis accounts for the phase-in of compliance from 2010 – 2014 as states renew their CGPs.

Because 2014 is the first year of full rule implementation, the cost value reported for 2014, $810 million (2008$), reflects the near-term cost of the rule under steady state-like conditions – i.e., the rule's requirements are fully effective to all covered site sizes, and the rule is anticipated to have been implemented over all states. EPA's primary estimate of $953 million (from Chapter 6) differs from this value because the primary value reflects the cost of the rule in 2008 constant dollars, at a long-term, steady-state activity level. EPA presents this cost estimate as an appropriate basis for understanding the long-term annual costs of the rule, in constant 2008 dollars, because it reflects EPA's estimate of the long-term, steady state activity level in the industry. As reported in *Table 2-3*, this long-term, steady-state activity level and compliance cost value, as estimated in Chapter 6, would not actually occur until the year 2020.

Table 2-2 reports the costs and impacts associated with the final rule over the period 2010 – 2014, as aggregate industry activity increases, the requirements of the rule become applicable, and additional states come into compliance. *Table 2-2* reports the total costs and impacts over this period on a *cumulative* basis as additional states come into compliance in each year following rule promulgation – i.e., the effects cannot be summed across years.

Table 2-2: Cumulative Cost and Economic Impacts for the Final Rule, 2010 - 2014

Impact Analysis Concept		2010	2011	2012	2013	2014
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)						
Total Costs ($millions, 2008$)		$8	$63	$204	$538	$810
Total Acreage Incurring Cost		36,212	107,646	603,875	603,875	729,384
Number of Firms	All Firms	132,701	155,728	180,028	194,442	200,163
	Firms In-Scope	53,078	59,581	67,571	73,056	75,578
	Firms Incurring Cost	781	2,522	5,826	17,515	20,918
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact						
Costs Unadjusted for Effect of Cost Pass-Through						
Exceeding 1% of Revenue	Number Incurring Effect	0	2	48	136	224
	% of All Firms	0.0%	0.0%	0.0%	0.1%	0.1%
	% of Firms In-Scope	0.0%	0.0%	0.1%	0.2%	0.3%
Exceeding 3% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]						
Exceeding 1% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Exceeding 3% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance						
Incurring Financial Stress	Number Incurring Effect	1	7	27	79	141
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.1%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.1%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)						
Negative Business Value (Potential Closures)	Number Incurring Effect	2	6	21	61	128
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.1%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.1%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.
EPA Estimates

For the years beyond 2014, EPA extended the time series of aggregate industry construction value, cost, and acreage to the year 2025 by assuming a uniform annual growth rate in aggregate construction value from 2015 to 2025 of 3.0% per year. This value is based on the industry's average annual growth rate of construction value – on a constant dollar basis – from Census' *Annual Value of Construction Put in Place* for the most recent 15-year period, 1994 – 2008 (Census 2009a). *Table 2-3* presents the values for 2010-2014 and for the specific years 2020 and 2025, along with an estimate of total compliance cost as a percentage of total construction value. As evidenced in the table, the total compliance costs associated with the final rule are expected to represent about one-tenth of one percent of total construction value in the C&D industry over the long-term.

Table 2-3: Total Value of Construction Activity and Cost, by Year (millions, 2008$)

	2010	2011	2012	2013	2014	2020	2025
Total Value of Construction	$487,534	$554,457	$641,041	$699,860	$726,669	$866,895	$1,004,210
Total Estimated Acreage	495,930	561,710	646,022	703,565	729,894	870,742	1,008,667
Total Compliance Cost	$7.8	$75.2	$253.3	$538.1	$809.9	$966.1	$1,119.2
as a % of total value	0.00%	0.01%	0.04%	0.08%	0.11%	0.11%	0.11%

EPA Estimates

Lastly, EPA calculated the annualized cost of the final rule from 2010 – 2025, using both a 3% and 7% discount rate. Using a 3% discount rate, the annualized cost of Option 4 is approximately $725 million. Using a 7% discount rate, the annualized cost of Option 4 is approximately $667 million.

2.3 Single-Family Housing Affordability Effects

This analysis estimates, by Metropolitan Statistical Area (MSA), the potential change in price for newly constructed single-family homes, and the associated number of prospective home buyers whose purchasing decisions may be affected by the potential increase in new home prices due to compliance requirements.

The results of the analysis are *produced* at the MSA-level and *reported* at the national-level by aggregating the total number of impacted households across all MSAs. Detailed state-level results are presented in Appendix D. As described above, EPA performed this analysis at three home price levels: the median price, lower quartile price, and specified lowest prices for new single-family homes, by MSA. For this analysis, EPA assumed that compliance costs would be *fully passed through* to consumers in increased housing prices. This assumption effectively contradicts the assumptions of *partial* and *no cost pass-through* that underlie the analysis of firm and industry-level regulatory impacts. Results from the median price analysis are summarized below.

Table 2-4 shows, by regulatory option, the estimated dollar value and percentage change in the price for a new single-family home and the number of households in the market for a new, median price single family home whose purchasing decision may be affected by the price change. The price increase assumes: (1) a compliance cost based on the median lot size, 0.20 acres, for *all* new single-family housing as reported in the Census of Housing and (2) that compliance costs are fully passed through as an increased price to the home purchaser.[2] This table also shows (1) the number of affected households as a percentage of the total number of home-purchasing households that also qualify to purchase the median price home, before compliance cost effect, and (2) the fraction and number of total households whose purchasing decision could be affected by a regulatory option, adjusted to account for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio. The key conclusion from this analysis is that, for all regulatory options, the total number of households incurring an affordability effect is small in comparison to the number of all likely single-family home buyers in any given year who can also afford the same home. For Option 4, this percentage is less than 0.2 percent

[2] The 0.20 acre lot size is the median value for new single-family housing as reported in the Census' *2008 Characteristics of New Housing*, adjusted for additional land development associated with roadways, which is not accounted for in the Census' lot size data.

Table 2-4: National Results from the MSA-Level Affordability Median New Home Price Analysis - Price and Household Affordability Effects - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home

		Option 1	Option 2	Option 3	Option 4
Weighted Average Baseline Median New Home Price[a]		$355,893	$355,893	$355,893	$355,893
National Average Price Change per New Single-Family Home[b]	Price Change[b]	$59	$2,231	$4,093	$415
	Percent Change[c]	0.02%	0.63%	1.15%	0.12%
Number of Households Whose Purchasing Decision for a New Single-Family Median Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices	Number of Households	239	9,757	17,222	1,667
	As % of SF home buyers qualifying for the new, option-in-scope, median-priced home	0.03%	1.05%	1.86%	0.18%
	As % of SF home buyers qualifying for the median-priced home	0.01%	0.30%	0.53%	0.05%
Number of Affected Households (from above), Adjusted to Account for Estimated Number of Households That Have the Ability to Increase Housing Payments and Still Remain Under 29% Housing Payment-to-Income Ratio	Number of Households	69	2,992	5,259	480
	As % of SF home buyers qualifying for the new, option-in-scope, median-priced home	0.01%	0.32%	0.57%	0.05%
	As % of SF home buyers qualifying for the median-priced home	<0.00%	0.09%	0.16%	0.01%

[a] This value, the weighted average based on the number of households and home prices across MSAs, is not directly used in the analysis; it is presented here for reference only.
[b] These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.
[c] The national average percent change in home price is estimated using the national average price change and the weighted-average home price across all MSAs.
EPA Estimates

Table 2-5 shows the effect of the estimated national average change in home prices on a typical monthly payment by comparing the baseline and post-compliance monthly payments for each option. For example, the median home price analysis shows increases in monthly payments of $1 for *Option 1*, $16 for *Option 2*, $29 for *Option 3,* and $3 for *Option 4*. In each case, the percentage increase in the monthly payment due to regulatory requirements is low – for example, 0.14 percent for Option 4.

Table 2-5: National Results from the MSA-Level Affordability Median New Home Price Analysis - Change in Monthly Mortgage Payment

		Option 1	Option 2	Option 3	Option 4
Weighted Average Baseline Monthly Mortgage Payment[a]		$1,953	$1,953	$1,953	$1,953
Weighted Average New Monthly Mortgage Payment[a]	Monthly Payment	$1,954	$1,969	$1,982	$1,956
	Percent Change	0.02%	0.80%	1.45%	0.14%

a These values are weighted by the number of households within each state.
EPA Estimates

The marginal affordability effects for likely buyers of newly constructed, single-family homes – in this case, a median price home – as illustrated in *Table 2-4* and *Table 2-5*, do not mean that these households would be unable to afford a single-family home, or even not be able afford the exact same new single-family home. Any potentially affected home buyer has a number of ways to mitigate any price increase due to the regulation, such as purchasing an existing home. See *Section 8.5*, at page 8-11, for a description of all of these options.

Another option, referred to as the *purchase deferment* option, is when the purchaser delays the home purchase long enough to save the requisite increase in the down-payment. Depending on a household's income and the amount of time over which the household saves the additional funds, the impact on a given household's disposable income will vary. For example, *for any given amount to be saved*, the fraction of income that would have to be set-aside over a 3-month period is twice the fraction of income set-aside if savings are accrued over a six-month deferment period.[3]

Table 2-6, below, presents the fraction of household income required to be saved, to offset the effect of the regulation on the monthly mortgage payment via an increase in the initial down-payment. The table shows the savings over 3, 6, and 12 month periods. In each case, the income used in the calculation is the income at which the prospective home buyer would just be able to purchase the home at the baseline price under conventional financing criteria. The results show, for example, that under Option 4, a household would need to set-aside 0.9% of its income over a 6-month period to offset the regulation's effect on the mortgage payment. The fraction of income required to be saved decreases, *for any savings time period*, for households that earn income in excess of this minimum income requirement. Therefore, the required increases in down payment in this table are overstated to the extent that the income of households interested in purchasing the median price home exceeds the minimum income threshold value.

Table 2-6: National-Level Change in Down-Payment Required to Offset Effect of the Regulation for the Median Home Price

	Baseline	Option 1	Option 2	Option 3	Option 4
Income necessary to pay baseline mortgage PITI[4]	$97,695				
Required increase in down payment to offset regulation price effect	$0	$60	$2,234	$4,098	$416
Percent of income required to be saved to accumulate marginal increase in down payment over:					
12 months	0.0%	0.1%	2.3%	4.2%	0.4%
6 months	0.0%	0.1%	4.6%	8.4%	0.9%
3 months	0.0%	0.2%	9.1%	16.8%	1.7%
EPA Estimates					

2.4 Social Cost of the Final Rule

The total social cost of the regulation is comprised of (1) the quantity-adjusted resource cost of compliance, (2) the additional welfare loss to society due to the construction market effect of the regulation, and (3) government administrative costs for reviewing and processing discharge monitoring reports (DMR). Note that the government administrative costs are also reported in *Table 2-10* as part of the UMRA analysis. The results of the social cost analysis are presented in *Table 2-7*.

For the *Option 4,* the total social cost is approximately $959 million with the total dead weight loss under $1 million (approximately $150,000). For comparision, other regulatory options considered have estimated social costs of $176 million, $4.86 billion, and $9.08 billion, respectively, for Options 1, 2, and 3.

[3] With no allowance for interest earned on the savings during the accumulation period.

[4] Principal, Interest, Taxes, and Insurance

Table 2-7: Total Social Cost of the Final Regulation, ($millions)

	Option 1	Option 2	Option 3	Option 4
Total Costs, Adjusted for Quantity Effect	$176	$4,856	$9,059	$952
Total Costs, Unadjusted for Quantity Effect	$176	$4,866	$9,090	$953
Change in Costs Due to Quantity Effect	$0.01	$10	$31	$0.29
Additional Social Welfare Loss	$0.0	$5.0	$15.5	$0.15
Government Administrative Cost for DMR Processing	$0.0	$2.2	$6.2	$6.2
Total Social Cost of the Regulation	$176	$4,863	$9,081	$959
Total Acreage Incurring Cost	852,615	851,253	850,249	852,418

EPA Estimates

2.5 Economy-Wide Output and Employment Effects of the Final Rule

The analysis of total output and employment effects is intended to account for inter-industry linkages in the national economy by estimating the magnitude of output and employment changes derived from both the resource cost of compliance, the direct change (contraction) in C&D industry output, and the output and employment effects resulting from administrative costs associated with activities performed by Federal, State, and Local governments (government costs are described in *Chapter 14)*. EPA used the Input-Output Modeling System (RIMS) multipliers from the Bureau of Economic Analysis (BEA) to estimate the total economic effects of the regulation on the overall U.S. economy. The results are presented in *Table 2-8*.

It is important to emphasize that the total output and employment effects, whether derived from resource cost outlays or the change in C&D industry output, are *not costs in addition to* the social cost of the rule. The reported output and employment effects are manifestations of the rule's social cost.

Table 2-8: Total Economic Output and Employment Effects, ($millions)

	Option 1	Option 2	Option 3	Option 4
Output Effects				
Total Change in Economic Output Arising from Compliance Cost Outlays	$529	$14,608	$27,253	$2,865
Change in C&D Industry Output	($39)	($1,621)	($2,786)	($269)
Total Change in Economic Output from Reduced C&D Industry Output	($127)	($5,241)	($9,009)	($869)
Total Change in Economic Output Arising from Government Cost	$0	$7	$19	$19
Total Effect on Total Economic Output	**$401**	**$9,373**	**$18,263**	**$2,015**
Employment Effects				
Total Change in Employment Arising from Compliance Cost Outlays (jobs)	3,296	91,071	169,908	17,861
Direct Employment Effect from Reduced C&D Industry Output (jobs)	(83)	(3,370)	(5,802)	(560)
Total Change in Employment from Reduced C&D Industry Output (jobs)	(988)	(40,612)	(69,810)	(6,734)
Total Change in Employment Arising from Government Cost (jobs)	0	60	167	167
Total Effect on Total Employment (jobs)	**2,309**	**50,519**	**100,266**	**11,295**

EPA Estimates

2.6 Regulatory Flexibility Analysis (RFA)

The RFA provides that EPA generally define small businesses according to the size standards established by SBA. Based on SBA's size criteria, EPA estimates that a total of 187,079 firms are in the C&D industry sectors of concern for this regulation. Of this total, EPA estimates that approximately 182,545 firms, or about 98 percent, are defined as small businesses.

Although a large percentage of C&D industry businesses are defined as small business, many of these firms are not likely to complete projects that fall within the coverage size thresholds of the regulatory options considered in this analysis. EPA assessed whether small businesses would likely perform projects of sufficient size to be within the scope of the C&D regulation using concepts described in *Chapter 6* for the firm- and industry-level analysis. This assessment was based on comparing firm annual revenue to the expected annual average return per acre from projects. EPA considers firms that are capable of completing the theoretically easiest of the 144 model project-types (i.e., a 1-acre project over a 3-year duration) to be within the potential scope of a C&D regulation. This capability assessment is performed for each model firm category, and is a function of not only the project size and duration, but also the model firm revenue, acreage intensity, and estimated number of projects ongoing at any one time for each model firm. EPA estimates that a much smaller number of small businesses – approximately 77,115 firms – are capable of performing in-scope projects than the total of small businesses (approximately 182,600) in the total C&D industry.

The impacts of the final regulatory option on small businesses are summarized below:

- For Option 4, EPA estimates that approximately 27,420 small businesses may incur costs, representing about 15 percent of all estimated small businesses in the affected C&D sectors and 36 percent of those small businesses estimated capable of performing the minimal model project (in terms of size and duration) within the scope of the final regulation. EPA estimates that none of these small businesses incur costs exceeding 1 or 3 percent of revenue when the expected increased revenue offset to compliance costs is accounted for in the cost-to-revenue comparison. Without accounting for this cost-pass-through effect, EPA estimates that 230 small firms will incur costs exceeding 1 percent of revenue, but no small firms are expected to incur costs exceeding 3 percent of revenue. In these 27,420 firms, EPA estimates that 135 will potentially incur financial stress as a result of the regulation and 122 would potentially incur negative net business value – an indicator of potential closure. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact are not additive. The number of small businesses estimated to incur financial stress or potential closure, represent approximately 0.07 percent of the total small businesses in the C&D sectors and about 0.2 percent of those potentially in-scope small businesses.

Overall, EPA estimates the small business impacts of the regulation are not substantial on the basis of the slight percentages of total small businesses and estimated small businesses that would potentially be adversely affected by the regulation. Although EPA estimates that Option 4 may cause approximately up to 230 firms to incur costs exceeding 1 percent of revenue, EPA does not judge this impact to be so substantial or so significant as to warrant a SISNOSE finding. The number of affected firms represents a small percentage of all small businesses (0.1 percent) and all small in-scope businesses (0.3 percent) in the C&D industry sectors of concern. The estimated effects relative to the 3 percent of revenue threshold is zero firms. Thus, EPA does not judge the number of adversely affected small businesses to be *substantial*. Moreover, if the expected pass-through of these compliance costs is accounted for in the cost-to-revenue analysis, then the number of adversely affected firms falls to zero under both cost-to-revenue impact thresholds. On this basis, EPA further concludes that the overall adverse impact is *not significant*.

Table 2-9: Summary of Small Business Cost and Impact Analysis for C&D Rule Options

Impact Analysis Concept		Option 1	Option 2	Option 3	Option 4
Resource Cost of Compliance and Affected Acreage and Firms					
Total Costs in Small Businesses ($millions)		$74	$1,498	$3,827	$403
Total Small Business Activity Acreage Incurring Cost		332,981	332,981	332,981	332,981
Number of Small Firms	All Small Firms	182,560	182,560	182,560	182,560
	Small Firms In-Scope	77,115	77,115	77,115	77,115
	Small Firms Incurring Cost	27,420	27,420	27,420	27,420
Small Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact					
Costs Unadjusted for Effect of Cost Pass-Through					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	3,454	11,889	230
	% of All Small Firms	0.0%	1.9%	6.5%	0.1%
	% of Small Firms In-Scope	0.0%	4.5%	15.4%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	1,843	8,106	0
	% of All Small Firms	0.0%	1.0%	4.4%	0.0%
	% of Small Firms In-Scope	0.0%	2.4%	10.5%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	593	3,008	0
	% of All Small Firms	0.0%	0.3%	1.6%	0.0%
	% of Small Firms In-Scope	0.0%	0.8%	3.9%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	60	187	0
	% of All Small Firms	0.0%	0.0%	0.1%	0.0%
	% of Small Firms In-Scope	0.0%	0.1%	0.2%	0.0%
Small Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance					
Small Firms Incurring Financial Stress	Number Incurring Effect	24	1,024	5,112	135
	% of All Small Firms	0.0%	0.6%	2.8%	0.1%
	% of Small Firms In-Scope	0.0%	1.3%	6.6%	0.2%
Small Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)					
Small Firms with Negative Business Value Because of Regulation (Potential Closures)	Number Incurring Effect	25	301	1,007	122
	% of All Small Firms	0.0%	0.2%	0.6%	0.1%
	% of Small Firms In-Scope	0.0%	0.4%	1.3%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

EPA Estimates

2.7 Unfunded Mandates Reform Act Analysis (UMRA)

Table 2-10 reports total compliance and administrative costs estimated to be incurred by Federal, State and Local government entities.

Table 2-10: Total Government Compliance and Administrative Costs ($millions)

	Option 1	Option 2	Option 3	Option 4
Compliance Costs				
Federal	$3.8	$87.1	$166.9	$17.7
State[a]	$8.1	$178.1	$323.0	$35.3
Local[a]	$46.2	$1,022.3	$1,854.0	$202.4
Administrative Costs				
State	$0.0	$2.2	$6.2	$6.2
Total Costs				
Federal	$3.8	$87.1	$166.9	$17.7
State[a]	$8.1	$180.3	$329.2	$41.5
Local[a]	$46.2	$1,022.3	$1,854.0	$202.4

a State and Local compliance costs were split-out from the State and Local total based on the proportion of total project value in state and local governments from Reed Construction Data.

Source: Reed (2008), U.S. Census Bureau's Government Organization (2002), EPA Estimates

Table 2-11 reports the findings from comparing the total compliance and administrative costs with three baseline measures: total government revenue, capital outlay, and capital outlay for construction only. Estimated impacts on *small* government entities are reported within *Chapter 14: Assessing the C&D Regulatory Options in Accordance with Unfunded Mandates Reform Act (UMRA) Requirements*.

Table 2-11: Impacts of Regulatory Option Compliance and Administrative Costs on State and Local Governments ($millions)

	Option 1	Option 2	Option 3	Option 4
State Governments Impact Analysis Concepts				
Total Revenues	1,097,829	1,097,829	1,097,829	1,097,829
Total Costs as % of Total Revenues	0.00%	0.02%	0.03%	0.00%
Capital Outlay	89,919	89,919	89,919	89,919
Total Costs as % of Total Capital Outlay	0.01%	0.20%	0.37%	0.05%
Construction Outlay Only	71,035	71,035	71,035	71,035
Total Costs as % of Total Construction Outlay	0.01%	0.25%	0.46%	0.06%
Local Governments Impact Analysis Concepts				
Total Revenues	1,083,129	1,083,129	1,083,129	1,083,129
Total Costs as % of Total Revenues	0.00%	0.09%	0.17%	0.02%
Capital Outlay	142,209	142,209	142,209	142,209
Total Costs as % of Total Capital Outlay	0.03%	0.72%	1.30%	0.14%
Construction Outlay Only	107,588	107,588	107,588	107,588
Total Costs as % of Total Construction Outlay	0.04%	0.95%	1.72%	0.19%

a State and Local compliance costs were split-out from the State and Local total based on the proportion of total project value in state and local governments from Reed Construction Data.

Source: Reed (2008), U.S. Census Bureau's Compendium of Government Finances (2005c), U.S. Census Bureau's Government Organization (2002), EPA Estimates

2.8 Benefits of the Final Rule

EPA estimated the total benefits under each post-compliance regulatory scenario by summing the benefits estimated for each of four monetized categories. *Table 2-12* presents low, midpoint, and high estimates of benefits under each policy option, consisting of benefits to navigation, water storage, drinking water treatment, and WTP.

Table 2-12 presents benefits for navigable waterway and reservoir dredging calculated using both 3 and 7 percent discount rates. Because the discount rate only applies to two of the four monetized benefits categories, which represent at most 5 percent of total benefits, varying it has little effect on the total benefits estimate. The remaining discussion presents the benefits estimates assuming a 3 percent discount rate; the associated tables present results for both discount rates. EPA calculated benefits for drinking water treatment and WTP for water quality improvements using a single-year timeframe, which did not require discounting or annualizing. All benefits presented reflect annual values.

Total national benefits vary significantly among the three regulatory options. Under Option 1, the estimated benefits range from approximately $59.0 million to approximately $434.3 million, with a midpoint estimate of $214.1 million. Estimated avoided costs range from $3.3 million to $4.1 million, with a midpoint of $3.8 million, and WTP for water quality improvements varies between $55.8 and $430.2 million at the 5 and 95 percent confidence intervals, with a mean estimate of $210.3 million.

For Option 2, the estimated benefits range from $100.5 million to $727.4 million, with a midpoint estimate of $360.1 million. The estimated WTP for water quality improvements from reduced sediment discharges from construction sites under Option 2 ranges from $94.2 to $719.7 million, with a mean value of $352.9 million. Estimated cost savings range from $6.3 million to $7.7 million per year, with a midpoint estimate of $7.2 million.

Under Option 3, total benefits are estimated to be between $118.0 and $852.2 million, with a midpoint estimate of $422.3 million. The avoided costs are estimated to be between $7.7 and $9.4 million per year, with a midpoint estimate of $8.9 million. WTP for water quality improvements under Option 3 ranges between $110.4 million and $842.8 million for the 10th and 90th percentile values, with a mean value of $413.4 million.

Under Option 4, the estimated benefits range from $104.3 million to $742.7 million, with a midpoint estimate of $368.9 million. Benefits estimated based on household WTP for surface water quality improvements account for 93, 98, and 99 percent of total benefits from the regulation in the low, mid, and high estimates, respectively. The estimated WTP for water quality improvements from reduced sediment discharges from construction sites under Option 4 ranges from $97.4 to $734.3 million, with a mean value of $361.0 million. The estimated cost savings to industry and government through reduced costs of navigable waterway maintenance, reservoir dredging, and drinking water treatment range from $6.8 million to $8.3 million per year, with a midpoint estimate of $7.9 million. Under Option 4, avoided cost benefits account for 7, 2, and 1 percent of total benefits in the low, mid, and high estimates, respectively. Because this option requires passive treatment at sites with 10 or more acres of land disturbed and establishes a numeric effluent limit, its benefits are more than double those of Option 1, which does not establish numeric criteria for sediment discharge. It also produces more benefits than Option 2, which requires active treatment of sediment but on fewer sites. Benefits under Option 4 are nearly as high as those under Option 3, which would require active sediment treatment on the same sites where Option 4 requires passive treatment, the latter being less burdensome.

Table 2-12 Total National Benefits by Benefit Category (million 2008$)

Benefit Category	3% Discount Rate			7% Discount Rate		
	Low	Mid	High	Low	Mid	High
Option 1						
Navigation	$1.0	$1.3	$1.3	$1.0	$1.2	$1.3
Water Storage[a]	$1.3	$1.4	$1.5	$1.1	$1.2	$1.4
Drinking Water[a]	$1.0	$1.2	$1.3	$1.0	$1.2	$1.3
Avoided Costs	*$3.3*	*$3.8*	*$4.1*	*$3.1*	*$3.7*	*$4.0*
WTP for Water Quality[a]	$55.8	$210.3	$430.2	$55.8	$210.3	$430.2
Total[b]	**$59.0**	**$214.1**	**$434.3**	**$58.8**	**$213.9**	**$434.2**
Option 2						
Navigation	$2.1	$2.6	$2.8	$2.1	$2.5	$2.7
Water Storage[a]	$2.7	$2.9	$3.0	$2.2	$2.6	$3.0
Drinking Water[a]	$1.4	$1.8	$1.9	$1.4	$1.8	$1.9
Avoided Costs	*$6.3*	*$7.2*	*$7.7*	*$5.8*	*$6.9*	*$7.5*
WTP for Water Quality [a]	$94.2	$352.9	$719.7	$94.2	$352.9	$719.7
Total[b]	**$100.5**	**$360.1**	**$727.4**	**$99.9**	**$359.8**	**$727.2**
Option 3						
Navigation	$2.7	$3.3	$3.4	$2.6	$3.2	$3.4
Water Storage[a]	$3.3	$3.6	$3.8	$2.8	$3.2	$3.7
Drinking Water[a]	$1.7	$2.1	$2.1	$1.7	$2.1	$2.1
Avoided Costs	*$7.7*	*$8.9*	*$9.4*	*$7.0*	*$8.4*	*$9.2*
WTP for Water Quality [a]	$110.4	$413.4	$842.8	$110.4	$413.4	$842.8
Total[b]	**$118.0**	**$422.3**	**$852.2**	**$117.4**	**$421.8**	**$852.0**
Option 4						
Navigation	$2.4	$2.9	$3.0	$2.3	$2.8	$3.0
Water Storage[a]	$3.0	$3.2	$3.4	$2.5	$2.9	$3.3
Drinking Water[a]	$1.5	$1.8	$1.9	$1.5	$1.8	$1.9
Avoided Costs	*$6.8*	*$7.9*	*$8.3*	*$6.3*	*$7.5*	*$8.2*
WTP for Water Quality [a]	$97.4	$361.0	$734.3	$97.4	$361.0	$734.3
Total[b]	**$104.3**	**$368.9**	**$742.7**	**$103.7**	**$368.5**	**$742.5**

[a] These savings were calculated for a one-year timeframe and that did not require discounting, and are equal under both discount rates
[b] Totals may not equal sum of categories due to rounding

EPA Estimates

2.9 Comparison of Total Social Cost and Monetized Benefits

The elements of social cost and monetized benefits and the net monetized benefits are presented in *Table 2-13*.

Anticipated social costs are greater than the monetized benefits for all options, except Option 1 – although Option 1 benefits are substantially less than any of the other three options. It is important to emphasize once again that *Chapter 11* discusses several other classes of benefits that could not be monetized but are likely to provide real social benefits, and therefore, the estimate of monetized benefits is not as complete an estimate as that of total social cost.

Total social costs include:

- The quantity-adjusted resource cost of compliance to the private sector and to governments;
- The additional social welfare loss due to construction market effects; and,
- Government administrative costs for reviewing and processing discharge monitoring reports (DMR) and other start-up costs.

The reduction of sediment and other pollutants entering surface waters from construction sites as a result of the C&D regulation will have a wide range of market and nonmarket benefits, as described in *Chapter 11*. As noted previously in *Chapter 11* and emphasized here, EPA's estimate of total monetized benefits does not represent the full-range and magnitude of benefits expected from this rule because certain categories of benefits are not able to be monetized.

Total estimated monetized benefits include:

- Benefits to navigation;
- Benefits to water storage;
- Benefits to drinking water treatment; and,
- Willingness-to-pay for water quality improvements.

Table 2-13: Comparison of Social Costs and Benefits ($millions)

	Option 1	Option 2	Option 3	Option 4
Social Costs				
Resource Cost of Compliance	$176	$4,856	$9,059	$952
Government Administrative Cost	$0.0	$2.2	$6.2	$6.2
Additional Social Welfare Loss	$0.0	$5.0	$15.5	$0.15
Total Social Cost of the Regulation	$176	$4,863	$9,081	$959
Monetized Benefits[a]				
Benefits to Navigation	$1.3	$2.6	$3.3	$2.9
Benefits to Water Storage	$1.4	$2.9	$3.6	$3.2
Benefits to Drinking Water Treatment	$1.2	$1.8	$2.1	$1.8
Avoided Cost	*$3.8*	*$7.2*	*$8.9*	*$7.9*
Water Quality Benefits	$210.3	$352.9	$413.4	$361.0
Total Monetized Benefits[b]	**$214.1**	**$360.1**	**$422.3**	**$368.9**
Net Benefit (Benefits minus Cost)	**$38**	**-$4,503**	**-$8,659**	**-$590**

[a] Based on a 3% social discount rate, (see *Chapter 11)*.

Totals may not sum due to rounding

Source: EPA Estimates

3 Economic Profile of the Construction and Development Industry

3.1 Introduction to the C&D Industry Profile

The Construction and Development (C&D) industry plays an integral role in the nation's economy, contributing approximately five percent of Gross Domestic Product. Furthermore, approximately 10 percent of the nation's nearly 7 million total business establishments are in the C&D industry, demonstrating the dominance of small firms in this industry. The number of paid employees in the C&D industry accounts for 6.6 percent of total U.S. employment (U.S. Census Bureau, 2005a). Establishments in this industry are involved in a wide variety of activities, including land development and subdivision, homebuilding, remodeling, construction of nonresidential buildings and other structures, and heavy construction work (including roadways and bridges). Establishments are also involved in a myriad of special trades, such as plumbing, roofing, electrical, excavation, and demolition work. Some of these activities result in land disturbance, which can cause erosion and transport soil and sediment in stormwater runoff. The regulatory options presented in this economic analysis report address these concerns.

Several characteristics of the C&D industry affect the structure of this economic analysis:

- Residential construction represents a large percentage of construction industry activity. Approximately 50 percent of the establishments included within the following analysis are residential contractors. In addition, approximately 32 percent of the total value of construction comes from residential construction. Therefore, individuals (e.g., homebuyers) are often the direct customers of the C&D industry. With residential housing representing a substantial share of total C&D industry activity, it is important to understand the potential effect of the C&D regulation on housing prices and housing affordability.
- Developers and builders work under a range of relationships in performing construction services. For example, developers may undertake all site improvements and sell completed lots directly to builders, or act as builders themselves and remain onsite to build out the development, or some combination of the two. Thus, both developers and builders may be the parties that are directly subject to the C&D regulation's compliance requirements.
- The C&D industry includes a very large number of small businesses. Therefore, EPA carefully considered the impacts on small businesses in accordance with RFA requirements in developing the options considered for this regulatory proposal and in choosing the option for proposal. As reported in *Section 3.3.3* of this chapter, EPA estimates that 95 percent or more of the firms in the C&D industry are small businesses according to Small Business Administration criteria.
- C&D activities are undertaken in markets in which business conditions vary substantially both over time and space. Furthermore, these regional variations in business conditions can persist for several years because of the immobile and long-lived character of the C&D industry's output product. Some factors affecting business conditions in C&D markets are national in character – e.g., interest rates and overall performance of the national economy – while other factors are more local in character – e.g., differences in regional economic and population growth patterns, differences in performance of sectors that are regionally concentrated, and the character of the supply/demand balance in a given local market. The highly local and varying character of C&D markets means that the economic analysis for the C&D regulation must account for these variations in market conditions, both over time and across local markets.

- Under the standard C&D industry definitions, the industry includes a large number of establishments primarily engaged in remodeling activities and special trades (e.g., plumbing, electrical). These establishments, however, are less likely to be involved in land-disturbing activities and thus are not likely to be subject the C&D regulation's requirements. *Chapter **4*** describes in more detail the breakout of the entities within the C&D industry that would either not engage in land-disturbing activities or would not be an NPDES permittee or co-permittee. Since these entities are not likely to be affected by this regulation, they will not be included in the cost and economic impact analysis for the C&D rule.
- The C&D regulation will apply only to activities that occur on land in the United States. Accordingly, competition from production of C&D industry products in international markets is not important for analyzing the impacts of this rule. If international firms engage in C&D production activities on U.S. land, they will be subject to the C&D regulation in the same way as U.S. firms and can gain no competitive advantage from a different level of regulation in their home countries. Similarly, any requirements applicable to U.S. firms in their domestic operations will not apply to their production activities in other countries. As a result, the C&D regulation will not affect U.S. firms' competitiveness in supplying their products in foreign countries.
- Since late 2006, residential construction has experienced a slowdown in housing starts: 2005 was a peak year for residential construction but the sector subsequently experienced a substantial contraction in activity due to decreased housing affordability and over-building. The residential construction sector appears now to be recovering from this sharp contraction, with housing starts and new home sales having hit bottom in mid to early 2009 (Global Insight, July 2009). On the other hand, while nonresidential construction remained on a positive growth trend during the housing downfall, this sector is currently experiencing a decrease in activity due to the weak economy, overbuilding of the lodging and retail sectors, and tightened credit practices (AIA, 2009). The nonresidential sector is expected to turn around in late 2010, when the building excesses have fallen and the U.S. economy is more stable (Global Insight, August 2009). Overall, the construction industry is expected to experience relatively flat growth in 2010, with a 1.6 percent increase or 1 percent decrease in total construction spending according to Reed and Global Insight, respectively (Reed, August 2009d; Global Insight, July 2009).

3.1.1 Defining the C&D Industry

The C&D industry, as defined for this rule, is comprised of three main industry groups.

1. Construction of buildings
   - Residential: single-family, multifamily, remodelers, and operative construction
   - Non-Residential: industrial and commercial/institutional building construction
2. Heavy and civil engineering construction
3. Specialty trade contractors: excavation contractors, wrecking and demolition contractors, and all other heavy construction.

Of these three industry groups, only the first two are likely to engage in land-disturbing activities and could be an NPDES permittee or co-permittee, and thus be within the scope of the final C&D rule. Furthermore, within the building construction category, residential remodelers are *not* included as a category that would be likely to engage in land-disturbing activities. EPA is concerned with stormwater runoff from construction sites, which carries sediment (and potentially metals and nutrients) into receiving waters, impairing water quality. These activities include site clearing or site preparation activities, such as tree removal, excavation, blasting, scraping, grading, etc. These activities can destabilize soils and create conditions that allow stormwater to accumulate and flow across the site. This increase in stormwater flow can cause erosion and lead to the transport of soil particles and attached pollutants, which eventually can be conveyed offsite and discharged into receiving waters. Both the increased flow and associated pollutant and sediment loads that result from land-disturbing activities can negatively impact the biological, physical, and chemical characteristics of the receiving waters.

EPA believes that many establishments in North American Industry Classification System (NAICS) 236 (*Construction of Buildings*) and NAICS 237 (*Heavy and Civil Engineering Construction*) are likely to engage in such activities on a regular basis. However, as described above and within *Chapter* ***4***, although establishments within selected five-digit industries that are part of NAICS 238 (*Specialty Trade Contractors*) could engage in land-disturbing activities[5], they are generally contracted by the NPDES permit holder and therefore will not be directly affected by the final regulation. *Table 3-1* lists the industry groups whose activities will likely be within the scope of the regulation. *Table 3-1* lists these industry groups according to the 2002 NAICS framework and with the correspondence to the previous 1997 NAICS framework. As described below, changes in the NAICS framework definitions between 1997 and 2002 affect the analysis of industry data over time and the ability to merge data from separate sources.

[5] Namely, NAICS 23593 (*Excavation Contractors*), 23594 (*Wrecking and Demolition Contractors*), and NAICS 23499 (*All Other Heavy Construction: Construction Equipment Rental with Operator and Right-Of-Way Clearing and Line Slashing, Blasting, and Trenching Contractors*) (all 1997 classifications).

Table 3-1: Industry Definitions for C&D Industry Profile

2002 NAICS	Description	Relevant 1997 NAICS
236	**Construction of buildings**	
2361	Residential building construction	
236115	New single-family general contractors	233210 Single-family housing construction (general contractors)
236116	New multifamily general contractors	233220 Multifamily housing construction (general contractors)
236117	New housing operative builders	233210 Single-family housing construction (operative builders) 233220 Multifamily housing construction (operative builders)
2362	Nonresidential building construction	
236210	Industrial building construction	233310 Manufacturing and industrial building construction (Other manufacturing and industrial building construction) 234930 Industrial nonbuilding structure construction (Other industrial nonbuilding construction) 234990 All other heavy construction (waste disposal plant)
236220	Commercial and institutional building construction	233220 Multifamily housing construction (barrack and dormitory) 233310 Manufacturing and industrial building construction (grain elevators, dry cleaning plants, and manufacturing and industrial warehouses construction) 233320 Commercial and institutional building construction 235990 All other special trade contractors (indoor swimming pool)
237	**Heavy and civil engineering construction**	
2371	Utility system construction	
237110	Water and sewer line and related structures construction	234910 Water, sewer, and pipeline construction (water and sewer line, mains, and related structures (including pumping stations, etc.) construction 234990 All other heavy construction (sewage and water treatment plants and irrigation systems construction 235810 Water well drilling contractors
237120	Oil and gas pipeline and related structures construction	213112 Support activities for oil and gas operations (partial) 234910 Water, sewer, and pipeline construction (Oil and gas pipelines, mains, and related structures (including oil storage)) 234930 Industrial nonbuilding structure construction
237130	Power and communication line and related structures construction	234920 Power and communication transmission line construction 234930 Industrial nonbuilding structure construction (power generation plants and transformer stations, except hydroelectric)
2372	Land subdivision	
237210	Land subdivision	233110 Land subdivision
2373	Highway, street, and bridge construction	
237310	Highway, street, and bridge construction	234110 Highway and street construction 234120 Bridge and tunnel construction (bridge construction) 235210 Painting and wall covering contractors (highway and traffic line painting contractors)
2379	Other heavy and civil engineering Construction	
237990	Other heavy and civil engineering Construction	234120 Bridge and tunnel construction (tunnel construction) 234990 All other heavy construction (all other heavy and civil engineering construction 235990 All other special trade contractors (anchored earth retention)

Source: U.S. Census Bureau (2007a)

As shown in *Table 3-1*, each 2002 NAICS industry includes one or more industry groups defined under the former 1997 NAICS industry codes. For the 2002 Economic Census, the Census Bureau redefined the NAICS code structure for certain C&D industry segments, making direct comparisons between the 2002 and 1997 Economic Census data not straightforward. Furthermore, in the 1997 Economic Census, the Census Bureau switched from reporting data on a Standard Industrial Classification (SIC) basis to a NAICS basis, adding to the difficulty of comparing data from 2002 and 1997 with that from the 1992 and earlier Economic Census-reporting periods. Within this economic profile, the objective is to provide data at the most detailed level possible, while still maintaining the ability to provide meaningful comparisons between 2002 and earlier Economic Census periods.

With this goal in mind, EPA identified and characterized the specific industry segments that meet the criteria of performing land development and disturbance activities that are within the scope of the final regulation and that will be subject to regulatory requirements based on the NPDES permitting process. The presentation in this chapter and in *Chapter **4*** of this regulatory analysis attempts to achieve consistency of data over the three reporting frameworks covering the C&D industry data over this time frame. In some instances, the adjustments to support comparisons involve estimations and reclassifications that are likely to contain an unknown degree of error.

As a result of these adjustments, the NAICS segments covered in this regulatory analysis include:

- NAICS 236 – *Construction of buildings (all subsectors except residential remodelers)*
- NAICS 237310 – *Heavy and civil engineering construction*[6]

3.1.2 Key Data Sources

This profile uses several data sources to characterize the C&D industry. The primary data source is the 2002 Economic Census, conducted every five years by the U.S. Census Bureau. EPA would have preferred to rely on data from a more recent year than 2002; however, the 2002 data remain the most current Economic Census data at the time of this writing, as the 2007 data were only beginning to be released and comprehensive data was not available. The U.S. Small Business Administration (SBA) and Census Bureau also provide important information in Statistics of U.S. Business (SUSB). SUSB provides firm-level data that is particularly important for the firm and industry impact assessment and for the small entity analysis (the Economic Census data is reported at the level of the construction establishment, not the firm). *Table 3-2*, below, compares the Economic Census and SBA data to further clarify the differences and identify how each data source is used in this regulatory analysis. To a large degree, this chapter relies on data from the 2002 Economic Census to profile the C&D industry, since that source provides a greater level of detail on industry characteristics.

Table 3-2: Comparison of Major Data Sources

	Economic Census	SBA
Level of Detail	Establishment[a]	Firm[b] and establishment
Source of Data	Survey (sent to approximately 130,000 establishments from a universe of 650,000)	SUSB report, which relies on administrative records data
How the Data are Applied in this Analysis	Industry-level analysis to determine the number of potentially affected establishments	Firm- and industry-level analysis, and also for determining the number of potentially affected firms considered “small” by SBA size standards

[a] The Census Bureau defines an establishment as “a relatively permanent office, or other place of business, where the usual business activities related to construction are conducted” (U.S. Census Bureau, 2005a).
[b] The Small Business Administration defines a firm as “the aggregation of all establishments owned by a parent company (within a geographic location and/or industry) that have some annual payroll.” (U.S. SBA, 2004). Therefore, one firm could comprise several establishments.

3.1.3 Key Insights into the Current and Future State of the C&D Industry

Overall, the Construction and Development industry has shown a substantial increase in the number of establishments and employees over the past 10 years. Although some segments of the industry are experiencing substantial economic weakness during the near term – due to weakness in residential housing markets, difficult credit markets, and weakness in the general economy – total economic activity and economic/financial

[6] EPA anticipates that some businesses and activities in the *Heavy Construction* sector (NAICS 237) will be affected by the C&D rule. However, with the exception of NAICS 237310 (*Highway, street, and bridge construction*), data are not available to support an assessment of the number and character of projects performed by NAICS 237 sector businesses that would be subject to compliance requirements and incur compliance costs. For this reason, of the sectors in NAICS 237, only NAICS 237310 (*Highway, street, and bridge construction*) is considered in the cost and impact analysis for the C&D rule.

performance in the industry is projected to remain strong over the longer term. Department of Labor projections indicate the industry will add approximately 1 million new construction jobs between 2002 and 2012 (U.S. Department of Labor, 2006).

SBA data on births and deaths of establishments and employment also show that the number of establishments and employees has generally grown over the past 10 years. At the same time, the industry has experienced periods of economic weakness, with year-to-year losses in establishments in 2001/2002, employees in 1999/2000, and in both establishments and employees in 2000/2001. This period of sector weakness reflects the overall weakness of the U.S. economy in the period, leading up to and through the short recession of 2002. More recently (2006/2008), the housing-related segments of the C&D industry are in a period of substantial business weakness, resulting in large part from an aggressive pace of new construction, fueled in part by low interest rates and "easy credit" from 2003 to 2007, followed by housing supply growth outpacing demand growth in a substantial number of U.S. markets. The current weakness accelerated during 2007 as the result of a tightening in residential financing terms and the deterioration of credit markets and the general economy in 2008. The consequent slow-down in residential construction caused a substantial weakening of business performance for C&D businesses whose activity is concentrated in the residential market.

Regionally, the decline in the housing market was most evident in the Southwest, Florida, and some areas in the Northeast. In California, Florida, Nevada, Arizona and Massachusetts, large home price increases were a major factor underlying a surge of new and existing home inventory; the inventory surge was followed by price declines. Florida and Nevada also experienced the largest decrease in new housing starts from 2005 to 2007, dropping approximately 58 and 47 percent, respectively. Currently, the residential market is now experiencing a return to positive growth with housing starts and new home sales both increasing over the recent months. Global Insight projects positive growth in spending, starts, and sales for 2010, with housing starts reaching their long term trend of approximately 1.7 million starts in 2013/2014.

During the slowdown in residential construction, non-residential construction had continued to achieve moderate business performance and growth. This performance in non-residential construction had partially offset the decline in the residential sector. Since the cyclical low in non-residential construction in 2003, this sector remained relatively flat until the end of 2005 when a steady recovery began. Retail construction (generally coinciding with residential construction trends) continued to have strong growth until mid-2007, even with residential construction beginning to decline during 2006. The lodging sector, although very cyclical, saw a sharp increase in growth from 2005 until mid-2007. And, in general, healthcare construction also experienced strong growth in 2006. However, recently the nonresidential market has experienced weakness due to overbuilding, tight credit markets, and increased vacancy rates. Following this decline, this sector is expected to return to positive growth in late 2010 (Global Insight August 2009).

A key consideration for the analysis of the final rule concerns the extent to which any rule-related increase in construction costs will be passed through to consumers of the C&D industry. A number of market factors will influence the extent to which construction cost increases will be passed through to consumers at a given point in time, in a given market segment (e.g., commercial real estate vs. residential real estate), and in a given location. In general, elasticities of supply and demand in a market will influence the extent of cost pass-through. Many factors contribute to the relationship between supply and demand elasticities and overall market conditions in a given market and at a given point in time. These factors include general economic factors – *for example, monetary and credit conditions, condition of the overall economy, etc.* – and factors that are more local in character – *for example, regional economic strength; extent to which a particular market has seen a substantial recent increase in supply in a particular real estate segment, which has exceeded the underlying strength in demand, etc*.

Currently, the national residential real estate housing market is recovering from a period of considerable weakness, due, as described above, to several factors, including "over-building" in some markets through the middle of the decade, tightened credit terms after several years of loose financing, increased supply of existing housing from foreclosures, and more recently, general economic weakness. In earlier years of the decade, the loose credit terms supported substantially increased housing prices and expansion of housing supply. When the issues stemming from loose credit terms began to manifest – in particular, loan defaults and foreclosures – credit terms tightened considerably and foreclosures increased the supply of housing available for sale. The tightened credit terms worked to reduce demand at the same time that foreclosures and over-building were substantially increasing supply. Coupled with the general downturn in the economy, the resulting effect on the residential construction sector was inevitably substantial.

Currently, the residential market appears overall to be stabilizing and beginning to recover – in terms of both housing sales and pricing, and in new home construction; however, the extent of residential market improvement varies substantially over specific regional and local markets. As noted above, markets in the Southwest, Florida and some areas of the Northeast experienced relatively greater price and sales volume weakness. Residential market recovery and increased home construction will likely occur later in such areas. At the same time, some markets that experienced less growth in supply and prices (e.g., parts of the Southeast and Pacific Northwest), experienced much less of a fall-off in prices and sales volume. Such markets will likely see an earlier up-turn in home construction.

In those markets with greater weakness in prices and sales volume, there is a greater likelihood that near-term increases in construction costs may be not be fully passed through to customers. In these instances, increased construction costs may be absorbed by the owners of the undeveloped land, project developers, and the builders of new construction. Based on recent forecasts by real estate industry analysts (e.g., Global Insight), however, the housing sector is beginning recovery, with housing starts now rising given the reduction in the inventory of unsold homes and increased new home sales due to recently improved housing affordability due to lower home prices and lower cost for home financing. Thus, it is reasonable to expect that market conditions will adjust to any changes in construction costs and that regulation-induced cost increases will become part of the "new equilibrium" and will be substantially passed through in prices to consumers.

Similar considerations will apply to other segments of real estate markets (e.g., commercial real estate) whose supply costs may be affected by a C&D regulation. Although the industrial/commercial segments recorded relatively stronger business performance than the residential segment over the past few years, the industrial/ commercial segments may now be entering a downturn that could leave these segments weaker overall than the residential segment during the initial period in which the C&D rule will be implemented. Therefore, in these segments, the likelihood that cost increases might not be so strongly recovered in increased prices would increase.

As described in the final part of this chapter (*Section 3.4: Industry Dynamics and Forecast*, page 3-40), overall, the construction industry is expected to see flat growth over the next year, due in particular to the effect of general economic weakness on the nonresidential market, regardless of the increase in residential construction activity. Housing starts, a good indicator of the strength of the residential sector, appear to have hit bottom in mid 2009 and have been gradually improving, although with some month-to-month irregularity. Non-residential spending, which often lags the residential sector, is expected to see declines in private non-residential building through 2010. Furthermore, the non-building sector (which are largely publicly-funded projects) is expected to see relatively flat growth until later in 2010, when much of the economic stimulus package goes into effect. In short, the industry is expected to achieve relatively flat growth over the next year but positive business performance over the longer-term, beginning around 2011. Given this outlook, EPA judges that the construction industry will achieve a sufficient recovery to sustain the compliance costs of the C&D rule without substantial economic/ financial burden during the period in which compliance with the regulation would begin.

3.1.4 Organization of the C&D Industry Profile

The purpose of this profile is to provide an overview of the C&D industry, describe its key characteristics and structure, and analyze current and historical trends. *Section 3.1* presents key findings concerning the C&D industry and the potential economic/financial impact of the final regulation. *Section 3.2* includes a summary of recent trends regarding the industry characteristics and the industry's financial condition. *Section 3.3* presents detailed characteristics of the C&D industry, including both industry and firm-level data. *Section 3.4* covers the industry economic and financial outlook.

3.2 Recent Trends in the C&D Industry

This section reviews recent trends in the number of establishments, firms, and employees in the C&D industry and in the value of construction by key activity segments. Overall, these data show that the industry has grown substantially over the past 10-15 years in terms of total value of business performed. However, the data also show that the various segments of the industry have experienced periods of weakness with brief declines in value of business performed. These periods of weakness don't necessarily occur simultaneously in all segments of the industry. Declines in commercial real estate occurred during the earlier years of the current decade while residential real estate construction was growing strongly. Currently, the residential segment is experiencing weakness while the commercial segment remains relatively strong.

3.2.1 Establishments by C&D Industry Segment

Table 3-3 and *Table 3-4* present the number of C&D establishments in 1992, 1997, and 2002. Between 1992 and 1997, the number of C&D industry establishments with payroll increased 12.8 percent, from 214,435 to 241,840. Between 1997 and 2002, the number of establishments with payroll increased an additional 8.2 percent to 261,585 (see *Table 3-3* and *Table 3-4*). However, the modest increase in total number of establishments masks some significant offsetting changes in establishment counts among groups within the industry as defined by NAICS.

These data are reported below in two tables that distinguish between the different 1997 and 2002 NAICS frameworks.[7] The 1997 NAICS framework reported the *All Other Heavy Construction* category as NAICS 23499, and thus as a part of the NAICS 234 3-digit sector. The 2002 NAICS framework reassigned the 1997 *All Other Heavy Construction* category over three different 3-digit sectors: NAICS 236 (*Construction of Buildings*), NAICS 237 (*Heavy and Civil Engineering Construction*), and NAICS 238 (*Specialty Trade Contractors*). To facilitate comparisons of activity data over the period 1992-2002, *Table 3-3* maintains the 1997 grouping method in displaying the 2002 data – that is, the *All Other Heavy Construction* categories data within 2002 NAICS 236, 237, and 238 were reassigned back into their 1997 classification of NAICS 234990. *Table 3-4* displays the data according to the NAICS framework definitions applicable during each reporting period – that is, for 1992 and 1997, *All Other Heavy Construction* remains within NAICS 234; for 2002, this sector is reported in NAICS 236 and 237. The two different classifications in these tables result in offsetting differences in the values for NAICS 237 in 2002.

7 This profile uses the 2002 NAICS framework. Since the 2002 NAICS classification reassigned the *Specialty Trade Contractors* section, some 1997 classifications have been used to further divide this section. *Appendix 2-1* at the end of this chapter provides a cross-walk to the complete 2002 NAICS classifications for the C&D industry. The Census Bureau classifies industries according to the North American Industry Classification System (NAICS). Under NAICS, economic activity is divided into twenty broad two-digit industry codes. One of these is Construction (NAICS 23), which is further divided into three-, four-, five-, and six-digit levels, as described in this chapter.

The summaries below are derived from the data in *Table 3-3*, which provides the more consistent comparison of establishment counts by NAICS sector over the full analysis period. However, the rest of the data reporting and analysis in this chapter will be derived from the current NAICS framework.

- The number of establishments in the *Land Subdivision* industry group (NAICS 2372) *decreased* by 7.5 percent between 1992 and 1997 and *increased* by 2.7 percent between 1997 and 2002.
- Between 1992 and 1997, the number of establishments in *Residential and Nonresidential Construction* (NAICS 236) *increased* by 13.5 percent. The number of establishments *increased* by another 10.7 percent between 1997 and 2002.
- The number of establishments in *Heavy Construction increased* by 14.5 percent between 1992 and 1997 and continued to *increase* by 16.2 percent from 1997 to 2002.

Table 3-3: Number of Establishments in the C&D Industry, 1992, 1997, and 2002, Economic Census Data

2002 Data Grouped by 1997 Categories						
NAICS	**Description**	**1992**	**1997**	**2002**	**Percent Change 1992-1997**	**Percent Change 1997-2002**
236	Construction of Buildings, except All other Heavy Construction[a]	168,407	191,101	211,629	13.5%	10.7%
237, except 237210	Heavy construction, except Land Subdivision	37,180	42,554	49,433	14.5%	16.2%
237210	Land Subdivision	8,848	8,185	8,403	-7.5%	2.7%
TOTAL		**214,435**	**241,840**	**269,465**	**12.8%**	**11.4%**

[a] In the 2002 NAICS classification framework, *All Other Heavy Construction* was assigned among NAICS 236, 237, and 238. To maintain relevant comparisons, 2002 *All Other Heavy Construction* data were reassigned back into NAICS 237 (*Heavy Construction*). Since residential remodelers are not broken out in the 1997 and 1997 frameworks, they are included in these counts (although not presented in the proceeding analysis).
Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a)

Table 3-4: Number of Establishments in the C&D Industry, 1992, 1997, and 2002, Economic Census Data

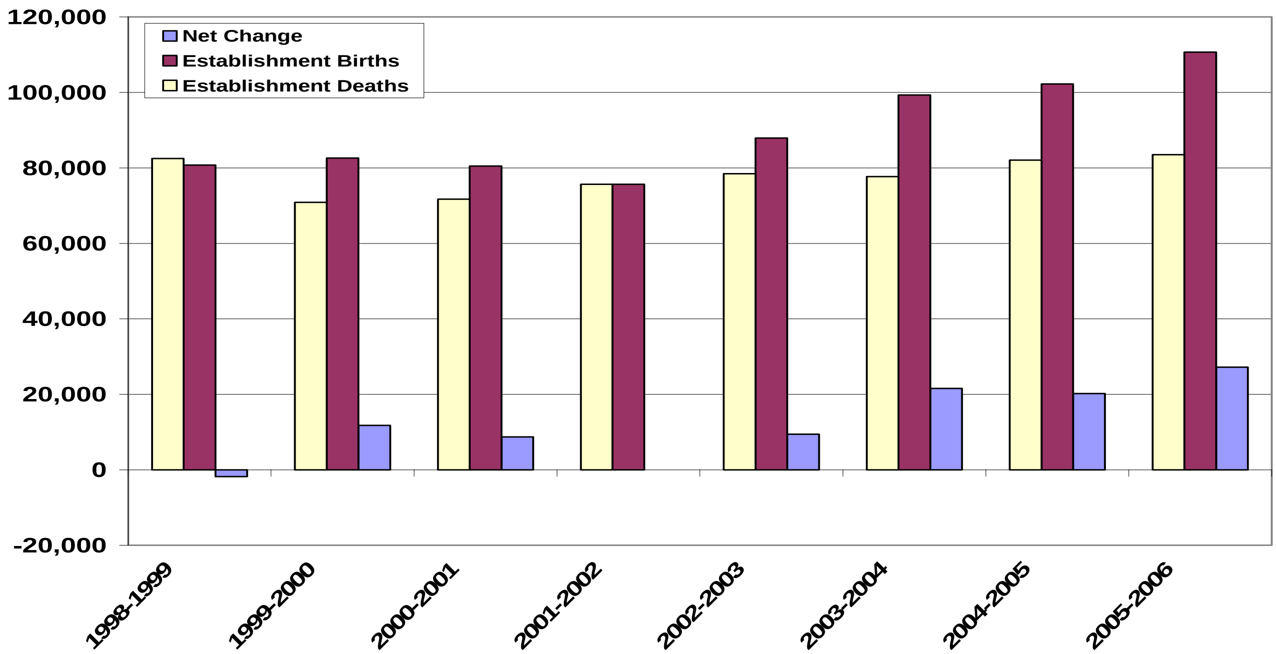
Data Grouped by Corresponding Year's Standards						
NAICS	**Description**	**1992**	**1997**	**2002**	**Percent Change 1992-1997**	**Percent Change 1997-2002**
236	Construction of Buildings[a]	168,407	191,101	211,647	13.5%	10.8%
237, except 237210	Heavy construction, except Land Subdivision	37,180	42,554	41,535	14.5%	-2.4%
237210	Land Subdivision	8,848	8,185	8,403	-7.5%	2.7%
TOTAL		**214,435**	**241,840**	**261,585**	**12.8%**	**8.2%**

[a] Since residential remodelers are not broken out in the 1997 and 1997 frameworks, they are included in these counts (although not presented in the proceeding analysis).
Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a)

3.2.2 Establishment and Employment Births and Deaths

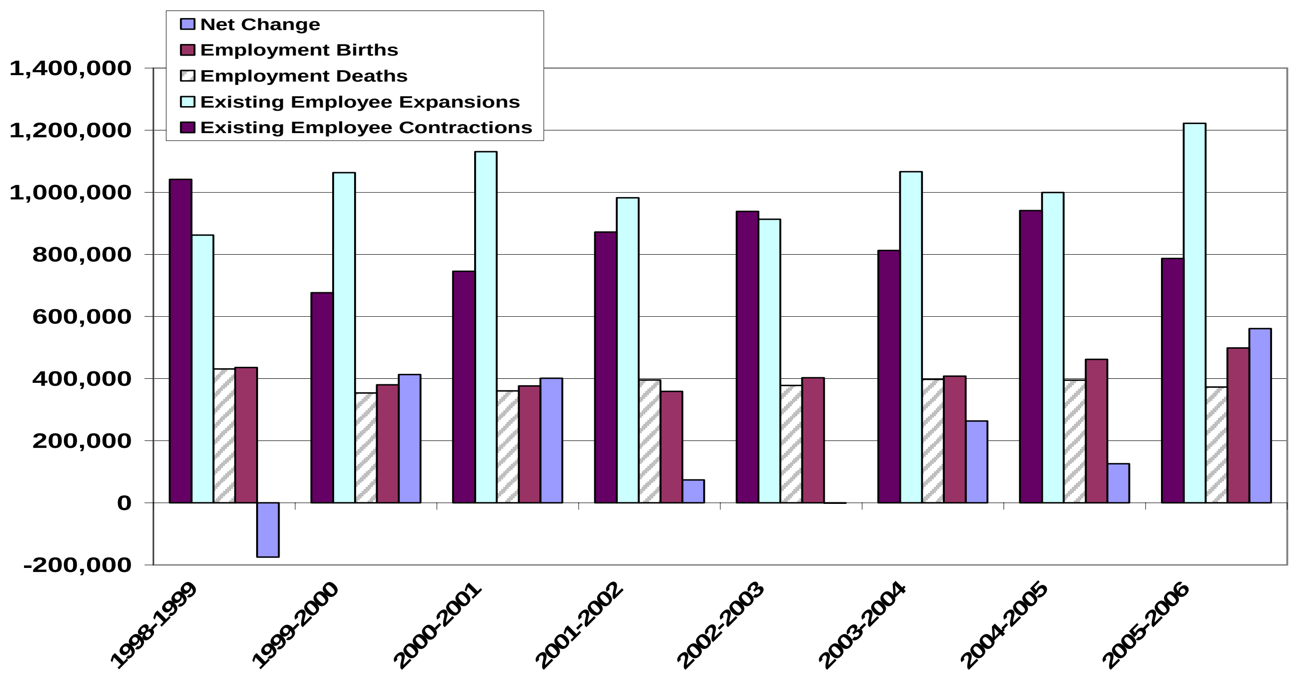
Figure 3-1 through *Figure 3-4* report year-to-year changes establishment and employment counts for the U.S construction industry and for the U.S economy as a whole, over the period 1998-2006. These values are reported in terms of net changes, births, and deaths of establishments. The *Net Change* values, determined by subtracting total firm deaths from total firm births during the one-year time period, indicate the total gains or losses during the time period. Comparing the net change in the construction industry to the U.S. total demonstrates that this industry does not always follow the same pattern as the national economy. Though the construction industry has generally experienced growth of establishments and employment over this period, the industry has shown more variability than the total economy.

Figure 3-1: Establishment Births, Deaths, and Net Change for the Construction Industry



Source: U.S. SBA (2009)

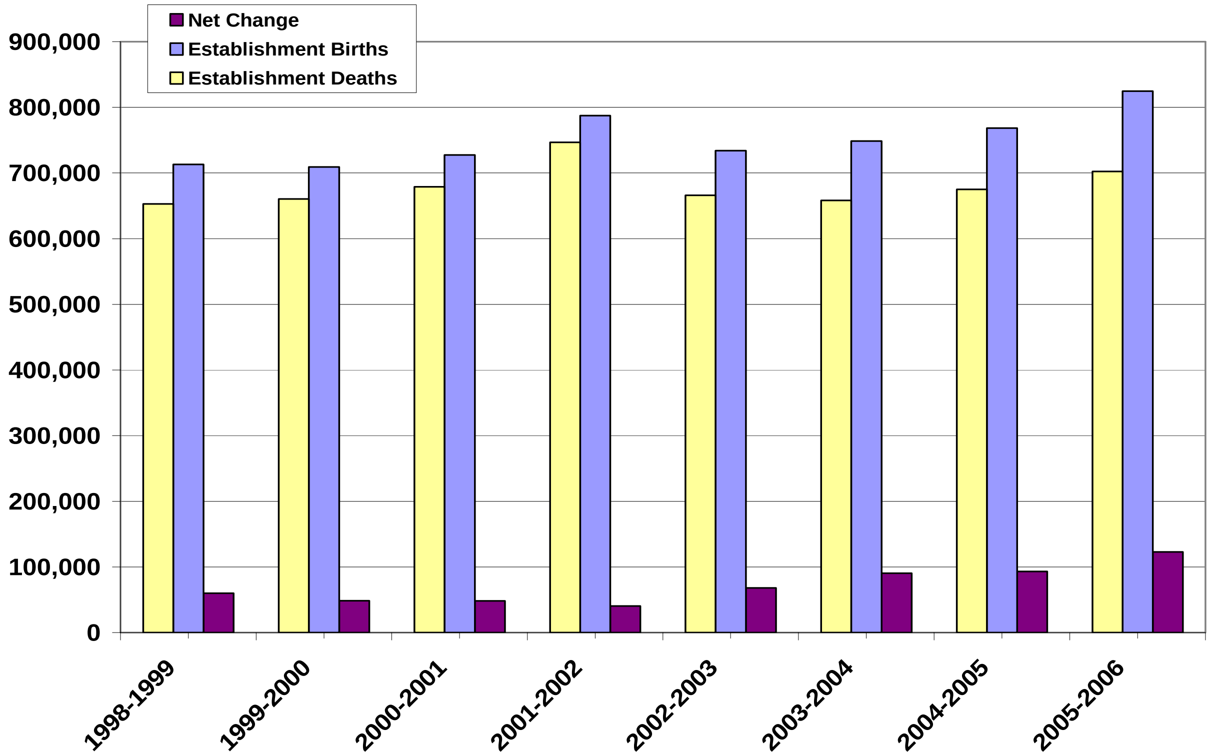
Figure 3-2: Employment Births, Deaths, and Net Change for the Construction Industry



Note: Employment net change is calculated by subtracting employment losses in "deaths" from employment gains in "births" and adding the net change from existing firm expansions and existing firm contractions.

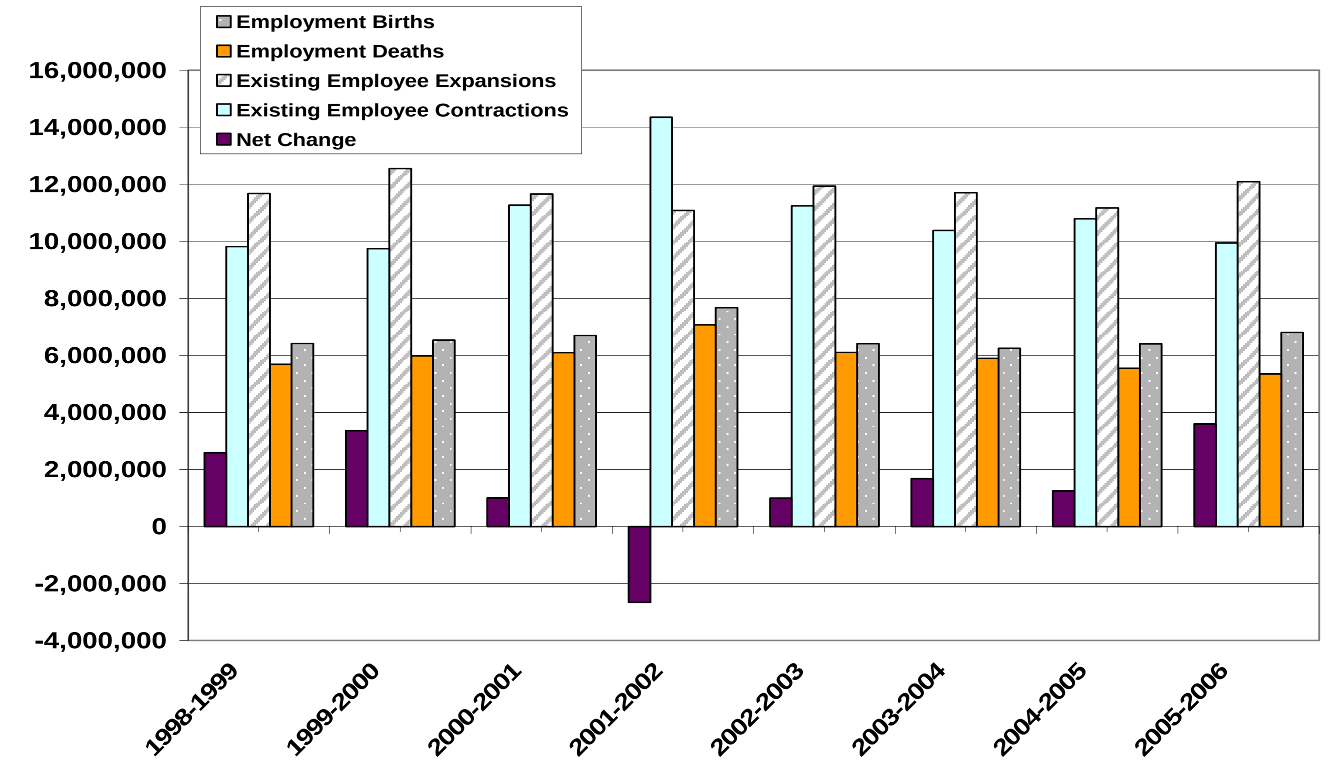
Source: U.S. SBA (2009)

Figure 3-3: Establishment Births, Deaths, and Net Change for the U.S. Total



Source: U.S. SBA (2009)

Figure 3-4: Employment Births, Deaths, and Net Change for the U.S. Total



Source: U.S. SBA (2009)

3.2.3 Value of Construction by C&D Industry Segment

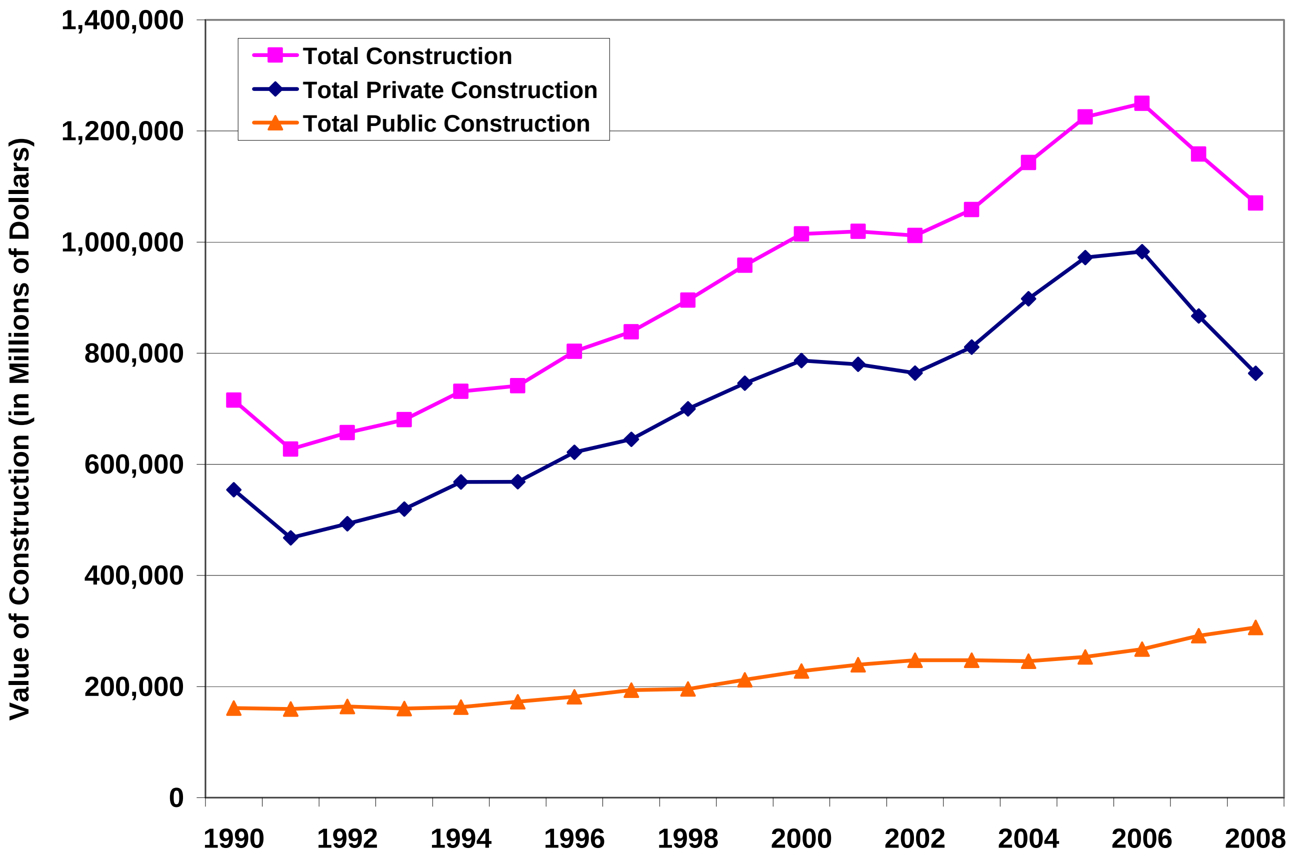
Figure 3-5 through *Figure 3-7* report the value of construction in key industry segments – Total Construction, Private Construction, and Public Construction – from 1990 to 2008.

As shown in *Figure 3-5*, the industry generally experienced stable growth from 1990 through 2000. More recently, the value of *total* construction from 2005 to 2006 grew slightly, from $1.16 trillion to $1.19 trillion ($2006), an increase of 2.1 percent. However, the value of *total* construction from 2006 to 2008 decreased approximately 14 percent. The Private Construction segment is considerably larger than the Public Construction segment, accounting for approximately 80 percent of the total value of construction in recent years, and most of the industry's growth and overall business performance.

Within the Private Construction segment (see *Figure 3-6*, following page), the Private Residential segment showed the most growth over the analysis period and generally grew consistently from 1990 to the middle of the current decade. The modest turndown of 3.1 percent in 2006 marks the beginning of the ongoing weakness in this industry segment. This turndown accelerated in 2007 and 2008 with a nearly 50 percent additional contraction in total value of Private Residential construction during these years. Private Non-Residential construction grew less over this period and shows more variability in total value of activity by year. Nevertheless, the Private Non-Residential showed growth through 2008. Overall, reflecting the turndown in the Residential Segment, the total value of Private Construction increased by only 1.1 percent from 2005 to 2006 and decreased by 22 percent from 2006 to 2008.

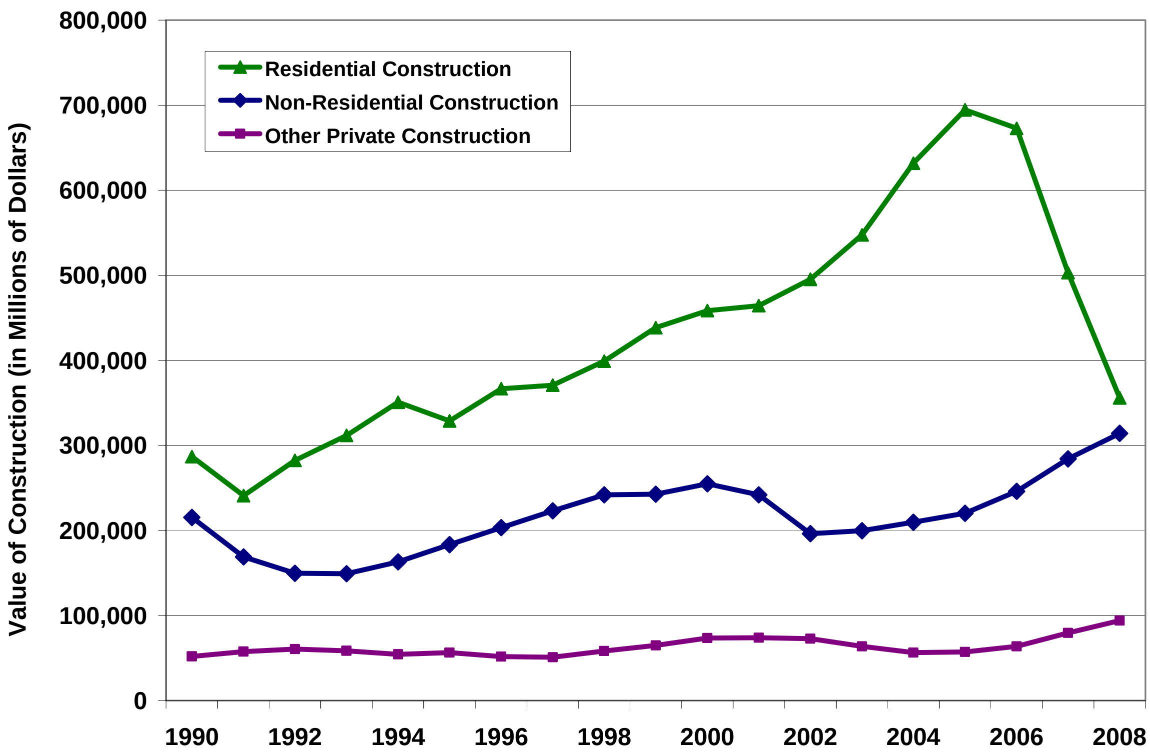
The Public Construction segment has also grown substantially since 1990 (see *Figure 3-7: Annual Value of Public Construction from 1990 to 2008 ($2008 Dollars)*. And overall, the Public Construction segment shows less volatility than the Private Construction segment. Over this period, only the Non-Residential segment recorded a material decline, during the period 2002-2004. The total value of public construction increased by 5.6 percent from 2005 to 2006, and increased by 14.7 percent from 2006 to 2008.

Figure 3-5: Annual Value of Total, Private, and Public Construction from 1990 to 2008 ($2008 Dollars)



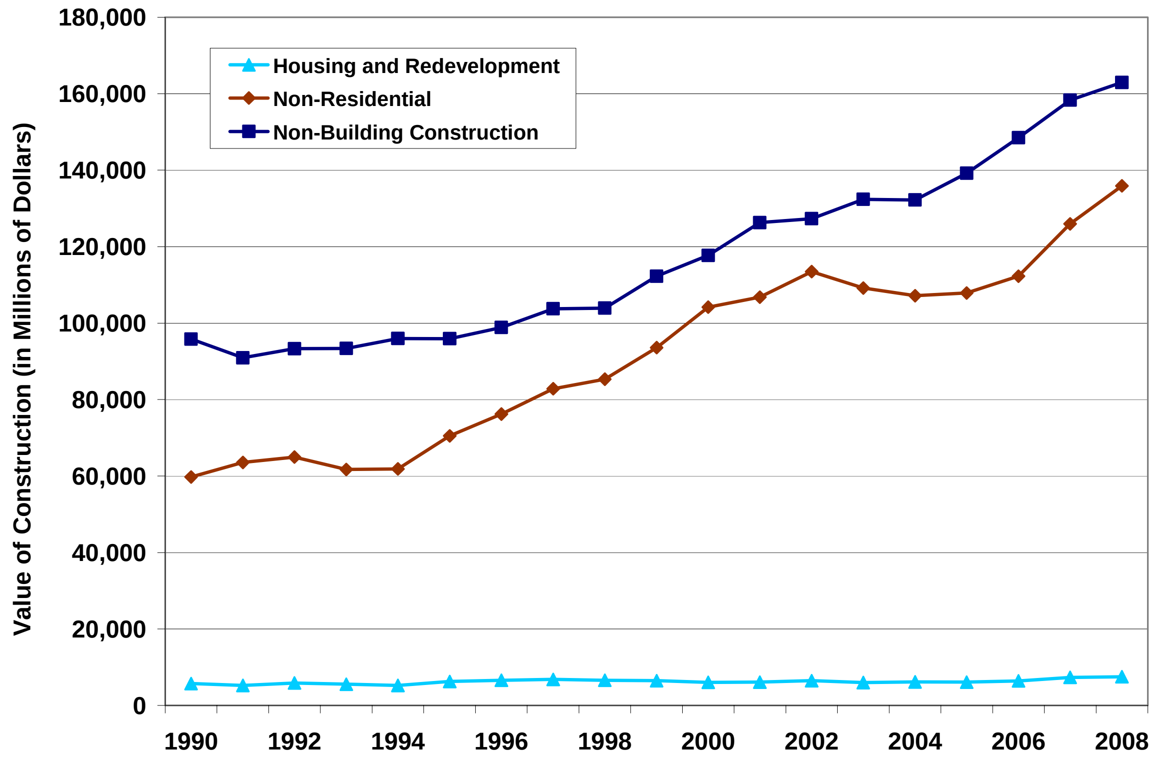
Source: U.S. Census Bureau (2009a)

Figure 3-6: Annual Value of Private Construction from 1990 to 2008 ($2008 Dollars)



Source: U.S. Census Bureau (2009a)

Figure 3-7: Annual Value of Public Construction from 1990 to 2008 ($2008 Dollars)



Source: U.S. Census Bureau (2009a)

3.3 Establishment and Firm Characteristics in the C&D Industry

The following section defines and describes the construction industry based on establishment and firm-level data. Based on data from the most recent Economic Census (2002), the industry includes 178,835 establishments, 2,573,215 employees, and has approximately $678 billion in value of construction. In addition, the industry is dominated by small businesses, with approximately 93% of establishments, 45% of employees, and 31% of value in the industry being in single-establishment firms that would be classified as a small business according to Small Business Administration business size criteria.

EPA used two steps to define the number of C&D establishments that could be affected by the various options that EPA considered for the C&D regulation. First, EPA identified all C&D establishments using data from the 2002 Economic Census (see *Table 3-1*). Second, EPA estimated the number of these establishments that will be affected by this action. *Section 3.3.1* examines industry-wide characteristics, including the number and size of establishments. *Section 3.3.2* describes firm-level data for the C&D industry. *Section 3.3.3* presents the number of small entities.

3.3.1 Establishment-Level Industry Characterization

This section presents data for all establishments within the C&D industry, based primarily on the 2002 Economic Census. Data presented include the number, size, value of construction, employment, legal form of organization, seasonality, payroll and benefits, and level of specialization of establishments, by principal industry sector.

3.3.1.1 Number of Establishments

Economic Census indicates that the C&D industry had a total of 178,835 establishments with payrolls in 2002 (i.e., 2002 NAICS 236, 237, see *Table 3-3*, *Table 3-4*, and *Table 3-5*). Of these establishments, the largest numbers are in NAICS 236 (*Construction of Buildings*). This subsector includes 128,897 establishments, representing 72.7 percent of all C&D industry establishments. Within NAICS 236, three categories fall in *Residential Home Construction*: 1) *New Single-Family General Contractors* (NAICS 236115), 2) *New Multifamily General Contractors* (NAICS 236116), and 3) *New Housing Operative Builders* (NAICS 236117). These three categories account for the majority of C&D industry establishments: 88,912 out of 128,897 or 69 percent. Also within NAICS 236 are two categories of *Non-Residential Building Construction*: 1) *Industrial Building Construction* (NAICS 236210) and 2) *Commercial and Institutional Building Construction* (NAICS 236220). Non-residential construction accounts for the other 31 percent (39,985 establishments) within NAICS 236 (*Construction of Buildings*).

The other segments of the C&D industry include establishments in *Heavy and Civil Engineering Construction* (NAICS 237). *Heavy and Civil Engineering Construction* accounts for 49,938 establishments, or 27.92 percent of the total C&D industry. Within NAICS 237 (*Heavy and Civil Engineering Construction*), *Land Subdivision* (NAICS 2372) accounts for 8,403 establishments, or 4.7 percent of all establishments in the C&D industry. Of the remaining heavy and civil engineering construction establishments, 22.5 percent (11,239 establishments) are primarily *Highway, Street, and Bridge Construction* contractors, while 39.6 percent (19,794 establishments) are contractors that work on *Water, Sewer, Pipeline, Communications, and Power Line* projects and 21.0 percent (10,502 establishments) are engaged in *Other Types of Heavy Construction*.

In addition to the establishments with payrolls, a large number of establishments – 531,952 in 2002[8] – reported no paid employees and are not included in the totals in the following tables. These establishments are nonemployers, typically self-employed individuals, which are not subject to payroll tax. Available data suggest these establishments are very small relative to establishments with payrolls. While employer establishments in NAICS 236 and 237 had $723.3 billion in receipts for 2002, non-employer establishments had only $46.9 billion in receipts, which represents only 6.5 percent of the receipts of employee establishments.

[8] This figure includes establishments in NAICS 236 and 237. Data on non-employer establishments was not broken out at the 6 digit NAICS level, thus, residential remodelers are included in this figure.

Table 3-5: Value of Construction (in $1000's) and Number of Establishments with Payrolls, 2002

NAICS	Description	Establishments	Percent of Total Establishments	Value of Construction	Percent of Total Value of Construction
236	*Construction of buildings*	*128,897*	*72.08%*	*$475,569,974*	*70.11%*
236115	New single-family general contractors	58,472	32.70%	$61,781,469	9.11%
236116	New multifamily general contractors	4,397	2.46%	$16,672,531	2.46%
237117	New housing operative builders	26,043	14.56%	$139,021,424	20.50%
236210	Industrial building construction	2,777	1.55%	$17,029,276	2.51%
236220	Commercial and institutional building construction	37,208	20.81%	$241,065,274	35.54%
237	*Heavy and civil engineering construction*	*49,938*	*27.92%*	*$202,713,062*	*29.89%*
237110	Water and sewer line and related structures construction	12,357	6.91%	$32,501,442	4.79%
237120	Oil and gas pipeline and related structures construction	1,403	0.78%	$11,458,718	1.69%
237130	Power and communication line and related structures construction	6,034	3.37%	$34,810,458	5.13%
237210	Land subdivision	8,403	4.70%	$20,480,936	3.02%
237310	Highway, street, and bridge construction	11,239	6.28%	$81,660,219	12.04%
237990	Other heavy and civil engineering construction	10,502	5.87%	$21,801,289	3.21%
TOTAL		**178,835**	**100%**	**$678,283,036**	**100%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. Census Bureau's Economic Census (2005a)

Number of Establishments, Employees, and the Value of Construction by Establishment Employee Size

As viewed in a number of data frameworks, C&D industry groups are dominated by small establishments.[9] *Table 3-6* through *Table 3-8* shows the number of establishments, employees, and the value of construction by the establishment's employee size*. Table 3-9* through *Table 3-11* shows the number of establishments, employees, and the value of construction by the establishment's value of business size.

As shown in *Table 3-6*, the Economic Census reports that 55.1 percent of establishments with payrolls have fewer than 5 employees, 75.0 percent have fewer than 10 employees, and 95.3 percent have fewer than 50 employees.[10] Overall, less than 0.2 percent of C&D establishments with payrolls have 500 or more employees. On average, establishments in NAICS 237 (*Heavy Construction*) are somewhat larger than those in the other NAICS industry groups, with a lower percentage of establishments appearing in each of the smaller establishment size classes.

9 The SBA uses size standards based on either the number of employees or annual revenue to classify firms as small. Qualifying revenue levels differ among NAICS industry groups, and, within the C&D industries, there is a range of revenue levels, from $6.5 million for NAICS 237210 (*Land Subdivision*) to $31.0 million for the majority of industry groups within NAICS 236 and 237 (U.S. SBA, 2006). A more detailed review of industry size distribution based on the SBA definitions will be presented as part of the Small Entity Impact Analysis.

10 531,952 establishments in the C&D industry report *no* employees.

Table 3-6: Number of Establishments with Payrolls in the C&D Industry, by Employment Size Class, 2002

			Establishments with less than 5 employees		Establishments with less than 10 employees		Establishments with less than 50 employees		Establishments with less than 100 employees		Establishments with less than 500 employees	
NAICS	**Description**	**Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**
236	*Construction of buildings*	*128,897*	*75,944*	*58.9%*	*101,975*	*79.1%*	*124,845*	*96.9%*	*127,242*	*98.7%*	*128,756*	*99.9%*
236115	New single-family housing construction	58,472	41,602	71.1%	53,171	90.9%	58,211	99.6%	58,387	99.9%	58,468	100.0%
236116	New multifamily housing construction	4,397	2,522	57.4%	3,358	76.4%	4,259	96.9%	4,351	99.0%	4,395	100.0%
236117	New housing operative builders	26,043	16,439	63.1%	21,789	83.7%	25,267	97.0%	25,697	98.7%	26,028	99.9%
236210	Industrial building construction	2,777	993	35.8%	1,630	58.7%	2,505	90.2%	2,633	94.8%	2,750	99.0%
236220	Commercial and institutional building	37,208	14,388	38.7%	22,027	59.2%	34,603	93.0%	36,174	97.2%	37,115	99.8%
237	*Heavy and civil engineering construction*	*49,938*	*22,565*	*45.2%*	*32,184*	*64.4%*	*45,616*	*91.3%*	*47,890*	*95.9%*	*49,714*	*99.6%*
237110	Water and sewer line and related structures construction	12,357	5,181	41.9%	7,948	64.3%	11,538	93.4%	12,047	97.5%	12,338	99.8%
237120	Oil and gas pipeline and related structures construction	1,403	280	20.0%	491	35.0%	1,093	77.9%	1,230	87.7%	1,377	98.1%
237130	Power and communication line	6,034	1,984	32.9%	3,284	54.4%	5,269	87.3%	5,668	93.9%	5,973	99.0%
237210	Land subdivision	8,403	6,268	74.6%	7,413	88.2%	8,281	98.5%	8,346	99.3%	8,394	99.9%
237310	Highway, street, and bridge construction	11,239	3,071	27.3%	5,211	46.4%	9,360	83.3%	10,330	91.9%	11,163	99.3%
237990	Other heavy and civil engineering construction	10,502	5,781	55.0%	7,837	74.6%	10,075	95.9%	10,269	97.8%	10,469	99.7%
TOTAL		**178,835**	**98,509**	**55.1%**	**134,159**	**75.0%**	**170,461**	**95.3%**	**175,132**	**97.9%**	**178,470**	**99.8%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. Census Bureau's Economic Census (2005a)

The total number of employees in establishments (*Table 3-7,* following page) by employee-size follows a similar trend by sector. Again, heavy construction stands out as having many more employees within the establishments employing over 100 people (54.3%). As expected, a much smaller fraction of total employees are within the category of establishments with fewer than 5 employees. Within this category, the percentage of total establishments is nearly 7 times greater than the percentage of total employees.

Table 3-7: Number of Employees in Establishments with Payrolls in the C&D Industry, by Employment Size Class, 2002

			Employees in Establishments with less than 5 employees		Employees in Establishments with less than 10 employees		Employees in Establishments with less than 50 employees		Employees in Establishments with less than 100 employees		Employees in Establishments with less than 500 employees	
NAICS	**Description**	**Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**
236	*Construction of buildings*	*1,367,558*	*161,401*	*11.8%*	*327,476*	*23.9%*	*764,482*	*55.9%*	*929,168*	*67.9%*	*1,201,566*	*87.9%*
236115	New single-family housing construction	273,055	86,849	31.8%	158,886	58.2%	243,330	89.1%	255,031	93.4%	268,688	98.4%
236116	New multifamily housing construction	44,384	5,144	11.6%	10,570	23.8%	28,219	63.6%	34,796	78.4%	39,930	90.0%
236117	New housing operative builders	240,292	34,724	14.5%	69,153	28.8%	134,177	55.8%	164,370	68.4%	226,476	94.3%
236210	Industrial building construction	93,931	2,180	2.3%	6,389	6.8%	24,075	25.6%	32,803	34.9%	44,457	47.3%
236220	Commercial and institutional building	715,896	32,504	4.5%	82,478	11.5%	334,681	46.7%	442,168	61.8%	622,015	86.9%
237	*Heavy and civil engineering construction*	*1,205,657*	*47,549*	*3.9%*	*109,098*	*9.0%*	*394,141*	*32.7%*	*550,841*	*45.7%*	*866,997*	*71.9%*
237110	Water and sewer line and related structures	204,085	11,137	5.5%	29,139	14.3%	105,768	51.8%	140,451	68.8%	191,235	93.7%
237120	Oil and gas pipeline and related structures	93,176	705	0.8%	1,958	2.1%	16,074	17.3%	25,733	27.6%	42,130	45.2%
237130	Power and communication line construction	253,506	4,499	1.8%	12,728	5.0%	53,995	21.3%	81,611	32.2%	142,851	56.4%
237210	Land subdivision	66,105	11,938	18.1%	18,806	28.4%	34,322	51.9%	38,779	58.7%	44,636	67.5%
237310	Highway, street, and bridge construction	434,714	7,179	1.7%	21,068	4.8%	114,986	26.5%	182,236	41.9%	341,856	78.6%
237990	Other heavy and civil engineering construction	154,071	12,091	7.8%	25,399	16.5%	68,996	44.8%	82,031	53.2%	104,289	67.7%
TOTAL		**2,573,215**	**208,950**	**8.1%**	**436,574**	**17.0%**	**1,158,623**	**45.0%**	**1,480,009**	**57.5%**	**2,068,563**	**80.4%**

Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a)

Table 3-8 reports the value of construction by establishment size. The value of construction, by establishment size, correlates closely with employment by establishment size. Again, a larger relative share of total business value occurs in the larger employment size categories.

Table 3-8: Value of Construction with Payrolls in the C&D Industry, by Employment Size Class (in $1000's), 2002

			Value of Construction in Establishments with less than 5 employees		Value of Construction in Establishments with less than 10 employees		Value of Construction in Establishments with less than 50 employees		Value of Construction in Establishments with less than 100 employees		Value of Construction in Establishments with less than 500 employees	
NAICS	Description	Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
236	*Construction of buildings*	*$475,569,974*	*$45,736,358*	*9.6%*	*$88,657,258*	*18.6%*	*$223,103,464*	*46.9%*	*$292,038,213*	*61.4%*	*$422,537,863*	*88.8%*
236115	New single-family housing construction	$61,781,469	$21,793,366	35.3%	$36,478,924	59.0%	$54,625,158	88.4%	$57,788,631	93.5%	$59,911,206	97.0%
236116	New multifamily housing construction	$16,672,531	$1,276,547	7.7%	$2,648,533	15.9%	$8,928,221	53.6%	$12,223,500	73.3%	$14,748,503	88.5%
236117	New housing operative builders	$139,021,424	$15,732,340	11.3%	$30,325,999	21.8%	$63,876,017	45.9%	$84,221,767	60.6%	$131,771,816	94.8%
236210	Industrial building construction	$17,029,276	$426,963	2.5%	$1,265,910	7.4%	$4,889,191	28.7%	$6,677,073	39.2%	$9,591,627	56.3%
236220	Commercial and institutional building	$241,065,274	$6,507,142	2.7%	$17,937,892	7.4%	$90,784,877	37.7%	$131,127,242	54.4%	$206,514,711	85.7%
237	*Heavy and civil engineering construction*	*$202,713,062*	*$8,432,679*	*4.2%*	*$17,156,991*	*8.5%*	*$60,702,284*	*29.9%*	*$88,527,335*	*43.7%*	*$146,439,254*	*72.2%*
237110	Water and sewer line and related structures	$32,501,442	$1,415,430	4.4%	$3,595,293	11.1%	$14,980,586	46.1%	$21,346,472	65.7%	$30,887,395	95.0%
237120	Oil and gas pipeline and related structures	$11,458,718	$76,428	0.7%	$204,478	1.8%	$1,604,355	14.0%	$2,758,431	24.1%	$4,934,845	43.1%
237130	Power and communication line	$34,810,458	$366,360	1.1%	$1,230,831	3.5%	$5,825,476	16.7%	$9,003,657	25.9%	$16,326,786	46.9%
237210	Land subdivision	$20,480,936	$4,349,376	21.2%	$6,323,548	30.9%	$10,484,766	51.2%	$11,693,997	57.1%	$12,583,532	61.4%
237310	Highway, street, and bridge construction	$81,660,219	$879,611	1.1%	$2,797,973	3.4%	$18,876,026	23.1%	$32,669,113	40.0%	$66,818,535	81.8%
237990	Other heavy and civil engineering construction	$21,801,289	$1,345,474	6.2%	$3,004,868	13.8%	$8,931,075	41.0%	$11,055,665	50.7%	$14,888,161	68.3%
TOTAL		**$678,283,036**	**$54,169,037**	**8.0%**	**$105,814,249**	**15.6%**	**$283,805,748**	**41.8%**	**$380,565,548**	**56.1%**	**$568,977,117**	**83.9%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. Census Bureau's Economic Census (2005a)

Number of Establishments, Employees, and the Value of Construction by Establishment Revenue Size

The dominance of small establishments in the C&D industry is also apparent when analyzed on the basis of revenue size class. In 2002, 27.4 percent of establishments with payrolls had annual revenue below $250,000, 44.8 percent had annual revenue below $500,000, 61.6 percent had annual revenue below $1.0 million, 88.0 percent had annual revenue below $5.0 million, and 93.6 percent had annual revenue below $10 million. These data are shown in *Table 3-9,* following page. Only 11,463 establishments, representing 6.4 percent of the total, had annual revenue in excess of $10.0 million.

Table 3-9: Number of Establishments in the C&D Industry, by Annual Revenue, 2002

			Establishments with less than $250,000 in Annual Revenue		Establishments with less than $500,000 in Annual Revenue		Establishments with less than $1 million in Annual Revenue		Establishments with less than $5 million in Annual Revenue		Establishments with less than $10 million in Annual Revenue	
NAICS	**Description**	**Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**	**Number**	**Percent of Total**
236	*Construction of buildings*	*128,897*	*34,668*	*26.9%*	*57,606*	*44.7%*	*79,703*	*61.8%*	*114,220*	*88.6%*	*121,163*	*94.0%*
236115	New single-family housing construction	58,472	20,804	35.6%	33,524	57.3%	44,581	76.2%	56,520	96.7%	57,759	98.8%
236116	New multifamily housing construction	4,397	1,260	28.7%	2,135	48.6%	2,779	63.2%	3,798	86.4%	4,050	92.1%
236117	New housing operative builders	26,043	4,675	18.0%	8,889	34.1%	13,134	50.4%	22,163	85.1%	24,032	92.3%
236210	Industrial building construction	2,777	514	18.5%	880	31.7%	1,336	48.1%	2,265	81.6%	2,529	91.1%
236220	Commercial and institutional building	37,208	7,415	19.9%	12,178	32.7%	17,873	48.0%	29,474	79.2%	32,793	88.1%
237	*Heavy and civil engineering construction*	*49,938*	*14,303*	*28.6%*	*22,440*	*44.9%*	*30,387*	*60.8%*	*43,146*	*86.4%*	*46,209*	*92.5%*
237110	Water and sewer line and related structures construction	12,357	3,258	26.4%	5,530	44.8%	7,781	63.0%	10,879	88.0%	11,612	94.0%
237120	Oil and gas pipeline and related structures construction	1,403	222	15.8%	431	30.7%	590	42.1%	1,071	76.3%	1,211	86.3%
237130	Power and communication line construction	6,034	1,630	27.0%	2,618	43.4%	3,467	57.5%	5,221	86.5%	5,586	92.6%
237210	Land subdivision	8,403	3,111	37.0%	4,573	54.4%	5,824	69.3%	7,851	93.4%	8,216	97.8%
237310	Highway, street, and bridge construction	11,239	2,171	19.3%	3,321	29.5%	4,988	44.4%	8,304	73.9%	9,425	83.9%
237990	Other heavy and civil engineering construction	10,502	3,911	37.2%	5,967	56.8%	7,737	73.7%	9,820	93.5%	10,159	96.7%
TOTAL		**178,835**	**48,971**	**27.4%**	**80,046**	**44.8%**	**110,090**	**61.6%**	**157,366**	**88.0%**	**167,372**	**93.6%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. Census Bureau's Economic Census (2005a)

As shown in *Table 3-10,* only 3.6 percent of all employees fall into establishments with less than $250,000 in value of business done as compared to 45 percent of employees within establishments of less than $10 million.

Table 3-10: Number of Employees in the C&D Industry, by Annual Revenue, 2002

			Employees in Establishments with less than $250,000 in Annual Revenue		Employees in Establishments with less than $500,000 in Annual Revenue		Employees in Establishments with less than $1 million in Annual Revenue		Employees in Establishments with less than $5 million in Annual Revenue		Employees in Establishments with less than $10 million in Annual Revenue	
NAICS	Description	Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
236	*Construction of buildings*	*1,367,558*	*66,711*	*4.9%*	*143,061*	*10.5%*	*248,686*	*18.2%*	*558,077*	*40.8%*	*698,363*	*51.1%*
236115	New single-family housing construction	273,055	41,087	15.0%	82,279	30.1%	130,806	47.9%	218,945	80.2%	239,650	87.8%
236116	New multifamily housing construction	44,384	2,007	4.5%	4,829	10.9%	8,281	18.7%	18,722	42.2%	23,750	53.5%
236117	New housing operative builders	240,292	8,005	3.3%	19,808	8.2%	35,505	14.8%	88,115	36.7%	110,784	46.1%
236210	Industrial building construction	93,931	900	1.0%	2,754	2.9%	5,616	6.0%	19,250	20.5%	28,330	30.2%
236220	Commercial and institutional building	715,896	14,712	2.1%	33,391	4.7%	68,478	9.6%	213,045	29.8%	295,849	41.3%
237	*Heavy and civil engineering construction*	*1,205,657*	*26,902*	*2.2%*	*60,247*	*5.0%*	*116,618*	*9.7%*	*330,299*	*27.4%*	*459,594*	*38.1%*
237110	Water and sewer line and related structures construction	204,085	5,845	2.9%	14,829	7.3%	30,803	15.1%	84,204	41.3%	112,761	55.3%
237120	Oil and gas pipeline and related structures construction	93,176	639	0.7%	2,167	2.3%	4,094	4.4%	16,824	18.1%	25,803	27.7%
237130	Power and communication line construction	253,506	3,446	1.4%	8,794	3.5%	16,244	6.4%	55,625	21.9%	79,383	31.3%
237210	Land subdivision	66,105	5,048	7.6%	9,451	14.3%	14,929	22.6%	29,519	44.7%	36,333	55.0%
237310	Highway, street, and bridge construction	434,714	5,064	1.2%	9,926	2.3%	23,783	5.5%	82,299	18.9%	128,475	29.6%
237990	Other heavy and civil engineering construction	154,071	6,860	4.5%	15,080	9.8%	26,765	17.4%	61,828	40.1%	76,839	49.9%
TOTAL		**2,573,215**	**93,613**	**3.6%**	**203,308**	**7.9%**	**365,304**	**14.2%**	**888,376**	**34.5%**	**1,157,957**	**45.0%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. Census Bureau's Economic Census (2005a)

As shown in *Table 3-11*, the total value of construction by establishment revenue class follows the same profile as seen in the previous tables, with a very high percentage of total construction value occurring in the higher revenue class establishments. Over half of the total value of annual revenue in the C&D sectors is generated in establishments with at least $10 million, although these establishments represent fewer than 7 percent of total establishments in this industry.

Table 3-11: Value of Construction in the C&D Industry, by Annual Revenue (in $1000's), 2002

			Value of Construction in Establishments with less than $250,000 in Annual Revenue		Value of Construction in Establishments with less than $500,000 in Annual Revenue		Value of Construction in Establishments with less than $1 million in Annual Revenue		Value of Construction in Establishments with less than $5 million in Annual Revenue		Value of Construction in Establishments with less than $10 million in Annual Revenue	
NAICS	Description	Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
236	*Construction of buildings*	*$475,569,974*	*$4,525,301*	*1.0%*	*$12,756,624*	*2.7%*	*$28,315,588*	*6.0%*	*$103,668,145*	*21.8%*	*$150,810,613*	*31.7%*
236115	New single-family housing construction	$61,781,469	$2,708,376	4.4%	$7,257,487	11.7%	$14,980,754	24.2%	$39,031,735	63.2%	$47,236,528	76.5%
236116	New multifamily housing construction	$16,672,531	$140,521	0.8%	$450,834	2.7%	$895,825	5.4%	$3,250,934	19.5%	$4,942,393	29.6%
236117	New housing operative builders	$139,021,424	$635,721	0.5%	$2,163,061	1.6%	$5,185,010	3.7%	$25,109,207	18.1%	$37,512,292	27.0%
236210	Industrial building construction	$17,029,276	$60,605	0.4%	$198,854	1.2%	$535,534	3.1%	$2,492,871	14.6%	$4,349,956	25.5%
236220	Commercial and institutional building	$241,065,274	$980,078	0.4%	$2,686,388	1.1%	$6,718,465	2.8%	$33,783,398	14.0%	$56,769,444	23.5%
237	*Heavy and civil engineering construction*	*$202,713,062*	*$1,728,506*	*0.9%*	*$4,630,104*	*2.3%*	*$10,217,938*	*5.0%*	*$38,714,981*	*19.1%*	*$59,688,164*	*29.4%*
237110	Water and sewer line and related structures	$32,501,442	$422,643	1.3%	$1,225,288	3.8%	$2,820,890	8.7%	$9,743,281	30.0%	$14,780,221	45.5%
237120	Oil and gas pipeline and related structures	$11,458,718	$34,501	0.3%	$113,835	1.0%	$231,607	2.0%	$1,347,896	11.8%	$2,325,083	20.3%
237130	Power and communication line	$34,810,458	$191,227	0.5%	$534,643	1.5%	$1,143,503	3.3%	$5,102,546	14.7%	$7,604,600	21.8%
237210	Land subdivision	$20,480,936	$318,156	1.6%	$857,673	4.2%	$1,725,426	8.4%	$6,057,496	29.6%	$8,467,937	41.3%
237310	Highway, street, and bridge construction	$81,660,219	$301,951	0.4%	$708,561	0.9%	$1,877,940	2.3%	$9,724,026	11.9%	$17,419,028	21.3%
237990	Other heavy and civil engineering	$21,801,289	$460,028	2.1%	$1,190,104	5.5%	$2,418,572	11.1%	$6,739,736	30.9%	$9,091,295	41.7%
TOTAL		**$678,283,036**	**$6,253,807**	**0.9%**	**$17,386,728**	**2.6%**	**$38,533,526**	**5.7%**	**$142,383,126**	**21.0%**	**$210,498,777**	**31.0%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. Census Bureau's Economic Census (2005a)

3.3.1.2 Number of Employees

The construction industry employs a substantial percentage of the total U.S. workforce. With approximately 2.6 million employees in 2002, the construction industry accounts for nearly 2.4 percent of the entire workforce (the total amount of employees is nearly 109 million). Total payroll (approximately $98.6 billion) is roughly the same percentage of the total U.S. payroll (approximately $3.7 trillion): 2.6 percent.

In 2002, establishments with payrolls in the C&D industry employed nearly 2.6 million people. *Table 3-12* shows the distribution of employment by NAICS industry group. Combined, NAICS 236115, 236220, and 237310 accounts for over 50 percent of total employment. NAICS 236115 (*New Single Family Housing Construction*) accounts for 273,055 employees (10.6 percent of the total), NAICS 236220 (*Commercial and Institutional Building Construction*) accounts for 715,896 employees (27.8 percent of the total), and NAICS 237310 (*Highway, Street, and Bridge Construction*) accounts for 434,714 employees, or 16.9 percent of the total.

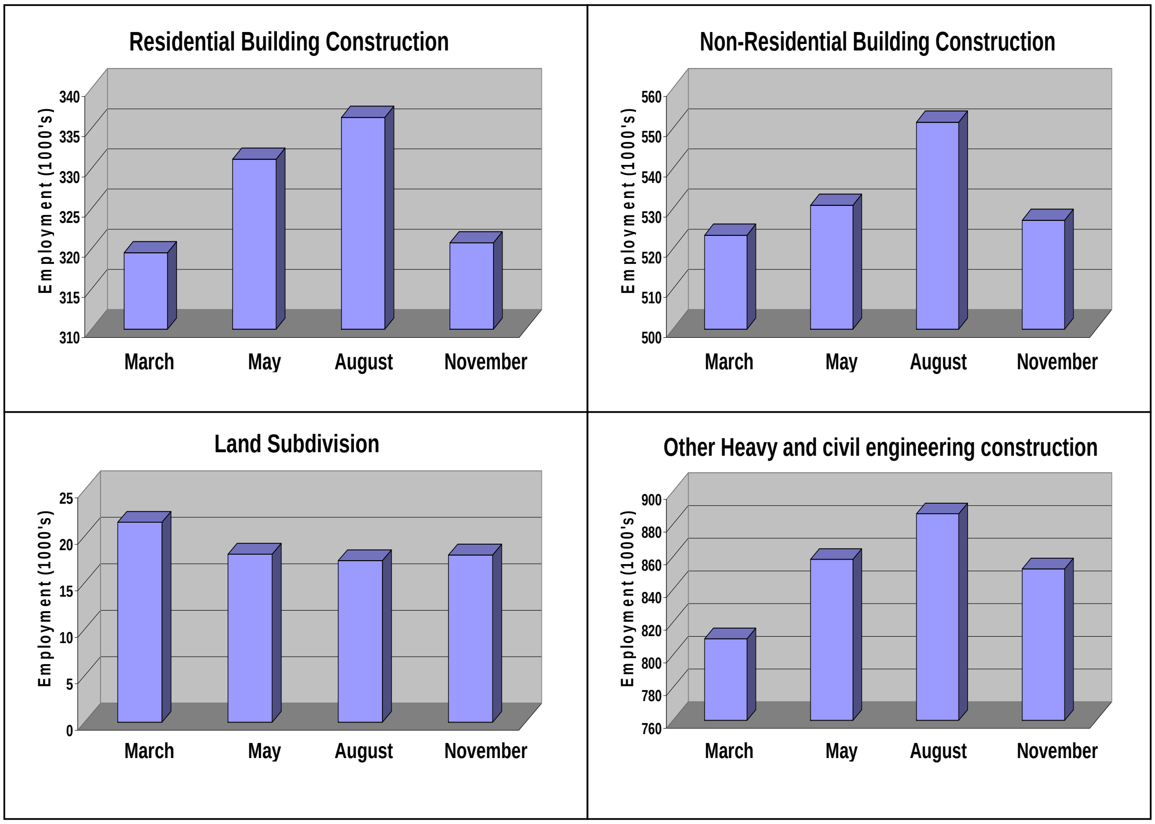
Table 3-12: Number of Employees in the C&D Industry, Establishments With Payrolls, in 2002

NAICS	Description	Number of Employees	Percent of Total
236	*Construction of buildings*	*1,367,558*	*53.2%*
236115	New single-family housing construction (except operative builders)	273,055	10.6%
236116	New multifamily housing construction (except operative builders)	44,384	1.7%
236117	New housing operative builders	240,292	9.3%
236210	Industrial building construction	93,931	3.7%
236220	Commercial and institutional building construction	715,896	27.8%
237	*Heavy and civil engineering construction*	*1,205,657*	*46.9%*
237110	Water and sewer line and related structures construction	204,085	7.9%
237120	Oil and gas pipeline and related structures construction	93,176	3.6%
237130	Power and communication line and related structures construction	253,506	9.9%
237210	Land subdivision	66,105	2.6%
237310	Highway, street, and bridge construction	434,714	16.9%
237990	Other heavy and civil engineering construction	154,071	6.0%
TOTAL		**2,573,215**	**100.0%**

Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a)

Construction is a seasonal activity in many parts of the country, and employment data from the industry reflect this fact. *Figure 3-8: Seasonal Trends in Employment in the C&D Industry, 2002*, following page, shows monthly employment data for select months for all NAICS groups in the C&D industry. Total employment of construction workers was lowest in March, at 1.67 million, and highest in August at 1.79 million.

Figure 3-8: Seasonal Trends in Employment in the C&D Industry, 2002



Source: U.S. Census Bureau's Economic Census (2005a)

3.3.1.3 Payroll and Benefits

In 2002, the payrolls of all C&D industry groups totaled $98.6 billion. Of this number, $60.5 billion (61.3 percent) went to construction workers and $38.1 billion (38.7 percent) went to other employees.[11] In addition, the C&D industry incurred $13.2 billion in legally-required fringe benefit expenditures and $9.1 billion in voluntary fringe benefits expenditures, for a total of $22.3 billion in fringe benefits.[12] *Table 3-13*, following page, shows detailed data on payrolls and benefits for each of the C&D industry groups.

[11] *Construction workers* include all workers, through the working supervisor level, directly engaged in construction operations, such as painters, carpenters, plumbers, and electricians. Included are journeymen, mechanics, apprentices, laborers, truck drivers and helpers, equipment operators, and onsite recordkeepers and security guards. *Other employees* include employees in executive, purchasing, accounting, personnel, professional, technical and routine office functions.

[12] *Legally required contributions* include Social Security contributions, unemployment compensation, workman's compensation, and state temporary disability payments. *Voluntary expenditures* include life insurance premiums, pension plans, insurance premiums on hospital and medical plans, welfare plans, and union negotiated benefits.

Table 3-13: Payrolls and Benefits for Employees in the Construction & Development Industry (in $1000's), 2002

		Payrolls[a]			Fringe Benefits (All Employees)		
NAICS	**Description**	**Total**	**Other Employees[b]**	**Construction Worker[c]**	**Legally Required Expenditures[d]**	**Voluntary Expenditures[e]**	**Total Fringe Benefits[f]**
236	*Construction of buildings*	*$53,488,317*	*$24,932,421*	*$28,555,896*	*$6,816,864*	*$4,091,629*	*$10,908,493*
236115	New single-family general contractors	$8,262,607	$3,780,204	$4,482,403	$1,020,034	$312,491	$1,332,525
236116	New multifamily general contractors	$1,730,843	$796,071	$934,772	$228,283	$116,543	$344,826
236117	New housing operative builders	$10,458,127	$6,371,039	$4,087,088	$1,075,153	$467,494	$1,542,647
236210	Industrial building construction	$3,826,648	$1,291,899	$2,534,749	$516,264	$348,233	$864,497
236220	Commercial building construction	$29,210,092	$12,693,208	$16,516,884	$3,977,130	$2,846,868	$6,823,998
237	*Heavy and civil engineering construction*	*$45,150,943*	*$13,206,331*	*$31,944,640*	*$6,429,632*	*$4,961,491*	*$11,391,123*
237110	Water and sewer system construction	$7,380,999	$2,069,415	$5,311,584	$1,036,078	$716,572	$1,752,650
237120	Oil and gas pipeline construction	$3,984,827	$812,781	$3,172,045	$599,899	$429,186	$1,029,085
237130	Power and communication line and related structures construction	$10,600,799	$2,857,301	$7,743,498	$1,430,879	$1,199,280	$2,630,159
237210	Land subdivision	$2,396,086	$1,696,602	$699,484	$282,350	$124,644	$406,993
237310	Highway and street construction	$15,790,835	$4,303,472	$11,487,363	$2,377,271	$1,966,930	$4,344,201
237990	Other heavy construction	$4,997,397	$1,466,760	$3,530,666	$703,155	$524,879	$1,228,035
TOTAL		**$98,639,260**	**$38,138,752**	**$60,500,536**	**$13,246,496**	**$9,053,120**	**$22,299,616**

[a] The payroll figures include the gross earnings paid in the calendar year 2002 to all employees on the payrolls of construction establishments. They include all forms of compensation, such as salaries, wages, commissions, bonuses, vacation allowances, and sick leave pay, prior to such deductions as employees' Social Security contribution, withholding taxes, group insurance, union dues, and savings bonds.
[b] Other employees include employees in executive, purchasing, accounting, personnel, professional, technical and routine office functions.
[c] Construction workers include all workers, through the working supervisor level, directly engaged in construction operations, such as painters, carpenters, plumbers, and electricians. Included are journeymen, mechanics, apprentices, laborers, truck drivers and helpers, equipment operators, and onsite record keepers and security guards.
[d] Legally required contributions include Social Security contributions, unemployment compensation, workman's compensation, and state temporary disability payments.
[e] Voluntary expenditures include life insurance premiums, pension plans, insurance premiums on hospital and medical plans, welfare plans, and union negotiated benefits.
[f] Total fringe benefits represent the expenditures made by the employer during 2002 for both legally required and voluntary fringe benefit programs for employees.
Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a)

3.3.1.4 Specialization

A construction establishment is classified within a type of construction according to the percentage of the construction work performed by that establishment. When 51 percent or more of the construction work done by the establishment falls within a specific type of construction, the establishment is considered *specialized*. Specialization data provide insight into the percentage of firms that perform work outside their firm's classification. Establishments report their degree of specialization to the Economic Census, based on the percentage of revenue earned from each type of construction work. For example, approximately 44.1 percent of establishments within NAICS 236115 (*New Single-Family Housing Construction)* perform 100 percent of their work within *New Single-Family Housing Construction*, 8.1 percent perform 80-99 percent of their work within *New Single-Family Housing Construction,* and 6.6 percent perform 51-79 percent of their work within *New Single-Family Housing Construction.*

As is the case with two other NAICS divisions (236117 and 236118), a large percentage of the establishments within *New Single-Family Housing Construction* did not report their degree of specialization. This could mean that this information was simply not provided to the Census or that these establishments in this sector often do not perform 51 percent or more of their work within one specified type of construction. Regardless, within every type of construction, *most* establishments reported that they were 51 percent or more specialized within the specified type of construction.

Since *most* establishments in any of the relevant segments reported that they were 51 percent or more specialized, for the economic analyses presented later in this document, it is reasonable to establish model firms according to the assumption that these firms perform all or nearly all business within their classified category. Thus, the assumption is made that these firms perform 100 percent of their business within their classified category. To the extent that a firm performs work in other types of construction that would not be affected by the regulation (such as those classified as *New Single-Family Housing Contractors* that also perform work as *Residential Remodelers)*, the assignment of compliance costs to *all* business performed by the firm may overstate the potential impact of the regulation on firms in those segments as part of the firm- and industry-level impact assessment.

Table 3-14: Percent of Establishments by Percent Specialization by Assigned Type of Construction, 2002

		Percent of Total Establishments			Percent of Total Value of Construction of Establishments		
NAICS	Description	100% Specialized	80-99% Specialized	51-79% Specialized	100% Specialized	80-99% Specialized	51-79% Specialized
236115	New single-family housing construction	44.1%	8.1%	6.6%	52.3%	12.5%	3.7%
236116	New multifamily housing construction	47.1%	14.6%	36.6%	35.3%	16.7%	26.6%
236117	New housing operative builders	54.2%	6.1%	5.3%	0.0%	14.4%	9.1%
236210	Industrial building construction	41.0%	19.1%	31.3%	28.9%	5.7%	0.0%
236220	Commercial and institutional building construction	30.9%	14.1%	28.3%	15.5%	10.3%	17.1%
237110	Water and sewer line and related structures construction	44.3%	7.4%	20.3%	0.0%	7.1%	12.1%
237120	Oil and gas pipeline and related structures construction	73.8%	12.0%	13.9%	51.0%	23.1%	14.2%
237130	Power and communication line and related structures construction	86.3%	6.6%	7.1%	67.7%	13.5%	10.4%
237210	Land subdivision	70.8%	3.6%	5.5%	70.8%	2.0%	5.7%
237310	Highway, street, and bridge construction	45.5%	19.6%	27.9%	0.0%	12.3%	20.9%
237990	Other heavy and civil engineering construction	53.4%	10.2%	12.7%	43.9%	8.4%	12.5%

Source: U.S. Census Bureau's Economic Census (2005a)

3.3.1.5 Legal Form of Organization

The Economic Census also reports construction establishments according to how they are organized legally, using the following classification scheme: (a) corporations, (b) proprietorships, (c) partnerships, and (d) other. In 2002, of establishments with payrolls, a total of 130,253(72.8 percent of the total, only of establishments with payrolls – as distinguished from total establishments) were organized as corporations (see *Table 3-15*). A further 33,184 (18.5 percent) were organized as proprietorships, while 13,642 (7.6 percent) operated as partnerships and 1,838 (1.0 percent) operated under some other legal form of organization.

Table 3-15: Number of Establishments in the C&D Industry with Payrolls, by Legal Form of Organization, 2002

		Corporations		Proprietorships		Partnerships		Other		Total	
NAICS	Description	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
236	*Construction of buildings*	*92,436*	*71.6%*	*26,084*	*20.2%*	*9,405*	*7.3%*	*1,168*	*0.9%*	*129,098*	*100.0%*
236115	New single-family housing construction	36,968	63.2%	17,004	29.1%	3,839	6.6%	677	1.2%	58,489	100.0%
236116	New multifamily housing construction	3,332	76.2%	552	12.6%	447	10.2%	40	0.9%	4,372	100.0%
236117	New housing operative builders	19,856	76.2%	3,338	12.8%	2,684	10.3%	168	0.6%	26,047	100.0%
236210	Industrial building construction	2,298	82.1%	328	11.7%	164	5.9%	8	0.3%	2,799	100.0%
236220	Commercial and institutional building	29,982	80.2%	4,862	13.0%	2,271	6.1%	275	0.7%	37,391	100.0%
237	*Heavy and civil engineering construction*	*37,817*	*75.9%*	*7,100*	*14.2%*	*4,237*	*8.5%*	*670*	*1.3%*	*49,830*	*100.0%*
237110	Water and sewer line and related structures construction	9,101	73.4%	2,475	20.0%	721	5.8%	98	0.8%	12,396	100.0%
237120	Oil and gas pipeline and related structures construction	1,155	81.5%	116	8.2%	141	9.9%	5	0.4%	1,418	100.0%
237130	Power and communication line construction	4,825	80.5%	709	11.8%	417	7.0%	43	0.7%	5,995	100.0%
237210	Land subdivision	6,217	73.6%	503	6.0%	1,554	18.4%	169	2.0%	8,444	100.0%
237310	Highway, street, and bridge construction	9,270	81.7%	1,245	11.0%	675	5.9%	158	1.4%	11,349	100.0%
237990	Other heavy and civil engineering construction	7,249	70.9%	2,052	20.1%	729	7.1%	197	1.9%	10,228	100.0%
TOTAL		**130,253**	**72.8%**	**33,184**	**18.5%**	**13,642**	**7.6%**	**1,838**	**1.0%**	**178,928**	**100.0%**

Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a)

3.3.2 Firm-Level Industry Characterization

The SBA Office of Advocacy works with the Census Bureau to produce firm-level data for U.S. industries. Currently, data on firms by employment size and receipt size for 2002 are available; as described previously, these data are reported in the 1997 NAICS framework.

The SBA data are based primarily on administrative records and are not directly linked to data collected for the Economic Census. As a result, data reported by SBA may differ from that reported by the Economic Census.[13] The SBA data, however, are the *only* firm-level data available for C&D industry groups, so EPA included them in this analysis. These data are important in the firm and industry-level impact analysis and the small entity analysis, both of which are focused at the firm, instead of establishment, level.[14]

3.3.2.1 Number of Firms, Employees, and Annual Payroll by Employment Size of Firm

Table 3-16 through *Table 3-18* present the number of firms, establishments, employees, and annual payroll totals for firms with payroll by employee size in the C&D industry in 2002, as reported by SBA.[15] Both the SBA data by employees and receipts are for the year 2002 but the NAICS sector classifications are based on the 1997 framework definitions. SBA did not report 2002 revenue and employment size class data in the 2002 NAICS format. Thus, the number of establishments reported here will differ from the number reported in previous tables due to the different sources used. Most notably, residential remodelers were not broken out in the 1997 NAICS framework. Thus, the number of firms, establishments, employees, and payroll is an overstatement. In the 2002 Economic Census data, residential remodelers account for 82,750 establishments.

Table 3-16, following page, presents the number of firms and establishments by employment size. These data indicate that *nearly all firms operate a single establishment and have fewer than 20 employees*. Of the 263,317 C&D firms listed within *Table 3-16*, approximately 98.8 percent operate only one establishment. Furthermore, 91.7 percent have fewer than 20 employees and less than 1 percent of firms have more than 500 employees (similar to *Table 3-6*). In 2002, there were 38,739 firms in heavy construction, which operated 39,949 establishments. Almost 97 percent of the heavy construction firms operate a single establishment, and approximately 80 percent of these firms have fewer than 20 employees.

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13 The SBA data, for example, provide estimates of the number of establishments operated by C&D firms. These establishment counts, however, do not match those reported in the Economic Census. This inconsistency is partially due to differences in coverage (the SBA data include administrative establishments while the Economic Census does not) as well as differences in data collection methods.

14 For clarification, an *establishment* is defined as "a relatively permanent office or other place of business where the usual business activities related to construction are conducted" (U.S. Census Bureau, 2005). A *firm* refers to the aggregation of all establishments owned by one company; one firm, therefore, could consist of several establishments.

15 "The data excludes non-employer businesses, thus excluding many self-employed individuals (employment is measured in March, so firms starting after March, firms closing before March, and seasonal firms can have zero employment)." (U.S. SBA, 2004)

Table 3-16: Firms and Establishments by Employment Size, 2002 (SBA Data)

Description	Firms					Establishments				
	Total	0 Employees	<20 Employees	<500 Employees	500+ Employees	Total	0 Employees	<20 Employees	<500 Employees	500+ Employees
Building, developing, & general contracting	*224,578*	*40,136*	*210,588*	*224,101*	*477*	*226,394*	*40,136*	*210,646*	*224,691*	*1,703*
Land subdivision & land development	13,860	2,804	12,935	13,766	94	14,044	2,804	12,952	13,858	186
Single-family housing construction	160,917	31,607	156,527	160,821	96	161,677	31,607	156,550	161,044	633
Multifamily housing construction	9,007	1,557	8,208	8,975	32	9,043	1,557	8,208	8,992	51
Mfg & industrial building construction	2,342	477	1,858	2,280	62	2,406	477	1,861	2,299	107
Commercial & institutional building construction	38,452	3,691	31,060	38,259	193	39,224	3,691	31,075	38,498	726
Heavy construction	*38,739*	*5,579*	*30,976*	*38,355*	*384*	*39,949*	*5,579*	*30,992*	*38,717*	*1,232*
Highway & street construction	10,507	1,478	7,874	10,405	102	10,985	1,478	7,877	10,546	439
Bridge & tunnel construction	792	83	490	760	32	833	83	490	773	60
Water, sewer, & pipeline construction	10,520	868	8,141	10,468	52	10,652	868	8,141	10,524	128
Power & communication transmission line construction	4,077	488	3,246	4,031	46	4,325	488	3,249	4,065	260
Industrial nonbuilding structure construction	470	56	285	414	56	527	56	285	426	101
All other heavy construction	12,373	2,606	10,940	12,277	96	12,627	2,606	10,950	12,383	244
TOTAL	**263,317**	**45,715**	**241,564**	**262,456**	**861**	**266,343**	**45,715**	**241,638**	**263,408**	**2,935**
Percent of Total	**100%**	**17.4%**	**91.7%**	**99.7%**	**0.3%**	**100%**	**17.2%**	**90.7%**	**98.9%**	**1.1%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004)

Compared to the number of firms by employment size, the number of employees by employment size of firm (*Table 3-17*) shows a higher percentage of employees within firms with fewer than 500 employees. Nearly 80 percent of construction employees fall in firms with fewer than 500 employees compared to 35.4 percent of employees in firms with fewer than 20 employees.

Table 3-17: Employees by Employment Size of Firm, 2002 (SBA Data)

Description	Employees			
	Total	**<20 Employees**	**<500 Employees**	**500+ Employees**
Building, developing, & general contracting	*1,585,717*	*713,062*	*1,352,351*	*233,366*
Land subdivision & land development	90,669	39,087	77,288	13,381
Single-family housing construction	696,886	459,873	637,023	59,863
Multifamily housing construction	73,965	31,447	65,991	7,974
Mfg & industrial building construction	86,859	8,396	33,834	53,025
Commercial & institutional building construction	637,338	174,259	538,215	99,123
Heavy construction	*856,312*	*150,925*	*588,730*	*267,582*
Highway & street construction	274,144	41,231	209,040	65,104
Bridge & tunnel construction	36,671	2,945	22,065	14,606
Water, sewer, & pipeline construction	198,821	46,770	170,174	28,647
Power & communication transmission line construction	98,465	16,991	61,950	36,515
Industrial nonbuilding structure construction	91,921	1,354	11,942	79,979
All other heavy construction	156,290	41,634	113,559	42,731
TOTAL	**2,442,029**	**863,987**	**1,941,081**	**500,948**
Percent of Total	**100%**	**35.4%**	**79.5%**	**20.5%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004)

Similarly, as shown in *Table 3-18*, compared to the number of firms by employment size, a higher percentage of the total annual payroll falls in firms with less than 500 employees: 79.9 percent. Only 31.6 percent of the total annual payroll falls in firms with fewer than 20 employees and only 20.1 percent in firms with greater than 500 employees.

Table 3-18: Annual Payroll by Employment Size of Firm, 2002 (SBA Data) (in $1000's)

Description	Annual Payroll				
	Total	**0 Employees**	**<20 Employees**	**<500 Employees**	**500+ Employees**
Building, developing, & general contracting	*$65,730,491*	*$1,501,802*	*$24,493,876*	*$53,114,552*	*$12,615,939*
Land subdivision & land development	$4,100,107	$141,975	$1,677,639	$3,391,406	$708,701
Single-family housing construction	$25,396,809	$1,033,760	$14,330,522	$21,854,918	$3,541,891
Multifamily housing construction	$3,013,295	$66,323	$1,118,615	$2,599,681	$413,614
Mfg & industrial building construction	$3,828,813	$24,182	$328,447	$1,409,376	$2,419,437
Commercial & institutional building construction	$29,391,467	$235,562	$7,038,653	$23,859,171	$5,532,296
Heavy construction	*$42,673,726*	*$476,071*	*$9,708,025*	*$33,462,725*	*$9,211,001*
Highway & street construction	$13,767,501	$130,528	$2,269,776	$10,723,098	$3,044,403
Bridge & tunnel construction	$1,987,630	$15,070	$163,706	$1,234,340	$753,290
Water, sewer, & pipeline construction	$8,785,618	$68,245	$1,940,101	$7,382,229	$1,403,389
Power & communication transmission line construction	$3,909,650	N/A	$619,090	$2,246,478	$1,663,172
Industrial nonbuilding structure construction	$7,439,651	$157,498	$3,208,334	$7,173,693	$265,958
All other heavy construction	$6,783,676	$104,730	$1,507,018	$4,702,887	$2,080,789
TOTAL	**$108,404,217**	**$1,977,873**	**$34,201,901**	**$86,577,277**	**$21,826,940**
Percent of Total	**100%**	**1.8%**	**31.6%**	**79.9%**	**20.1%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004)

3.3.2.2 Number of Firms, Employees, and Annual Payroll by Firm Receipt Size

Table 3-19 through *Table 3-21* report 2002 data on the number of firms, establishments, annual payroll, receipts, and number of employees based on revenue size class. Again, the SBA data are for the year 2002, but the data are reported in the NAICS 1997 framework. *Table 3-19*, following page, shows SBA data on the number of employer firms and establishments, in 2002, based on revenue size class and 1997 NAICS industry groupings. These data show again that most segments of the C&D industry are dominated by small firms. Almost three-quarters (70 percent) of the firms in the target industry sectors reported under $1.0 million in revenue for 2002; 92.6 percent of firms reported revenue lower than $5.0 million.

Table 3-19: Firms and Establishments by Receipt Size, 2002 (SBA Data)

	Firms							Establishments						
Description	**Total**	**< $1 Million**	**< $5 Million**	**< $10 Million**	**< $50 Million**	**< $100 Million**	**More than $100 Million**	**Total**	**< $1 Million**	**< $5 Million**	**< $10 Million**	**< $50 Million**	**< $100 Million**	**More than $100 Million**
Building, developing, & general contracting	*224,578*	*161,023*	*210,748*	*217,230*	*223,097*	*223,793*	*785*	*226,394*	*161,030*	*210,801*	*217,356*	*223,421*	*224,340*	*2,054*
Land subdivision and Development	13,860	9,954	13,035	13,463	13,707	13,756	104	14,044	9,955	13,045	13,488	13,763	13,836	208
Single-family housing Construction	160,917	125,011	156,409	158,773	160,555	160,730	187	161,677	125,014	156,428	158,818	160,686	160,925	752
Multifamily housing Construction	9,007	6,063	8,290	8,581	8,907	8,956	51	9,043	6,063	8,291	8,584	8,917	8,968	75
Manufacturing and industrial building construction	2,342	1,354	1,964	2,107	2,252	2,272	70	2,406	1,354	1,966	2,115	2,263	2,289	117
Commercial and institutional building construction	38,452	18,641	31,050	34,306	37,676	38,079	373	39,224	18,644	31,071	34,351	37,792	38,322	902
Heavy construction	*38,739*	*23,185*	*33,182*	*35,581*	*37,999*	*38,304*	*435*	*39,949*	*23,186*	*33,211*	*35,638*	*38,199*	*38,604*	*1,345*
Highway and street construction	10,507	5,085	8,185	9,108	10,208	10,359	148	10,985	5,085	8,187	9,117	10,268	10,448	537
Bridge and tunnel construction	792	271	524	607	730	754	38	833	271	524	609	737	767	66
Water, sewer, and pipeline construction	10,520	5,666	8,972	9,756	10,424	10,468	52	10,652	5,666	8,973	9,759	10,457	10,521	131
Power and communication transmission line construction	4,077	2,704	3,675	3,879	4,013	4,035	42	4,325	2,705	3,682	3,894	4,045	4,074	251
Industrial nonbuilding structure construction	470	221	339	364	405	418	52	527	221	343	369	411	431	96
All other heavy construction	12,373	9,238	11,487	11,867	12,219	12,270	103	12,627	9,238	11,502	11,890	12,281	12,363	264
TOTAL	**263,317**	**184,208**	**243,930**	**252,811**	**261,096**	**262,097**	**1,220**	**266,343**	**184,216**	**244,012**	**252,994**	**261,620**	**262,944**	**3,399**
Percent of Total	**100%**	**70.0%**	**92.6%**	**96.0%**	**99.2%**	**99.5%**	**0.5%**	**100%**	**69.2%**	**91.6%**	**95.0%**	**98.2%**	**98.7%**	**1.3%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004)

Similar to the data reported by employment size classifications, data by receipt size classifications as shown in *Table 3-20*, shows a higher percentage of employees fall in the firms with the higher revenue classes. Although 70 percent of the firms fell into the revenue size class of less than $1 million, only 19.6 percent of employees fall in this same classification. Approximately 71.9 percent of employees fall in firms with less than $50 million in receipts.

Table 3-20: Employees by Receipt Size of Firm, 2002 (SBA Data)

	Employees						
Description	**Total**	**< $1 Million**	**< $5 Million**	**< $10 Million**	**< $50 Million**	**< $100 Million**	**More than $100 Million**
Building, developing, & general contracting	*1,585,717*	*400,687*	*825,818*	*970,528*	*1,233,903*	*1,309,200*	*276,517*
Land subdivision and Development	90,669	23,871	50,508	59,567	74,550	79,134	11,535
Single-family housing Construction	696,886	285,905	500,867	547,928	612,479	630,949	65,937
Multifamily housing Construction	73,965	17,655	39,583	46,495	59,613	63,197	10,768
Manufacturing and industrial building construction	86,859	4,352	13,713	18,076	31,152	33,198	53,661
Commercial and institutional building construction	637,338	68,904	221,147	298,462	456,109	502,722	134,616
Heavy construction	*856,312*	*78,309*	*235,250*	*323,108*	*522,640*	*587,321*	*268,991*
Highway and street construction	274,144	16,044	58,009	88,024	171,075	198,641	75,503
Bridge and tunnel construction	36,671	852	4,380	6,955	16,831	21,049	15,622
Water, sewer, and pipeline construction	198,821	22,295	76,111	105,053	161,175	173,543	25,278
Power and communication transmission line construction	98,465	12,210	32,437	43,571	59,581	64,028	34,437
Industrial nonbuilding structure construction	91,921	886	3,641	5,175	11,854	15,121	76,800
All other heavy construction	156,290	26,022	60,672	74,330	102,124	114,939	41,351
TOTAL	**2,442,029**	**478,996**	**1,061,068**	**1,293,636**	**1,756,543**	**1,896,521**	**545,508**
Percent of Total	**100%**	**19.6%**	**43.5%**	**53.0%**	**71.9%**	**77.7%**	**22.3%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004)

Again, compared to the data by employment size classifications, according to *Table 3-21*, a greater amount of the total annual payroll falls within the firms in the larger receipt size classifications. A much smaller percentage of total annual payroll, 11.4 percent, falls within those firms with fewer than $1 million in receipts. Most of the annual payroll (64.6 percent) is within those firms that have less than $50 million in receipts. As for firms with more than $100 million in receipts, 28.3 percent of the total annual payroll falls into this size category.

Table 3-21: Annual Payroll by Receipt Size of Firm, 2002 (SBA Data) (in $1000's)

	Annual Payroll						
Description	**Total**	**< $1 Million**	**< $5 Million**	**< $10 Million**	**< $50 Million**	**< $100 Million**	**More than $100 Million**
Building, developing, & general contracting	*$65,730,491*	*$9,841,223*	*$25,380,538*	*$31,902,959*	*$45,338,394*	*$49,455,644*	*$16,274,847*
Land subdivision and Development	$4,100,107	$766,932	$1,937,669	$2,351,978	$3,133,152	$3,382,706	$717,401
Single-family housing Construction	$25,396,809	$6,731,744	$14,439,948	$16,598,807	$19,983,582	$20,950,921	$4,445,888
Multifamily housing Construction	$3,013,295	$443,853	$1,201,777	$1,484,787	$2,134,387	$2,353,392	$659,903
Manufacturing and industrial building construction	$3,828,813	$110,322	$438,278	$642,612	$1,222,167	$1,328,145	$2,500,668
Commercial and institutional building construction	$29,391,467	$1,788,372	$7,362,866	$10,824,775	$18,865,106	$21,440,480	$7,950,987
Heavy construction	*$39,321,547*	*$2,141,039*	*$8,300,356*	*$12,394,074*	*$22,512,332*	*$25,874,624*	*$13,446,923*
Highway and street construction	$13,767,501	$497,076	$2,320,042	$3,823,119	$8,217,132	$9,730,007	$4,037,494
Bridge and tunnel construction	$1,987,630	$27,081	$192,793	$326,536	$901,508	$1,151,619	$836,011
Water, sewer, and pipeline	$8,785,618	$596,161	$2,640,097	$3,976,847	$6,788,390	$7,344,222	$1,441,396
Power and communication transmission line construction	$3,909,650	$300,671	$998,753	$1,426,230	$2,083,707	$2,317,027	$1,592,623
Industrial nonbuilding structure construction	$4,087,472	$23,904	$120,039	$184,471	$496,099	$673,946	$3,413,526
All other heavy construction	$6,783,676	$696,146	$2,028,632	$2,656,871	$4,025,496	$4,657,803	$2,125,873
TOTAL	**$105,052,038**	**$11,982,262**	**$33,680,894**	**$44,297,033**	**$67,850,726**	**$75,330,268**	**$29,721,770**
Percent of Total	**100%**	**11.4%**	**32.1%**	**42.2%**	**64.6%**	**71.7%**	**28.3%**

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004)

3.3.3 Small Entity Characterization

EPA used the establishment-level Economic Census data and firm-level data from SBA to estimate the number of entities in the C&D industry that are small businesses in accordance with SBA criteria. SBA uses size standards based either on number of employees or on annual revenue to define small entities (13 CFR 121). For all of the C&D industry groups, SBA's business size standards are based on annual revenue. The SBA revenue thresholds for the C&D industry are, as follows:

- NAICS 236 (*Construction of Buildings*): $33.5 million
- NAICS 237 (*Heavy and Civil Engineering Construction*), except 2372: $33.5 million
- NAICS 2372 (*Land Subdivision* of NAICS 237): $7.0 million

The data sources reviewed above do not provide data according to these exact size standards. As a result, the number of firms falling within the SBA small business classifications cannot be determined precisely from these data sources but must be estimated, using the data-reporting range from each data source that most nearly matches the SBA size classifications.

In using the *SBA data*, the data-reporting ranges most closely corresponding to the SBA thresholds are as follows:

- NAICS 236: $50 million (Overstates number of small businesses)
- NAICS 237, except 2372: $50 million (Overstates number of small businesses)

- NAICS 2372: $5 million (Understates number of small businesses)

Table 3-22 and *Table 3-23* present estimates of the number of entities falling within the SBA small business criteria, based, respectively, on SBA firm-level data and on Economic Census establishment-level data. Based on the SBA firm-level data, an estimated 260,424 C&D firms, representing approximately 99 percent of all businesses in the C&D industry, have revenue below the corresponding SBA thresholds listed above and, therefore could qualify as small businesses under SBA definitions. As reported in *Table 3-22*, this estimate of the number of firms qualifying as a small business is likely to be an overestimate, given the relationship between the SBA data reporting ranges and the SBA small business criteria. Furthermore, since the SBA data was reported in the 1997 NAICS framework, these numbers include residential remodelers, which are not included within the Economic Census data presented below. Thus, this number could be overstated by approximately 80,000 firms since residential remodelers are not included within the EA.

As described previously, approximately 99 percent of firms operate only one establishment. Thus, looking at the Economic Census data, which are reported for establishments instead of firms, also provides significant insight into the presence of small entities in the C&D industry. As expected, given the large percentage of single-establishment firms in the C&D industry, the 2002 Economic Census and SBA report very nearly the same numbers of entities, whether establishments or firms. However, as stated previously, the number of firms within the SBA data is overstated due to the inclusion of residential remodelers. In the same way as for the SBA data, Economic Census data are not reported in ranges that match precisely the SBA small business criteria values.

In using the *Economic Census data*, the data-reporting ranges most closely corresponding to the SBA thresholds are as follows:

- NAICS 236: $10 million (Understates number of small businesses)
- NAICS 237, except 2372: $10 million (Understates number of small businesses)
- NAICS 2372: $5 million (Understates number of small businesses)

Based on the Economic Census establishment-level data, approximately 167,007 C&D establishments, representing approximately 93.4 percent of all establishments in the C&D industry, have revenue below the corresponding SBA thresholds listed above. Given that nearly all C&D industry firms are single-establishment firms, this value, by definition, cannot be substantially different from the number and percentage of small business firms. As reported in *Table 3-23*, this estimate of the number of establishments potentially qualifying as a small business is very likely an underestimate, given the relationship between the Economic Census data reporting ranges and the SBA small business criteria.

In reviewing *Table 3-22* and *Table 3-23*, it is important to note that the subsector definitions differ for the two tables: the SBA-based data are reported in the 1997 NAICS sector framework; the Economic Census data are reported in the 2002 NAICS sector framework. This difference is most evident in the comparison of the total establishment and firm data since residential remodelers are not included within the Economic Census data presented but are included within the SBA data presented. Residential remodelers account for an additional 82,750 establishments. The difference is also evident in the comparison of the establishment and firm data for the NAICS 2372, *Land Subdivision*, where the reported number of firms, 13,860, is greater than the number of establishments, 8,403.

The SBA firm-level data suggests that 99 percent of total C&D industry firms are small firms, while the Economic Census data suggests that small firms make-up 93.4 percent of total establishments. As explained above, EPA considers the SBA data to slightly overestimate the percentage of small entities and the Census data to slightly underestimate the actual percentage. The conclusion that can be made from both estimates is that the C&D industry is dominated by small entities. Small firms, as defined according to SBA criteria, very likely represent more than 95 percent of all firms in the relevant C&D industry subsectors.

Table 3-22: Number of Firms Above and Below SBA Small Business Thresholds, 2002

From Small Business Administration Data						
NAICS Subsector	**SBA Revenue Threshold (million $)**	**SBA Reporting Range (million $)**	**Total Firms**	**Indicated Small Firms**	**Small Firms as Percent of Total**	**Under/Over Estimate**
Land subdivision and Development	$7.0	$5.0	13,860	13,035	94.0%	Underestimate
Single-family housing Construction	$33.5	$50.0	160,917	160,555	99.8%	Overestimate
Multifamily housing Construction	$33.5	$50.0	9,007	8,907	98.9%	Overestimate
Manufacturing and industrial building construction	$33.5	$50.0	2,342	2,252	96.2%	Overestimate
Commercial and institutional building construction	$33.5	$50.0	38,452	37,676	98.0%	Overestimate
Highway and street construction	$33.5	$50.0	10,507	10,208	97.2%	Overestimate
Bridge and tunnel construction	$33.5	$50.0	792	730	92.2%	Overestimate
Water, sewer, and pipeline construction	$33.5	$50.0	10,520	10,424	99.1%	Overestimate
Power and communication transmission line construction	$33.5	$50.0	4,077	4,013	98.4%	Overestimate
Industrial nonbuilding structure construction	$33.5	$50.0	470	405	86.2%	Overestimate
All other heavy construction	$33.5	$50.0	12,373	12,219	98.8%	Overestimate
Total	**–**	**–**	**263,317**	**260,424**	**98.9%**	**Overestimate**

For two of the C&D NAICS subsectors (236 and 237), the upper bound of the related SBA reporting range is below the SBA small business criterion. For these subsectors, the indicated small firm counts are almost certainly an *overestimate* of the number of small firms. For the subsector (2372), the upper bound of the reporting range is above the SBA small business criterion. For these subsectors, the indicated small firm counts are almost certainly an *underestimate* of the number of small firms. Given that subsectors 236 and 237 (except 2372) represent over 85 percent of the total of firms in the four subsectors, the total of the indicated small firm counts across the four subsectors is more like also an overestimate.

Note: SBA data and assignments by NAICS subsectors are based on the 1997 NAICS sector definition framework.

Figures do not necessarily add to totals due to rounding.

Source: U.S. SBA (2004) and U.S. SBA (2008)

Table 3-23: Number of Establishments Above and Below SBA Small Business Thresholds, 2002

From Economic Census Data						
NAICS Subsector	**SBA Revenue Threshold (million $)**	**Census Reporting Range (million $)**	**Total Estabs.**	**Indicated Small Estabs.**	**Small Estabs. as Percent of Total**	**Under/Over Estimate**
236115: New single-family housing construction (except operative builders)	$33.5	$10.0	58,472	57,759	98.80%	Underestimate
236116: New multifamily housing construction (except operative builders)	$33.5	$10.0	4,397	4,050	92.10%	Underestimate
236117: New housing operative builders	$33.5	$10.0	26,043	24,032	92.30%	Underestimate
236210: Industrial building construction	$33.5	$10.0	2,777	2,529	91.10%	Underestimate
236220: Commercial and institutional building construction	$33.5	$10.0	37,208	32,793	88.10%	Underestimate
237110: Water and sewer line and related structures construction	$33.5	$10.0	12,357	11,612	94.00%	Underestimate
237120: Oil and gas pipeline and related structures construction	$33.5	$10.0	1,403	1,211	86.30%	Underestimate
237130: Power and communication line and related structures construction	$33.5	$10.0	6,034	5,586	92.60%	Underestimate
237210: Land subdivision	$7.0	$5.0	8,403	7,851	93.43%	Underestimate
237310: Highway, street, and bridge construction	$33.5	$10.0	11,239	9,425	83.90%	Underestimate
237990: Other heavy and civil engineering construction	$33.5	$10.0	10,502	10,159	96.70%	Underestimate
Total	**–**	**–**	**178,835**	**167,007**	**93.4%**	**Underestimate**

Because the upper bound of the Economic Census reporting range is below the SBA small business criterion for all of the C&D subsectors, the indicated small establishment counts are almost certainly an *underestimate* of the number of small establishments, and the total of these values is therefore also likely an underestimate.
Note: Economic Census data and assignments by NAICS subsectors are based on the 2002 NAICS sector definition framework.
Figures do not necessarily add to totals due to rounding.
Source: U.S. Census Bureau's Economic Census (2005a) and U.S. SBA (2008)

3.4 Industry Dynamics and Forecast

By a number of measures, the C&D industry has historically been a relatively volatile sector, and is subject to wider swings of economic performance than the economy as a whole. Although the industry has been on a fairly continuous growth trend since 1964, there have been a few interruptions within this upward movement. Within the industry, residential construction, as compared to nonresidential and other public construction, has experienced the most volatility of business performance.

From 1991 to 2005, the industry overall grew steadily. Single-family housing, for example, grew from an annual level of 0.8 million housing starts in 1991 to 1.7 million housing starts in 2005, representing an average annual growth rate of 5.5 percent. During this same period, real GDP grew by an average of 3.2 percent per year (BEA, 2009a). Since 2006, however, the construction industry has experienced a downturn, with the weakness occurring mostly in the residential sector. To provide insight into recent industry performance and to provide a backdrop for understanding the outlook for the industry, this section first reviews:

- Annual value of total construction, private construction, and public construction indexed to real GDP (*Section 3.4.1*)
- Historical trend of key financial measures for selected public companies within these industries (*Section 3.4.2*)

The next subsections review a combination of historical data and industry forecasts:

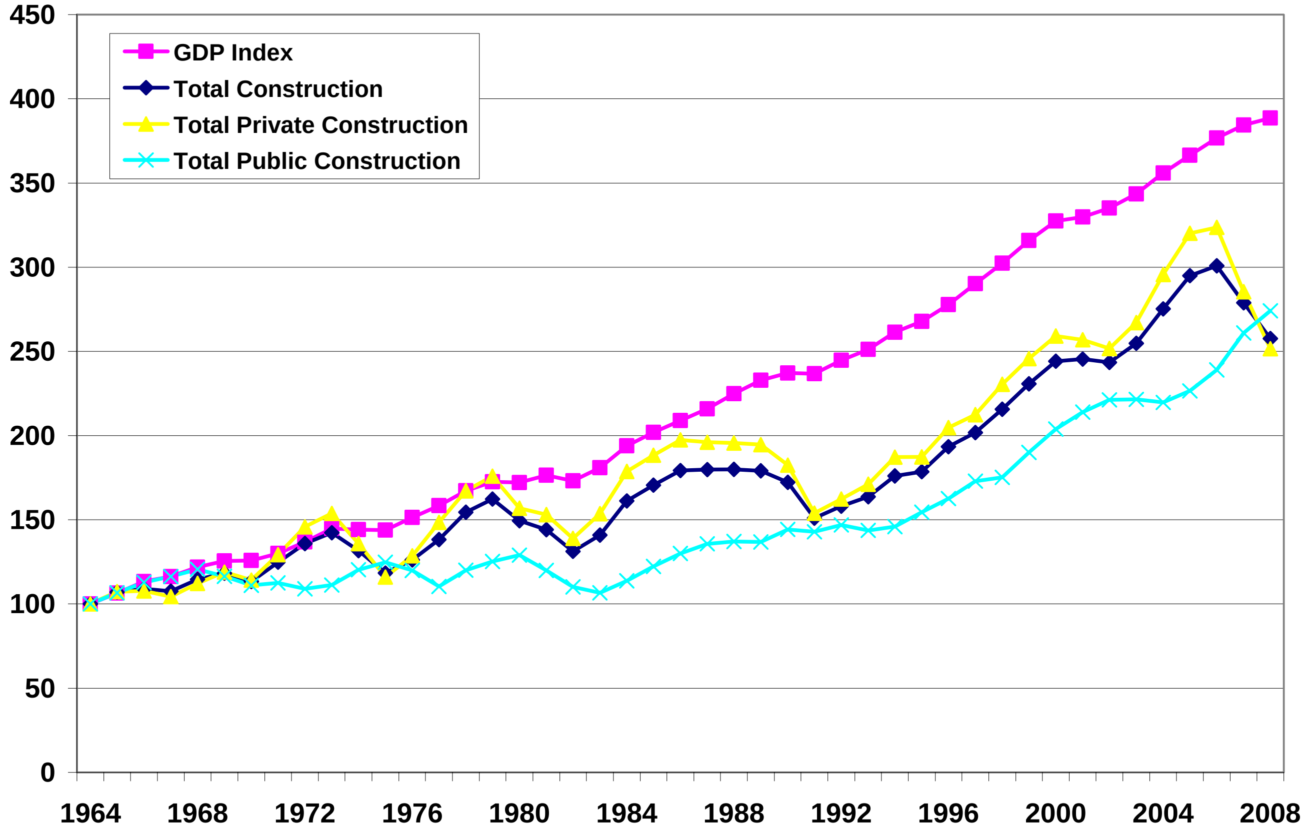
- Housing starts indexed to real GDP, and forecast of housing starts (*Section 3.4.3*)
- Value of construction by industry segment (*Section 3.4.4*)

The final subsection of the chapter provides a summary assessment of the outlook for the industry, as a whole.

3.4.1 Annual Value of Construction and Housing Starts Indexed to Real GDP

Figure 3-9 (*Total Construction*), *Figure 3-10* (*Private Construction*), and *Figure 3-11* (*Public Construction*) display the annual value of construction, by segment, indexed to 100 in 1964, with GDP for the period 1964-2008 (all underlying values in constant $2008). *Figure 3-14* presents annual housing starts and real GDP, again as index series over the same analysis period. All of these figures demonstrate the greater variability of the construction industry compared to the entire economy. Slight declines or slow-downs in the general economy, as occurred in 1981/1982, 1991/1992, and 2001/2002, are accompanied by much larger drops in construction industry activity (see *Figure 3-9*, below).

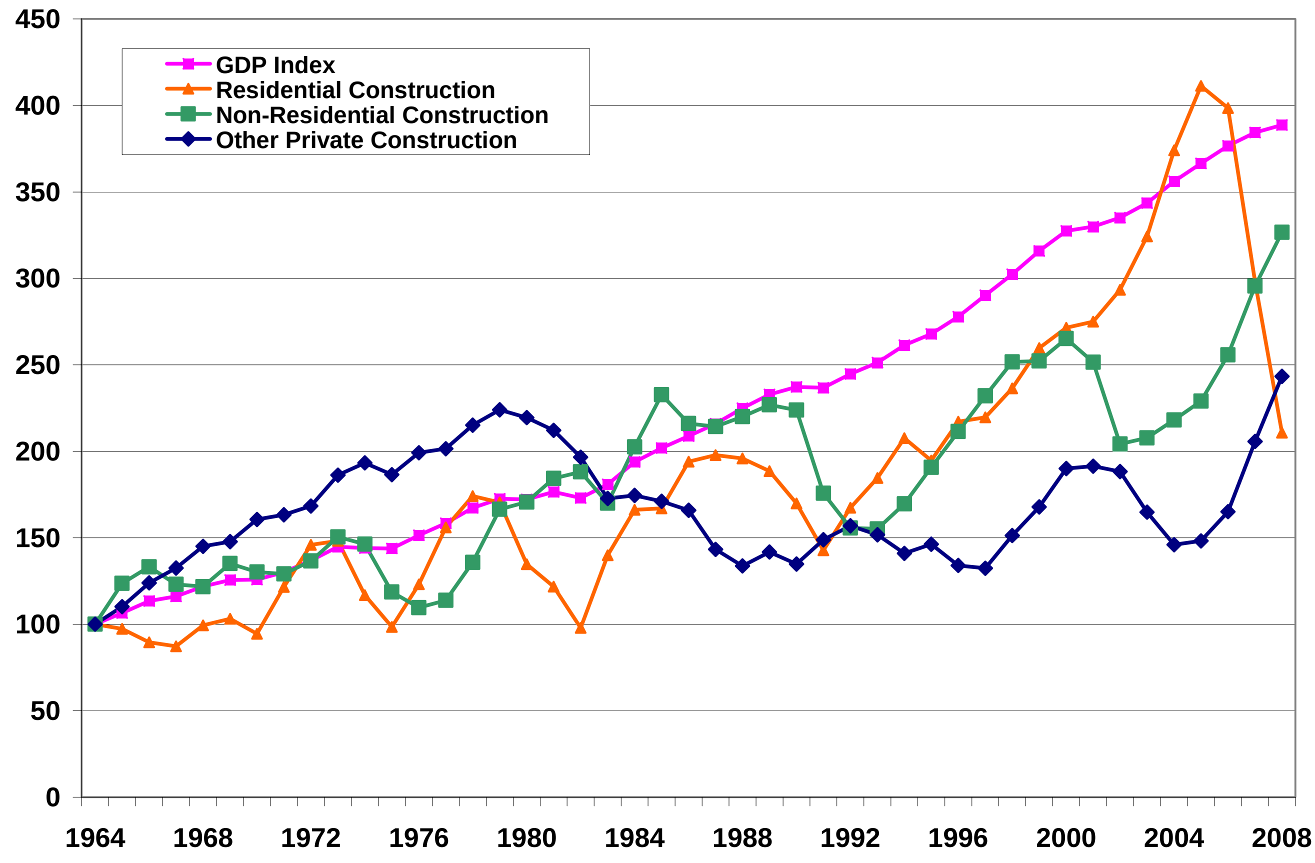
Figure 3-9: Annual Value of Total, Private, and Public Construction and Real GDP, as Index Series



Source: U.S. Census Bureau (2009a) and BEA (2009a)

Private residential construction shows considerably greater volatility than the construction industry as a whole. Before the trough in 1991, the annual profile of private residential construction varied substantially from year to year. Only after 1991 did private residential construction see relatively continuous growth persisting for a period of more than five years. As shown by the steeper curve segments in *Figure 3-10*, private residential construction grew more rapidly than the economy, as a whole, from the mid 1990s to 2005. However, as previously discussed, this segment began a sharp downturn in 2006, as shown in *Figure 3-10*.

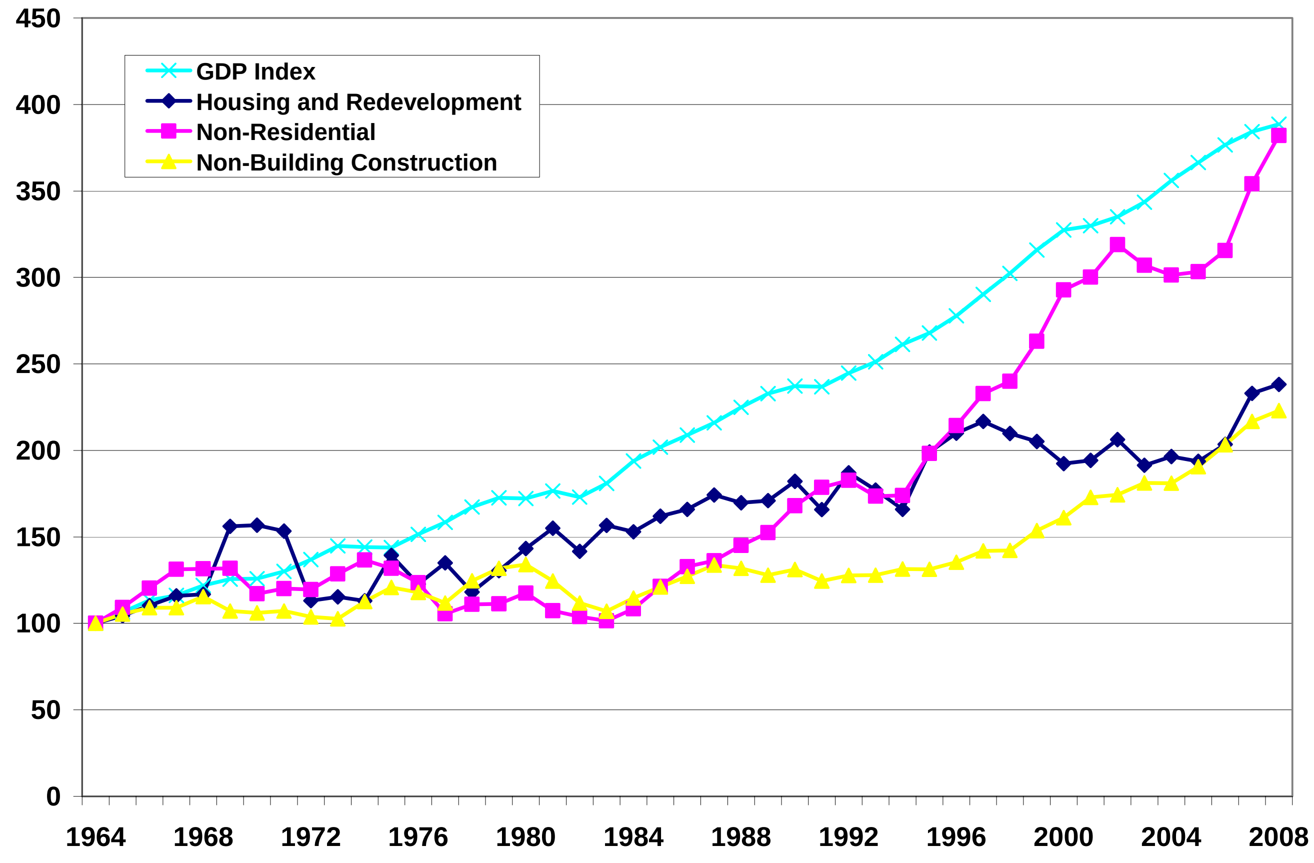
Figure 3-10: Annual Value of Private Construction and Real GDP, as Index Series



Source: U.S. Census Bureau (2009a) and BEA (2009a)

Overall, public construction has generally been less volatile, year-to-year, than private construction. However, the Housing and Redevelopment segment and the Non-Residential segment have shown greater volatility than the Other Public Construction segment and greater volatility than the national economy. All three segments have grown more slowly than the overall economy, although the Non-Residential segment grew faster than the general economy from 1993 to 2003.

Figure 3-11: Annual Value of Public Construction and Real GDP, as Index Series



Source: U.S. Census Bureau (2009a) and BEA (2009a)

3.4.2 Financial Condition and Performance

The financial performance and condition of the Construction and Development industry are important determinants of its ability to withstand the costs of regulatory compliance without material adverse economic/financial impact. To provide insight into the industry's financial performance and condition, and to bring these insights as near to the present as possible, EPA reviewed two key measures of financial performance – *net profit margin* and *return on total capital* – for public-reporting firms over the 16-year period, 1993-2008. EPA used data from the Value Line Investment Survey (VL) to construct these data series. The general company dataset of VL reports summary financial information for nearly all (approximately 7,000) publicly traded companies in the United States, and thus reports information for a substantial number of firms in the C&D industry.

The financial data summarized below repeat data items that are contained in the Risk Management Association (RMA) financial dataset, which underlies the development of the analytic frameworks used in EPA's analysis of firm and industry impacts (see Chapters 4 and 6). However, because the VL firms are all publicly traded and thus subject to Securities and Exchange Commission timely reporting requirements, these data come much closer to the present than the RMA data. At the same time, however, the VL data necessarily reflect only a subset of C&D industry firms – namely, the very large, publicly traded firms. Although these firms represent, in the aggregate, a substantial share of the total economic activity in the C&D industry, they represent only a small share of the *total* number of firms in the affected industry segments. Nevertheless, because these data are the best readily available financial data *that are reasonably current* for firms in the C&D industry, EPA judges that the data have substantial value for understanding current business performance trends in the industry.[16]

VL identifies and groups companies in a business content classification scheme that approximates 4-digit NAICS classifications. These business classifications support identification of firms within the Construction and Development industries at a level of sector detail sufficient for this analysis. The dataset is by company instead of by aggregate groups and the business classifications are defined by practical business content instead of in a rigid SIC or NAICS classification scheme. The VL dataset reports key accounting items that will readily support an analysis of the trend of two key financial metrics: *net profit margin* and *return on total capital*.

As discussed above, VL organizes firms by industry groups, which, in most instances, approximate 4-digit NAICS classifications. From review of the VL industry groups and the Construction and Development industries, EPA selected two VL industry groups – *Homebuilding* and *Heavy Construction* – and the 44 firms within these industry groups as candidates for this analysis.[17] Following review of the firms within these industry groups, EPA retained 37 firms for use in this analysis.[18] Key considerations in selecting the firms are as follows:

- Within the industry groups, only those firms whose business operations reasonably match the profile of business activities of the two Construction and Development industries, *Building Construction* and *Heavy Construction*, were considered candidates for the analysis. In the industry groups, some firms included in the VL industry groups were excluded from the analysis because they were not engaging in the activities applicable to the scope of the Construction and Development regulation.
- EPA retained only those firms that are based in the United States.
- EPA retained only the firms for which some or all of the financial data were available during the period 1993-2008.

EPA organized the 37 firms selected for the analysis into two industry groups: the *Residential Construction* industry includes 25 firms and the *Non-Residential/Non-Building Construction* industry includes 12 firms. The *Residential Construction* industry is comprised of single-family and multifamily designers, developers, homebuilders, and sellers. The *Non-Residential/Non Building Construction* industry is comprised of companies specializing in the design, engineering, project management, and construction of non-residential buildings and infrastructure.

To provide insight into the industry's historical financial performance and condition, EPA calculated *net profit margin* and *return on total capital* measures as a *revenue-weighted average* for the firms in the respective industries. In some instances, VL did not report a data item for some firms in one or more years in the analysis

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16 EPA also used the VL dataset to develop adjustment factors applied to the 2007 RMA-reported values to construct "Adverse Business Conditions Case" financial statement values that reflect more current financial condition and performance of the homebuilding segment of the C&D industry.

17 EPA also selected one company, Tutor Perini Corp., from the VL *Industrial Services* industry not identified in either of these segments, but identified as also being substantially involved in heavy construction activity.

18 The firms in the VL dataset report data for each fiscal year, 2008 being the latest. Of the 37 firms identified for this analysis, 23 report a fiscal closing date of 12/31/2008. Ten of the remaining 14 firms report a fiscal closing date within 3 months of 12/31/2008, and one firm reports a fiscal closing date within 6 months of 12/31/2008. VL did not report data for 2008 the remaining three firms.

period; in these cases, the average values of the financial metrics were simply calculated without the firms with missing data.[19]

Net profit margin is calculated as after-tax income before nonrecurring gains and losses as a percentage of sales or revenue, and measures profitability, as reflected in the conventional accounting concept of net income. Over time, the firms in an industry, and the industry collectively, must generate a sufficient positive profit margin if the industry is to remain economically viable and attract capital. Year-to-year fluctuations in profit margin stem from several factors, including: variations in aggregate economic conditions or variations in industry-specific market conditions.

Return on total capital is calculated as annual net profit, plus one-half of annual long-term interest, divided by the total of shareholders' equity and long-term debt (total capital). This concept measures the total productivity of the capital deployed by a firm or industry, regardless of the financial source of the capital (i.e., equity, debt, or other liability element). As such, the return on total capital provides insight into the profitability of a business' assets independent of financial structure and is thus a "purer" indicator of asset profitability than return on equity. In the same way as described for net profit margin, the firms in an industry, and the industry collectively, must generate, over time, a sufficient return on capital if the industry is to remain economically viable and attract capital. The factors causing short-term variation in net profit margin will also be the primary sources of short-term variation in return on total capital.

Figure 3-12 and *Figure 3-13*, following pages, show trends in net profit margins and return on total capital for the Residential and Non-Residential/Non-Building segments between 1993 and 2008. The decline in the residential construction segment starting in 2006 as well as the relatively stronger performance in the non-residential/non-building segment experienced since 2002, are apparent in both of these figures.

For both financial metrics, the residential construction segment shows a sharp decline in financial performance beginning in 2006 and continuing through 2008. Clearly, the financial performance of this segment of the C&D industry has been strongly affected by the challenges facing the housing sector and economy, generally, as described in preceding sections. On a modestly favorable note, the decline during 2008 is not as severe note as the decline during 2007. Regardless, the levels of financial performance achieved during these most recent years are not indicative of the longer-trend of performance in the segment, and the segment will necessarily need to return to historical performance levels to sustain itself as a viable industry capable of attracting capital over the longer term. The most recent data on housing starts suggest that the segment is in the beginning stages of this business recovery. In addition, the public market valuations of firms in the home-building segment also indicate an improving outlook for this segment. For example, the Dow Jones U.S. Home Construction index, which reflects a basket of U.S. firms in the homebuilding and closely related business sectors, has increased by approximately 30 percent since the beginning of 2009, and by approximately 100 percent since the overall low point in U.S. equity markets in March 2009. This equity market performance is indicative of the public capital markets' improving confidence in the business outlook for the homebuilding industry.

In contrast, the non-residential/non-building construction segment shows continued financial strength through 2008, with both performance metrics recording increases in 2008. The performance of this segment may weaken during the current year, but through 2008, the overall understanding of financial performance and condition for this segment is no different from, and in fact, stronger than that observed in the data presented earlier in this chapter.

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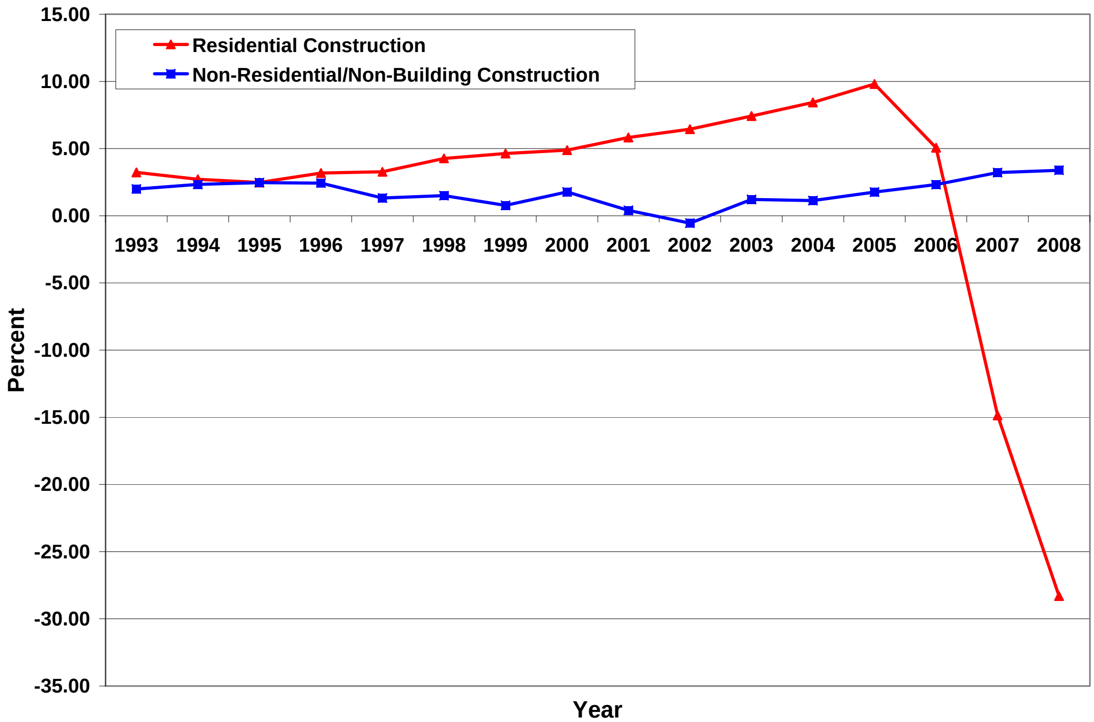
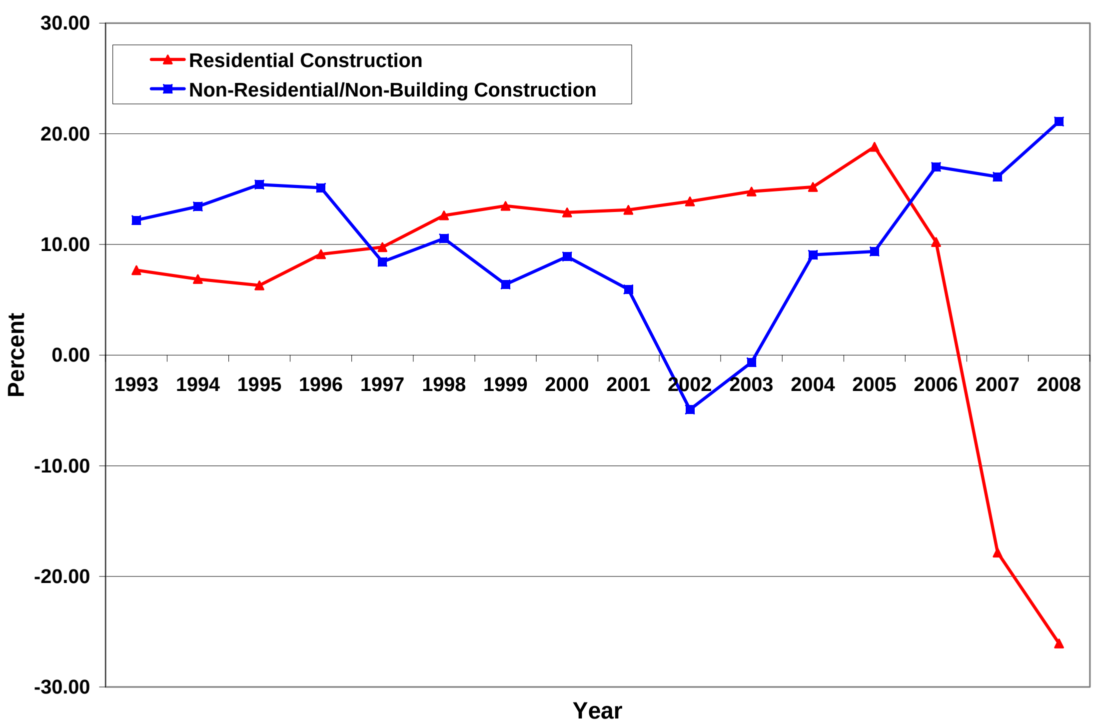
[19] The revenue-weighted calculation of *net profit margin* was based on the aforementioned 37 firms. However, the revenue-weighted calculation of *return on total capital* was based on 35 firms because VL did not report the data item for two firms during the 16 year time period for this variable.

Figure 3-12: Historical Net Profit Margin, Based on Public Company Data from ValueLine



Source: ValueLine, 2009

Figure 3-13: Historical Return on Total Capital, Based on Public Company Data from ValueLine

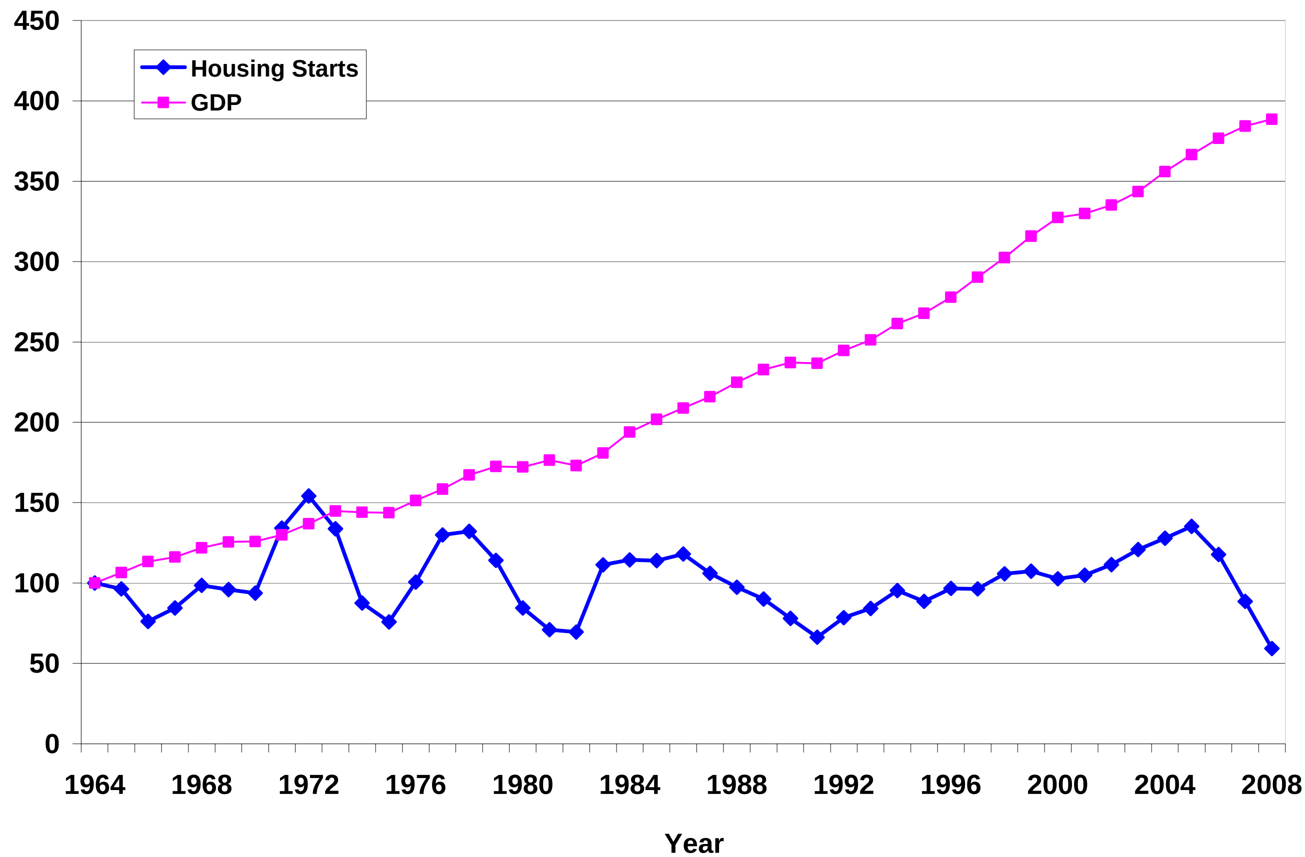


Source: ValueLine, 2009

3.4.3 Housing Starts: Actual and Forecast

Annual housing starts, as an index and compared with real GDP, also illustrate the higher variability within the residential construction industry compared to the economy as a whole (see *Figure 3-14*). This exhibit also shows the fairly stable growth trend of housing starts over the past 10-15 years and the corresponding drop in housing starts in 2006 through 2008.

Figure 3-14: Annual Housing Starts and Real GDP, as Index Series



Source: U.S. Census Bureau (2009b) and BEA (2009a)

Figure 3-15, page 3-49, reports *annual* housing starts from 1992 to 2005 (in the red, dashed line) and *quarterly* housing starts from 2006 Q1 to 2009 Q1 (in light purple). The quarterly values have been multiplied by four to approximate annual equivalents. The substantial fall-off in housing construction beginning in the second quarter of 2006 and continuing through 2008 is apparent. One of the main reasons 2007 showed such a substantial decline is a speculative run-up in house prices accompanied by a substantial acceleration in new housing supply, which was most widespread within single-family housing. As a result, single-family housing activity declined more substantially than multi-family housing construction activity. Standard and Poor's Industry Outlook for the housing construction sector provides a similar assessment: since late 2006, the housing market has experienced a downturn after nearly a decade of rising home prices and strong demand. On the other hand, S&P believes that during the current housing downturn, "homebuilders continue to reduce lot inventories and lower outstanding debt…builders are strengthening their balance sheets by boosting cash or reducing debt" (S&P, 2009). S&P forecasts that market stability should occur by the end of 2009 when housing prices should pass their trough and home inventories continue to decline due to the decrease of foreclosures. According to S&P, a new, stable equilibrium of supply and demand, should be reached by 2011.

Another construction industry business analysis firm, Global Insight, provides further assessments of the construction industry (Global Insight, October 2008, July, August 2009). Due to relatively low interest rates and aggressive credit practices, mortgage rates for home purchases remained historically low until recently. However, in 2005, housing affordability began to decline with increasing home prices and mortgage lending rates. In addition, an increasing volume of home sales were accomplished via non-traditional financing arrangements in which interest rates and/or principal payments might be maintained at low levels during the early years of a loan, with the expectation of increasing to more traditional structure levels within a few years of loan issuance. As interest rates were marked to market and payment obligations increased under these non-traditional mortgages, loan payment delinquencies and foreclosures began to increase. These foreclosures added to the excess supply of homes on the market.

Beginning in mid-2005, new and existing *home sales* started to fall sharply. However, as demonstrated by *Figure 3-15*, *housing starts* continued to increase well into the first quarter of 2006, adding to the already large inventory of unsold homes. Global Insight assesses that housing starts bottomed out in mid 2009 at approximately 500,000 total starts and new home sales reached their trough in early 2009 at approximately 340,000 sales. Even with home prices rising in most parts of the country, new home sales have been rising for the fourth month in a row, increasing 9.6 percent in July (ElBoghdady, 2009). This is due in large part to housing affordability being at record highs: the National Association of Realtors (NAR) Housing Affordability Index (HAI) reached a record high of 166.7 in March, 30.8 percentage points higher than a year ago[20] (NAR, May 2009a). Another key factor pointing to recovery in residential segment construction is the inventory of unsold homes. According to the Washington Post, 271,000 new homes were for sale in July, "the lowest reading since March 1993." As the unsold inventory declines, developers and builders will see economically attractive opportunities for new home construction and will be more confident to commit the capital needed for these new home ventures.

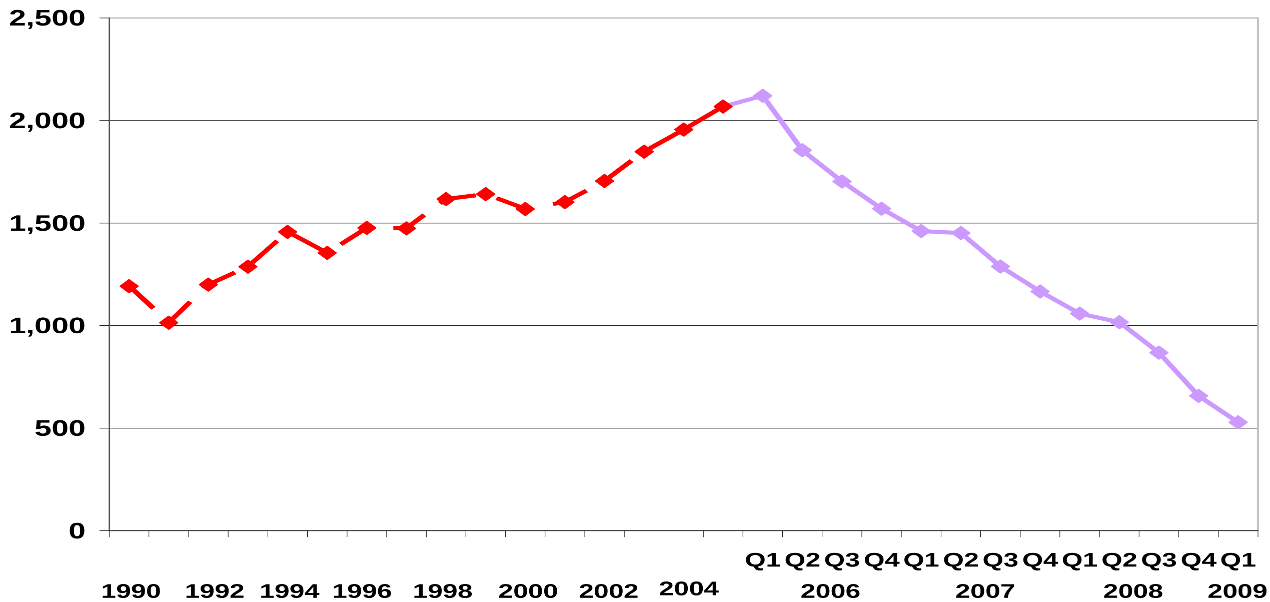
Although the single-family market appears to be in recovery, the multifamily segment activity may be recovering at a slower pace. Although this subsegment is assessed has having an activity trough, for example, by Global Insight, the subsegment appears to be recovering more slowly than the single-family subsegment. Financing for new multifamily housing construction remains more challenging than for new single-family construction and sales, and this subsegment is therefore projected to recover at a slower pace than single-family construction (Barrons, 2009). Longer term forecasts project that total housing starts will continue increasing until 2013/2014 when they are near their forecasted long-term trend of 1.7 million starts (see *Table 3-24* for Global Insight's projection of housing starts) (Global Insight July 2009, October 2008).

Although housing starts and sales have been returning to a positive growth trend, home prices are lagging behind and are not expected to return to a positive growth trend until late 2010/early 2011 due to the high inventory levels and the high foreclosure rate. Nonetheless, Global Insight believes that regardless of the current housing weakness, falling home prices coupled with continued long-run demand for housing will eventually return the housing market to a sustainable market equilibrium of increased construction and sales of new housing (Global Insight, November 2007). Long-run demand factors – household formation, demand for second homes, and demolitions – will also support recovery in the residential construction segment. According to Harvard University's Joint Center for Housing Studies, the number of new homes demanded will increase due to demographic factors such as increased immigration and the aging of the echo-boom generation and the longer life expectancy of baby-boomers (Joint Center, 2008). Household formation growth is expected to increase to 14.4 million during 2010-2020, compared to 12.6 million during 1995-2005 (Joint Center, 2008). Demolitions are also expected to increase due to the aging housing stock, thus supporting demand for new homes to replace older units.

[20] "The Housing Affordability Index is a relative index where a value of 100 means that a family with the median income has exactly enough income to qualify for a mortgage on median-priced existing single-family home, taking into account the relationship between median home price, average effective interest rate for loans closed on existing homes, and median family homes. The higher the index, the better housing affordability is for buyers" (NAR, May 2009a).

In a long-term forecast for the housing construction industry published by the National Association of Home Builders (NAHB) in 2006, NAHB forecasted that, on average, annual housing starts in the next ten years will exceed those of the previous decade – despite the current weakness of the housing construction industry. The NAHB publication forecasts that households trading up for larger homes will cause an upturn from 2010 to 2015 (NAHB, 2006).

Figure 3-15: Annual Housing Starts from 1992 to 2005 and Quarterly Housing Starts from Q1 2006 to Q1 2009 (in Thousands of Units)



Note: Quarterly figures were multiplied by four to allow for comparison among annual and quarterly housing starts.
Source: U.S. Census Bureau (2009b)

Table 3-24 reports the number of actual housing starts for 2004 through 2008, and forecasted starts by Global Insight, Reed Construction, and Mortgage Bankers Association (MBA) for 2009 through 2014 (Reed's and MBA's projections are only until 2011). The 12.9 percent decrease from 2005 to 2006 reflects the beginning of the decline in housing starts after the 2005 peak and the 24.8 and 33.2 percent decrease in housing starts from 2006-2007 and 2007-2008, respectively, demonstrates the continued decline. Reed's August forecast, Global Insight's July forecast, and MBA's August forecast all show a continuation of this trend through 2009, with housing starts projected to decrease by 37.4 percent (Reed), 38.9 percent (Global Insight), and 36.3 percent (MBA). According to Global Insight, due to the large decrease in inventories of unsold new homes, housing starts and new home sales hit their trough in the early to mid part of 2009. Both single-family and multifamily starts are expected to improve over the next two to three years, with full recovery expected in 2012/2013.

Table 3-24: Housing starts, Actual and Forecasts (in Millions of Starts)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Housing Starts	2.07	1.80	1.36	0.91	**Reed Forecast**					
					0.57	0.71	0.90	-	-	-
					Global Insight Forecast					
					0.56	0.87	1.29	1.56	1.66	1.67
					MBA Forecast					
					0.58	0.71	0.98		-	-
Housing Starts, year-to-year Percent Change		-12.9%	-24.8%	-33.2%	**Reed Forecast**					
					-37.4%	23.2%	26.8%	-	-	-
					Global Insight Forecast					
					-38.9%	55.6%	49.6%	20.8%	6.1%	0.4%
					MBA Forecast					
					-36.3%	22.4%	38.0%		-	-

Source: Actuals: U.S. Census (2009b); Forecasts: Reed Construction Data (August 2009b), Global Insight (July 2009), and Mortgage Bankers Association (August 2009)

3.4.4 Value of Construction by C&D Industry Segment: Actual and Forecasts

Residential construction, although now appearing to be on a recovery path, has experienced a clear decline in housing starts since early 2006 as illustrated in *Figure 3-15* and *Table 3-24*. However, housing starts and sales have increased since the middle of 2009. Throughout 2006 and 2007, while residential construction was experiencing housing start declines and negative growth, non-residential construction somewhat offset this weakness. *Table 3-25*, following page, lists the value of construction in constant 2008 dollars, by segment, for previous years (from the BEA) and for forecasted years (from Global Insight). As shown in the table, residential construction reported a relatively large *decrease* in construction value (-17.8 percent) from 2006 to 2007. At the same time, non-residential construction reported a relatively large *increase* in construction value (12.9 percent) from 2006 to 2007. Looking to the future, for 2010, Global Insight projected (in its July 2009 forecast) a return to growth for the residential segment (9.5 percent) but projects weakness in the non-residential segment (-14.2 percent). The non-building sector (i.e., largely publicly-funded projects), is also expected to see flat to declining growth through 2009 before turning up in 2010 and 2011. In short, after experiencing flat to modestly declining performance through 2010, the *overall* industry is expected to achieve positive business performance beginning in 2010 and continuing longer term. Specifically, Global Insight projects a slight decline for the construction industry overall in 2010 (-1 percent) and, beyond 2010, expects the overall industry to perform more favorably with projected total growth of 13.3 percent in 2011 and 12.3 percent in 2012, before returning to a more sustainable *real* growth (i.e., in dollar values adjusted for inflation) of 2.8 percent, overall, in 2014 (Global Insight, July 2009).

Table 3-25: Value of Construction, Actual and Forecasts (in 2008 Billions of Dollars)

		Actual				Forecasts					
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Nonresidential	Value	$303.36	$328.83	$371.39	$414.74	$340.31	$292.08	$303.22	$345.58	$385.85	$408.87
	Percent Change		8.40%	12.94%	11.67%	-17.95%	-14.17%	3.81%	13.97%	11.65%	5.96%
Residential	Value	$719.44	$685.46	$567.69	$430.04	$331.01	$362.47	$466.65	$551.11	$587.35	$595.30
	Percent Change		-4.72%	-17.18%	-24.25%	-23.03%	9.50%	28.74%	18.10%	6.57%	1.35%
Government	Value	$242.75	$239.44	$248.62	$251.32	$244.22	$251.69	$255.36	$254.87	$256.95	$260.01
	Percent Change		-1.36%	3.83%	1.08%	-2.83%	3.06%	1.46%	-0.19%	0.82%	1.19%
Total	**Value**	**$1,265.55**	**$1,253.74**	**$1,187.70**	**$1,096.10**	**$915.54**	**$906.24**	**$1,025.23**	**$1,151.56**	**$1,230.15**	**$1,264.18**
	Percent Change		**-0.93%**	**-5.27%**	**-7.71%**	**-16.47%**	**-1.02%**	**13.13%**	**12.32%**	**6.82%**	**2.77%**

Source: BEA (2008 and 2009b) and Global Insight (July 2009)

Reed Construction, a commercial construction industry data service that collects and reports information on U.S. multifamily, commercial/institutional, and industrial construction projects, also projected recently (August 2009) that the residential sector will begin recovery in 2009 through 2010. According to Reed, the housing turnaround has and will be slow but due to federal assistance such as the mortgage payment forgiveness program, foreclosures are decreasing, a key driver in the single-family housing recovery. Overall, Reed Construction projects that residential construction will see an increase in activity of nearly 14.4 percent from 2009 to 2010. Reed projects an increase in single-family and multifamily starts from 2009 to 2010 of 27.9 and 5.5 percent, respectively. (Reed Construction, August 2009b).

The non-residential sector, which often lags the residential sector, has been in a period of weakness since early 2009 after starts and spending peaked in mid to late 2007 (Reed, July 2009a). This decline is attributed to overbuilding in the retail, lodging, and higher education construction sectors, the tight credit market, overpriced commercial real estate, and increased vacancy rates due to the weak economy (Global Insight, August 2009). According to the NAR, commercial real estate will continue to face negative absorption, increasing vacanies for all property types, and declining rents (NAR, August 2009b). However, this industry segment is expected to turn around by late 2010 as (1) the U.S. economy recovers from the current recession, (2) the inventory of excess building is eliminated, and (3) actions of the Federal Reserve improve the flow of capital into commercial lending (NAR, August 2009c). *Table 3-26*, below, lists year-to-year forecasts (from July 2009) for non-residential construction during the periods 2008/2009 and 2009/2010. Overall, the average consensus among these forecasts is a 15.8 percent *decrease* for 2008/2009 and a 11.6 percent *decrease* for 2009/2010. Although declines are expected for the remainder of 2009 and most of 2010, Global Insight projects a return to positive growth into 2011 (3.8 percent), as presented in *Table 3-25*.

Table 3-26: Non-Residential Value of Construction Growth, Compared Forecasts

	McGraw-Hill Construction	**Global Insight**	**Portland Cement Association**	**Moody's Economy.com**	**FMI**	**Reed Business Information**	**CONSENSUS**
Percent Change 2008-2009	-20.6%	-18.0%	-26.1%	-7.0%	-14.8%	-4.5%	**-15.8%**
Percent Change 2009-2010	-3.8%	-14.2%	-19.4%	-5.2%	-20.3%	-4.2%	**-11.6%**

Source: Global Insight (July 2009) and American Institute of Architects (July 2009)

Nonbuilding construction, of which the transportation and pipelines sectors may be affected by this rule, has generally experience flatter, less cyclical growth as compared to the building construction sectors. Nevertheless, this sector has been affected by the recession due to decreased state and local government spending. However, due to the federal stimulus funding, this sector is expected to see good growth in 2011, an approximately 5 percent increase in spending. The increase in spending and activity effect in 2010 is limited, since the majority of the federal stimulus spending on infrastructure projects is expected to occur in 2010 and 2011 (Reed, August 2009c; Global Insight, August 2009).

3.4.5 Overall Outlook

In summary, the construction industry overall is expected to recover from its current weakness by 2011, with the residential construction segment beginning recovery during late 2009 and continuing through 2010. The nonresidential segment entered a period of weakness during 2009, but is also expected to resume growth by 2011 as the economy recovers from the current recession.

Currently, the C&D rule is scheduled to be promulgated at the end of 2009. However, EPA anticipates that the rule's requirements will become practically effective over the timeframe of 2010 through 2014, as states incorporate the rule's requirements into their construction general permits as they come up for renewal.[21] In addition, in the final rule, EPA has delayed the effective compliance date of certain requirements.

Given the construction industry outlook and the reality that the rule's requirements will not be immediately applicable throughout the country, EPA expects the industry will have achieved sufficient business performance to absorb the rule's requirements without undue adverse effect.

[21] Under the NPDES program, authorized states renew their general permits every five years.

4 Developing the Analysis Baseline

In most previous effluent limitations guideline rulemakings, EPA has used its authority under §308 of the Clean Water Act to gather data on the technologies in use and financial characteristics of firms directly from the potentially regulated firms. This data is usually gathered via survey, and whenever there is an industry survey, the questionnaire must first be approved by OMB under the authority of the Paperwork Reduction Act (PRA). The PRA requirements essentially impose a minimum of nine months' time associated with the approval process prior to fielding a survey. While work can proceed during this time, the nine months is largely in addition to the time it takes to develop and field a survey and analyze the resulting data. Given that the district court order included specific dates by which the proposed and final rule were to be published, the three years allotted to EPA to complete the rulemaking effectively eliminated the option of gathering data from firms in the construction industry by survey.

The data collected in an industry survey is used to establish the baseline conditions in the industry. A financial analysis of the baseline often shows that some firms in the industry are in poor financial health even before the regulation being analyzed, and if this condition is very poor, the firms may not be expected to survive even if they face no additional costs due to the regulation. These "baseline closures," as they are often called, are set aside from the set of firms analyzed to determine the economic impacts of the regulation. At the level of the firm, compliance costs represent the difference between the baseline and post-regulation industry conditions, and vary with the regulatory options considered. In technology-based regulations, the compliance costs are estimated with a high degree of confidence, and can represent an accurate upper bound on compliance costs.[22] The economic impacts analysis is a description of how firms fare in the post-regulation world, but depends not just on the compliance costs, but also the baseline conditions; high compliance costs at a very financially healthy firm may leave the firm in a still healthy financial position while very low compliance costs at a financially weak firm may result in closure of the firm.

In the absence of primary survey data, other sources of secondary data could instead be used to construct an estimate of baseline conditions. One data source provided EPA with a rich source of information on construction projects; this source of information was useful in developing compliance cost estimates, because compliance costs are critically dependent on characteristics and features of the project. Another data source provided EPA with a rich source of information on the financial health of construction firms through income statement and balance sheet information, which was particularly important for the economic impacts analysis of Chapter 6. Two other data sources provided information on overall activity in the construction sector of the economy, which allowed EPA to devise a process of attributing projects to firms.

It was important for EPA to develop a relationship between project acreage and construction value in order to project future costs and impacts. EPA calls this relationship acreage intensity, which is defined as the acres of construction per million dollars of revenue (2008$). Acreage intensity allows EPA to construct national estimates of affected acreage in each year from projections of future revenue in the construction industry. This national acreage is then allocated to states, industry NAICS sectors, construction type (residential, non-residential, and transportation) and model projects. The model project classification is a 12x12 matrix of project size (acreage) by project duration (time of construction); the 12 ranges that define each dimension are mutually exclusive and

[22] Many technology-based regulations, including effluent limitation guidelines, are written as performance standards rather than design standards. A performance standard means a firm is free to choose any technology to comply as long as they meet the standard. Because the costs have been analyzed for a technology known to be technically feasible, economically available, and meet the standard, EPA is confident that it has estimated the upper bound of costs faced by firms.

exhaustive; EPA uses the median project size in each range and the midpoint of the project duration range to represent these projects (see Exhibits 4-1 and 6-1). The distribution of projects across cells in the model project matrix is determined from the Notice Of Intent (NOI) data from four states which are applied to each of the remaining 46 states and the District of Columbia (see Exhibit 4-15).

Ultimately the matrix of model projects shows projects as follows: the projects that even the smallest firms are capable of conducting are in the NE corner of the matrix, which represents the smallest size and longest duration projects. As projects become either larger in size (later rows) or shorter in duration (earlier columns), the firms that remain capable of conducting those projects is a successively smaller and smaller set, until reaching the projects in the SW corner, which only the largest of firms are capable of conducting.

The industry is in a downturn in 2008; if EPA were to base its analysis on the actual 2008 level of activity and then project the long-term growth from that starting point, it would be tantamount to assuming that this sector never rebounds to normal business conditions. Instead, EPA uses 19 years of value data to estimate a long-term trend, and then uses the values predicted from that trend relationship for 2008 instead of the actual values. Then EPA determined the underlying financial characteristics of the 42 model firms using Risk Management Association (RMA) data.

This chapter presents the baseline specification of aggregate C&D activity, the industry segments affected by the final rule, and the model C&D firms, all of which underlie the economic analysis of the final rule:

- *Section 4.1* describes the estimated baseline quantity of aggregate acreage and number of projects developed annually by the C&D industry.
- *Section 4.2* describes how aggregate C&D activity is distributed in the baseline across states, C&D industry segments, and ultimately, individual model project categories;
- *Section 4.3* describes the initial industry baseline for C&D industry entities that are affected by the final regulation, based on the 2002 Economic Census;
- *Section 4.4* describes how the initial industry baseline was updated to reflect the anticipated structure and composition of the C&D industry during 2008, based on the industry's long-term trend. The 2008 *trend-based* specification of the C&D industry (e.g., number of firms, revenues) is used to support the *General Business Conditions* analysis of firm- and industry-level impacts due to the final regulation;[23]
- *Section 4.5* presents the baseline specification of the model C&D firms used to support the firm- and industry-level economic analysis; and,
- *Section 4.6* highlights the primary sources of uncertainty and limitations in the analysis baseline.

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23 An alternative analysis, aimed at assessing impacts of the regulation on the industry during *Adverse Business Conditions* was also developed, and is presented in *Appendix A*. This analysis reflects a baseline derived from reported industry activity in the residential sector for 2008, as opposed to estimates of 2008 activity based on the industry's long-term trend. For the non-residential construction and non-building sectors, EPA estimated the deviation from trend by these sectors during periods of weak business performance, and used this deviation to reduce total activity from the actual 2008 values to derive an *Adverse Business Conditions* case activity value. EPA judges the *General Business Conditions* to be a more accurate representation of the industry's long-run steady-state condition in terms of quantity of activity and financial condition, whereas the *Adverse Business Conditions* case more accurately reflects the current, rare condition of the industry.

4.1 Estimating the Baseline Quantity of Acreage Developed Annually by the C&D Industry

In any year, the cost of the C&D rule to the construction industry and society will depend on the quantity of acreage on which in-scope construction activity is performed. Accordingly, the baseline estimate of construction activity and acreage – and how that activity is distributed geographically and across C&D industry segments – is a key element of the regulatory analysis baseline.

The analysis described in this section is used to estimate the quantity of acreage developed annually based on the industry's long-term trend. Using this approach, a trend-based estimate of industry activity was generated for the baseline analysis year, 2008. *Section 4.2* describes how this aggregate measure of the 2008-trend level of C&D industry activity was subsequently distributed across states, C&D industry segments, and model C&D industry project categories.

EPA's approach for estimating aggregate acreage includes four primary steps:

1. Estimate acreage-intensity by C&D industry sector and year, based on acreage and construction value data from the U.S. Census Bureau, Reed Construction, and the Federal Highway Administration;
2. Analyze acreage-intensity over time to determine whether there is a statistically significant non-zero rate of change in acreage intensity over time;
3. Based on the results of the statistical analysis, identify or estimate acreage-intensity value(s) to support annual estimates of developed acreage for each C&D sector; and,
4. Estimate the quantity of acreage developed during 2008, by C&D sector, based on the selected acreage intensity values and each sector's 2008 value of construction. The estimate of 2008 value of construction is based on each sector's long-term trend in the value of construction. Using the *2008 trend-line value* better reflects the industry's steady-state condition, whereas the *actual reported 2008 value* of construction reflects a trend-outlier year, in particular for residential construction activity.

It is important to note that the acreage estimates generated in this section represent the *baseline* – i.e. *total* activity estimates, not necessarily estimates of in-scope acreage as in-scope acreage is also a function of the regulation's coverage definition.

4.1.1 Estimating Historical Acreage Intensity Values, by C&D Sector

EPA's estimate of aggregate acreage is based on the historical relationship between the quantity of acreage that the industry develops annually and the revenue and/or project value generated by the industry, here called acreage intensity, for projects in the various broad categories of construction activity. EPA relied on data from the Census Bureau's *Characteristics of New Housing* and from Reed Construction to derive this relationship between project acreage and value. Acreage intensity is measured in units of acres developed per million dollars value of activity in the C&D industry segment.

Based on data availability and consideration of outliers, the time period for estimating acreage intensity varies for each C&D sector:

- Residential sector: data from 1990 to 2005
- Non-residential sector: data from 2001 to 2007
- Highway (non-building) sector: data from 1990 to 2001.

Acreage Intensity in the Residential Sector

As the basis for estimating acreage intensity in the residential construction sector, EPA first obtained the annual value of construction from the U.S. Census Bureau's *Construction Spending*. To support consistent comparisons among values from different years, these values were adjusted to constant 2008 dollars using the BEA's implicit GDP price deflator series.

Second, EPA estimated annual acreage quantities for the residential sector based on project data from the U.S. Census Bureau's *Characteristics of New Housing* and Reed Construction:

- For detached and attached single-family housing, Census data indicating the annual number of detached and attached single-family units, by site-size range, were used to develop total acreage estimates for this construction category. EPA first determined the *average* site size within each site-size range reported in the Census data using the midpoint among the range. EPA then multiplied each range's average site size by the number of reported units in the site-size range to estimate the total number of acres by site-size range. Summing these sub-totals across all Census site-size ranges yields an estimate of total single-family acreage.
- For multifamily construction, EPA combined data from Census and Reed Construction to develop estimates of total acreage by site-size range. Specifically, the Census reports the annual number of multifamily buildings completed by "number of units per building" ranges. Reed Construction reports data on the number of units per building and site size for multifamily building construction. EPA used the Reed Construction data for the period 2001-2007 to calculate an average site size per building within each number of units per building range (see discussion of the Reed dataset in the following section). Multiplying the *number of buildings* by the *average site size per building* within each *number of units per building* range yields the total number of acres in each range. Summing the totals across all ranges yields an estimate of the total quantity of multifamily acreage.

Sufficient data were available to obtain both construction value and acreage estimates annually in the residential sector from 1990 - 2005. For each year, EPA summed the quantity of single- and multi-family acreage to arrive at total acreage for the residential category. Lastly, residential acreage intensity was estimated by simply dividing the annual quantity of residential acreage by the annual value of residential construction. *Table 4-1*, below, summarizes the aggregate activity and acreage values, and resulting acreage intensity values for the residential sector.

Table 4-1: Acreage Intensity, Residential Sector ($millions, 2008 dollars)

Year	Value	Acreage	Acreage per $Million
1990	$198,253	166,335	0.84
1991	$166,095	147,734	0.89
1992	$191,406	162,965	0.85
1993	$209,024	157,750	0.75
1994	$239,231	181,632	0.76
1995	$227,807	187,713	0.82
1996	$249,278	216,630	0.87
1997	$254,111	241,644	0.95
1998	$284,216	253,426	0.89
1999	$314,294	285,818	0.91
2000	$324,457	283,483	0.87
2001	$334,004	318,437	0.95
2002	$350,665	330,650	0.94
2003	$397,708	352,674	0.89
2004	$466,905	373,643	0.80
2005	$520,867	397,895	0.76

Source: EPA analysis

Acreage Intensity in the Non-Residential Sector

For the non-residential sector, EPA relied on information on individual projects reported in the Reed Construction dataset. Acreage intensity estimates were developed directly from the Reed Construction data set because Census does not report data that can be used to estimate annual acreage values for the non-residential sector. Reed Construction Data (Reed) is a commercial construction industry data service that collects and reports information on multifamily, commercial/institutional, and industrial construction projects undertaken nationally. Project data reported by Reed that are relevant to this analysis include site size, constructed square footage, and project value. This analysis used data from Reed over the period 2001 - 2007. EPA converted all dollar data to constant 2008 dollars using the BEA's implicit GDP price deflator series. EPA used the Reed data to develop a distribution of project-level acreage intensity, by year, for the non-residential construction sector. The median acreage-intensity value from each year's distribution is used as the point estimate for that year.

To determine the annual median acreage intensity values, EPA analyzed approximately 13,000 commercial and industrial project records from the Reed Construction dataset. EPA used a subset of project records, consisting of all records between the 5th and 95th percentiles of the overall (e.g., 2001 - 2007) acreage intensity distribution in the Reed data. Using this set of records, EPA estimated a distribution of acreage intensity values for the non-residential sector based on the set of project-value weighted acreage intensity estimates for each year. *Table 4-2*, below, lists the resulting acreage intensity values for non-residential construction.

Table 4-2: Acreage Intensity, Non-Residential Sector ($millions, 2008 dollars)

Year	Acreage per $Million
2001	0.85
2002	1.04
2003	0.88
2004	0.96
2005	1.03
2006	0.79
2007	0.82

Source: EPA analysis

EPA used the median from the Reed dataset observations to represent the central tendency value of acreage intensity in order to avoid the potential for distribution skewness to shift the mean away from the central tendency of the overall distributions.

Acreage Intensity in the Highway Transportation Sector

For the highway transportation sector, EPA obtained the annual values of highway construction projects from the Federal Highway Administration's *Highway Statistics*.

EPA estimated acreage from the Federal Highway Administration's *Highway Statistics*, using data on the number of miles funded for new construction, highway relocation, highway reconstruction, and major widening. The quantity of miles of new construction was converted into acres using a multiplier of 10.67 acres per mile.[24] Annual acreage intensity values were then estimated based on the value of construction and quantity of developed

[24] This figure is based on the previous 2002 C&D proposed rule analysis (EPA, 2002a). EPA assumed that the combined width of the road surface, median, and buffers is 4 lanes and 88 feet, and therefore, one mile of new highway would represent 10.67 acres in disturbed area.

acreage for 1990 - 2001. Table 4-3, below, summarizes the aggregate activity and acreage values, and resulting acreage intensity values for the transportation sector.

Table 4-3: Acreage Intensity, Transportation Sector ($millions, 2008 dollars)

Year	Value	Acreage	Acreage per $Million
1990	$9,618	38,697	4.02
1991	$11,018	40,270	3.65
1992	$11,824	49,159	4.16
1993	$8,560	38,311	4.48
1994	$9,189	33,708	3.67
1995	$9,302	19,688	2.12
1996	$6,619	23,505	3.55
1997	$6,879	26,790	3.89
1998	$7,110	28,169	3.96
1999	$7,871	24,263	3.08
2000	$6,753	20,796	3.08
2001	$7,456	19,342	2.59

Source: EPA analysis

4.1.2 Analyzing Changes in Acreage Intensity over Time

For each C&D sector, EPA performed a regression analysis on the acreage intensity data to examine whether there is a statistically significant change in acreage intensity over time.[25] *Table 4-4* summarizes the results of these analyses. Both linear and exponential trend relationships were examined; the linear relationship provided modestly better regression statistics. The regression analyses indicate that that the rate of change in acreage intensity over time for all three sectors is *not* statistically different from zero. Therefore, EPA assumed that acreage intensity essentially does not change over time (on a constant dollar basis). As a result, EPA opted to utilize *a single acreage intensity value* per sector to support the analysis.

Table 4-4: Summary of Acreage Intensity Regression Analysis

Summary Stat	Residential	Non-Residential	Highway
Time Period	1990 - 2005	2001 - 2007	1990 - 2001
Observations	16	7	12
R Square	0.024	0.105	0.283
Slope	0.002	-0.015	-0.101
t-Stat	0.591	-0.765	-1.984
P-Value	0.564	0.479	0.075
Lower 95%	-0.006	-0.065	-0.214
Upper 95%	0.010	0.035	0.012

Source: EPA analysis

EPA based the aggregate C&D industry acreage estimate on the mean acreage intensity value observed over time for each C&D sector (from *Table 4-1*, *Table 4-2,* and *Table 4-3*). In estimating the mean acreage intensity values, each year carries equal weight. *Table 4-5* presents these values, along with the maximum and minimum observed values for reference.

[25] *Table 4-1* through *Table 4-3* illustrate the variability in values over time, but a clear trend is not present. Over the very long-term (not captured in the relatively short time series available), one would expect acreage intensity to decline, reflecting the increasing scarcity of undeveloped land over time.

Table 4-5: Range of Constant Acreage Intensity Values (acreage per $million, 2008 dollars)

C&D Sector	Mean Intensity	Minimum	Maximum
Residential	**0.86**	0.76	0.95
Non-Residential	**0.91**	0.79	1.04
Non-Building	**3.52**	2.12	4.48

Source: EPA analysis

4.1.3 Estimating the Quantity of Acreage Developed During 2008

For each C&D sector, EPA estimated the quantity of acreage that would have been developed at the 2008-trend baseline year based on:

- An estimate of each sector's value of construction for 2008, based on the long-term trend;
- Multiplying the estimated 2008 value of construction by each of the selected acreage intensity values produces a 2008-trend acreage estimate. EPA used the mean acreage estimate to support the economic analysis of the final regulation; and,
- As a final adjustment, EPA recognizes that the Census and Reed project data do not account for road development associated with a building's construction. As a result, the estimated acreage values were adjusted to address this omission. EPA applied a multiplier to increase all acreage estimates to account for the typical road development associated with new construction site. These multipliers (13% for residential, and 6% for non-residential) were derived from information in the Center for Watershed Protection's *Impervious Cover and Land Use in the Chesapeake Bay Watershed* (Capiella and Brown, 2001). This document provides data, by sector, on the acreage allocations among the different elements of a lot – e.g., buildings, roads, sidewalks, open space, etc. EPA determined the percent allocation for roads within a lot area and applied these multipliers to the acreage values. EPA assumes that the characteristics of a lot in the Cheseapeake Bay Watershed are representative of the U.S. since the watershed is part of six states and the District of Columbia.

Estimating 2008-Trend Based Values of Construction, by C&D Sector

Table 4-6 reports the value of construction for the residential (source: Census), non-residential (source: Census), and transportation construction (source: FHWA) sectors, along with estimated trend values (all in constant 2008 dollars). Based on the trend analysis:

- The actual 2008 value of construction in the residential sector is considerably below the long-term growth trend, by about 48% (whereas 2005 was far above the long-term trend, as expected);
- The value of construction in the non-residential sector during 2008 was 12% above the long-term growth trend; and,
- The estimated value of construction in the new highway construction sector during 2008 was about 7.5% above the long-term growth trend.

Table 4-6: Reported and Trend-Based Value of Construction, by C&D Sector ($2008)

	Residential		Non-Residential		Transportation	
Year	*Census Value*	*Trend Value*	*Census Value*	*Trend Value*	*FHWA Value*	*Trend Value*
1990	$198,253	$189,589	$272,887	$223,136	$9,618	$8,828
1991	$166,095	$198,758	$229,867	$230,602	$11,018	$8,848
1992	$191,406	$208,370	$212,023	$238,318	$11,824	$8,869
1993	$209,024	$218,447	$208,519	$246,292	$8,560	$8,889
1994	$239,231	$229,012	$223,012	$254,533	$9,189	$8,909
1995	$227,807	$240,088	$251,941	$263,050	$9,302	$8,930
1996	$249,278	$251,699	$277,682	$271,852	$6,619	$8,950
1997	$254,111	$263,871	$304,629	$280,948	$6,879	$8,971
1998	$284,216	$276,633	$326,024	$290,348	$7,110	$8,991
1999	$314,294	$290,011	$335,018	$300,063	$7,871	$9,012
2000	$324,457	$304,037	$357,650	$310,104	$6,753	$9,033
2001	$334,004	$318,741	$346,794	$320,480	$7,456	$9,053
2002	$350,665	$334,156	$307,534	$331,203	$12,066	$9,074
2003	$397,708	$350,316	$308,929	$342,285	$11,526	$9,095
2004	$466,905	$367,258	$316,948	$353,738	$9,555	$9,116
2005	$520,867	$385,019	$328,178	$365,574	$9,436	$9,137
2006	$492,087	$403,640	$358,182	$377,806	$10,668	$9,158
2007	$361,059	$423,161	$410,227	$390,447	$9,575	$9,179
2008	$230,216	**$443,626**	$450,083	**$403,512**	$9,954*	**$9,200**

Source: EPA analysis

* The 2008 FHWA value was not yet released at the time of publication. EPA estimated this value based on the percentage change from 2007 to 2008 in the Census' reported value of construction spending for all highway and street construction (i.e., including both new and existing construction activity).

Figure 4-1, Figure 4-2, and *Figure 4-3*, following page, show the actual values of construction, by sector, and the estimated trend lines, with all values in 2008 dollars.

Figure 4-1: Residential Sector Value of Construction, with Trend ($2008)

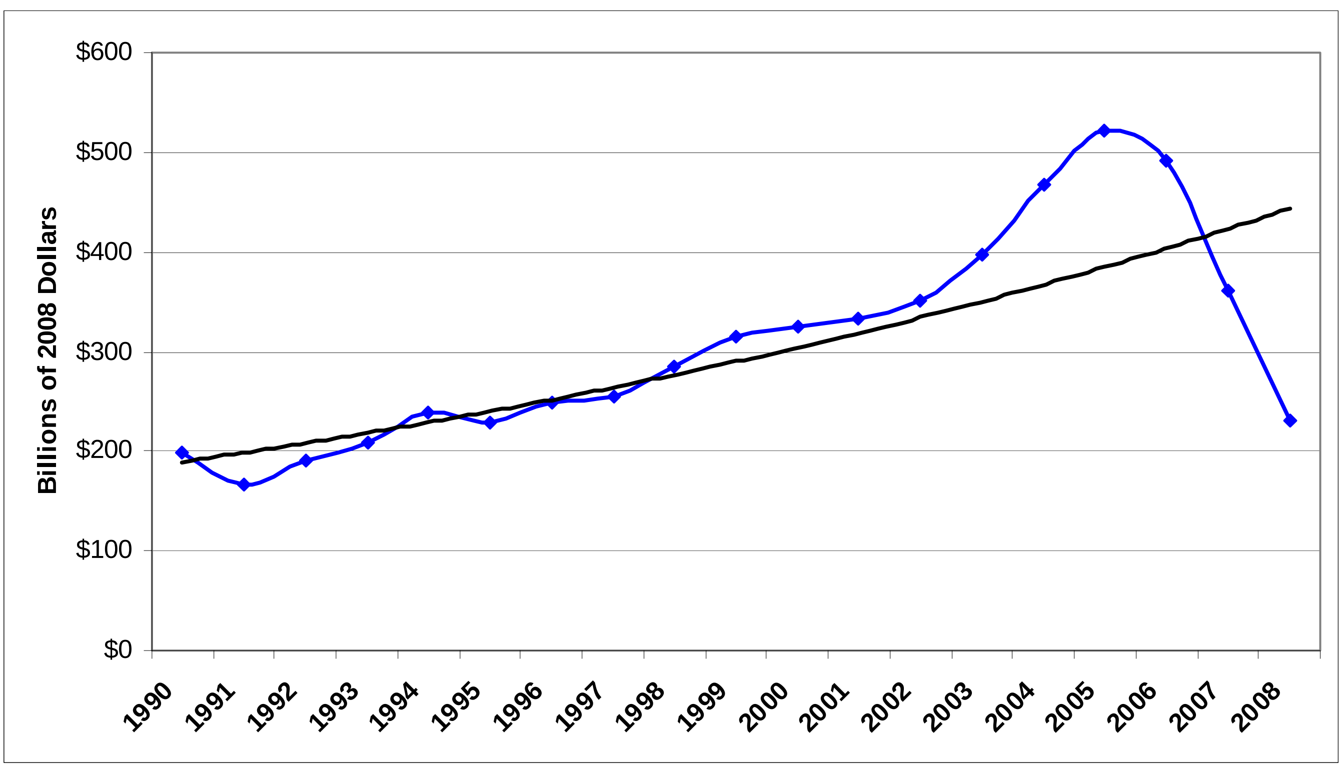


Figure 4-2: Non-Residential Sector Value of Construction, with Trend ($2008)

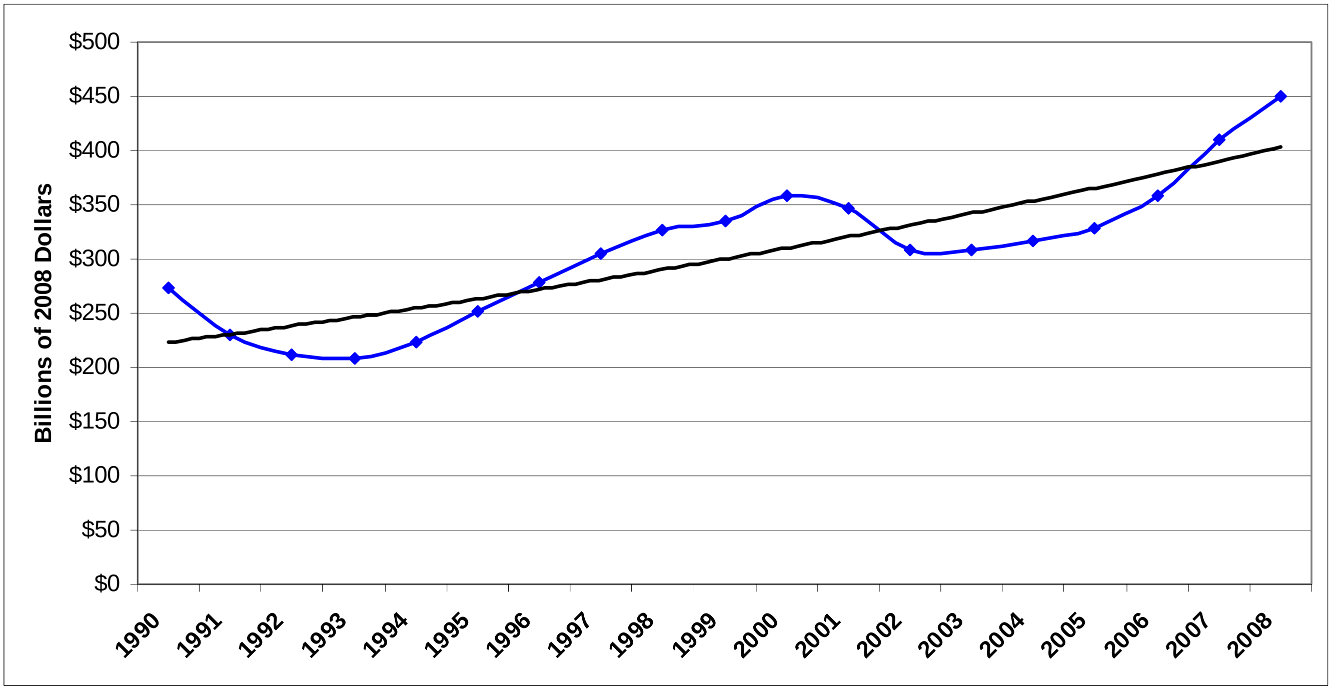
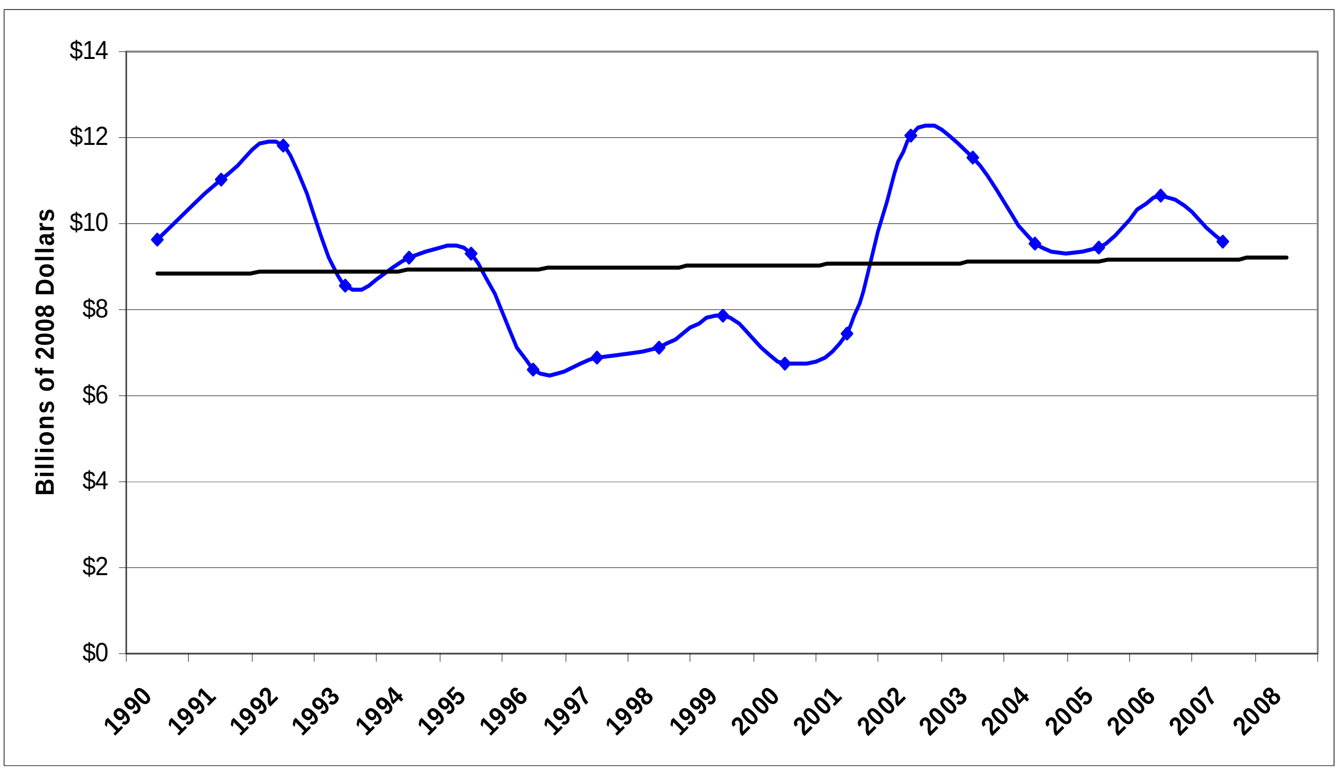


Figure 4-3: Highway Sector Value of Construction, with Trend ($2008)



Estimating the 2008-Trend Baseline Quantity of Developed Acreage

EPA calculated the baseline quantity of developed acreage used to support the economic analysis by multiplying the selected acreage intensity values by the trend-based value of construction during 2008. *Table 4-7* summarizes the resulting values of acreage for the estimated 2008 trend-adjusted year, by C&D sector.

As reported in the table, EPA estimated that approximately 853,349 acres would have been developed by the C&D industry during 2008 under long-term trend conditions. The *actual* quantity of acreage developed during 2008 is less than this quantity, due to the industry's presently adverse condition in the residential sector.[26] EPA elected to use the 2008-trend estimate as the baseline for the economic analysis to capture an activity level and overall economic conditions that are more representative of the longer term steady state for the industry, in particular for the residential construction sector. Note that this initial estimate of 2008-trend acreage is subsequently revised slightly lower – to 852,649 acres – as a result of rounding that occurs in EPA's process for distributing the aggregate acreage estimate across model project categories, and ultimately, reconciling the implicit error in those distributions. This process is described below in *Section 4.2.3*.

Table 4-7: Estimate of Baseline-Year, 2008, Acreage

Time Period	Total	Residential	Non-Residential	Highway
2008 Mean	853,349	431,109	389,841	32,399

Source: EPA analysis

4.2 Distributing Baseline Acreage across States, Sectors, and Project Categories

As described above, EPA's estimate of developed acreage for the 2008-trend analysis year provides an estimate of total acreage, but does not account for the configuration of that activity in terms of:

- The quantity of acres developed in each state, and within each state, the quantity developed in the NAICS sectors expected to be affected by the final regulation; or,
- Within a NAICS sector, the number of acres developed in different project configurations, which can vary due to a variety of factors, but most especially with respect to project size and duration.

This section of the analysis presents the data that EPA used as the basis for distributing the aggregate estimate of 2008 acreage across states, construction activity sectors, and project categories.

4.2.1 Distributing Acreage across States and C&D Activity Sectors

To develop the baseline profile of acreage activity by state and construction activity sector, EPA distributed the approximately 853,000 acres in proportion to the total 2008-trend value of construction estimated to occur in each category, according to the firm- and industry-level analysis model. Within each state and subsequent C&D activity sector, EPA calculated the value of construction used to support the firm- and industry-level analysis by multiplying:

- The average model firm revenue in the 2008-trend year, which varies across seven revenue ranges in each sector (see e.g., *Table 4-21*), *times*
- The estimated number of firms in the 2008-trend year for each revenue range, by state and sector.

[26] The alternative *Adverse Business Conditions* analysis case captures the current adverse conditions for the residential sector.

Table 4-8 and *Table 4-9*, following pages, present the allocation factors used to distribute the national acreage estimate across states and C&D industry sectors. Following these tables, *Section 4.2.2* describes how the state- and sector-level acreage estimates were then distributed across the model project categories defined for this economic analysis.

Table 4-8: Acreage Allocation Factors, by State and Aggregate Sector

State	Total Activity by State	Total Activity in Each State, by Aggregate C&D Sector			
		Residential	Non-Residential	Transportation	Total
Alabama	1.7%	36.2%	55.6%	8.2%	100%
Alaska	0.4%	27.0%	60.4%	12.6%	100%
Arizona	1.6%	39.9%	52.9%	7.2%	100%
Arkansas	0.9%	30.8%	58.7%	10.5%	100%
California	9.6%	33.4%	60.7%	5.9%	100%
Colorado	2.4%	40.4%	53.3%	6.3%	100%
Connecticut	1.0%	35.7%	50.3%	14.0%	100%
Delaware	0.3%	36.0%	52.5%	11.4%	100%
District of Columbia	0.1%	8.0%	86.4%	5.6%	100%
Florida	4.9%	41.2%	51.5%	7.2%	100%
Georgia	3.8%	38.6%	53.5%	7.9%	100%
Hawaii	0.4%	34.2%	63.2%	2.6%	100%
Idaho	0.9%	44.0%	48.6%	7.4%	100%
Illinois	4.2%	37.7%	51.1%	11.2%	100%
Indiana	2.1%	40.9%	50.1%	9.1%	100%
Iowa	1.2%	28.3%	59.8%	11.9%	100%
Kansas	1.0%	29.4%	51.7%	18.9%	100%
Kentucky	1.3%	30.9%	58.4%	10.7%	100%
Louisiana	1.3%	34.2%	56.6%	9.2%	100%
Maine	0.6%	47.8%	43.9%	8.3%	100%
Maryland	2.0%	36.4%	56.5%	7.1%	100%
Massachusetts	2.0%	30.6%	59.5%	9.9%	100%
Michigan	3.8%	42.5%	49.7%	7.9%	100%
Minnesota	2.2%	42.5%	43.9%	13.6%	100%
Mississippi	0.8%	24.3%	57.5%	18.2%	100%
Missouri	2.2%	37.9%	54.4%	7.7%	100%
Montana	0.6%	56.7%	28.6%	14.7%	100%
Nebraska	0.8%	28.5%	60.3%	11.2%	100%
Nevada	0.8%	26.3%	68.1%	5.5%	100%
New Hampshire	0.5%	39.3%	50.4%	10.3%	100%
New Jersey	3.2%	34.3%	54.3%	11.4%	100%
New Mexico	0.8%	44.2%	48.4%	7.4%	100%
New York	5.5%	34.9%	56.4%	8.8%	100%
North Carolina	3.5%	48.2%	41.7%	10.1%	100%
North Dakota	0.4%	20.2%	65.6%	14.2%	100%
Ohio	3.8%	35.2%	57.0%	7.9%	100%
Oklahoma	1.1%	37.1%	53.9%	9.0%	100%
Oregon	1.9%	44.9%	44.6%	10.5%	100%
Pennsylvania	3.7%	36.1%	55.7%	8.1%	100%
Rhode Island	0.4%	50.1%	46.4%	3.6%	100%
South Carolina	1.5%	42.0%	50.6%	7.3%	100%
South Dakota	0.4%	38.9%	38.0%	23.1%	100%
Tennessee	1.8%	34.8%	54.7%	10.5%	100%
Texas	6.6%	25.5%	66.0%	8.5%	100%
Utah	1.2%	44.8%	50.0%	5.1%	100%
Vermont	0.3%	44.4%	51.0%	4.6%	100%
Virginia	2.7%	45.2%	43.6%	11.2%	100%
Washington	2.9%	48.8%	41.0%	10.2%	100%
West Virginia	0.7%	39.7%	52.1%	8.2%	100%
Wisconsin	1.9%	48.1%	43.7%	8.3%	100%
Wyoming	0.3%	29.1%	55.3%	15.6%	100%

Source: EPA analysis

Table 4-9: Acreage Allocation Factors, by NAICS Sector

State	Residential			Non-Residential		Transportation
	236115	236116	236117	236210	236220	
Alabama	28%	13%	59%	19%	81%	100%
Alaska	43%	6%	51%	12%	88%	100%
Arizona	39%	13%	48%	3%	97%	100%
Arkansas	31%	5%	64%	12%	88%	100%
California	41%	10%	49%	10%	90%	100%
Colorado	45%	10%	45%	8%	92%	100%
Connecticut	43%	3%	54%	11%	89%	100%
Delaware	49%	1%	50%	0%	100%	100%
District of Columbia	65%	16%	19%	0%	100%	100%
Florida	39%	10%	50%	6%	94%	100%
Georgia	22%	8%	70%	17%	83%	100%
Hawaii	41%	0%	59%	1%	99%	100%
Idaho	39%	2%	59%	14%	86%	100%
Illinois	35%	7%	58%	13%	87%	100%
Indiana	35%	10%	56%	21%	79%	100%
Iowa	58%	4%	38%	12%	88%	100%
Kansas	53%	2%	45%	17%	83%	100%
Kentucky	39%	3%	59%	12%	88%	100%
Louisiana	19%	24%	57%	12%	88%	100%
Maine	55%	1%	43%	11%	89%	100%
Maryland	38%	13%	49%	5%	95%	100%
Massachusetts	38%	13%	48%	18%	82%	100%
Michigan	37%	10%	53%	18%	82%	100%
Minnesota	35%	3%	63%	3%	97%	100%
Mississippi	35%	6%	59%	19%	81%	100%
Missouri	40%	1%	59%	11%	89%	100%
Montana	47%	2%	51%	1%	99%	100%
Nebraska	37%	2%	61%	19%	81%	100%
Nevada	31%	6%	63%	17%	83%	100%
New Hampshire	32%	5%	63%	23%	77%	100%
New Jersey	31%	18%	51%	14%	86%	100%
New Mexico	45%	5%	50%	16%	84%	100%
New York	36%	16%	48%	12%	88%	100%
North Carolina	34%	6%	60%	11%	89%	100%
North Dakota	29%	9%	62%	12%	88%	100%
Ohio	39%	8%	53%	22%	78%	100%
Oklahoma	37%	4%	59%	10%	90%	100%
Oregon	32%	9%	59%	7%	93%	100%
Pennsylvania	41%	6%	53%	15%	85%	100%
Rhode Island	27%	7%	65%	1%	99%	100%
South Carolina	38%	3%	59%	12%	88%	100%
South Dakota	34%	15%	51%	0%	100%	100%
Tennessee	33%	1%	66%	6%	94%	100%
Texas	34%	11%	55%	17%	83%	100%
Utah	37%	3%	60%	10%	90%	100%
Vermont	54%	1%	45%	0%	100%	100%
Virginia	36%	8%	56%	8%	92%	100%
Washington	37%	8%	55%	3%	97%	100%
West Virginia	35%	5%	61%	35%	65%	100%
Wisconsin	51%	11%	38%	11%	89%	100%
Wyoming	51%	1%	48%	16%	84%	100%

Source: EPA analysis

4.2.2 Distributing Acreage across Model Project Categories

Within each state and in-scope C&D industry sector, EPA distributed the 2008-trend developed acreage values across 144 model project categories, defined by acreage size and project duration, for which compliance costs were estimated in developing the C&D final rule. Analyzing compliance costs within this detailed project framework supports differentiation of how the technologies and associated costs of compliance change with project size and project duration. EPA analyzed project-level information in *Notices of Intent* (NOI) for selected states, to develop the model project definitions and the basis for distributing acreage across model project categories within each state and sector. An NOI is filed for any project requiring coverage under a NPDES permit. A detailed description of the NOI data analysis is presented in the Technical Development Document (TDD). Here, EPA summarizes the overall approach and key findings from this effort, and presents the allocation factors ultimately used as the basis for distributing acreage among model project categories.

- EPA analyzed project-level data present in the NOI data from selected states (explained below), and based on this information, defined 12 model project size ranges and 12 model project duration ranges. These categories are presented in *Table 4-10*.
  - To represent each model project duration range in the firm- and industry-level economic analysis, EPA used the midpoint of the range. For projects in the *three-years or more* duration category, EPA assumed that all of these projects last three years.
  - To represent each model project size range in the firm- and industry-level economic analysis, EPA used the median project size among all projects in that range in the NOI data;

Table 4-10: C&D Industry Model Project Size and Duration Categories

Model Project Duration Categories		Model Project Size Categories	
Range (days)	Midpoint (years)[a]	Range	Median
0-46	0.1	1-2.99	1.0
47-91	0.2	3-4.99	3.8
92-182	0.3	5-7.49	6.0
183-274	0.6	7.5-9.99	8.5
275-365	0.8	10-14.99	12.0
366-456	1.1	15-19.99	17.0
457-547	1.3	20-29.99	23.0
548-639	1.6	30-39.99	34.0
640-730	1.8	40-59.99	46.0
731-912	2.3	60-79.99	69.0
913-1095	2.7	80-99.99	85.1
1096+	3.0	100+	145.0

[a] The midpoint, in days, was rounded to the equivalent number of whole months, and then divided by twelve to convert the midpoint of project duration into units of years.
Source: EPA analysis

Exhibit 4-1, following page, illustrates the structure and content of the model project matrix.

Exhibit 4-1: Illustration of Model Project Matrix

	Project Durations (years)											
Project Sizes (acreage)	0.1	0.2	0.3	0.6	0.8	1.1	1.3	1.6	1.8	2.3	2.7	3.0
1.0												
3.8												
6.0												
8.5												
12.0												
17.0												
23.0												
34.0												
46.0												
69.0												
85.1												
145.0												

For each state and construction activity sector, each cell is defined by a:
- Number of projects and
- Total acreage

And for each regulatory option, by an estimated compliance cost

- Next, EPA used the NOI project data from the selected states to develop a distribution of acres across the 144 model project matrix.
  - Due to limitations in available NOI data, and the less comprehensive data from some states, EPA was not able to develop a project category distribution for each individual state;
  - Instead, EPA developed project category distribution for four states that had generally better quality NOI data and that reflect diverse construction and development activity profiles across the country: New York, South Carolina, South Dakota, and California.
  - In using these distributions to allocate acreage, EPA used the residential distributions to represent all three residential NAICS sectors (236115, 236116, and 236117), the non-residential distributions to represent the non-residential NAICS sectors (236210 and 236220), and the transportation distribution to represent the transportation NAICS sector (237310).

Table 4-11, *Table 4-12*, *Table 4-13*, and *Table 4-14* present the final NOI acreage distributions, respectively, for New York, South Carolina, South Dakota, and California across the 144 model project categories. The selection of states to use in developing state-by-state project distributions is based in part on judgments about the quality and comprehensiveness of the NOI data and the ability of these states to reflect diversity of construction activity across states by region and construction profile. These judgments are somewhat subjective and introduce uncertainty in the use of the distributions to represent the project development profiles for other states. Each cell in the matrix shows the percentage of acreage in the sector that occurs in that cell of the matrix.

Table 4-11: New York Project Acreage Distribution

Project Size (acres)	Project Duration Category (days)											
	0 - 46	**47 - 91**	**92 - 182**	**183 - 274**	**275 - 365**	**366 - 456**	**457 - 547**	**548 - 639**	**640 - 730**	**731 - 912**	**913 - 1095**	**1096+**
Residential												
1.0 – 2.99	0.14%	0.11%	0.43%	0.43%	0.89%	0.67%	0.29%	0.37%	0.29%	0.51%	0.14%	0.09%
3.0 – 4.99	0.24%	0.18%	0.58%	0.44%	1.12%	0.96%	0.73%	0.57%	0.66%	0.90%	0.41%	0.56%
5.0 – 7.49	0.21%	0.06%	0.34%	0.15%	0.90%	0.62%	0.14%	0.37%	0.64%	0.66%	0.37%	0.49%
7.5 – 9.99	0.19%	0.10%	0.44%	0.41%	0.65%	0.88%	0.20%	0.35%	0.59%	0.74%	0.49%	0.90%
10.0 – 14.99	0.13%	0.14%	0.28%	1.29%	2.12%	1.98%	0.97%	0.34%	0.51%	2.64%	0.59%	2.26%
15.0 – 19.99	0.29%	0.10%	0.28%	0.65%	1.10%	0.68%	0.87%	1.09%	0.83%	2.39%	1.07%	1.12%
20.0 – 29.99	0.13%	0.26%	0.44%	0.84%	1.07%	1.33%	0.64%	0.98%	1.18%	2.69%	1.35%	3.87%
30.0 – 39.99	0.00%	0.00%	0.20%	0.37%	1.23%	1.04%	0.21%	0.53%	0.36%	2.75%	1.17%	3.06%
40.0 – 59.99	0.49%	0.00%	0.23%	0.60%	0.24%	0.25%	0.25%	0.23%	1.95%	2.27%	2.22%	3.32%
60.0 – 79.99	0.00%	0.00%	0.00%	0.38%	0.37%	0.36%	0.74%	1.19%	0.46%	1.55%	0.00%	2.67%
80.0 – 99.99	0.00%	0.00%	0.00%	0.00%	0.00%	0.46%	0.00%	0.00%	0.52%	0.53%	0.95%	0.98%
100+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.96%	0.00%	1.13%	0.67%
Non-Residential												
1.0 – 2.99	0.22%	0.51%	2.01%	2.43%	2.29%	1.57%	0.68%	0.50%	0.30%	0.37%	0.16%	0.12%
3.0 – 4.99	0.28%	0.63%	1.87%	3.06%	2.59%	1.76%	1.36%	0.72%	0.31%	0.72%	0.29%	0.25%
5.0 – 7.49	0.33%	0.28%	1.25%	1.64%	2.03%	1.55%	1.09%	0.72%	0.64%	0.14%	0.23%	0.27%
7.5 – 9.99	0.06%	0.18%	1.23%	1.66%	1.02%	1.50%	0.56%	0.40%	0.50%	1.03%	0.21%	0.47%
10.0 – 14.99	0.36%	0.00%	0.88%	0.87%	2.34%	1.77%	1.63%	0.86%	0.62%	1.20%	0.08%	0.29%
15.0 – 19.99	0.14%	0.28%	0.76%	0.56%	1.87%	1.76%	1.59%	0.24%	0.79%	0.57%	0.25%	0.38%
20.0 – 29.99	0.23%	0.16%	0.34%	0.39%	2.31%	0.95%	1.47%	1.76%	1.28%	1.30%	0.34%	0.39%
30.0 – 39.99	0.00%	0.25%	0.24%	0.85%	0.77%	1.27%	0.47%	0.49%	0.29%	1.05%	0.00%	0.48%
40.0 – 59.99	0.00%	0.00%	0.31%	0.35%	0.76%	0.65%	0.69%	2.10%	0.00%	1.20%	1.05%	0.33%
60.0 – 79.99	0.00%	0.00%	0.00%	0.00%	0.00%	1.10%	0.00%	2.30%	0.00%	0.48%	0.00%	0.55%
80.0 – 99.99	0.00%	0.00%	0.63%	0.00%	1.43%	0.00%	0.63%	0.71%	0.00%	0.00%	0.00%	0.00%
100+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.85%	2.71%	0.00%
Transportation												
1.0 – 2.99	0.29%	0.52%	1.28%	0.65%	0.72%	0.53%	0.63%	0.30%	0.22%	0.20%	0.05%	0.02%
3.0 – 4.99	0.23%	0.24%	0.51%	1.52%	0.89%	0.34%	0.75%	0.69%	0.28%	0.43%	0.28%	0.11%
5.0 – 7.49	0.24%	0.00%	0.26%	1.14%	0.41%	0.51%	0.56%	0.37%	0.00%	0.94%	0.32%	0.13%
7.5 – 9.99	0.18%	0.19%	0.21%	0.73%	0.78%	0.71%	0.81%	1.97%	0.00%	0.20%	0.58%	0.19%
10.0 – 14.99	0.00%	0.33%	0.24%	1.07%	0.75%	1.75%	0.54%	1.58%	0.80%	1.28%	0.33%	1.42%
15.0 – 19.99	0.00%	0.00%	0.00%	0.37%	0.36%	0.70%	0.77%	0.00%	0.41%	1.93%	0.38%	0.80%
20.0 – 29.99	0.00%	0.00%	0.55%	1.12%	0.53%	1.60%	1.54%	2.04%	0.97%	4.76%	1.44%	0.54%
30.0 – 39.99	0.00%	0.00%	0.00%	0.00%	0.00%	0.82%	0.75%	0.00%	0.86%	0.67%	1.69%	0.00%
40.0 – 59.99	0.00%	0.00%	0.00%	2.30%	0.00%	2.36%	2.16%	0.00%	1.02%	0.00%	0.00%	2.39%
60.0 – 79.99	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.67%	0.00%	1.64%	3.11%	0.00%
80.0 – 99.99	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.23%
100+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.78%	5.63%	11.60%	2.29%

Source: EPA analysis

Table 4-12: South Carolina Project Acreage Distribution

Project Size (acres)	Project Duration Category (days)											
	0 - 46	47 - 91	92 - 182	183 - 274	275 - 365	366 - 456	457 - 547	548 - 639	640 - 730	731 - 912	913 - 1095	1096+
Residential												
1.0 – 2.99	0.02%	0.12%	0.38%	0.20%	0.39%	0.40%	0.04%	0.02%	0.05%	0.14%	0.03%	0.02%
3.0 – 4.99	0.02%	0.13%	0.44%	0.49%	0.54%	0.72%	0.06%	0.05%	0.05%	0.24%	0.03%	0.04%
5.0 – 7.49	0.06%	0.15%	0.72%	0.53%	0.61%	0.55%	0.10%	0.05%	0.05%	0.23%	0.02%	0.00%
7.5 – 9.99	0.03%	0.14%	0.90%	0.75%	1.19%	0.97%	0.07%	0.03%	0.15%	0.32%	0.00%	0.10%
10.0 – 14.99	0.00%	0.05%	1.41%	0.88%	2.18%	1.42%	0.00%	0.27%	0.10%	0.97%	0.09%	0.36%
15.0 – 19.99	0.08%	0.06%	0.91%	2.07%	1.06%	2.18%	0.27%	0.00%	0.22%	1.63%	0.07%	0.35%
20.0 – 29.99	0.00%	0.30%	1.75%	1.90%	2.71%	3.37%	0.43%	0.28%	0.39%	1.99%	0.18%	0.61%
30.0 – 39.99	0.13%	0.00%	1.12%	1.58%	2.95%	2.94%	0.45%	0.30%	0.30%	1.61%	0.14%	0.42%
40.0 – 59.99	0.00%	0.00%	1.33%	2.42%	3.48%	3.66%	0.24%	0.19%	0.00%	2.06%	0.17%	1.00%
60.0 – 79.99	0.00%	0.00%	0.30%	2.34%	1.49%	2.69%	0.29%	0.25%	0.00%	0.00%	0.58%	0.59%
80.0 – 99.99	0.00%	0.00%	0.39%	0.37%	0.74%	1.42%	0.00%	0.00%	0.00%	1.41%	0.00%	0.00%
100+	0.00%	0.00%	1.96%	2.01%	3.93%	5.37%	0.00%	0.00%	1.29%	2.34%	0.00%	0.87%
Non-Residential												
1.0 – 2.99	0.31%	0.86%	2.40%	1.98%	2.23%	1.72%	0.09%	0.16%	0.20%	0.34%	0.05%	0.08%
3.0 – 4.99	0.19%	0.50%	1.48%	1.76%	1.57%	1.48%	0.29%	0.07%	0.13%	0.18%	0.05%	0.08%
5.0 – 7.49	0.18%	0.29%	1.05%	1.05%	1.34%	1.12%	0.23%	0.02%	0.08%	0.34%	0.03%	0.02%
7.5 – 9.99	0.11%	0.36%	0.97%	0.99%	0.96%	1.13%	0.24%	0.32%	0.20%	0.34%	0.04%	0.00%
10.0 – 14.99	0.26%	0.27%	1.64%	1.55%	1.44%	1.82%	0.26%	0.12%	0.29%	0.49%	0.16%	0.12%
15.0 – 19.99	0.00%	0.66%	1.21%	1.43%	1.54%	1.31%	0.09%	0.30%	0.00%	0.39%	0.07%	0.08%
20.0 – 29.99	0.09%	0.43%	1.25%	1.89%	2.14%	1.83%	1.25%	0.32%	0.52%	0.51%	0.00%	0.00%
30.0 – 39.99	0.00%	0.44%	0.43%	1.20%	1.11%	0.74%	0.31%	0.33%	0.30%	0.54%	0.00%	0.32%
40.0 – 59.99	0.00%	0.19%	1.27%	0.81%	0.64%	1.73%	0.18%	0.18%	0.38%	1.54%	0.00%	0.21%
60.0 – 79.99	0.00%	0.00%	0.88%	0.84%	0.91%	0.26%	0.58%	0.58%	0.00%	1.66%	0.00%	0.29%
80.0 – 99.99	0.00%	0.00%	0.00%	0.00%	0.39%	1.20%	0.00%	0.40%	0.00%	1.56%	0.00%	0.83%
100+	0.00%	1.16%	2.65%	3.57%	5.93%	1.01%	0.57%	0.00%	0.88%	3.68%	0.50%	1.49%
Transportation												
1.0 – 2.99	0.10%	0.75%	2.30%	1.95%	1.31%	1.79%	0.14%	0.00%	0.89%	0.81%	0.00%	0.00%
3.0 – 4.99	0.12%	0.64%	2.38%	1.68%	2.28%	1.65%	0.21%	0.00%	0.26%	0.50%	0.10%	0.00%
5.0 – 7.49	0.20%	0.00%	2.29%	1.26%	2.80%	0.18%	0.15%	0.16%	0.00%	0.66%	0.00%	0.35%
7.5 – 9.99	0.24%	0.00%	1.64%	1.00%	1.78%	1.78%	0.00%	0.00%	0.47%	0.00%	0.00%	0.00%
10.0 – 14.99	0.00%	0.00%	1.82%	2.33%	0.72%	1.55%	1.05%	0.00%	0.30%	0.00%	0.35%	0.36%
15.0 – 19.99	0.00%	0.00%	1.94%	1.11%	1.00%	0.00%	0.00%	0.00%	0.00%	0.55%	0.00%	1.00%
20.0 – 29.99	0.00%	0.58%	0.00%	1.54%	0.00%	2.70%	0.00%	0.59%	0.00%	0.60%	0.00%	0.60%
30.0 – 39.99	0.00%	0.00%	0.00%	0.00%	1.88%	0.00%	0.00%	0.00%	0.00%	0.00%	2.02%	0.00%
40.0 – 59.99	0.00%	0.00%	0.00%	0.00%	2.56%	0.00%	0.00%	0.00%	0.00%	3.14%	1.32%	4.71%
60.0 – 79.99	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
80.0 – 99.99	0.00%	0.00%	2.73%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.85%	0.00%
100+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.17%	0.00%	19.11%

Source: EPA analysis

Table 4-13: South Dakota Project Acreage Distribution

Project Size (acres)	Project Duration Category (days)											
	0 - 46	**47 - 91**	**92 - 182**	**183 - 274**	**275 - 365**	**366 - 456**	**457 - 547**	**548 - 639**	**640 - 730**	**731 - 912**	**913 - 1095**	**1096+**
Residential												
1.0 – 2.99	0.16%	0.09%	0.18%	0.13%	0.18%	0.12%	0.04%	0.04%	0.04%	0.07%	0.00%	0.00%
3.0 – 4.99	0.00%	0.20%	0.23%	0.18%	0.55%	0.26%	0.00%	0.15%	0.14%	0.14%	0.00%	0.14%
5.0 – 7.49	0.10%	0.00%	0.44%	0.41%	0.56%	0.22%	0.23%	0.11%	0.11%	0.00%	0.10%	0.13%
7.5 – 9.99	0.15%	0.15%	0.33%	0.65%	0.16%	0.18%	0.16%	0.45%	0.00%	0.30%	0.29%	0.28%
10.0 – 14.99	0.57%	0.38%	1.20%	0.22%	0.67%	0.88%	0.39%	0.18%	0.00%	0.55%	0.00%	0.36%
15.0 – 19.99	0.00%	0.00%	0.91%	0.29%	0.33%	0.00%	0.29%	0.69%	0.33%	0.31%	0.29%	0.93%
20.0 – 29.99	0.00%	0.94%	0.36%	0.46%	0.36%	1.20%	0.73%	0.97%	0.00%	0.00%	0.75%	0.00%
30.0 – 39.99	0.64%	0.00%	1.31%	0.00%	0.00%	0.55%	0.56%	0.00%	0.00%	1.83%	1.18%	2.51%
40.0 – 59.99	0.73%	0.00%	0.00%	1.68%	0.00%	0.73%	0.78%	0.82%	0.00%	0.00%	2.46%	3.25%
60.0 – 79.99	0.00%	0.00%	0.00%	1.20%	0.00%	0.00%	0.00%	0.00%	1.28%	0.00%	1.45%	3.77%
80.0 – 99.99	0.00%	0.00%	1.55%	1.51%	0.00%	1.46%	1.50%	3.16%	1.46%	0.00%	0.00%	9.19%
100+	0.00%	0.00%	0.00%	2.60%	4.03%	2.19%	0.00%	4.20%	4.20%	2.46%	6.75%	2.92%
Non-Residential												
1.0 – 2.99	0.37%	0.47%	1.24%	1.10%	0.60%	0.23%	0.12%	0.12%	0.15%	0.12%	0.04%	0.02%
3.0 – 4.99	0.32%	0.24%	1.20%	1.21%	1.05%	0.25%	0.12%	0.33%	0.13%	0.15%	0.12%	0.13%
5.0 – 7.49	0.11%	0.40%	1.41%	0.91%	0.68%	0.28%	0.35%	0.33%	0.08%	0.11%	0.08%	0.09%
7.5 – 9.99	0.58%	0.28%	1.10%	0.30%	0.31%	0.31%	0.13%	0.57%	0.00%	0.15%	0.00%	0.15%
10.0 – 14.99	0.40%	1.03%	2.45%	2.82%	1.27%	0.94%	0.18%	0.92%	0.20%	0.17%	0.25%	0.39%
15.0 – 19.99	0.00%	0.00%	1.06%	1.04%	0.88%	0.57%	0.25%	0.25%	0.30%	0.76%	0.54%	0.25%
20.0 – 29.99	0.80%	1.55%	1.14%	2.36%	1.77%	1.16%	0.44%	0.68%	0.00%	0.47%	0.82%	0.84%
30.0 – 39.99	0.50%	0.00%	2.73%	2.21%	0.00%	0.59%	0.64%	2.28%	0.00%	0.50%	0.00%	0.00%
40.0 – 59.99	0.00%	0.92%	0.67%	1.44%	2.21%	3.13%	1.53%	1.60%	0.00%	1.63%	0.00%	0.68%
60.0 – 79.99	0.00%	0.00%	2.16%	1.21%	0.00%	0.00%	2.35%	0.00%	0.00%	0.00%	0.00%	0.00%
80.0 – 99.99	0.00%	0.00%	1.39%	0.00%	1.42%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
100+	0.00%	0.00%	4.06%	1.68%	6.03%	2.68%	4.44%	0.00%	1.85%	0.00%	0.00%	0.00%
Transportation												
1.0 – 2.99	0.16%	0.29%	0.54%	0.31%	0.09%	0.35%	0.17%	0.10%	0.07%	0.03%	0.00%	0.00%
3.0 – 4.99	0.08%	0.38%	0.68%	0.29%	0.12%	0.23%	0.18%	0.06%	0.00%	0.13%	0.05%	0.06%
5.0 – 7.49	0.18%	0.72%	0.70%	0.34%	0.11%	0.27%	0.41%	0.11%	0.08%	0.00%	0.00%	0.00%
7.5 – 9.99	0.14%	0.43%	0.39%	0.12%	0.12%	0.39%	0.28%	0.12%	0.00%	0.00%	0.00%	0.00%
10.0 – 14.99	0.00%	0.31%	1.40%	0.61%	0.15%	0.95%	0.60%	0.58%	0.00%	0.00%	0.22%	0.00%
15.0 – 19.99	0.00%	0.25%	0.71%	0.97%	0.46%	0.00%	0.79%	0.49%	0.24%	0.00%	0.00%	0.23%
20.0 – 29.99	1.11%	1.03%	1.61%	1.03%	0.72%	1.63%	1.43%	0.39%	0.00%	0.43%	0.00%	0.00%
30.0 – 39.99	0.00%	0.00%	0.51%	2.57%	0.00%	0.00%	2.19%	0.00%	0.00%	1.06%	0.00%	0.00%
40.0 – 59.99	0.00%	1.43%	0.62%	1.28%	0.00%	1.58%	1.57%	1.57%	0.80%	2.39%	0.00%	0.00%
60.0 – 79.99	1.00%	0.00%	0.00%	0.00%	1.08%	0.00%	1.97%	1.11%	0.97%	1.12%	0.00%	0.00%
80.0 – 99.99	0.00%	0.00%	0.00%	0.00%	0.00%	1.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
100+	0.00%	0.00%	4.17%	4.70%	0.00%	8.01%	6.18%	9.94%	8.83%	4.47%	0.00%	0.00%

Source: EPA analysis

Table 4-14: California Project Acreage Distribution

Project Size (acres)	Project Duration Category (days)											
	0 - 46	47 - 91	92 - 182	183 - 274	275 - 365	366 - 456	457 - 547	548 - 639	640 - 730	731 - 912	913 - 1095	1096+
Residential												
1.0 – 2.99	0.06%	0.08%	0.25%	0.39%	0.52%	0.47%	0.21%	0.11%	0.07%	0.10%	0.03%	0.01%
3.0 – 4.99	0.04%	0.07%	0.20%	0.34%	0.47%	0.41%	0.24%	0.14%	0.10%	0.15%	0.02%	0.03%
5.0 – 7.49	0.05%	0.05%	0.25%	0.34%	0.53%	0.43%	0.27%	0.28%	0.18%	0.30%	0.13%	0.10%
7.5 – 9.99	0.02%	0.04%	0.13%	0.18%	0.41%	0.27%	0.24%	0.19%	0.12%	0.25%	0.05%	0.06%
10.0 – 14.99	0.06%	0.03%	0.37%	0.45%	0.76%	0.73%	0.55%	0.48%	0.39%	0.65%	0.34%	0.29%
15.0 – 19.99	0.03%	0.08%	0.24%	0.21%	0.80%	0.66%	0.55%	0.43%	0.41%	0.73%	0.25%	0.27%
20.0 – 29.99	0.10%	0.13%	0.44%	0.70%	1.50%	1.15%	0.99%	0.99%	0.99%	1.68%	0.84%	0.92%
30.0 – 39.99	0.07%	0.04%	0.42%	0.36%	0.88%	0.75%	0.74%	0.80%	0.70%	1.17%	0.92%	0.35%
40.0 – 59.99	0.09%	0.05%	0.48%	0.65%	1.71%	1.19%	0.82%	1.30%	1.06%	1.94%	1.53%	1.33%
60.0 – 79.99	0.05%	0.12%	0.36%	0.32%	1.24%	0.35%	0.45%	0.41%	1.17%	1.28%	0.99%	1.09%
80.0 – 99.99	0.00%	0.00%	0.28%	0.41%	0.77%	0.55%	0.34%	0.39%	0.75%	1.03%	0.67%	1.12%
100+	0.00%	0.07%	0.93%	1.49%	4.35%	1.64%	3.20%	2.42%	2.00%	6.35%	4.47%	10.09%
Non-Residential												
1.0 – 2.99	0.19%	0.37%	1.80%	2.27%	1.60%	0.96%	0.36%	0.18%	0.07%	0.07%	0.03%	0.03%
3.0 – 4.99	0.12%	0.28%	1.50%	2.39%	2.35%	1.12%	0.53%	0.30%	0.12%	0.28%	0.02%	0.07%
5.0 – 7.49	0.18%	0.31%	1.43%	2.67%	2.55%	1.52%	0.62%	0.34%	0.24%	0.38%	0.13%	0.12%
7.5 – 9.99	0.11%	0.11%	0.69%	1.27%	1.50%	0.69%	0.21%	0.17%	0.19%	0.15%	0.06%	0.04%
10.0 – 14.99	0.03%	0.33%	1.11%	2.60%	3.48%	2.20%	0.76%	0.41%	0.54%	0.64%	0.14%	0.18%
15.0 – 19.99	0.04%	0.16%	0.73%	0.94%	1.76%	1.35%	0.38%	0.37%	0.37%	0.62%	0.04%	0.05%
20.0 – 29.99	0.32%	0.24%	1.06%	1.42%	3.00%	0.95%	0.60%	0.86%	0.34%	0.42%	0.10%	0.06%
30.0 – 39.99	0.10%	0.16%	0.54%	0.90%	1.62%	0.43%	0.58%	0.43%	0.41%	0.45%	0.17%	0.40%
40.0 – 59.99	0.00%	0.37%	0.26%	1.08%	1.97%	1.55%	1.02%	1.14%	0.22%	0.89%	0.40%	0.69%
60.0 – 79.99	0.16%	0.15%	0.48%	1.08%	0.69%	0.54%	0.37%	0.52%	0.66%	0.55%	0.18%	0.19%
80.0 – 99.99	0.00%	0.00%	0.23%	0.22%	0.86%	0.24%	0.22%	0.00%	0.00%	0.67%	0.00%	0.24%
100+	0.00%	0.00%	0.35%	2.12%	3.95%	2.09%	0.28%	1.29%	0.58%	2.96%	0.39%	0.65%
Transportation												
1.0 – 2.99	0.28%	0.33%	1.08%	0.63%	0.33%	0.21%	0.13%	0.12%	0.06%	0.04%	0.00%	0.01%
3.0 – 4.99	0.15%	0.55%	1.29%	0.37%	0.57%	0.52%	0.09%	0.04%	0.10%	0.10%	0.06%	0.00%
5.0 – 7.49	0.07%	0.37%	2.15%	0.55%	1.14%	0.73%	0.34%	0.34%	0.07%	0.07%	0.10%	0.10%
7.5 – 9.99	0.13%	0.25%	0.51%	0.85%	0.13%	0.39%	0.24%	0.13%	0.25%	0.00%	0.00%	0.00%
10.0 – 14.99	0.55%	0.81%	0.87%	2.03%	0.85%	0.69%	1.05%	0.00%	0.00%	0.16%	0.00%	0.00%
15.0 – 19.99	0.00%	0.45%	2.26%	1.70%	0.28%	0.78%	0.22%	0.00%	0.00%	1.03%	0.00%	0.22%
20.0 – 29.99	0.34%	0.00%	1.78%	0.76%	0.00%	1.02%	1.76%	0.00%	0.40%	1.30%	0.33%	0.00%
30.0 – 39.99	0.00%	0.00%	0.45%	1.66%	1.02%	0.00%	1.64%	0.99%	0.57%	0.94%	0.00%	0.57%
40.0 – 59.99	0.00%	0.00%	0.72%	0.00%	0.00%	0.88%	2.15%	2.33%	0.66%	1.42%	0.00%	1.63%
60.0 – 79.99	0.00%	0.00%	0.00%	1.02%	1.06%	1.17%	0.00%	0.00%	0.00%	1.05%	0.00%	0.00%
80.0 – 99.99	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	0.00%	0.00%	1.35%	1.45%	0.00%	2.45%
100+	0.00%	0.00%	0.00%	0.00%	4.40%	1.69%	0.00%	0.00%	6.26%	10.09%	8.12%	3.35%

Source: EPA analysis

- Next, EPA assigned one of these four project distributions to represent each state, based primarily on region, to produce an estimate of the quantity of acres developed in each state and sector, by model project category. *Table 4-15* lists the assignment of NOI distributions to each state.

Table 4-15: NOI Distribution Assignments, by State

State	Assigned NOI Project Distribution
Alabama	South Carolina
Alaska	South Dakota
Arizona	California
Arkansas	South Carolina
California	California
Colorado	California
Connecticut	New York
Delaware	New York
District of Columbia	New York
Florida	South Carolina
Georgia	South Carolina
Hawaii	New York
Idaho	South Dakota
Illinois	New York
Indiana	New York
Iowa	South Dakota
Kansas	South Dakota
Kentucky	South Carolina
Louisiana	South Carolina
Maine	New York
Maryland	New York
Massachusetts	New York
Michigan	New York
Minnesota	New York
Mississippi	South Carolina
Missouri	South Carolina
Montana	South Dakota
Nebraska	South Dakota
Nevada	California
New Hampshire	New York
New Jersey	New York
New Mexico	California
New York	New York
North Carolina	South Carolina
North Dakota	South Dakota
Ohio	New York
Oklahoma	South Carolina
Oregon	California
Pennsylvania	New York
Rhode Island	New York
South Carolina	South Carolina
South Dakota	South Dakota
Tennessee	South Carolina
Texas	California
Utah	California
Vermont	New York
Virginia	South Carolina
Washington	California
West Virginia	South Carolina
Wisconsin	New York
Wyoming	South Dakota

4.2.3 Final Calibration of the Model Project Distributions

As detailed in the *Technical Development Document,* the NOI data – and the analysis used to develop the state-specific NOI distributions – contain a degree of error with respect to the proportion of acreage developed in each model project category. Additional error is introduced by applying four project acreage distributions to all 50 states, and then applying each aggregate sector distribution (e.g., residential) to their corresponding NAICS sectors. The combined effect of these sources of error resulted in instances where the quantity of acreage estimated to be developed in a given project category was not consistent with the definition of that category. For example, the number of acres in the 1-year/85.1-acre category for a given state may have been estimated initially as 40 acres. In this example, the number of total acres in the model project category cannot make sense because the total number of acres is less than the equivalent of one project for this category.

The final step in the acreage distribution process was to adjust the initial distribution of acreage across model project categories, by state and sector, such that each model project category with acreage has at least enough acreage in that category to account for one whole project. The approach for applying these adjustments individually by state and sector is described in the TDD for the final regulation. Below, *Table 4-16* presents the final distribution of C&D projects at the national level after these adjustments were applied, on a state-by-state and sector-by-sector basis. The final project set represents 852,649 acres. The state-level versions of this project data set are used to support the firm- and industry-level economic analysis (*Chapter 6*).

Table 4-16: National-Level Project Distribution, 2008-Trend Baseline Year (number of projects)

Median Project Size (acres)	Mid-Point of Project Duration Category (years)											
	0.1	0.2	0.3	0.6	0.8	1.1	1.3	1.6	1.8	2.3	2.7	3
Residential												
1.0	124	147	632	571	1,111	926	283	293	222	450	98	57
3.8	68	100	351	341	703	657	312	213	249	397	125	177
6.0	44	28	242	168	444	301	81	110	169	220	76	109
8.5	22	26	187	172	318	309	52	70	109	180	68	167
12.0	23	14	195	218	506	388	139	78	72	430	75	283
17.0	18	2	84	174	209	219	95	107	74	360	77	137
23.0	1	28	107	133	239	303	73	90	103	325	101	307
34.0	1	0	48	59	182	143	23	42	18	214	69	185
46.0	11	0	33	84	126	114	11	24	70	155	101	192
69.0	0	0	1	38	38	54	17	19	18	60	11	117
85.1	0	0	0	2	17	36	0	7	7	43	27	103
145.0	0	0	8	11	45	50	15	12	37	50	39	77
Non-Residential												
1.0	558	1359	4910	5334	4806	3276	940	685	442	592	180	155
3.8	219	547	1990	2973	2643	1715	910	461	199	465	140	148
6.0	150	206	996	1368	1516	1059	513	285	240	188	89	99
8.5	55	97	578	736	616	617	165	152	144	274	49	96
12.0	77	73	493	660	950	741	347	178	162	291	41	71
17.0	13	82	246	261	505	419	203	60	114	131	29	39
23.0	38	59	166	264	542	250	215	208	135	142	25	34
34.0	3	27	78	164	176	126	48	72	29	101	5	36
46.0	0	17	49	65	129	150	57	152	12	131	51	34
69.0	2	2	29	50	33	30	30	87	16	71	2	14
85.1	0	0	10	1	86	22	11	21	0	51	0	11
145.0	0	8	25	46	124	25	10	11	5	58	29	15
Transportation												
1.0	82	210	629	418	308	323	136	55	132	117	7	0
3.8	25	87	277	255	246	146	81	60	34	58	22	7
6.0	16	23	184	138	170	53	45	26	0	78	15	22
8.5	7	15	70	73	78	78	33	89	17	7	21	6
12.0	8	21	70	109	39	95	52	43	17	36	13	45
17.0	0	3	63	49	13	15	21	2	8	64	6	28
23.0	5	2	31	36	6	76	40	27	14	95	16	15
34.0	0	0	1	26	17	6	16	4	9	5	42	2
46.0	0	1	2	19	9	25	21	15	9	24	4	51
69.0	0	0	0	0	3	9	10	4	0	5	21	0
85.1	0	0	7	0	0	3	0	0	2	4	12	28
145.0	0	0	0	1	3	4	1	9	11	24	35	30

Source: EPA analysis

4.3 Baseline Specification of Industry Segments, Establishments, and Firms Affected by the Final C&D Rule

As described in *Chapter 3* the Construction and Development industry encompasses business operating in a range of construction industry segments. This section outlines those industry segments that are likely to perform activities within the scope of the regulation and that are the focus of this regulatory analysis.

Table 4-17 shows the 2002 universe of establishments in the entire C&D industry, as reported in the 2002 NAICS framework. As described in *Chapter 3*, 2002 is the most recent year for which comprehensive SUSB and Economic Census data are available. Accordingly, EPA used this data set as the basis for developing the 2008-trend set of industry data (i.e., in *Section 4.4*).

In the remainder of this section, tables and information are presented at the firm level, which is the focus of the industry impact analysis. The following section summarizes the exclusion of industry segments that are not applicable to this regulatory analysis.

Table 4-17: All Establishments within the C&D Industry (2002 data)

2002 NAICS	Description	Establishments
236115	New single-family housing construction (except operative builders)	58,472
236116	New multifamily housing construction (except operative builders)	4,397
236117	New housing operative builders	26,043
236118	Residential remodelers	82,750
236210	Industrial building construction	2,776
236220	Commercial and institutional building construction	37,209
237110	Water and sewer line and related structures construction	12,356
237120	Oil and gas pipeline and related structures construction	1,403
237130	Power and communication line and related structures construction	6,034
237210	Land subdivision	8,403
237310	Highway, street, and bridge construction	11,240
237990	Other heavy and civil engineering construction	10,501
238110	Poured concrete foundation and structure contractors	27,151
238120	Structural steel and precast concrete contractors	4,321
238130	Framing contractors	14,455
238140	Masonry contractors	25,720
238150	Glass and glazing contractors	5,294
238160	Roofing contractors	23,192
238170	Siding contractors	6,632
238190	Other foundation, structure, and building exterior contractors	2,786
238210	Electrical Contractors	62,586
238220	Plumbing, heating, and air-conditioning contractors	87,501
238290	Other building equipment contractors	6,086
238310	Drywall and insulation contractors	19,598
238320	Painting and wall covering contractors	38,943
238330	Flooring contractors	12,865
238340	Tile and terrazzo contractors	8,950
238350	Finish carpentry contractors	35,087
238390	Other building finishing contractors	3,729
238910	Site preparation contractors	30,498
238990	All other specialty trade contractors	33,453
	Total	**710,431**

Source: U.S. Census Bureau, Economic Census (2005a)

The majority of business that fall within the industry definitions outlined in *Table 4-17* will not be affected by the final regulation. A substantial number of businesses are not expected to be subject to the regulation because they are primarily engaged in subcontracted parts of a building project, such as flooring contracts, or they are involved in remodeling activities that will not disturb land. In this section, EPA identifies and sets aside from further analysis those industry segments that are *not* likely to perform activities that would be within the scope of the regulation. The estimates for the remaining segments are brought together to derive estimates of the number of firms expected to be covered by a C&D regulation on the basis of 2002 industry data.

4.3.1 Excluding Segments and Establishments That Are Not Involved in Land Disturbance

The final regulation applies only to those activities that disturb land and that are of sufficient scale to be within the regulation's scope. Therefore, most business within the *Special Trade Contractors* (NAICS 238) sector will not be affected and are excluded from this analysis. The only *Special Trade Contractors* segment whose activities have the potential to result in land disturbance are those entities within NAICS 238910, *Site Preparation Contractors*. The primary groups of entities within this NAICS sector are *Excavation Contractors, Wrecking and Demolition Contractors,* and *All Other Heavy Construction.*

The other sector within the C&D industry that is not likely to perform activities that result in land disturbance is NAICS 236118, *Residential Remodelers.* Based on the Economic Census definitions of the specific sectors within NAICS 238 and all of the entities within NAICS 236118, EPA excluded these segments from this analysis.

4.3.2 Excluding Segments and Establishments That Are Not NPDES Permittees

As stated above, EPA included certain categories within NAICS 238 in the analysis – 1997 NAICS 235930 (*Excavation Contractors*), 235940 (*Wrecking and Demolition Contractors*), and 234990 (*All Other Heavy Construction),* all within 2002 NAICS 238910 – because these establishments engage in land disturbing activities. Most often, however, establishments in 2002 NAICS 238910 act as subcontractors on C&D projects and are hired by developers or general contractors to perform specific tasks for projects where they are not the primary developer/manager. EPA believes that these establishments will not generally appear as NPDES permittees or co-permittees.

4.3.3 Adjustments and Exclusions Based on Data Limitations

EPA expects that businesses in NAICS 237210 (*Land Subdivision*) will undertake activities that are within the scope of the C&D rule. However, data for characterizing the profile of projects performed by NAICS 237210 and assigning compliance costs to businesses in this segment are not available and/or cannot be separated from the activities performed by the primary construction sectors – NAICS 236115, 236116, 236210, and 236220 – that are expected to be principally affected by the regulation. For this reason, EPA allocated the businesses and economic activity reported for NAICS 237210 *among these four primary focus sectors*. Thus, EPA accounted for the impact of the C&D rule on the NAICS 237210 sector in this regulatory analysis, but with those impacts being estimated and accounted for in the analysis for the four principal impact sectors: NAICS 236115, 236116, 236210, and 236220.

EPA also anticipates that some businesses and activities in the *Heavy Construction* sector (NAICS 237) will be affected by the C&D rule. However, with the exception of NAICS 237310 (*Highway, street, and bridge construction*), data are not available to support an assessment of the number and character of projects performed by NAICS 237 sector businesses that would be subject to compliance requirements and incur compliance costs. For this reason, of the sectors in NAICS 237, only NAICS 237310 (*Highway, street, and bridge construction*) is considered in the cost and impact analysis for the C&D rule.

4.3.4 Number of Potentially Affected Establishments

To summarize, EPA took several steps to adjust the number of affected entities to account for regulatory coverage and data availability. A total of 710,431establishments are within the C&D industry, as broadly defined. However, as stated in the two previous sections, a large number of businesses are not expected to perform activities within the scope of this regulation and were therefore excluded from this regulatory analysis. As a result of these exclusions, only about one-fourth of the total C&D industry establishments are expected to be affected by the regulation and are covered in this analysis. The specific steps leading to the estimate of potentially affected establishments are detailed within *Table 4-18*.

Table 4-18: Sectors and Establishments in the C&D Industry Included in this Analysis (2002 data)

2002 NAICS	Description	All Sectors in C&D Industry	Sectors Involved in Land Disturbance		
				Sectors that are NPDES Permittees	
			All	All	Sectors With Sufficient Data for Analysis[a]
236115	New single-family housing construction (except operative builders)	58,472	58,472	58,472	58,472
236116	New multifamily housing construction (except operative builders)	4,397	4,397	4,397	4,397
236117	New housing operative builders	26,043	26,043	26,043	26,043
236118	Residential remodelers	82,750	-	-	-
236210	Industrial building construction	2,776	2,776	2,776	2,776
236220	Commercial and institutional building construction	37,209	37,209	37,209	37,209
237110	Water and sewer line and related structures construction	12,356	12,356	12,356	-
237120	Oil and gas pipeline and related structures construction	1,403	1,403	1,403	-
237130	Power and communication line and related structures construction	6,034	6,034	6,034	-
237210	Land subdivision	8,403	8,403	8,403	8,403
237310	Highway, street, and bridge construction	11,240	11,240	11,240	11,240
237990	Other heavy and civil engineering construction	10,501	10,501	10,501	-
238110	Poured concrete foundation and structure contractors	27,151	-	-	-
238120	Structural steel and precast concrete contractors	4,321	-	-	-
238130	Framing contractors	14,455	-	-	-
238140	Masonry contractors	25,720	-	-	-
238150	Glass and glazing contractors	5,294	-	-	-
238160	Roofing contractors	23,192	-	-	-
238170	Siding contractors	6,632	-	-	-
238190	Other foundation, structure, and building exterior contractors	2,786	-	-	-
238210	Electrical Contractors	62,586	-	-	-
238220	Plumbing, heating, and air-conditioning contractors	87,501	-	-	-
238290	Other building equipment contractors	6,086	-	-	-
238310	Drywall and insulation contractors	19,598	-	-	-
238320	Painting and wall covering contractors	38,943	-	-	-
238330	Flooring contractors	12,865	-	-	-
238340	Tile and terrazzo contractors	8,950	-	-	-
238350	Finish carpentry contractors	35,087	-	-	-
238390	Other building finishing contractors	3,729	-	-	-
238910	Site preparation contractors	30,498	30,498	-	-
238990	All other specialty trade contractors	33,453	-	-	-
Total		**710,431**	**209,332**	**178,834**	**148,540**

a Before allocating entities within *Land Subdivision* (NAICS 237210) among the four building categories - NAICS 236115, 236116, 236210, and 236220.
Source: U.S. Census Bureau's Economic Census (2005a)

4.3.5 The Firm Universe Affected by the C&D Regulation

Since the Economic Census reports data by establishment and not at the level of the firm, EPA used SUSB data to develop the firm-level data needed for this analysis: number of firms, employees, and receipts by revenue size.

Further, because the 2002 SUSB data are reported in the 1997 NAICS framework, EPA used the 2002 Economic Census data on the number of establishments, employees, and value of construction by revenue size, to reconfigure the 2002 SUSB data within the 2002 NAICS framework, as described below:

1. The most significant difference between the 2002 and 1997 NAICS frameworks involves the framework for reporting data on the residential construction sectors. The *1997 NAICS* framework reports residential sector data in two sectors – (1) Single-Family Housing Construction and (2) Multifamily Housing Construction – while the *2002 NAICS* framework reports residential sector data in four sectors: (1) New Single-Family Housing Construction, (2) New Multifamily Housing Construction, (3) Residential Remodelers, and (4) New Housing Operative Builders. To achieve consistency in its analyses using data from both the 1997 and 2002 frameworks, EPA needed to reconfigure the 1997 framework data to align with the 2002 framework – by excluding Residential Remodelers from the two 1997 framework sectors and by breaking out New Housing Operative Builders as a separate sector. Specifically, EPA used Economic Census data to disaggregate the SUSB data among the four 2002 NAICS residential categories. EPA based this disaggregation on the Census proportions of establishments, employees, and value within the four residential building categories as compared to the totals within residential building construction.

2. Furthermore, to align the 2002 and 1997 NAICS frameworks, the highway, street, and bridge construction and industrial building construction sector required combining two 1997 NAICS sectors. The 1997 NAICS 234110 and 234120 (Highway and Street Construction, Bridge and Tunnel Construction, respectively) were combined to align with the 2002 NAICS 237310 (Highway, Street, and Bridge Construction). In addition, all of NAICS 233310 and part of NAICS 234930[27] (Manufacturing and Industrial Building Construction, Industrial Nonbuilding Structure Construction, respectively) were combined to align with the 2002 NAICS 236210 (Industrial Building Construction).

3. In addition, Economic Census data were used to break down some of the SUSB revenue size ranges into size ranges that are more relevant for reflecting differences in baseline financial performance/condition by business size and for understanding potential economic/financial impacts by business size. The specific revenue ranges used in this analysis are:

   - $100 thousand - $1 million
   - $1 - $2.5 million
   - $2.5 - $5 million
   - $5 - $10 million
   - $10 - $50 million
   - $50 - $100 million
   - $100 million and greater

   EPA used Economic Census proportions to break the SUSB $1 - $5 million range into $1 - $2.5 million and $2.5 - $5 million revenue ranges.

4. As noted above, because of data limitations, EPA allocated the firm level information for NAICS 237210 (*Land Subdivision*) among the four building sectors according to the each sector's proportion of establishments, employees, and value out of the total.

[27] The percent of 1997 NAICS 234930 that was assigned to 2002 NAICS 236210 was determined by identifying the percent of establishments, value, and employment assigned to the 2002 NAICS 236210 from the Economic Census Bridge Between 2002 NAICS and 1997 NAICS Construction.

Because expected regulatory effect and compliance costs vary across states, it was also necessary to disaggregate the firm data by state. Although Economic Census reports establishments, employees, and value of construction for each sector by state, SUSB does not report firm-level information by state for specific construction sectors. As a result, to develop firm-level data by state, for each of the relevant firm-level data items, EPA apportioned the *national level* SUSB data over states based on the Economic Census' proportions *by state*.[28] EPA further applied sector-specific national revenue range distributions – from Economic Census and SUSB, as described above – to the state totals to develop revenue range estimates by state.

Reflecting the adjustments described above, *Table 4-19* presents the universe of firms, revenue, employees, and average firm revenue by construction sector and revenue range during 2002, which is the basis for developing the equivalent 2008-trend industry data set.

Table 4-19: Baseline Firm Level Data by Revenue Range and NAICS Sector

	Revenue Ranges						
NAICS Sector[a]	Range 1: $100 thousand - $1 million	Range 2: $1 million - $2.5 million	Range 3: $2.5 million - $5 million	Range 4: $5 million - $10 million	Range 5: $10 million - $50 million	Range 6: $50 million - $100 million	Range 7: $100 million and more
Average Revenue Values (Rounded to the Nearest Thousand)							
236115	$335,000	$1,555,000	$3,424,000	$6,685,000	$18,515,000	$58,703,000	$256,404,000
236116	$326,000	$1,635,000	$3,403,000	$6,876,000	$18,675,000	$59,211,000	$258,622,000
236117	$408,000	$1,586,000	$3,566,000	$6,814,000	$18,737,000	$60,317,000	$294,450,000
236210	$315,000	$1,628,000	$3,559,000	$6,657,000	$17,653,000	$50,416,000	$191,930,000
236220	$379,000	$1,607,000	$3,537,000	$7,013,000	$19,872,000	$61,150,000	$209,888,000
237310	$375,000	$1,602,000	$3,430,000	$6,928,000	$20,279,000	$57,507,000	$162,938,000
Number of Firms							
236115	49,620	10,650	3,580	893	443	49	56
236116	3,134	724	497	182	239	26	31
236117	12,750	6,484	3,209	1,231	1,305	139	147
236210	1,630	485	233	165	167	23	103
236220	21,238	8,428	5,272	3,540	3,534	439	442
237310	5,314	2,002	1,324	998	1,213	174	185
Total Revenue (in Millions of Dollars)							
236115	$16,647	$16,559	$12,258	$5,973	$8,197	$2,867	$14,470
236116	$1,021	$1,183	$1,692	$1,254	$4,471	$1,564	$7,892
236117	$5,204	$10,282	$11,441	$8,390	$24,452	$8,364	$43,384
236210	$514	$789	$830	$1,098	$2,943	$1,152	$19,861
236220	$8,051	$13,547	$18,651	$24,823	$70,219	$26,824	$92,679
237310	$1,992	$3,208	$4,541	$6,914	$24,605	$9,984	$30,066
Number of Employees							
236115	122,637	60,751	31,345	17,605	13,306	3,796	12,797
236116	7,838	5,727	5,255	4,305	8,550	2,439	8,223
236117	30,066	27,823	22,489	17,892	50,773	14,417	50,143
236210	5,213	5,627	5,681	5,288	16,427	3,374	82,718
236220	76,752	86,069	80,276	83,313	168,179	49,960	139,859
237310	16,751	19,935	25,168	32,310	92,130	31,511	90,343

a NAICS 236115 is New single-family housing construction (except operative builders), NAICS 236116 is New multifamily housing construction (except operative builders), NAICS 236117 is New housing operative builders, NAICS 236210 is Industrial building construction, NAICS 236220 is Commercial and institutional building construction, NAICS 237310 is Highway, street, and bridge construction

b Alaska and Hawaii are not included in this firm-level baseline.

Source: U.S. SBA (2004) and U.S. Census Bureau's Economic Census (2005a)

[28] For example, according to Economic Census data, Alabama has approximately 1 percent of the 273,197 national employees within NAICS 236115 (Single-family residential construction). Therefore, applying the 1 percent of the national *SUSB* employee data to NAICS 236115, EPA determined that 2,655 employees (out of the 265,542 national total) were within NAICS 236115 in Alabama.

4.4 Adjusting the Baseline Firm Universe to Reflect 2008-Trend Conditions

EPA's baseline specification of the level of industry activity, and of the structure and composition of the C&D industry for the primary economic analysis, is intended to reflect the present condition of the industry assuming long-term steady state conditions prevail. As described previously in *Section 4.1*, EPA used each industry segment's estimated 2008-trend value of construction as the basis for estimating the total quantity of acreage in the primary analysis. Similarly, the C&D firm universe underlying the primary economic analysis also needed to reflect 2008-trend conditions.

Table 4-19 presents the 2002 C&D industry firm universe, which reflects the most recently available data from Census and SUSB. This section describes the approach EPA used to adjust this 2002 snapshot of the C&D industry to reflect 2008-trend conditions with respect to the number of firms, employees, total revenues, and average firms revenues for each in-scope industry segment and model firm revenue range.

In adjusting the 2002 industry snapshot, one of EPA's objectives was to ensure that the adjusted average firm revenue values remained within the boundaries of the fixed revenue range definitions. A simple application of aggregate growth in total industry revenue from 2002 to 2008-trend could violate this constraint, and also would not take into account that the change in aggregate industry revenue may be due to a combination of factors, including changes in average revenues per firm and in the total number of firms by revenue, and shifts in the numbers of firms across the revenue ranges. This analysis thus attempts to break down the known change in revenues by NAICS code from 2002 to 2008-trend into these two components of change, based on their contributions to the change in total revenues from 1997 to 2002, the two most recent years for which comprehensive data were available and which could provide an indication of the composition of change going forward from 2002.

The approach for adjusting the C&D firm universe is based primarily on:

- The change in total revenues, number of firms, and average revenues per firm, by sector and revenue range, from the 1997 Economic Census to the 2002 Economic Census.
- Change in total revenues, by sector, from 2002 to 2008-trend (e.g., see *Section 4.1* for 2008-trend values):
  - Residential = 26.5%
  - Commercial = 28.9%
  - Industrial = 76.7%
  - Transportation = 76.3%
- An assumption that the change in total sector revenue from 2002 to 2008 is composed of a change in the number of firms and a change in the average revenue per firm;
- An assumption that change over time in both the total values and the components that make up these values could be characterized by a model of constant exponential change, and
- An assumption that the relative contribution of these factors to the aggregate change between 2002 and 2008-trend revenues, by sector, is the same as the relative contributions to the aggregate change in revenues from 1997 and 2002.

Using this overall framework of assumptions, the first step to adjust the 2002 baseline firm universe was to compute the relative contributions of the change in the number of firms and average revenues per firm, by sector and revenue range, between 1997 and 2002. This analysis assumed constant exponential growth of the variables, so EPA determined the relative contributions based on the natural logarithms of the changes in the factors.

Next, assuming that the relative contributions of these factors to the aggregate change between 2002 and 2008-trend is the same as the relative contributions to change between 1997 and 2002, EPA calculated these changes for each revenue range and sector and then estimated the number of firms and average revenue for the 2008-trend year based on the estimated change in total revenue from 2002 to 2008.

This analysis involved the following steps:

- Calculating the relative contributions to change in total revenue from 1997-2002 for the number of firms and average revenues per firm:
  - Calculate the growth in average revenue and in firms from 1997 to 2002 by dividing the 2002 value by the 1997 value
  - Calculate the natural logarithm of the growth in average revenue (g^A) and of the growth in firms (g^F)
  - Divide g^A by g^F to calculate the ratio (relative contribution) of change between g^A and g^F
- Applying these relative contributions to the change in total revenues from 2002-2008 trend
  - Estimate 2008-trend total revenue based on 2002 total revenue by multiplying 2002 total revenue by the change in revenue from 2002 to 2008-trend for each NAICS code
  - Using the equations below, solve for g^A and g^F to estimate the growth of average revenues (g_{08}^A) and number of firms (g_{08}^F)from 2002 to 2008-trend, for each revenue range and NAICS code:

$$T_{08} = A_{02} \times e^{g_{08}^A} \times F_{02} \times e^{g_{08}^F} \tag{1}$$

$$R = \frac{g_{02}^F}{g_{02}^A} \tag{2}$$

$$T_{08} = A_{02} \times e^{g_{08}^A} \times F_{02} \times e^{g_{08}^A \times R} \tag{3}$$

Where:

=

T08	=	Total Revenue estimated for 2008
A02	=	Average revenue for 2002
g_{08}^A	=	Growth in average revenue from 2002 to 2008
F02	=	Number of firms for 2002
g_{08}^F	=	Growth in number of firms from 2002 to 2008
R	=	ratio of growth in average revenue to growth in number of firms from 1997 to 2002

  - Apply this estimated change in the number of firms and average revenue to the 2002 number of firms and average revenue to estimate the number of firms and average revenue by revenue range and NAICS code in 2008

Following the above set of calculations, EPA then made additional adjustments to account for inconsistencies in the data sources and/or limited occurrence of anomalies in applying the calculations outlined above:

- Revenue range definitions differ between the 1997 and 2002 data, and therefore EPA combined some revenue ranges to create range definitions that could be mapped to both datasets. Estimated changes for combined revenue ranges are used for each of the revenue ranges that the combined range includes. The following table summarizes the synthesis of revenue ranges to account for differences between 1997 and 2002 definitions.

Table 4-20: Reconciliation of 1997 and 2002 Revenue Ranges ($millions)

1997	$0-$0.05	$0.05-$0.1	$0.1-$0.5	$0.5-$1	$1-$3	$3-$5	$5-$7.5	$7.5-$25	$25-$100	$100+
2002	$0 - $0.1		$0.1-$0.5	$0.5-$1	$1-$2.5	$2.5-$5	$5-$10	$10-$50	$50-$100	$100+
Comb.	$0-$0.1		$0.1-$0.5	$0.5-$1	$1-$5		$5-$100			$100+

- In some cases (specifically for NAICS 236117 in combined range $5-$100 million and for NAICS 237310 in combined range $1-$5 million), the ratio of growth in firms to growth in average revenue from 1997 to 2002 caused unrealistic estimations of growth for 2002 to 2008-trend. In these cases, this ratio (R in the equation above) was set to 1.
- If the estimated average revenue for 2008-trend was outside of the revenue range (which occurs for NAICS 236210 for 2002 range $2.5-$5 million and for NAICS 236115 for 2002 range $5-$10 million), the average revenue value was set to either the minimum or maximum value of the revenue range, whichever is appropriate. This can occur when the total revenue changes from 2002 to 2008-trend that underlie the calculation of the changes in average revenue differ substantially from the observed changes from 1997 to 2002, leading to changes in average revenue that push average revenue outside of the revenue range.

EPA also estimated the number of employees for each sector and revenue range based on the average number of employees per firm in each revenue range and NAICS code in 2002. This average was then multiplied by the estimated number of firms in 2008 to estimate the number of employees in each revenue range and NAICS code.

The ultimate result of the above-described process is a data set indicating the estimated number of firms, total revenue, and average revenue per firm by C&D sector and revenue range. *Table 4-21* presents the national 2008-trend C&D firm universe data set, which EPA used to support the firm- and industry-level economic analysis. Based on this data set, EPA estimated that there are approximately 187,079 total firms within the affected C&D NAICS sectors. Among this set of firms, EPA estimates that the number of firms that may be directly affected by rule's requirements in the steady-state approximately 81,700. This sub-set of firms – indicated as the in-scope set of firms in *Chapter 6* – represents the number of firms that are capable of performing at least the minimum sized project over the longest duration given their revenue and acreage intensity (i.e. firms that can do the "easiest" project on their own given revenue and acreage intensity).

Table 4-21: Baseline Firm Level Data by Revenue Range and NAICS Sector

	Revenue Ranges						
NAICS Sector[a]	**Range 1: $100 thousand - $1 million**	**Range 2: $1 million - $2.5 million**	**Range 3: $2.5 million - $5 million**	**Range 4: $5 million - $10 million**	**Range 5: $10 million - $50 million**	**Range 6: $50 million - $100 million**	**Range 7: $100 million and more**
Average Revenue Values							
236115	$491,237	$1,978,937	$4,358,418	$9,999,999	$28,155,369	$89,269,838	$395,706,187
236116	$393,503	$1,892,237	$3,938,401	$8,443,670	$22,931,274	$72,706,242	$331,924,407
236117	$543,720	$1,812,774	$4,076,286	$8,999,094	$24,746,340	$79,662,752	$194,636,254
236210	$443,340	$2,357,310	$4,999,999	$9,996,696	$26,509,033	$75,706,422	$188,973,697
236220	$359,899	$1,489,122	$3,277,381	$7,679,540	$21,761,325	$66,963,867	$229,734,835
237310	$365,242	$1,647,982	$3,527,157	$7,473,328	$21,875,868	$62,034,746	$156,290,456

Table 4-21: Baseline Firm Level Data by Revenue Range and NAICS Sector

	Revenue Ranges						
NAICS Sector[a]	Range 1: $100 thousand - $1 million	Range 2: $1 million - $2.5 million	Range 3: $2.5 million - $5 million	Range 4: $5 million - $10 million	Range 5: $10 million - $50 million	Range 6: $50 million - $100 million	Range 7: $100 million and more
Number of Firms							
236115	51,023	12,593	4,233	899	438	48	55
236116	3,860	929	638	221	290	32	35
236117	14,310	8,480	4,196	1,394	1,477	157	333
236210	2,411	695	345	228	230	32	218
236220	33,838	13,778	8,619	4,896	4,887	607	611
237310	4,939	1,763	1,166	838	1,018	146	174
Total Revenue (in Millions of Dollars)							
236115	$25,064	$24,920	$18,447	$8,988	$12,336	$4,314	$21,776
236116	$1,519	$ 1,758	$ 2,514	$1,864	$ 6,645	2,324	$11,731
236117	$7,781	$15,371	$17,105	$12,544	$36,556	$12,505	$64,860
236210	$1,069	$1,639	$1,723	$2,279	$6,110	$2,392	$41,235
236220	$12,178	$20,516	$28,248	$37,596	$106,348	$40,626	$140,364
237310	$1,804	$2,905	$4,112	$6,261	$22,280	$9,041	$27,225
Number of Employees							
236115	126,618	72,080	37,190	17,773	13,213	3,769	12,522
236116	9,600	7,357	6,750	5,212	10,353	2,954	9,527
236117	33,606	36,237	29,290	20,170	57,237	16,252	112,942
236210	7,626	8,032	8,359	7,280	22,616	4,646	173,686
236220	122,399	140,782	131,306	115,291	232,732	69,136	193,633
237310	15,581	17,564	22,175	27,140	77,386	26,469	85,343

a NAICS 236115 is New Single-Family Housing Construction (except operative builders), NAICS 236116 is New Multifamily Housing Construction (except operative builders), NAICS 236117 is New Housing Operative Builders, NAICS 236210 is Industrial Building Construction, NAICS 236220 is Commercial and Institutional Building Construction, NAICS 237310 is Highway, Street, and Bridge Construction

b Alaska and Hawaii are not included in this firm-level baseline.

Source: EPA analysis

4.5 Baseline Specification of Model C&D Firms

EPA based its assessment of industry impacts on an analysis of model firms that were defined for the specific construction industry sectors and revenue ranges outlined above. This section summarizes key financial information for the model firm baseline.

4.5.1 Defining Economic Sectors and Revenue Size Ranges for Model Firms

As described above, EPA identified six principal C&D business segments that are expected to be within the scope of the final regulation and for which sufficient data are available to estimate compliance costs and assess potential regulatory effects. As the basis for its firm and industry impact analysis, EPA constructed model firms for the NAICS sectors aligning with each of these business segments:

- New Single-Family Housing Construction (except Operative Builders) (NAICS sector 236115)
- New Multifamily Housing Construction (except Operative Builders) (NAICS sector 236116)
- New Housing Operative Builders (NAICS sector 236117)
- Industrial Building Construction (NAICS sector 236210)
- Commercial and Institutional Building Construction (NAICS sector 236220)
- Highway, Street, and Bridge Construction (NAICS sector 237310).

Within each business segment, EPA further defined model firms according to business size based on seven revenue size categories in which SUSB and Economic Census report data. As described previously, SUSB reports business data (e.g., number of entities, revenue, and number of employees) by "firm" while Economic Census reports business data by "establishment." Each data source uses slightly different revenue size categories for reporting business data. Because this analysis is focused on "firm-level" impacts, the analysis relied primarily on SUSB as the data source for average size of business, and numbers of businesses and employees within revenue ranges. However, Economic Census data were used to disaggregate some of the SUSB revenue size ranges into smaller size ranges to improve understanding of the differences in baseline financial performance/condition by business size and how economic/financial impacts might vary by business size. The revenue ranges used in the firm-level analysis are:

- $100 thousand - $1 million
- $1 - $2.5 million
- $2.5 - $5 million
- $5 - $10 million
- $10 - $50 million
- $50 - $100 million
- $100 million and greater

4.5.2 Assigning Baseline Financial Information to Model Firms

EPA assigned baseline financial characteristics – balance sheet, income statement, and metrics of financial performance and condition – to each of the model firms as defined by NAICS sector and revenue size range, from financial statement information reported by Risk Management Association (RMA) in its publication, *Annual Statement Studies*. The RMA data are compiled from the financial statements submitted by the borrowers and applicants for lending to financial institutions, and are collected and reported annually. The number of statements represented in the RMA data for a given year varies from several hundred to several thousand in the business sectors analyzed.

The firm-level financial models are defined for both the General Business Conditions case and Adverse Business Conditions case.

- ***General Business Conditions case***: RMA data by sector and revenue range for the 6-year period generally covering years 2002 through 2007 were used to define the General Business Conditions case models. The earliest eStatement Studies year gathered from RMA is 2003-2004, representing data with fiscal closing dates of April 1, 2002 through March 31, 2003. As reported by RMA, the number of statements that fall within the first six months of the year period is small (an average of 17 percent across all years and sectors) compared to the number of statements that fall within the latter six months. Therefore, the majority of the data within the 2003-2004 eStatement Studies is from 2002, with some data from 2001 and 2003. Since the 2008-2009 eStatement Studies are the most recent dataset, following the same date description as above, the latest complete data year from RMA is 2007. For all of the affected C&D sectors, this 6-year period encompasses periods of relative weakness and strength.
  - For the residential construction sectors, 2002 through 2005 is a period of growth and generally good financial performance. However, beginning in 2006, this sector has been in a period of weakness.
  - For the non-residential construction sectors, 2000 to 2003 is a period of relative weakness. From 2003 to 2005, these sectors saw relatively flat performance followed by strong growth in from late 2005 into 2007.
- ***Adverse Business Conditions case***: To develop the Adverse Business Conditions case models, EPA used RMA data from the *worst* financial performance year in the 6 RMA reporting years beginning with fiscal years ending between April 2002 and March 2003 through fiscal years ending between April 2007 and March 2008, as indicated in the RMA data for each sector, as the initial basis of the model firm financial statements (see Appendix A for specifications of the *Adverse Business Conditions* case).
  - For the <u>residential construction sectors</u>, EPA began with data from the most recent RMA reporting year, 2008-2009, which corresponds with RMA reporters' fiscal years ending in April 2007 through

March 2008, as the basis of the Adverse Business Conditions case financial statements. In most instances, the fiscal years of these reporting businesses ended at December 31, 2007. Although calendar/fiscal year 2007 represents the worst performance year for the residential construction sectors among the RMA-reported years and is clearly an adverse performance year for these sectors (as documented in *Chapter 3*), it does not likely represent the worst business performance year of the current downturn facing the residential construction sectors. Accordingly, EPA adjusted the RMA statements to reflect the further deterioration in financial performance/condition for residential sector firms from 2007 through 2008. EPA based this adjustment on the *decline* in key financial metrics from 2007 through 2008 for public-reporting firms in the residential construction sectors. EPA used data for *public-reporting firms* for this adjustment because no comprehensive dataset of financial metrics for private, non public-reporting firms is available for a more recent period than the data reported by RMA. EPA applied these adjustments to the RMA data to develop baseline financial statements for the Adverse Business Conditions case that would better reflect the severity of the current downturn. In all instances – by sector, revenue range, and quartile of baseline financial performance – application of these adjustments yielded financial statements that were substantially weaker than the unadjusted RMA statements (see *Chapter 3* for information on the development of the financial data for public-reporting firms, and see *Appendix A* for further details of the adjustment and the resulting financial statements).

- For the <u>non-residential construction and transportation sectors</u>, EPA used data from the 2004-2005 RMA reporting year, which coincides with fiscal years ending April 2003 through March 2004 (most often ending at December 31, 2003), as the basis of the Adverse Business Conditions case financial statements for these model firms. Financial statement data from this RMA reporting year represent the weakest performance/condition data among the RMA-reported years for the non-residential construction sectors. No further adjustment was applied to these financial statements.

The revenue ranges for which RMA reports data align closely with the revenue size categories derived from SUSB and Economic Census:

Model Firm Revenue Range (from SUSB and Economic Census)	**RMA Revenue Range Mapped to SUSB/Economic Census Revenue Range**
Less than $1 million	Less than $1 million
$1 - $2.5 million	$1 - $3 million
$2.5 - $5 million	$3 - $5 million
$5 - $10 million	$5 - $10 million
$10 - $50 million	$10 - $25 million
$50 - $100 million	$25 million and greater
$100 million and greater	$25 million and greater

RMA reports balance sheet and income statement information by revenue range for firms in each of the six NAICS sectors for which model firms were developed. The balance sheet and income statement information is reported as percentages for important accounting items for the *average* statement in each business sector and size category:

- Balance sheet – asset percentages are reported for the following items:
  - Cash & Equivalents
  - Trade Receivables (net)
  - Inventory
  - All Other Current Assets
  - Total Current Assets
  - Fixed Assets (net)
  - Intangibles (net)
  - All Other Non-Current Assets
  - Total Assets.
- Balance sheet – capital elements (liabilities and equity) are reported for the following items:
  - Notes Payable-Short Term
  - Current Maturity of Long Term Debt

- Trade Payables
- Income Taxes Payable
- All Other Current Liabilities
- Total Current Liabilities
- Long Term Debt
- Deferred Taxes
- All Other Non-Current Liabilities
- Net Worth
- Total Liabilities & Net Worth.

➢ Income statement – income statement/operating statement are reported for the following items:
- Net Sales
- Gross Profit
- Operating Expenses
- Operating Profit
- All Other Expenses (net)
- Profit Before Taxes

In addition to reporting average income statement and balance sheet information, RMA also reports values for a large number of metrics of financial structure, performance, and condition by quartile – first quartile, median, and third quartile – as calculated from the statements in the sector and revenue size categories. Key ratios of interest for this analysis include:

➢ Sales/Total Assets
➢ Pre-Tax Income/Total Assets
➢ Earnings before Interest and Taxes (EBIT)/Interest
➢ Total Liabilities/Tangible Net Worth.

These financial ratio values by quartile are important for developing baseline financial statements that vary by baseline financial condition and performance. This information is also used to establish the values of financial performance metrics (for Pre-Tax Income/Total Assets and EBIT/Interest) that are judged indicative of below-standard performance for the business sectors and thus can provide insight into the potential for adverse financial impact of the C&D rule by business sector and size.

4.5.2.1 Steps in Developing the Baseline Financial Statements

EPA performed the following steps to develop the baseline financial statements for the model firms:

➢ Use the estimated average of revenue by sector and revenue range for 2008-trend (described above) as the baseline revenue value for firms within each business sector and revenue category. This value applies for each of the three quartiles of baseline financial performance.

➢ Use RMA-reported value of Sales/Total Assets, by quartile, *and* SUSB-reported average of revenue by sector and revenue range to assign a baseline dollar value of total assets and capital (liabilities and equity) for firm-level balance sheets. This calculation yields a varying baseline total capitalization by baseline financial performance: as expected, more weakly performing firms have lower asset productivity as indicated by the ratio of sales to total assets and thus carry higher capitalizations for the given revenue value.

➢ Use the RMA-reported values of Pre-Tax Income/Total Assets, EBIT/Interest, Total Liabilities/ Tangible Net Worth, by quartile, to develop baseline *dollar-valued* income statement and balance sheet for each of the three quartiles of baseline performance. These specific RMA-reported values are judged important as the basis for differentiating the baseline financial statements by baseline financial performance – lower quartile performance, median performance, and higher quartile performance – and thus providing insight into the potential impacts of the C&D rule on firms in varying baseline financial circumstances. All else equal, firms with weaker baseline financial circumstances would be at risk of more severe impacts than firms with stronger baseline financial circumstances. The basis for using these specific measures to establish financial statements by quartile is as follows:

  - ***Pre-Tax Income/Total Assets*** is a key measure of the fundamental asset productivity and profit performance of a business, and thus is an important differentiator of financial statements by baseline financial performance and condition. For this analysis, Pre-Tax *and Pre-Interest* Income/Total Assets would have provided stronger insight into basic business financial performance since the income measure would have been before payments to debt capital and thus independent of capital structure. However, RMA does not provide this financial measure.

- ***Earnings before Interest and Taxes (EBIT)/Interest*** indicates the extent to which pre-interest and pre-tax income exceeds interest obligations and thus is a key measure of the ability of an enterprise to meet its current interest obligations and as well the risk to a borrower for extending additional credit to the enterprise. As such, EPA also judges this measure as an important differentiator of financial statements by baseline financial performance and condition. Businesses with relatively greater debt as a component of total capital and/or with relatively lower basic profitability will have lower EBIT/Interest values.
- ***Total Liabilities/Tangible Net Worth*** is less closely linked to baseline financial performance and condition and indeed is likely to be a managed element of capital structure. However, the measure is also a direct indicator of the riskiness of a firm's capital structure – and of the risk of the capital structure to providers of both debt and equity capital. Because firms in weaker financial circumstances *may* be more likely to have higher debt as a component of total capital (e.g., as stated in the preceding paragraph, high debt in itself can be a contributor to a low EBIT/Interest value), this measure was also used to differentiate the baseline financial statements by performance/condition quartile.

➢ In general, the *median quartile* reported values align closely with the values for these measures as calculated from the *average* financial statement information reported in the RMA statements. However, as expected, the RMA-reported values for the lower and upper quartiles of these metrics differ substantially from those indicated by the average financial statements. Accordingly, the lower and upper quartiles for the three financial measures were used to calibrate the baseline balance sheets and income statements to represent lower and upper quartile baseline financial statements for firms by sector and revenue range, as follows:

- The fraction of total capitalization represented by baseline equity *less intangible assets* was adjusted to yield the reported value of Total Liabilities/Tangible Net Worth. The composition of the resulting residual of total liabilities was structured in terms of the baseline composition of liabilities for the *average* business by sector and revenue range. As a result, the financial statements for the *lower quartile* firm models are assigned a higher debt fraction of total capital than the median and upper quartile firms.
- Total expenses *before interest and tax expense* and *interest expense* were adjusted to yield the target values of Pre-Tax Income/Total Assets and EBIT/Interest. This calculation yielded a baseline income statement value for interest expense which is not broken out separately in the RMA-reported income statements (but is implicitly available through the reporting of the EBIT/Interest value), and is needed for the firm-level impact analysis.

➢ As described more specifically in *Chapter 6*, the analysis of baseline performance and potential impact of the C&D rule relies in part on an assessment of the change in business value of affected firms. To develop the baseline and post-compliance estimates of business value requires an estimate of after-tax income, which is not reported by RMA in its income statements. To calculate after-tax income, a composite federal/state income tax rate based on (1) the estimated federal rate applicable to pre-tax income for the given model firm and (2) an average of state tax rates of 7.3 percent, was applied to the indicated pre-tax income for the model firms. Where tax rates are unable to be differentiated by pre-tax income level – e.g., in the project analysis – a combined federal/state tax rate of 42.5 percent was used to account for tax effects.

4.5.2.2 Estimating Baseline Business Value for the Model Firms

The final step in developing the baseline firm financial models by sector, revenue range, and baseline performance quartile was to develop an estimate of the baseline business value of the model firms. As noted in the preceding paragraph, change in business value is one of the impact measures in the firm analysis. Baseline business value is determined as follows:

- Calculate after-tax cash flow from operations available to debt and equity capital, which is the sum of after-tax income and interest payments on a pre-tax basis (total operating cash flow to all capital).[29]
- Discount total operating cash flow to all capital by the estimated weighted average after-tax cost of capital, which yields going concern value for the business on the basis of total capital – i.e., debt and equity.
- Subtract long-term liabilities from the total capitalization value to yield going concern value to the business' equity owners.
- Add net current assets to the net going concern value to yield total business value to the business' equity owners, including net going concern value and net balance sheet liquidity.

In this calculation, the business is assumed to operate in a "no real growth" steady state – i.e., the firm's cash flow is assumed static, neither increasing nor decreasing, except for the effect of inflation. As a result, a discounted cash flow analysis using the cash flow from a single time period is appropriate for estimating the business value of the firm.

4.5.2.3 Developing the Cost of Capital Used in Calculating the Business Value of Model Firms

The cost of capital used in the discounted cash flow calculation is based on the model firm's financial structure (debt and equity as fractions of total capital) and further varies according to business size (assumed to affect firms' terms of access to capital markets) and the business conditions case (Copeland et al., 2000b). Key elements of the cost of capital calculation are as follows:

Cost of debt:

- For the General Business Conditions case, the cost of debt is based on the reported market yield of 7.0 percent for "Moody's Baa-rated corporate bonds - all industries," over the period 2000-2007 (U.S. Federal Reserve, 2007a).[30] The Baa rating is considered "Medium Grade" debt and is the lowest of the "Investment Grade" debt ratings.[31]
- For the Adverse Business Conditions case, based on the estimated market yield of 12.7 percent for Moody's B-rated debt in the year 2001, the most recent declared recession year in the U.S. economy (NBER, 2003) for which full-year data are available. The B rating is considered "Low Grade (speculative)" and the second highest debt grade in the "Not Investment Grade" debt ratings. This rating and the associated debt cost would be appropriate for firms with appreciably weak financial performance.

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29 The calculation of after-tax cash flow from operations would also typically involve adding back depreciation, since this a non-cash charge, and subtracting an allowance for ongoing outlays to maintain the existing capital stock and associated baseline production capability. EPA did not "add back" depreciation in the cash flow calculation because no information was available for estimating an appropriate allowance for ongoing capital outlays. In effect, the value of depreciation recorded in the baseline operating statements is being treated as approximately equal to the ongoing capital outlay value.

30 Moody's yield on seasoned corporate bonds - all industries, Baa (medium grade, lowest investment grade rating).

31 Debt ratings definitions from The Bond Market Association.

The estimated 12.7 percent cost for B-rated debt is calculated from reported interest rate spreads for industrial bonds of various ratings against the debt cost for 10-year Treasury Bonds (Bondsonline, 2006).

- To convert the debt cost to an after-tax basis, the debt costs are reduced by the estimated combined federal/state tax rate for each of the firm models, by revenue range, as described above. The resulting after-tax debt costs were applied to firms of all sizes in calculating a cost of capital for use in the firm-level analysis.

Cost of equity:

- The cost of equity is calculated on the basis of the Capital Asset Pricing Model (CAPM) analytic convention, which determines the cost of equity capital as the return on a "riskless" investment plus a risk-adjusted equity market premium. The risk-adjusted equity market premium is based on a firm's or sector's undiversifiable, or systematic, market risk – conventionally defined as the market "beta" for the firm or sector[32] – and the observed equity cost premium to the "riskless" investment – typically a Treasury bond of 10 years or more maturity (Copeland et al., 2000a).
- The riskless return value is based on the average market yield, 4.6 percent, on 10-Year Treasury Bonds over the period 2000-2008 (U.S Federal Reserve, 2009).
- The equity market premium varies by business conditions case. The General Business Conditions case uses an equity market premium of 4.9 percent, which is at the lower end of the range of equity market premiums estimated for U.S. equity markets (Damoradan, 2008).[33] The Adverse Business Conditions case uses a higher equity market premium of 6.0 percent to reflect the higher degree of investor risk aversion during periods of weak economic performance (Copeland et al., 2000a).
- The *beta* values applied in the equity cost analysis are based on the average market beta for 41 publicly-traded firms in the Homebuilding Sector[34], as identified by the Value Line Investment Survey (Damoradan, 2008).[35] Two *beta* values are used in the analysis for each analysis case. For the General Business Conditions case, model firms judged of sufficient size to access public markets for equity capital – $100 million and greater, the highest revenue category in the analysis – were assigned a *beta* of 0.98, which is based on public securities markets. For model firms in the revenue categories below $100 million, which are judged not to be of sufficient size to access public capital markets, a so-called "total market risk" *beta* of 1.32 is used in the analysis. Under the Adverse Business Conditions case the two beta values are 1.36 and 1.46, respectively. The "total" *beta* reflects the total variance in securities' value for firms in the Value Line Homebuilding Sector and does not set aside the "diversifiable" component of variance. The "total" *beta* concept is judged more appropriate for estimating equity cost for private firms whose owners are likely to have heavily concentrated, less diversified ownership in those firms.
- The resulting after-tax equity costs range from 9.5 percent for large businesses under the General Business Conditions case to 13.4 percent for small businesses under the Adverse Business Conditions case.

32 The extent of correlation of the firm's or sector's returns with the overall market, which thus cannot be "diversified away" in a portfolio.

33 As recommended in the internet-based financial data portal maintained by Aswath Damoradan, professor of finance at New York University's Stern School of Business.

34 The Homebuilding Sector provides the "best" sector match within the Value Line companies and sectors dataset for identifying the relevant financial characteristics of firms in the construction and development industries.

35 Both *beta* values – the "standard public securities market" *beta*, applicable to publicly traded firms and the "total" *beta*, applicable to private companies – are as reported by Aswath Damoradan.

The after-tax cost of debt and cost of equity are combined according to the baseline capital structure – debt and equity fractions of total long-term capital – of model firms, by sector, revenue range, and financial performance quartile, to yield the weighted average cost of capital used in the business value analysis for model firms.

The cost of equity developed in this analysis is an after-tax cost of equity, since it reflects the income payable to the firm's equity owners, which by definition, is after taxes. The after-tax cost of equity is converted to a pre-tax basis by dividing by one *minus* the estimated combined federal/state tax rate of 42.5 percent.

Table 4-22, following page, summarizes cost of capital values used in the firm and industry impact analysis.

Table 4-22: Cost of Capital for C&D Industry Effluent Guidelines Analyses

	General Business Conditions Case	Adverse Business Conditions Case
Cost of Debt Capital	7.0%	12.7%
Cost of Equity Capital		
After-tax		
for Public Market Sized Firms	9.5%	12.7%
for Smaller Undiversified Ownership Firms	11.2%	13.4%
Pre-tax		
for Public Market Sized Firms	13.5%	18.1%
for Smaller Undiversified Ownership Firms	16.0%	19.1%

Source: EPA estimates based on underlying data sources

All business operating financial parameters and, as a result, cash flow are assumed to be constant, except for the effect of inflation. Accordingly, the present value of cash flow is determined simply by dividing the constant (*in real terms*) cash flow value by the estimated cost of capital. To account for the effect of inflation in this analysis, the estimated cost of capital is reduced by the assumed constant rate at which cash flow is assumed to grow. This approach is equivalent mathematically to using a *real* discount rate (i.e., setting aside the component of cost of capital which results from inflation) in the discounted cash flow calculation. For this adjustment, EPA used a nominal cash flow growth rate of 3.1 percent, which is the average of year-to-year rates of change of the Engineering News-Record's *Construction Cost Index* over the period 1990-2007 (McGraw Hill, 2008).

As detailed in this section, the firm-level financial models are defined for both the General Business Conditions case and Adverse Business Conditions case. *Table 4-23* summarizes the parameter definitions for these business cases.

Table 4-23: Summary of Key Parameters that Define the *General* and *Adverse* Business Conditions Cases

Sector	General Business Conditions Case	Adverse Business Conditions Case	Data Source	Methodology
Model Firm Rate of Compliance Cost Pass-Through				
NAICS 236115	85.0%	0.0%	*Price elasticity of supply:* Green, Malpezi, and Mayo (2005); and, Benjamin, Jud, and Winkler (1998). *Price elasticity of demand:* HUD, 2006; DiPasquale, 1999; Benjamin, Jud, and Winkler, 1998.	➢ *General Business Conditions Case:* estimates of cost pass-through rates for the residential and non-residential sectors are based on estimates of price elasticity of supply (Es) and demand (Ed). ➢ *Adverse Business Conditions Case*: firms are assumed to absorb all of the compliance outlay within their current operating finances – i.e., the cost pass-through rate is set to zero.
NAICS 236116	85.0%	0.0%		
NAICS 236117	85.0%	0.0%		
NAICS 236210	71.0%	0.0%		
NAICS 236220	71.0%	0.0%		
NAICS 237310	71.0%	0.0%		
Model Firm Cost of Debt Capital				

Table 4-23: Summary of Key Parameters that Define the *General* and *Adverse* Business Conditions Cases

Sector	General Business Conditions Case	Adverse Business Conditions Case	Data Source	Methodology
All Sectors	7.0%	12.7%	Moody's Seasoned data (U.S. Federal Reserve, 2007a).	➢ *General Business Conditions Case*: based on the reported market yield for Moody's Baa-rated corporate bonds (investment grade) over the period 2000-2008. ➢ *Adverse Business Conditions Case*: based on the reported market yield for Moody's B-rated debt (speculative grade) over the period 2000-2008.
Model Firm Cost of Equity Capital, After-Tax				
All Sectors, for Public Market Sized Firms	9.5%	12.7%	Based on the Capital Asset Pricing Model (CAPM) analytic convention, using data on equity market premiums from Damoradan (2008) and Copeland (2000a).	➢ *General Business Conditions Case*: based on an equity market premium that is at the lower end of the range of equity market premiums estimated for U.S. equity markets. ➢ *Adverse Business Conditions Case*: based on a higher equity market premium to reflect the higher degree of investor risk aversion during periods of weak economic performance. ➢ Also, cost of equity differs by size of firm. The cost of equity for smaller, undiversified ownership firms reflects a larger market risk premium since these firms are not expected to be of sufficient size to access public capital markets.
All Sectors, for Smaller Undiversified Ownership Firms	11.2%	13.4%		
Industry Average Deviation from Trend of Construction Activity During Adverse Performance Years				
NAICS 236115	N/A	N/A	U.S. Census, value of construction by sector: 1990 to 2008 (U.S. Census, 2009a).	➢ *General Business Conditions Case*: No assumed deviation from trend. ➢ *Adverse Business Conditions Case*: For the non-residential and transportation sectors, EPA assigned each year into categories of *at trend*, *above trend*, or *below trend* based on that's year's deviation in the value of construction activity from the long term trend for the sector. An average deviation from trend during each adverse performance years was estimated for each general industry sector. EPA used these percentage values to model a contraction from the 2008-trend in the non-residential and transportation sectors during adverse market conditions. For the residential sector, the actual 2008 level of activity was used to define adverse conditions in this sector. See Appendix A for more detail.
NAICS 236116	N/A	N/A		
NAICS 236117	N/A	N/A		
NAICS 236210	N/A	-13.89%		
NAICS 236220	N/A	-13.89%		
NAICS 237310	N/A	-4.23%		
Model Firm Baseline Financial Information				
NAICS 236115			EPA estimates based on Risk Management Association (RMA) eStatement Studies. RMA reports financial statement metrics by each NAICS sector and for seven revenue ranges.	➢ *General Business Conditions Case*: Values are based on an average of values over the period April 2002 through March 2008, as detailed above. ➢ *Adverse Business Conditions Case*: Based on adverse performance years within each sector using Census data on the value of construction activity from 1990 to 2008. The adverse performance years used in the analysis are 2008 for the residential sector (based on adjusted RMA data) and 2003 for the non-residential and non-building sectors. ➢ *Note*: EPA performed the analysis for each of the six NAICS sectors and for the seven revenue ranges within each NAICS code. The values reported here –
Pre-Tax Income/Total Assets	5.77%	-1.93%		
EBIT/Interest	5.5	0.7		
Net Income Margin	2.17%	-2.62%		
NAICS 236116				
Pre-Tax Income/Total Assets	6.53%	0.14%		
EBIT/Interest	8.3	2.8		
Net Income Margin	1.85%	-0.63%		
NAICS 236117				
Pre-Tax Income/Total Assets	5.47%	-1.49%		
EBIT/Interest	6.4	1.5		
Net Income Margin	2.29%	-1.88%		
NAICS 236210				
Pre-Tax Income/Total Assets	5.38%	3.49%		

Table 4-23: Summary of Key Parameters that Define the *General* and *Adverse* Business Conditions Cases

Sector	General Business Conditions Case	Adverse Business Conditions Case	Data Source	Methodology
EBIT/Interest	9.0	6.2		for illustration – are the averages of the median financial ratios across the seven revenue ranges within each NAICS sector.
Net Income Margin	1.22%	0.85%		
NAICS 236220				
Pre-Tax Income/Total Assets	5.70%	3.93%		
EBIT/Interest	10.0	7.9		
Net Income Margin	1.33%	0.92%		
NAICS 237310				
Pre-Tax Income/Total Assets	6.45%	4.10%		
EBIT/Interest	5.0	3.7		
Net Income Margin	1.94%	1.27%		

Source: EPA Analysis

4.5.3 Summary of Model Firm Financial Data

Table 4-24 through *Table 4-26* present key baseline financial information – Pre-Tax Income/Total Assets, Earnings Before Interest and Taxes (EBIT)/Interest, and Net Income Margin – for model firms in each of the construction sectors and revenue ranges. The summary presented below reflects the *General Business Conditions* case relationships (i.e., an averaged dataset over the 6-year period 2002 through 2007), and this is the basis for the primary economic impact analysis. As expected, the values necessarily show improvement in baseline financial performance over the three quartile values – First Quartile (weakest performance), Median, and Third Quartile (strongest performance). In addition, these data generally show strengthening financial performance as business size increases within each NAICS sector. This observation underscores the importance of accounting for variation in baseline financial condition and performance by business size in the cost and economic impact analysis for this regulation.

Table 4-24: Model Firms: Pre-Tax Income/Total Assets

Revenue Range	Quartile	NAICS Sector[a] 236115	236116	236117	236210	236220	237310
Revenue Range 1: $100 thousand to $1 million	First Quartile	-2.4%	-5.0%	-2.2%	-4.9%	-3.8%	-9.9%
	Median	2.2%	2.2%	3.7%	1.9%	3.4%	3.3%
	Third Quartile	12.3%	15.2%	12.7%	13.9%	15.1%	15.4%
Revenue Range 2: $1 million to $3 million	First Quartile	0.0%	0.5%	-1.2%	-1.5%	-1.3%	0.3%
	Median	4.6%	6.0%	4.7%	5.8%	6.1%	6.4%
	Third Quartile	13.7%	16.6%	22.0%	18.4%	19.3%	18.0%
Revenue Range 3: $3 million to $5 million	First Quartile	0.9%	1.7%	0.4%	-1.3%	-0.4%	0.7%
	Median	4.9%	7.2%	3.5%	5.2%	5.9%	7.1%
	Third Quartile	12.5%	20.1%	11.8%	15.6%	15.1%	18.6%
Revenue Range 4: $5 million to $10 million	First Quartile	1.1%	1.2%	1.3%	0.4%	1.3%	1.1%
	Median	5.2%	6.1%	5.8%	6.0%	6.7%	6.7%
	Third Quartile	12.9%	15.1%	14.3%	15.2%	16.1%	15.7%
Revenue Range 5: $10 million to $50 million	First Quartile	1.5%	1.5%	1.3%	1.7%	1.5%	2.2%
	Median	6.1%	6.5%	5.1%	5.8%	6.1%	7.1%
	Third Quartile	14.0%	16.1%	12.0%	13.1%	13.5%	15.6%
Revenue Range 6: $50 million to $100 million	First Quartile	3.8%	4.2%	3.2%	2.5%	2.4%	3.0%
	Median	8.7%	8.9%	7.7%	6.5%	5.8%	7.3%
	Third Quartile	15.8%	17.8%	14.9%	12.6%	11.3%	13.3%
Revenue Range 7: $100 million and more	First Quartile	3.8%	4.2%	3.2%	2.5%	2.4%	3.0%
	Median	8.7%	8.9%	7.7%	6.5%	5.8%	7.3%
	Third Quartile	15.8%	17.8%	14.9%	12.6%	11.3%	13.3%

a NAICS 236115 is New single-family housing construction (except operative builders), NAICS 236116 is New multifamily housing construction (except operative builders), NAICS 236117 is New housing operative builders, NAICS 236210 is Industrial building construction, NAICS 236220 is Commercial and institutional building construction, NAICS 237310 is Highway, street, and bridge construction.

Source: EPA Estimates based on RMA

Table 4-25: Model Firms: EBIT/Interest

Revenue Range	Quartile	NAICS Sector[a] 236115	236116	236117	236210	236220	237310
Revenue Range 1: $100 thousand to $1 million	First Quartile	-0.7	-4.0	0.3	-5.8	-1.9	-1.5
	Median	2.2	1.6	3.7	2.3	3.2	1.9
	Third Quartile	8.3	10.7	9.9	14.4	9.5	7.4
Revenue Range 2: $1 million to $3 million	First Quartile	1.0	1.1	-0.4	0.1	-0.3	0.8
	Median	3.9	4.5	4.7	3.5	3.9	3.3
	Third Quartile	13.4	18.6	20.5	13.3	13.3	11.6
Revenue Range 3: $3 million to $5 million	First Quartile	1.5	2.1	1.4	0.0	0.3	0.8
	Median	4.7	6.0	5.9	4.8	4.9	4.5
	Third Quartile	18.8	19.0	20.7	16.2	17.6	13.0
Revenue Range 4: $5 million to $10 million	First Quartile	1.8	0.8	1.7	0.8	1.8	1.3
	Median	5.4	5.1	4.8	7.3	7.2	5.4
	Third Quartile	21.9	18.9	22.9	24.5	27.3	15.2
Revenue Range 5: $10 million to $50 million	First Quartile	2.2	2.0	1.8	2.6	2.7	2.3
	Median	7.2	8.2	6.6	7.8	9.9	6.2
	Third Quartile	27.4	38.8	29.6	38.0	42.2	18.1
Revenue Range 6: $50 million to $100 million	First Quartile	3.1	4.1	2.5	4.1	5.6	2.8
	Median	7.6	16.3	9.4	18.6	20.4	6.7
	Third Quartile	26.4	91.0	47.7	69.4	81.1	19.0
Revenue Range 7: $100 million and more	First Quartile	3.1	4.1	2.5	4.0	5.6	2.9
	Median	7.7	16.3	9.4	18.6	20.4	6.7
	Third Quartile	26.4	91.0	47.7	69.4	81.1	19.0

a NAICS 236115 is New single-family housing construction (except operative builders), NAICS 236116 is New multifamily housing construction (except operative builders), NAICS 236117 is New housing operative builders, NAICS 236210 is Industrial building construction, NAICS 236220 is Commercial and institutional building construction, NAICS 237310 is Highway, street, and bridge construction.

Source: EPA Estimates based on RMA

Table 4-26: Model Firms: Net Income Margin

Revenue Range	Quartile	NAICS Sector[a]					
		236115	236116	236117	236210	236220	237310
Revenue Range 1: $100 thousand to $1 million	First Quartile	-4.7%	-11.2%	-6.2%	-8.0%	-5.2%	-11.0%
	Median	1.7%	1.5%	3.1%	1.0%	1.5%	1.5%
	Third Quartile	4.0%	3.6%	3.0%	3.3%	3.0%	3.6%
Revenue Range 2: $1 million to $3 million	First Quartile	0.0%	0.4%	-1.2%	-0.9%	-0.8%	0.2%
	Median	2.1%	2.5%	2.1%	1.7%	1.9%	2.4%
	Third Quartile	3.0%	3.3%	3.7%	2.8%	3.4%	3.9%
Revenue Range 3: $3 million to $5 million	First Quartile	0.6%	1.0%	0.3%	-0.7%	-0.2%	0.3%
	Median	1.6%	2.0%	1.4%	1.2%	1.5%	1.9%
	Third Quartile	2.4%	3.1%	2.1%	2.3%	2.1%	3.4%
Revenue Range 4: $5 million to $10 million	First Quartile	0.6%	0.7%	0.8%	0.1%	0.4%	0.5%
	Median	1.7%	1.5%	2.0%	1.2%	1.2%	1.8%
	Third Quartile	2.6%	2.0%	2.7%	2.2%	2.2%	3.3%
Revenue Range 5: $10 million to $50 million	First Quartile	0.8%	0.7%	0.6%	0.4%	0.3%	0.7%
	Median	2.0%	1.5%	1.5%	1.1%	1.1%	1.8%
	Third Quartile	3.1%	2.5%	2.5%	1.9%	1.9%	3.2%
Revenue Range 6: $50 million to $100 million	First Quartile	1.9%	1.7%	1.9%	0.6%	0.5%	1.1%
	Median	3.1%	1.9%	3.0%	1.2%	1.1%	2.1%
	Third Quartile	3.8%	2.5%	3.5%	1.9%	1.7%	3.0%
Revenue Range 7: $100 million and more	First Quartile	1.9%	1.7%	1.9%	0.6%	0.5%	1.1%
	Median	3.0%	1.9%	3.0%	1.2%	1.1%	2.1%
	Third Quartile	3.7%	2.6%	3.5%	1.9%	1.7%	3.0%

a NAICS 236115 is New single-family housing construction (except operative builders), NAICS 236116 is New multifamily housing construction (except operative builders), NAICS 236117 is New housing operative builders, NAICS 236210 is Industrial building construction, NAICS 236220 is Commercial and institutional building construction, NAICS 237310 is Highway, street, and bridge construction.

Source: EPA Estimates based on RMA

4.6 Key Sources of Uncertainty and Limitations

The primary sources of uncertainty and limitations in the analysis baseline are highlighted below:

- ***Compilation of the C&D Firm Universe Potentially Subject to Regulation.*** As described in *Section 4.3.5*, to develop the firm-level analysis baseline, EPA blended firm-level data from the Economic Census and SUSB to reconcile inconsistencies between data reported at the level of the establishment versus the level of C&D firms. In addition, EPA reconfigured these data to develop firm-level data by state. This process, although appropriate and credible for the stated purpose, inevitably introduces error into the baseline economic data. EPA has no basis for knowing the quantity or direction of error in these data. EPA does not judge these errors/uncertainties to materially affect the findings from the analyses performed for the final regulation.
- ***Acreage estimates do not exclude sites less than 1-acre in size****.* These acreage estimates presented in this chapter do not exclude sites less than 1-acre in size. Ideally, these estimates would be adjusted downward to exclude acreage developed in projects of less than 1-acre in size, to be consistent with the definition of the quantity of acreage subject to the final regulation. However, the available data do not indicate what portion of acreage may fall into this category, and therefore, EPA may be overstating the quantity of activity subject to the regulation, and thus overstate the compliance costs resulting from the final regulation.
- ***Baseline Financial Data for Model Firms.*** To develop the model firms, EPA assigned financial characteristics – balance sheet, income statement, and metrics of financial performance and condition – to each of the model firms as defined by the six NAICS sectors and seven revenue size ranges, from financial statement information reported by Risk Management Association (RMA) (see *Section 4.5*). RMA compiles and reports financial statement information by industry as provided by member

commercial lending institutions. Because the financial statements received by RMA are for businesses applying for credit from member institutions, these data do not constitute a statistically valid random sample. In particular, the RMA data would not generally be representative of firms that are of sufficient size to access capital markets directly, for example, through issuance of corporate debt securities in public capital markets. Nevertheless, EPA, which has utilized the same data in previous economic analyses, believes these data are of high quality and do offer the advantage of being available at the 6-digit NAICS level and for quartile ranges of baseline financial performance and condition.

- ***Potential Bias in the RMA Financial Data.*** Expanding on the item above, EPA evaluated whether the RMA financial data is potentially biased in its representation of the financial performance and condition of firms in the overall C&D sectors. To assess whether a bias existed in the RMA eStatement Studies data, EPA compared the RMA data used in the firm impact analysis to data from the IRS Corporate Source Book, which are representative of all firms filing federal income tax forms. Three different key ratios were analyzed from each data source: EBIT/Interest, Return on Assets, and Profit before Tax. Although the RMA variables were directly presented in the eStatement Studies, some of these variables required calculation from the IRS Corporate Source Book dataset. *Table 4-27*, below, presents the calculations performed to determine the ratios from the IRS Corporate Source Book.

Table 4-27: Calculations in the IRS Corporate Source Book Dataset to Compare to RMA Ratios

Ratio	Calculation
EBIT/Interest	(Net Income + Interest Paid)/Interest Paid
Return on Assets	Net Income/Total Assets
Profit Before Tax	Net Income/Total Receipts

To assess the presence of bias, EPA compared ratio values from the RMA eStatement Studies to ratio values from the IRS Corporate Source Book, calculated by asset size range for the below years.[36] The RMA data used in the comparison were for the median quartile. Because the IRS Corporate Source Book presents data for NAICS 236 and 237 only at the level of the 3-digit NAICS sector, the RMA data used for the comparison for these sectors was an average of all data available for the 6-digit NAICS codes in these 3-digit sectors (see *Table 4-28*, below).

Table 4-28: RMA eStatement Studies and IRS Corporate Source Book Years Compared

IRS	RMA				
IRS Data Year	RMA eStatement Studies Year	Fiscal Closing Dates	Earliest 12-Month Period Covered	Latest 12-Month Period Covered	Majority of RMA Data During Year
2006	2007-2008	April 1, 2006 - March 31, 2007	April 1, 2005 - March 31, 2006	April 1, 2006 - March 31, 2007	2006
2005	2006-2007	April 1, 2005 - March 31, 2006	April 1, 2004 - March 31, 2005	April 1, 2005 - March 31, 2006	2005
2004	2005-2006	April 1, 2004 - March 31, 2005	April 1, 2003 - March 31, 2004	April 1, 2004 - March 31, 2005	2004
2003	2004-2005	April 1, 2003 - March 31, 2004	April 1, 2002 - March 31, 2003	April 1, 2003 - March 31, 2004	2003
2002	2003-2004	April 1, 2002 - March 31, 2003	April 1, 2001 - March 31, 2002	April 1, 2002 - March 31, 2003	2002

36 The IRS Corporate Source Book provides more disaggregated asset range breakouts than RMA. Three of the six asset ranges are the same (Less than 500k, 50 million to 100 million, 100 to 250 million), one asset range breakout is nearly the same (RMA: 500k to 2 million, IRS: 500k to 1 million), and the remaining two RMA asset ranges are aggregated among four IRS revenue ranges (RMA: 2 to 10 million, IRS: 1 to 5 million and 5 to 10 million; RMA: 10 to 50 million, IRS: 10 to 25 million and 25 to 50 million). For the two asset ranges for which IRS provided more disaggregate ranges, the RMA variable was compared to both the low and high asset size range variable from the IRS data.

Table 4-29, below, presents the results of this comparison, showing, by NAICS sector, year, and key ratio, the percent of the RMA ratios across asset size ranges that were *below* the IRS Corporate Source Book ratios, also by asset size range. As seen in the table, the majority of the RMA ratios are lower than the IRS ratios – an average of 63.8 percent – indicating that the RMA data actually reflect poorer performance than presented in the IRS data. In addition, no pattern is present *across asset size ranges* in these relationships – in particular, lower asset size ranges do not appear to have systematically lower performance in the IRS data than in the RMA data.

Table 4-29: Summary Results of Comparison of Financial Metrics from IRS Corporate Source Book and RMA (median quartile) eStatement Studies

NAICS Sector		Average Percent of RMA Ratios Among Asset Size Ranges *below* IRS ratios — Year: 2002	2003	2004	2005	2006
236	EBIT/Interest	50.0%	50.0%	62.5%	50.0%	37.5%
	Return on Assets	75.0%	100.0%	100.0%	100.0%	100.0%
	Profit Before Tax	50.0%	25.0%	25.0%	25.0%	12.5%
237	EBIT/Interest	75.0%	62.5%	50.0%	87.5%	62.5%
	Return on Assets	87.5%	62.5%	75.0%	87.5%	87.5%
	Profit Before Tax	0.0%	0.0%	0.0%	25.0%	0.0%
237210	EBIT/Interest	50.0%	37.5%	50.0%	25.0%	50.0%
	Return on Assets	100.0%	50.0%	62.5%	87.5%	50.0%
	Profit Before Tax	37.5%	12.5%	12.5%	25.0%	12.5%
238210	EBIT/Interest	100.0%	100.0%	83.3%	71.4%	37.5%
	Return on Assets	100.0%	100.0%	100.0%	100.0%	75.0%
	Profit Before Tax	100.0%	100.0%	100.0%	57.1%	62.5%
238220	EBIT/Interest	83.3%	71.4%	100.0%	100.0%	100.0%
	Return on Assets	83.3%	85.7%	100.0%	85.7%	87.5%
	Profit Before Tax	83.3%	71.4%	66.7%	57.1%	37.5%

- ***Acreage Intensity Source Data.*** There is uncertainty with respect to the Reed Construction data that underlies the estimated acreage intensity values for the multifamily and nonresidential building construction sectors. Recall that acreage intensity is defined as the number of acres developed per dollar value of activity accruing as revenue to the firm. The source of potential error derives from the Reed "value of construction" data, which is used as the denominator in estimating acreage intensity. The value field is intended to capture the value of the construction activity itself, and may not capture other components of eventual total project revenue, e.g., land value, financing costs, or developer's markups. As such, the Reed-reported value may understate the overall project value, and thus revenue that could accrue from these activities (thus overstating the quantity of acreage developed per dollar of total project value). Furthermore, because this information is self-reported by builders/developers and not subsequently verified at the end of a project, there is fundamentally an unknown amount of error in the value estimates.

- ***NOI Project Distribution Source Data.*** The matrixes of model projects by size and duration, by state and construction activity sector, which underlie the assignment of model projects to model firms for the firm-level impact analysis, are based on NOI data from a limited sample of states. The data, and the use of the data for this purpose, are subject to several uncertainties, including:

  - As received from states, the NOI data are not necessarily comprehensive and may contain reporting errors, in terms of the acreage size of a project, the project's duration, or the type of project. EPA attempted to remove records with apparent errors from the NOI dataset, but this process is inevitably imperfect.

  - The selection of states to use in developing state-by-state project distributions is based in part on judgments about the quality and comprehensiveness of the NOI data and the ability of these states to reflect diversity of construction activity across states by region and construction profile. These judgments are somewhat subjective and introduce uncertainty in the use of the distributions to represent the project development profiles for other states.

- The need to use data from selected states to represent the project development matrix for other states, underscores the limitations and uncertainties in understanding the project development profile and in estimating the potential cost and impact of the final regulation. Further, the determination of the states to which the four individual state distributions are applied in developing project distributions, involves additional judgment and again introduces uncertainty. The observation that the state- and sector-level distributions yielded acreage values by size range that could not make sense within the size range – i.e., total acreage in a size *x* duration cell that is less than the acreage size of the size *x* duration cell – is another indicator of the imperfection and uncertainty in this process. The algorithm used to redistribute acreage to achieve a sensible size distribution again introduces uncertainty in the analysis.

Overall, EPA does not judge these uncertainties to materially affect the findings from the cost and economic impact analysis for the C&D regulation.

- ***Changes in the NOI Project Distributions and Other Factors Potentially Affecting Aggregate Compliance Cost Estimates.*** As described in this Chapter, the distribution of construction projects across model project categories derives from the NOI project distribution information for selected states. In the analysis of compliance cost and impact, EPA does not assume any change or shift in the profile of project performance across the model project categories. That is, in response to the regulation, profit-maximizing C&D firms might alter the profile of projects undertaken, for example, in recognition of the acreage cut-offs for project coverage and the level of compliance requirements under the regulation. Such changes could lead to modest differences in the overall project profile by size and/or duration, which in turn could affect the total quantity of in-scope acreage and/or the estimates of total compliance cost for in-scope projects. In addition, firms may identify methods, on a specific project basis, that enable them to meet the rule's requirements using lower cost practices/ technologies.

5 Overview of the Economic Impact Analyses

This chapter presents an overview EPA's methodology for analyzing the economic impacts of the regulation. EPA has employed a number of different methods for assessing the economic impacts on C&D businesses and consumers of construction industry output at the project-level, firm-level, industry-level, and national-level.

This overview section summarizes some of the key underlying concepts and assumptions EPA has used to develop and implement the economic analysis methodology, including the regulatory baseline and the mechanisms by which the final rule may affect the C&D industry. The last part of this overview summarizes the various methodologies developed for this EA and how the rest of the chapter is organized.

5.1 The Regulatory Baseline

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. For the economic analysis, EPA assumes that affected C&D markets have fully implemented the existing Phase I and II stormwater regulations and any state-level requirements. EPA also assumes that industry will be in 100 percent compliance following promulgation of the final rule. These criteria define the general regulatory baseline criteria for this economic analysis.

In addition to these general regulatory baseline conditions, EPA has established detailed information that describes the nature, composition, and quantity of baseline industry activity against which the regulation's incremental effects are measured. The baseline specifications that support the economic analysis are detailed in *Chapter 4 – Developing the Analysis Baseline*, which estimates key baselines metrics describing the C&D industry, model construction firms, and developed acreage that underlie the analysis of the regulatory options. Please refer to *Chapter 4* for the results of the baseline analysis.

5.2 Mechanisms by which C&D Markets May be Affected by the Final Rule

Some of the mechanisms by which the C&D industry regulation can potentially affect product markets and, as a result, induce impacts of concern in the analysis of a C&D industry regulation include:

1. Regulatory requirements may increase construction costs and lengthen project construction periods, which further increases total project costs. Increased project costs may in turn adversely affect the financial performance of construction projects and the firms that undertake these projects and/or increase the prices paid by consumers of C&D industry output. Increased prices will increase sale prices or rents of completed projects. The extent to which increased construction costs manifest as higher sales prices and rents will depend on supply and demand elasticities in specific construction product markets. These elasticities may vary substantially both over time, across regional markets, and within regional markets according to supply and demand conditions in specific product segments.

2. *Consumers' response to increased project prices can affect the overall bundle of characteristics (e.g., size, technical design and finished product specifications) that determine consumers' value of, and price paid for, the finished real estate product.* Faced with increased construction costs and potential price increases for a finished product, consumers (and project developers as their surrogate) may select lower cost specifications on other aspects of final project design. The flexibility to adjust project design specifications can buffer consumers from the construction cost increase and upward price pressure resulting from regulatory requirements, but may also result in trade-offs of valuable attributes. Such flexibility is particularly important

if the potential construction cost and price increases are substantial and consumers faced income-based constraints on the price (or rent) that may be paid for the finished product.

3. *If producers are unable to pass all increased costs along to consumers in the form of higher prices, this could lead to weakened financial performance of, and lower employment among, C&D industry businesses.* Affected businesses may lose business value and could face financial stress, leading potentially to reductions in business activity and, in the worst case, closure of individual businesses. Given the relative fluidity of the C&D industry sectors expected to be affected by this regulation, idled economic resources – i.e., labor and capital – might be redeployed relatively quickly into other existing C&D industry businesses or new industry entrants. Regional and temporal variation in market response to increased construction costs and potential price effects may lead to substantial variation in the extent and character of impacts within the C&D industry.
4. *Increased project costs and associated pressure on project prices for <u>new</u> finished product may spill over into price effects – as increased sales prices or rents, in the present and in the future – for <u>existing</u> finished product or new product not subject to the regulation's requirements.* Because the quantity of new home sales represents a small fraction of total home sales, EPA does not expect this effect to be significant.
5. *Conversely, the presence of existing finished product and new product not impacted by the rule serves as competition for newly constructed finished product and can thus limit the potential for upward pricing pressure on finished product subject to the regulation's requirements.* The presence of existing finished product provides a buffer against price and rent increases to C&D industry product consumers.
6. *Regulatory requirements may change the expected profitability (economic rent) of undeveloped land.* Overall, the C&D rule is expected to increase the production costs of C&D industry output. As described above, the increase in production costs can be pushed forward to consumers via increased prices and/or become a reduction in profits to C&D industry firms. These two potential incidences of effect are the primary focus of the economic impact analysis undertaken for the final C&D rule. However, the increase in production cost can also be pushed upstream in the production chain and lead to reduced value of undeveloped land, and thereby affect a third incidence category. To the extent that the increase in production costs is capitalized into the prices for undeveloped property, the reduction in value of undeveloped property can become an offset to an increase in project costs and buffer the project developer/construction firm and/or consumers from the economic/financial effects of regulatory requirements as assessed in this economic impact analysis. This effect does not mean that the reduced value of undeveloped property reduces the overall costs of the regulation, but rather, it represents a potentially different distribution of the rule's effects, where some of the costs of the regulation are shifted to the owners of undeveloped property in the long-run.
7. *These effects will vary depending on the compliance requirements that apply to properties of given physical characteristics.* On a relative basis, some undeveloped properties will become less valuable as a result of a regulation while others could become more valuable. The differential changes in economic rent and value of undeveloped properties may also cause shifts in the ordering and timing of project development. On the margin, the economically desirable time for project development will be delayed for some properties while being accelerated for other properties. For example, in a given local market, *all else equal*, the development of in-scope undeveloped property may be delayed while the development of out-of-scope undeveloped property may be accelerated.

All of these regulatory response effects – increased construction costs from regulation compliance; distribution of compliance costs among owners of undeveloped property, construction businesses, and consumers; changes in the characteristics of C&D industry finished product; and potential effects on the timing and configuration of property development – reflect the internalization of construction-related costs to society that are currently not accounted for in the private transactions of property purchase, development, and sale/rent. These cost and price effects, and the decision responses by property owners, producers and consumers, are indicative of the correction of production costs and market prices to account for the costs to society that were previously unaccounted for in the various affected transactions.

Of these effect mechanisms, EPA considers items 1, 2, 3, and 7 to be of most importance in causing a material regulatory impact. Of these, items 1, 2, and 3 are able to be addressed in this cost and economic impact analysis.

5.3 Summary of Economic Impact Analysis Models and Organization

This section provides a summary of the analysis methodologies developed for the EA and how the next five chapters are organized:

- *Chapter 6 – Analysis of Firm- and Industry-Level Economic Impacts.* Assessment of the cost and economic/financial impact of regulatory requirements on C&D industry firms, and the potential industry-level effects in terms of numbers of firms that may be adversely affected, potential employment at risk, and total costs to the C&D industry for regulation compliance;
- *Chapter 7 – Projection of Cost and Impacts.* Analysis that simulates the rule's phase-in over the period 2010 – 2014 and projects the estimated total cost out to the year 2025. This analysis accounts for the expected phase-in of compliance over the first five years as states renew their Construction General Permits, the expected phase-in of the rule's requirements during that period, and estimated levels of C&D activity for the years 2010 – 2014.
- *Chapter 8 –Analysis of Single-Family Housing Affordability Impacts*. An assessment of housing affordability, where impacts are measured in terms of the expected change in price for median- and lower-quartile priced new single-family homes and the associated number of prospective home buyers that may experience an affordability effect due to the price change;.
- *Chapter 9 – Analysis of Social Cost.* An assessment of partial equilibrium market effects in the C&D industry building sectors is used to adjust the initial firm-level estimate of total resource cost of compliance to account for the potential reduction in C&D industry output. The analysis also estimates the overall social welfare loss to society arising from the change in each market's output level. The quantity-effect-adjusted resource cost of compliance and the additional social welfare loss comprise two components of the total social cost of the final rule.
- *Chapter 10 – Analysis of Economy-Wide Output and Employment Impacts*. An input-output multiplier analysis that considers total economy effects – in terms of output and employment – based on the total change in demand for society's resources arising from (1) compliance outlays, and (2) the reduction in C&D industry output. The analysis also estimates the *net* change in demand for society's resources arising from these two effect mechanisms; and,

6 Analysis of Firm- and Industry-Level Economic Impacts

The firm- and industry-level analysis examines the impact of the rule's compliance costs on firms in the major C&D industry segments that are expected to incur compliance requirements and costs because of the regulation:

- Single-family residential construction
- Multifamily residential construction
- Industrial building construction
- Commercial and institutional building construction
- Non-building construction.

EPA began this analysis by assessing the effect of compliance requirements and costs on C&D projects, and then carries this project-level assessment to the level of C&D firms for the assessment of firm and industry-level effects. C&D firms are the appropriate entity for assessing the impact the regulation in terms of effects on financial performance, business value, and employment because these are the entities that will be responsible for incorporating the regulation's requirements into their construction project operations. The firm- and industry-level analysis is based on model firms that represent the baseline (i.e., pre-regulation) financial performance and condition of "typical" businesses in these industry segments. These model firms are used in combination with model project-based compliance cost estimates to examine the potential for financial stress, employment effects, and increased barriers to the entrance of new firms to the industry.

The model firms are structured as baseline financial statements for each of the NAICS sectors that align with the C&D industry segments expected to be affected by the regulation, and within NAICS sectors, by revenue size ranges for which data are reported by the Statistics of U.S. Business (SUSB) and the Economic Census (see *Chapter 4*). The financial statements for the model firms are constructed to capture two business condition cases for the firm-level analysis:

1. A *General Business Conditions* case, which is meant to reflect the financial performance and condition of C&D industry businesses during *normal* – neither excessively strong nor weak – economic conditions for the specific industrial segments. The analyses under the General Business Conditions case examine the potential for unfavorable impacts on firms over the longer term of general steady-state business conditions in the C&D industries.

2. An *Adverse Business Conditions* case, which is meant to reflect the financial performance and condition of C&D industry businesses during weak economic conditions for the specific industry segments. As described above in *Chapter 3: Economic Profile of the Construction and Development Industry*, the conditions that the residential construction sub-sector faced in 2007 and 2008 – prior to the recovery this sub-sector is *currently* experiencing – and the nonresidential sub-sector faced in 2003 as well as the *current* decrease in nonresidential activity could be interpreted as matching the Adverse Business Conditions case. During these periods, the potential economic/financial impact of the C&D rule on some firms in the industry may be relatively greater due to their weakened financial performance and condition and lower ability to recover compliance costs from customers. Thus, the analyses under the Adverse Business Conditions case provide an alternate, more severe case assessment of the potential for adverse financial impact on firms as a result of the C&D rule.

The two business condition cases are differentiated by the baseline operating financial circumstances of the model firms as well as other important factors in financial performance, including cost of debt and equity capital, and the estimated ability of the model firms to recover compliance costs from customers via price increases.

Impact findings are assessed in terms of occurrence of compliance costs exceeding impact thresholds, increased frequency of weak financial condition and performance, and occurrence of negative business value due to compliance costs. The findings from the analysis of model firms are aggregated by revenue size range and total industry sub-sector to assess the total potential adverse impact in the various sub-sectors. These impact findings are also used in assessing the potential impact of the C&D rule on small entities. The model firm analysis also supports an assessment of potential barriers to entry for new businesses seeking to enter the C&D industry.

The top two boxes in Figure 6-1, "Model Projects (and compliance costs)" and "Model Firms," represent EPA's characterization of the baseline as described in Chapter 4. This chapter differs from Chapter 4 in that the costs of compliance are assigned in this chapter to the model projects, in order to conduct the economic impacts analysis of the regulatory options.

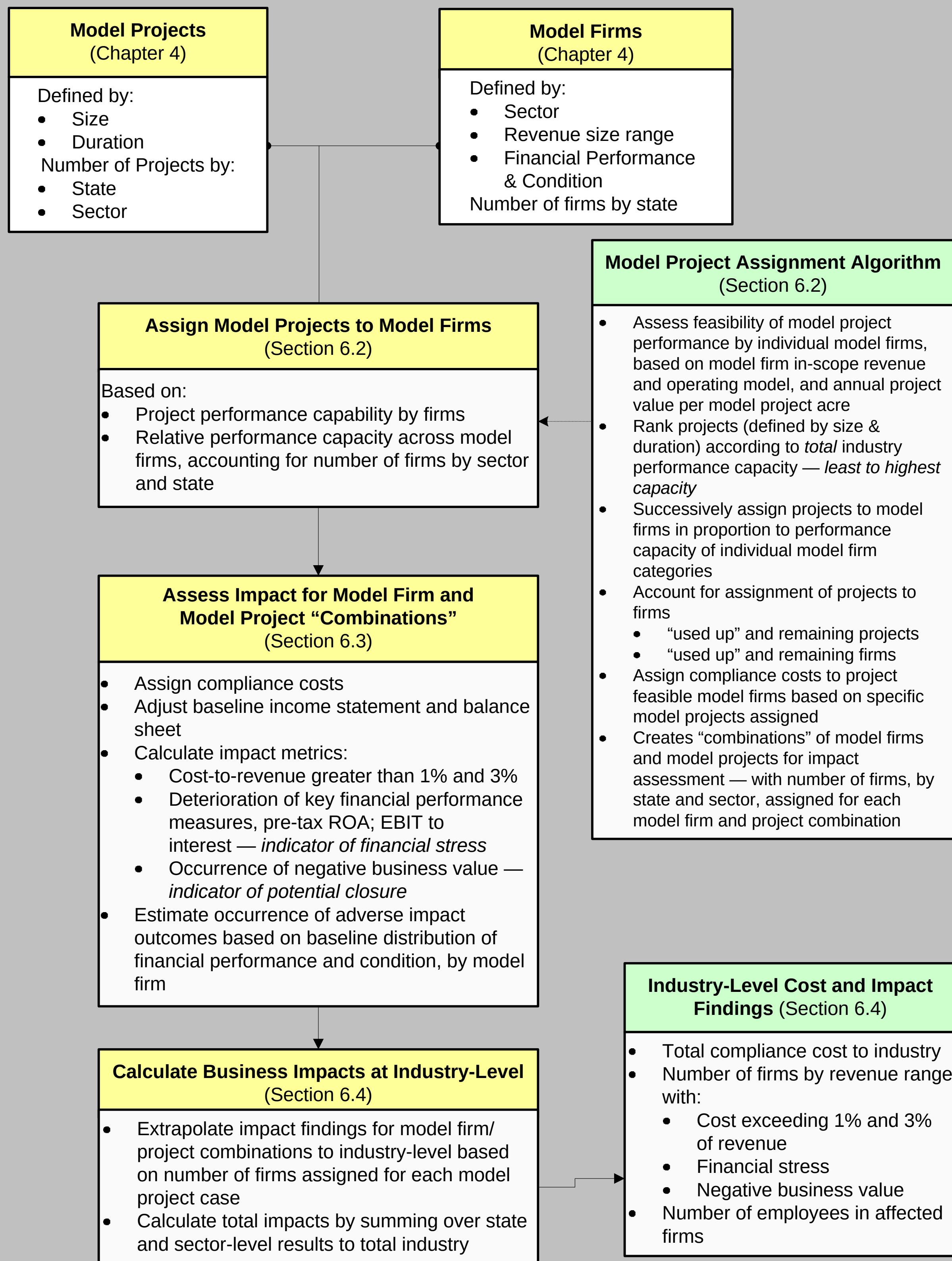
This chapter introduces the step of assigning model projects to model firms. This step was not introduced in the baseline chapter because this step is not necessary for determining the baseline. This step is inherently a forecasting exercise, as the projects being analyzed do not exist yet. As such, there are many ways to assign model firms to model projects, and no single rule or simple set of rules is likely to be truly representative of the future actual distribution of projects to firms.[37] In the absence of primary industry survey data that would show which firms had previously done which projects, EPA instead made a series of reasonable allocation assumptions that are consistent with economic theory.

The duration and timing of projects are important features of the allocation of projects to firms. Think of firms as having an annual acreage capacity, as determined by their annual revenue and the acreage intensity for the sector/type of construction project they perform. Within this construct, duration and timing determine the ability of firms to undertake projects of a given size and duration. In terms of duration, whether projects are completed within a year or take longer than a year influences the potential for firms to undertake projects of a given size: if projects are completed over a longer performance period, firms will generally be capable of performing larger projects. In addition, in terms of timing, the firm's annual acreage capacity for performing new projects is also determined by projects undertaken *in that year*, and whether some capacity is already accounted for by projects *begun in prior years* as well as projects newly undertaken in that year. In other words, when allocating projects to firms according to their capacity, it is important that duration and timing are taken into account.

The project matrix introduced in Chapter 4 represents projects ranging from the SW corner of the project matrix (largest acreage in shortest duration) as having the fewest firms capable of performing that project, to those projects in the NE corner of the project matrix (smallest acreage over longest duration) as having the most firms capable of performing that project (indeed, all firms). EPA determined that a very logical assignment algorithm, perhaps even well represented in the real world, would be to assign projects beginning with the relative scarcity of capacity associated with the SW corner and then proceed to the relative abundance of capacity associated with the NE corner.

[37] EPA also performed a sensitivity analysis that tests the sensitivity of firm- and industry-level impacts to changes in the allocation method used in EPA's primary analysis (see Appendix C).

Figure 6-1: Overview of Firm and Industry Impact Analysis Framework



The following sections describe the data sources and approach for the firm-level analysis:

- *Section 6.1: Review of Model Projects and Model Firm Concepts*
- *Section 6.2: Assigning Model Projects and Associated Compliance Costs to Model Firms*
- *Section 6.3: Estimating the Change in Model Firm Financial Performance and Condition*
- *Section 6.4: Applying the Findings from the Model Firm Analysis to the Total Industry*
- *Section 6.5: Assessing Potential Barriers to Entry of New Businesses to the C&D Industry*.

Figure 6-1: Overview of Firm and Industry Impact Analysis Framework, following page, provides a schematic summary of the overall firm and industry impact analysis described in Sections *6.1* - *6.4*.

6.1 Review of Model Projects and Model Firm Concepts

The two primary input components underlying the firm and industry level analysis are:

1. The model projects, with the associated compliance costs, and
2. The model firms.

In the impact analysis, model projects and model firms are brought together, according to the assignment algorithm described in *Section 6.2*, to provide model project/model firm combination cases for the impact analysis. The model project and model firm frameworks are described in depth in *Chapter 4.* This section provides a brief review of these analysis components.

6.1.1 Model Projects

EPA developed estimates of the total acreage and number of projects potentially subject to compliance requirements for the C&D rule, by state and construction subsector, within a model project matrix structured by 12 project durations and 12 project sizes. Each cell of the resulting 12 *x* 12 (144 cell) matrix contains a number of projects (and associated acreage) for which compliance costs were estimated for each of the compliance outlays considered in developing the C&D final rule. Analyzing compliance costs within this project framework supports differentiation of how the technologies and associated compliance costs of alternative regulatory options vary with project size and project duration. *Exhibit 6-1*, below, illustrates the structure and content of the model project matrix.

Exhibit 6-1: Illustration of Model Project Matrix

		Project Durations (months)											
		<1.5	1.5-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-30	30-36	>36
Project Sizes (acreage)	1-3												
	3-5												
	5-7.5												
	7.5-10												
	10-15												
	15-20												
	20-30												
	30-40												
	40-60												
	60-80												
	80-100												
	>100												

For each state and construction subsector, each cell is defined by a:
- Number of projects and
- Total acreage

And for each regulatory option, by an estimated compliance cost

EPA performed the estimation and assignment of compliance costs to model firms *on a state-by-state basis* for each regulatory option. EPA estimates that the frequency and level of compliance requirements and compliance costs per acre of construction activity will vary from state to state. The variation over states results from three factors:

1. The presence of state requirements that already capture elements of the compliance requirements of a given regulatory option. For those states in which all or part of the requirements of a given C&D rule regulatory option are already required by the states, EPA adjusted the compliance costs per acre to reflect only the *incremental* requirement, if any, for the regulatory option in estimating costs for the state.
2. For some regulatory options, variation by state in soil characteristics and rainfall levels, which may affect the extent and character of compliance response required for a regulatory option. For example, states with more frequent occurrence of large rainfall events will typically have higher compliance costs for a given regulatory option.
3. Variation in compliance activity costs by state resulting from differences in labor and other compliance input costs by state.

As a result of these factors, for certain regulatory options, some states have no or substantially lower compliance costs per acre of in-scope construction activity than other states. As a result, the assessments of aggregate subsector and industry level impacts described in later sections of this chapter are based on model firm analyses that are *performed on a state-by-state basis*. The state-by-state findings are then aggregated to the national level to yield national cost and impact results.

6.1.2 Model Firms

EPA defined model firms for each of 6 construction subsectors and by 7 revenue ranges, resulting in a 42-cell matrix of model firms. *Exhibit 6-2*, below, illustrates the structure and content of the model firm matrix.

<table>
<tr><th colspan="10">Exhibit 6-2: Illustration of Model Firm Matrix</th></tr>
<tr><th colspan="3" rowspan="2"></th><th colspan="7">Revenue Ranges</th></tr>
<tr><th>Range 1: $100,000 - $1 million</th><th>Range 2: $1 - $2.5 million</th><th>Range 3: $2.5 - $5 million</th><th>Range 4: $5 - $10 million</th><th>Range 5: $10 - $50 million</th><th>Range 6: $50 - $100 million</th><th>Range 7: > $100 million</th></tr>
<tr><td rowspan="6">NAICS Sector and Name</td><td>236115</td><td>New single-family housing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>236116</td><td>New multifamily housing</td><td colspan="7" rowspan="4">Model firms defined by baseline financial statements based on Risk Management Association data; differentiated by sector, revenue range, and median, low and high quartile performance/condition; firm counts by state, sector, and revenue range based on Economic Census and SUSB data</td></tr>
<tr><td>236117</td><td>New housing operative builders</td></tr>
<tr><td>236210</td><td>Industrial building</td></tr>
<tr><td>236220</td><td>Commercial/institutional building</td></tr>
<tr><td>237310</td><td>Highway, street, and bridge</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Within the 42-cell matrix defined by construction subsector and regulatory requirement, model firms are further differentiated by baseline financial performance and condition based on the low, median, and high quartile values of key financial metrics reported by Risk Management Association (RMA), which leads to 126 model firm financial statements underlying the firm-level analysis. The differentiation of firms by subsector, revenue range, and baseline financial performance/condition supports assessment of the potential impact of regulatory requirements on firms across the diversity of these defining characteristics. Each model firm – by state, subsector, and revenue range – is associated with a specific number of firms that serve as *analysis weights* for extrapolating findings from the model project/model firm analysis to the level of the industry – again differentiated by state, subsector, and revenue range.

6.2 Assigning Model Projects and Associated Compliance Costs to Model Firms

As described above, EPA developed compliance cost estimates for regulatory options on the basis of model projects defined by project duration, project acreage, state, and construction subsector. The objective of this part of the firm- and industry-level analysis is to assign the model projects and the associated compliance cost estimates to the model firms to support assessment of the firm- and industry-level financial impacts of the C&D regulation.

The assignment of model projects (and associated compliance costs) to model firms involved the following steps:

1. Assessment of the feasibility of performance of a given model project by individual model firms
2. Assignment of model projects to model firms
3. Assignment of compliance costs for the economic/financial impact analysis.

Each step is discussed below. All elements of this assignment procedure are performed by state and construction subsector.

6.2.1 Assessing the Feasibility of Model Project Performance by Individual Model Firms

The first step in assigning model projects to model firms is to assess the feasibility of model firms to perform the individual model projects present for a given state and construction subsector. The test of performance feasibility is required because not all model firms are capable of performing the full slate of model projects present for a given state and construction subsector. Specifically, larger firms are capable of performing larger, shorter duration projects that would not be feasible for smaller firms, which have smaller performance capacity in terms of the size and duration of the projects that they are capable of undertaking.

The test of performance feasibility involves comparing:

- For a given model firm, the *Annual Effective Performance Capacity*, or steady state maximum project acreage on an annual effective performance basis (i.e., acres of performance capacity per year), that the model firm is estimated capable of performing – assuming that the model firm performs only in-scope projects of a given duration

  with

- For a given model project, the *Annual Effective Performance Requirement* of the project, which is based on project size and the duration over which the project is performed. The annual effective performance requirement is the number of acres of project performance capacity – *for a model firm* – that is required for performance of the project *on an annual equivalent basis* (i.e., acres of performance requirement per year). To illustrate, a 5 acre project performed over a 6 month period requires 10 acres of annual performance capacity in order to be undertaken by a model firm, while a 5 acre project performed over a 12 month period would require 5 acres of annual performance capacity. Similarly, a 5 acre project period over a 24 month period would require 2.5 acres of annual performance capacity.

The discussion below provides further definition of these concepts and the details of their calculation.

If the model firm's *Annual Effective Performance Capacity* exceeds the model project's *Annual Effective Performance Requirement*, then the model firm is assumed capable of performing the model project. These comparisons are performed for all possible combinations of model projects and model firms for a given state and construction subsector. The feasibility determination is independent of the actual number of model projects that will need to be assigned to model firms, and likewise is independent of the actual number of model firms to which the model projects will be assigned.

The model firm's steady state *Annual Effective Performance Capacity* is a function of:

- *The model firm's baseline in-scope revenue.* In-scope revenue, together with the other factors described below, is a key determinant of a model firm's project performance capacity. All else equal, the larger the model firm's revenue, the larger will be the size of project that the firm is capable of performing.
- *The acreage intensity of the model project category.* As described previously in *Chapter* ***4***, acreage intensity is the acreage quantity per dollar of construction project value (which is assumed to translate to business revenue) and was estimated by EPA for the principal construction activities – single-family housing construction, multifamily housing construction, commercial project construction, and industrial project construction – estimated to be within the scope of the C&D rule. Acreage intensity is used as the *translator* between a firm's in-scope revenue and the annual effective project acreage that the model firm is capable of performing.
- *The assumed steady state operating model of the firm,* in terms of the length of time between project starts. That is, how long following the start of one model project (or bundle of model projects of the same size and duration) before the model firm begins another model project(s), with the assumption that the length of time between project starts is, by definition, no longer than the duration of the model projects under analysis.[38] This factor interacts with the duration of the model project under analysis to determine the total number of model projects, of a given type, that a firm will have ongoing in a single analysis year – accounting both for the model project (or bundle of model projects) started in that year and for the model projects (or single-year project bundles) that may have started in prior years but remain ongoing (and continuing to generate compliance costs) in the current analysis year. The factor is particularly important for understanding the potential for smaller revenue firms – and otherwise smaller project performance capacity firms – for performing in-scope projects. To illustrate, in the steady state, if a firm starts a new project, or round of projects, each year, *and* those projects last longer than one year, then the firm will have more than one year's projects ongoing in any given year. The ongoing performance of projects from more than one year of project starts will *use up* some of the firm's project start capacity, in any given year. Alternatively, in the steady state, if a firm *does not* start a new project, or new round of projects, each year, but instead waits to complete the ongoing project(s) from a given year before starting new projects, then the firm will have ongoing only the project(s) from one year at any time – even though those projects may require longer than one year to complete. In this case, all else equal, the firm will be able to start and undertake a *larger* project in a given year than would otherwise be possible if the firm starts a new slate of projects in each year.

  For the final rule analysis, EPA's adopted the following operating model assumptions:

  - Larger firms – Revenue of at least $50 million (Revenue Ranges 5-7) – will start a new project/slate of projects each year. This assumption is consistent with the expectation that these firms will replenish annually their ongoing project slate, adding new projects to replace the slate of projects completed in the prior year, regardless of the duration of the projects.

    This assumption reflects the more general expectation that firms operate in a steady state in which the character of their business is effectively the same from year to year. The alternative assumptions adopted for mid-range firms and smaller firms, as described below, deviate from this model in delaying the start of new projects and increase the potential of these smaller revenue firms to undertake larger projects, which would otherwise exceed these firms' Annual Effective Project Performance Acreage – *if a new round of these projects were started in each year.*

[38] Otherwise, the firm would have operating gaps, in which no projects were being performed and no project revenue generated.

- <u>Mid-range firms</u> – Revenue between $5 and $50 million (Revenue Ranges 4-5) – will start a new project/slate of projects after a two year lag, *for model projects that are at least two years duration*. For model projects that are less than two years duration, these firms are assumed to start a new slate of projects each year. This assumption increases the potential for this size of firm to undertake larger projects.
- <u>Smaller firms</u> – Revenue less than $5 million (Revenue Ranges 1-3) – will not start a new project/slate of projects until the completion of the current project/slate of projects. In this case, the project start lag is the duration of the model project under analysis for projects longer than one year. This assumption maximizes the potential for smaller firms to undertake a given project *alone*, by size and duration.

In all instances, for any model projects of one year or longer, the project start lag is assumed to be no longer than the duration of the model project under analysis (otherwise the firm would have revenue gaps). Because the basic time unit of the model project analysis is one year, the project lag concept applies to the re-starting of an annual project, or bundle of projects. Thus, for projects of less than one year duration, the project start lag remains one year. However, projects that are less than one year duration are assumed to be performed sequentially over the course of an analysis year, and the full slate of projects completed in a given year is assumed to be replenished in the following year.

- *<u>Duration of the model project.</u>* As described above, *model project duration* interacts with the *project start lag* to determine the *number of model projects* ongoing in a given analysis year – including both the projects from the current year and projects continuing from prior years. For projects of greater than one year duration, EPA assumed that the model project, and its value, could be spread uniformly over the project's duration for determining the annual effective performance requirement of the model project. When the number of projects ongoing includes projects from prior years, the model firm's annual effective project acreage that is available for performing *new* model projects is reduced to account for the project performance capacity that is being used for those projects from prior years.

The model project's *Annual Effective Performance Requirement* is a function of:

- *<u>The model project's total acreage.</u>* Ability to perform a project of a given acreage is the fundamental requirement of the project feasibility test.
- *<u>Duration of the model project.</u>* Given the model project's total acreage, project duration determines the *annual effective* performance requirement for the project. As described above, for projects of greater than one year duration, EPA assumed that the model project could be spread uniformly over the project's duration for determining the annual effective performance requirement of the model project.

The equations for determining the model firm's Annual Effective Performance Capacity and the model project's Annual Effective Performance Requirement, *for a given model project case*, are as follows:

$$Annual\_Effective\_Performance\_Capacity_{d,sctr,rr} = \frac{\left(Revenue_{sctr,rr} * Acreage\_Intensity_{sctr}\right)}{\left(Project\_Duration_{p} / Project\_Start\_Lag_{d,rr}\right)} \quad (1)$$

Where:

Annual_Effective_Performance_Capacity $_{d,sctr,rr}$ = The steady state maximum project acreage, on an annual effective performance basis, for performance of *new model projects* of a given project duration *d*, for a model firm in sector *sctr* and revenue range *rr*

		(model firms are denoted according to their sector *sctr* and revenue range – *rr*)
Revenue $_{sctr,rr}$	=	Model firm in-scope revenue by sector *sctr* and revenue range *rr*
Acreage_Intensity $_{sctr}$	=	Acres per Dollar of Project Value by sector *sctr*
Project_Duration $_{p}$	=	Duration in years for model project *p*
Project_Start_Lag $_{d,\ rr}$	=	The lag between starts of model projects (or bundles of projects), for projects of duration *d* for model firms in revenue range *rr*; constrained to be less than or equal to the duration of the model project under analysis, but no less than one year.

$$Annual\_Effective\_Performance\_Requirement_{\,p} = \frac{Acreage_{\,p}}{Project\_Duration_{\,p}} \qquad (2)$$

Where:

Annual_Effective_Performance_Requirement $_{p}$	=	Project performance capability, on an annual effective performance basis (acres per year), that must be met by a model firm in order to perform model project *p* (model projects defined by acreage and duration)
Acreage $_{p}$	=	Acreage for model project *p*
Project_Duration $_{p}$	=	Duration in years for model project *p*

As described above, if the model firm's *Annual Effective Performance Capacity* exceeds the *Annual Effective Performance Requirement* for the model project under analysis, then the model firm is deemed capable of performing the given model project.

6.2.2 Assigning Model Projects to Model Firms

Based on the findings from the feasibility test, EPA assigned model projects to model firms. Unlike the previous step, the assignment of model projects to model firms accounts for the estimated *number of industry-level firms*, by state and subsector, required to perform the estimated *number of model projects*, again by state and subsector. In this part of the calculation, the industry-level number of firms, by state and subsector, for each revenue range category serves as an *analysis weight* for the model firms that represent the state, subsector, and revenue range. Thus, multiplying information determined at the level of the model firm – e.g., project performance capacity or an impact analysis result – by the model firm analysis weight, yields an industry-level finding, for a given state, subsector, and revenue range. Similarly, the number of model projects, by state and construction subsector, serves as an analysis weight for calculating the total number of projects and annual effective performance requirement, by model project size *x* duration category, that are assigned to model firms.

The assignment accounts for the following:

- Relative *industry-level* performance capability across model firm categories for performance of individual model projects – i.e., accounting for the performance capability of individual model firms and the number of firms, at the industry level by state and subsector, that the model firm represents.
- Relative performance capability for a given model project across the model firm categories that are assessed as capable of performing a project of that size and duration.

- "Using up" of the *actual* firms, by state and subsector, available for project performance; "using up" of the *actual* projects, by state and subsector, to be assigned to the model firms.

As the first step in the assignment algorithm, EPA calculated the total *feasible* project performance capacity, on the basis of annual effective acreage, for all model projects that are estimated to occur in a given state and construction subsector. The total feasible project performance capacity for a given model project is calculated by multiplying the industry-level number of firms (the *analysis weight*, as described above), by state and subsector, *times* the *Annual Effective Performance Capacity* calculated for the model firm in the preceding section (see equation (1)), and summing this value *for all model firms that were found feasible of performing the given model project in the calculations of the preceding section*. The equation for this calculation is as follows:

$$Total\_Performance\_Capacity_{s,sctr,p} = \sum_{rr}\left(F_{sctr,rr,p} * N\_Firms_{s,sctr,rr} * Annual\_Effective\_Performance\_Capacity_{rr,\,p,sctr}\right) \qquad (3)$$

Where:

$Total\_Performance\_Capacity_{s,sctr,p}$	=	The total feasible project performance capacity, in annual effective acreage, for model project *p*, in state *s* and sector *sctr*
$F_{sctr,rr,p}$	=	Whether model firm representing revenue range *rr* is assessed as capable of performing project *p* in sector *sctr*; 1 = feasible, 0 = not feasible
$N\_Firms_{s,sctr,rr}$	=	Number of firms in state *s*, sector *sctr* and revenue range *rr*
$Annual\_Effective\_Performance\_Capacity_{rr,p,sctr}$	=	Annual effective performance capacity in acres per year, for model firm *rr*, for project *p*, in sector *sctr*, from equation (1), above

In the second step of the assignment algorithm, EPA ranked all model projects, for a given state and sector, *from lowest to highest*, based on Total Performance Capacity, in annual effective acreage. The purpose of this ranking is to identify those projects for which the least performance capacity is available, and subsequently to begin assignment of model projects to model firms starting with those model projects for which the least performance capacity is available. In general, the model projects for which least performance capacity is available are *large acreage, short duration* projects. Based on the feasibility calculation outlined above, these projects require the largest *Annual Effective Performance Capacity* by a model firm in order for the model firm to be able to undertake the project, and as a result, fewer firms will have sufficient revenue and annual project performance capacity for these projects than for projects of smaller acreage and/or longer duration. Said another way, the "more difficult" projects are larger, shorter duration projects, and "less difficult" projects are smaller, longer duration projects. EPA assigned model projects to model firms beginning from the model projects for which the least performance capacity is available *to ensure that sufficient project performance capacity would be available to perform these projects*: the requirements for these projects are "met" before moving to successively "easier" projects, for which more model firms were found feasible to undertake.

In the third step of the algorithm, EPA worked sequentially through the ranked schedule of model projects to assign model projects to the project-feasible model firm categories. Model project performance responsibility is assigned to each of the project-feasible model firm categories (defined by revenue range) in proportion to the *available* annual effective performance capacity of each individual model firm category out of the total *available* performance capacity across all model firm categories that were found feasible of performing the given model project. In effect, under this assignment step, whenever a given model firm is determined capable of performing a given model project *and "some" of that model firm's analysis weight remains available for assignment*, the model firm category will be assigned its proportionate share of model project performance. The procedure described below repeats iteratively through the cells of the model project matrix (see *Exhibit 6-1,* above) until all projects and acreage have been assigned to model firms.

As in other steps of this algorithm, the assignment of model project performance is done on the basis of the *Annual Effective Performance Requirement* for the given model project (calculated in equation (2)). The total acreage performance requirement assigned for a given model project is calculated as follows:

$$Total\_Performance\_Requirement_{s,sctr,p} = N\_Projects_{s,sctr} * Annual\_Effective\_Performance\_Requirement_{p} \quad (4)$$

Where:

$Total\_Performance\_Requirement_{s,sctr,p}$	=	The total project performance requirement, in annual effective acreage, for model project *p*, in state *s* and sector *sctr*
$N\_Projects_{s,sctr}$	=	Number of model projects in state *s* and sector *sctr*
$Annual\_Effective\_Performance\_Requirement_{p}$	=	Project performance capability, on an annual effective performance basis (acres per year), that must be met by a model firm in order to perform model project *p* (model projects defined by acreage and duration), from equation (2)

The quantity of model project performance responsibility (in annual effective acreage) assigned to a given model firm category (defined by sector and revenue range), for a given model project category, is calculated as follows:

$$Project\_Performance_{s,sctr,p,rr} = Total\_Performance\_Requirement_{s,sctr,p} * \left[\frac{\left(Remaining\_Firms_{s,sctr,rr} * Annual\_Effective\_Performance\_Capacity_{sctr,rr,p}\right)}{\sum_{rr}\left(Remaining\_Firms_{s,sctr,rr} * Annual\_Effective\_Performance\_Capacity_{sctr,rr,p}\right)} \right] \quad (5)$$

Where:

$Project\_Performance_{s,sctr,rr,p}$	=	Project performance responsibility, in annual effective acreage, for model project *p* assigned to model firm category *rr*, in state *s* and sector *sctr*
$Total\_Performance\_Requirement_{s,sctr,p}$	=	The Total Project Performance Requirement, in annual effective acreage, for model project *p*, in state *s* and sector *sctr*, from equation (4)
$Remaining\_Firms_{s,sctr,rr}$	=	Number of firms in state *s*, sector *sctr* and revenue range *rr*, remaining after assignment of project performance responsibility for preceding model projects in the model project assignment schedule
$Annual\_Effective\_Performance\_Capacity_{rr,p,sctr}$	=	Annual effective performance capacity in acres per year, for model firm *rr*, for project *p*, in sector *sctr*, from equation (1), above

The assignment of model project performance responsibility to model firms generates the impact analysis combination cases – combinations of model firm and model project – that underlie the cost and financial impact analysis discussed in the next section. For each analysis case, it is necessary to know the *number of firms* at the industry-level to which the analysis case applies. This value, which becomes the *model firm analysis weight* in the impact case analysis, is calculated by converting the *Project Performance* value from an *annual effective acreage* concept to a *number of firms* concept, as follows:

$$N\_Firms_{s,sctr,rr,\,p} = \frac{Project\_Performance_{s,sctr,rr,p}}{Annual\_Effective\_Performance\_Capacity_{sctr,rr,p}} \tag{6}$$

Where:

$N\_Firms_{s,sctr,rr,p}$	=	Number of firms in state *s*, sector *sctr* and revenue range *rr*, to which model project *p* performance responsibility is assigned
$Project\_Performance_{s,sctr,rr,p}$	=	Project performance responsibility, in annual effective acreage, for the current model project *p* assigned to model firm category *rr* in state *s* and sector *sctr*, from equation (5)
$Annual\_Effective\_Performance\_Capacity_{rr,p,sctr}$	=	Annual effective performance capacity in acres per year, for model firm *rr*, for project *p*, in sector *sctr*, from equation (1), above

In equation (5), *Remaining Firms* refers to the number of firms in a given subsector and revenue range that remain *not fully assigned* from the preceding model project assignments. At the beginning of the assignment algorithm, Remaining Firms necessarily equals the number of firms in the subsector and revenue range. However, as firms' project capacity is assigned for performance of projects, the Remaining Firms value is decremented to reflect the remaining, *not fully assigned* firms balance. This updating of the Remaining Firms value uses the Number Of Firms from equation (6) to decrement the number of remaining firms with unused project performance capacity as the algorithm proceeds through the ranked schedule of model projects, according to the following equation:

$$Remaining\_Firms\_New_{s,sctr,p,rr} = Remaining\_Firms\_Prv_{s,sctr,p} - N\_Firms_{s,sctr,rr,p} \tag{7}$$

Where:

$Remaining\_Firms\_New_{s,sctr,rr}$	=	Updated number of firms in state *s*, sector *sctr* and revenue range *rr*, remaining after assignment of project performance responsibility for the current model project
$Remaining\_Firms\_Prv_{s,sctr,rr}$	=	Number of firms in state *s*, sector *sctr* and revenue range *rr*, remaining *after preceding steps but before assignments for the current model project*
$N\_Firms_{s,sctr,rr,p}$	=	Number of firms in state *s*, sector *sctr* and revenue range *rr*, to which model project *p* performance responsibility is assigned in the analysis for the current model project *percent*, from equation (6)

The updated *Remaining Firms New* is carried forward for analysis of the next model project in the schedule of model projects as outlined in the description of model project ranking, above.

The final information item needed from this step of the project assignment algorithm is the *number of model projects* assigned to each model firm. This data item is required to calculate the total compliance cost assigned to the model firm in the impact analysis combination cases – combinations of model firm and model project – that underlie the cost and financial impact analysis discussed in the next section. EPA developed compliance cost estimates on a single model project basis; therefore, to know the total compliance cost assigned to a model firm, it is necessary to multiply the single project compliance cost *times* the number of model projects assigned per model firm. The number of model projects value is calculated by converting the *Project Performance* value from an *annual effective acreage* concept to a *number of model projects* concept, as follows:

$$N\_Projects_{s,sctr,rr,p} = \frac{Project\_Performance_{s,sctr,rr,p}}{\left(N\_Firms_{s,sctr,rr,p} * Annual\_Effective\_Performance\_Requirement_{p}\right)} \quad (8)$$

Where:

$N\_Projects_{s,sctr,rr,p}$	=	Number of model projects *p* in state *s* and sector *sctr* assigned to each model firm *rr*
$Project\_Performance_{s,sctr,rr,p}$	=	Total project performance responsibility, in annual effective acreage, for the current model project *p*, assigned to model firm category *rr* in state *s* and sector *sctr*, from equation (5)
$N\_Firms_{s,sctr,rr,p}$	=	Number of firms in state *s*, sector *sctr* and revenue range *rr*, to which model project *p* performance responsibility is assigned in the analysis for the current model project *percent*, from equation (6)
$Annual\_Effective\_Performance\_Requirement_{p}$	=	Project performance capability, on an annual effective performance basis (acres per year), that must be met by a model firm in order to perform model project *p* (model projects defined by acreage and duration), from equation (2)

This assignment procedure continues until all model projects in the project ranking schedule are exhausted. The result of the preceding steps is a set of impact analysis combination cases for use in the cost and financial impact analysis cases. For each state and construction subsector, each impact analysis combination case is defined as a combination of model firm and model project with the number of model projects assigned to each model firm, and the number of industry-level firms that the analysis case represents.

In performing the above steps to assign model projects to model firms, EPA found for some states and subsectors that the project assignment algorithm did not assign the full set of model projects to model firms. This result occurred even though project performance capacity *for the total industry* exceeded the performance requirements of the compliance projects. The shortfall occurred because of the limitations imposed by the project feasibility test outlined in *Section 6.2.1*, above (see page 6-6): smaller and mid-size firms were not found project performance-feasible early enough, and thus were not able to be assigned projects early enough, in the project ranking schedule to meet the project performance requirements for some of the larger and/or shorter duration projects. In short, in some instances, the assignment algorithm did not "clear the market." To allow all model projects to be assigned to model firms – and thus "clear the market" – EPA adjusted the project feasibility test by adding a multiplier to the calculation, which specifies a fraction less than one, by which the feasibility test can be relaxed. Specifically, the multiplier indicates the fraction of Annual Effective Performance Requirement – from equation (2) – for a given model project that a model firm must supply in Annual Effective Performance Capacity – from equation (1) – to be assessed as capable of performing the model project. This multiplier was developed on a state- and sector-specific basis to just exhaust the project performance needs of the state and subsector. Application of the multiplier lets smaller and mid-size firms into the project performance feasibility set earlier than would otherwise be the case, as the assignment algorithm proceeds through the ranking of model projects from least to greatest performance capacity. Apart from allowing the assignment algorithm to clear the market, the overall effect of the adjustment is to increase the participation of smaller and mid-size firms in the performance of in-scope projects. A practical interpretation of this adjustment is that it simulates the performance of in-scope projects by a group of firms – e.g., via joint venture/partnership or subdivision of a larger project into several smaller projects – as opposed to requiring that a given model firm be capable of performing a given model project *by itself* in order to be assessed as capable of performing the model project.

The procedure described above for developing the analysis combinations of model firms and model projects for use in assessing potential firm- and industry-level impacts involves a specific preferential assignment concept in which model projects, by state and subsector, are:

- Ranked and processed according to the industry-level capacity for project performance – least to highest – or, in other words, according to *project performance difficulty*, with the larger acreage/shorter duration projects for which less performance capacity is available, being assigned before smaller acreage/longer duration projects are assigned.
- Assigned to the model firm categories that are assessed as capable of performing the given model project, in proportion to the total performance capacity of each model firm category out of the total of performance capacity that remains available across all model firm categories assessed as capable of performing the given model project.
- Assigned to model firms, and subsequently analyzed, in such way that each model project/model firm combination involves *one* specific combination of a model firm and a model project. Although the procedure develops and analyzes as many as 1,008 model project/model firm combination analysis cases for each state and construction subsector (144 cell model project matrix *times* 7 model firms defined by revenue range in each construction subsector), each combination analysis case that is specifically analyzed involves only *one* model firm and *one* model project. For the purpose of impact assessment, the analysis does not consider cases in which a given model firm performs more than one kind of model project. Moreover, as described more fully below, each model project/model firm combination analysis case is analyzed as though the model firm performs the assigned model project in a way that exhausts the full performance capacity of the model firm. This particular configuration does not match the reality of how firms would likely perform in-scope projects: most C&D firms would not perform only in-scope projects as the basis of their business and further would not perform only one kind of in-scope project. However, this configuration provides a practical basis for assessing the business impact of performing in-scope projects over a large set of model project/model firm combination cases. Moreover, by *exhausting each model firm's performance capacity*, this configuration maximizes the assignment of compliance costs and therefore the potential business impact of regulatory requirements.

Clearly, a virtual infinity of other assignment concepts are possible and will occur in actuality. However, EPA judges that this assignment algorithm and the subsequent assessment of firm- and industry-level impacts on which it is based, provide an appropriate basis for assessment of impacts. The preferential assignment concept – assign most difficult projects first, assign performance responsibility across model firm categories in proportion to capability at the industry-level – reflects the reality that *larger* firms are more likely to perform large/short duration projects than smaller firms, and conserves the performance capacity of the larger capacity firms for these projects. Conversely, smaller firms are more likely to perform smaller projects: these are the projects that they are found feasible to perform, and that are assigned to them. In the typical profile of implementation of this algorithm, a substantial share of large firms' performance capacity is used up in the assignment of performance capacity to the larger/shorter duration projects. Then, as the algorithm reaches model projects that are "less difficult" for performance – i.e., mid/small size projects of mid/longer duration – by mid- and smaller size firms, these firms become increasingly capable of performing projects, and because of the much greater number of these mid- and smaller size firms, they are assigned increasingly larger shares of performance responsibility for the mid/small size projects of mid/longer duration. Overall, EPA judges this assignment concept to be reasonable in capturing a plausible allocation of projects to industry firms for performance of the firm- and industry-level impact analysis.

Further, EPA judges that the assignment, and analysis, of model project performance responsibility to model firms in such way that the performance capacity of each model firm is fully exhausted in performing the assigned model projects, also provides a reasonable basis for the impact analysis. Specifically, this assignment and analysis concept *maximizes* the assignment of compliance costs to the model firm, and therefore maximizes the potential to find adverse financial impacts on the model firm in the analysis for each model project/model firm combination analysis case. Alternative project assignment and analysis algorithms could be implemented in which each project-feasible model firm *would not be assigned* project performance responsibility to the extent that the firm's project performance is fully exhausted by the model project assignments. In this case, project performance responsibility would be assigned to a larger number of firms within each state and construction subsector, *but* the in-scope project performance responsibility and, therefore, compliance cost would generally be less for any given model firm. As a result, the *number of firms* estimated to incur compliance costs in performing projects *would increase* but the *likelihood of finding an adverse financial impact* in any given model firm/model project analysis case *would decrease*.

6.2.3 Assignment of Compliance Costs for the Economic/Financial Impact Analysis

The result of the preceding steps is a set of model firm/model project combination analysis cases on which the cost and financial impact analyses are performed. Each combination case is defined by:

- A model firm
- A model project
- The number of model projects that are assigned to the model firm – given the model firm's project performance capacity *on an annual effective acreage basis*, and the model project's performance requirement also *on an annual effective acreage basis*
- The number of industry-level firms (the *model firm analysis weight*), by state, subsector and revenue range, that the model firm represents for the particular model firm/model project combination analysis case.

EPA estimated compliance costs for each model project, by state, subsector and project size and duration as described in *Technical Development Document*. Based on the assignment of model projects to model firms as described above, compliance costs were assigned to the model firms as described below. The assignment of model project costs to the model firm for the cost and financial impact analysis involves three adjustment concepts:

1. Assignment of costs on an annual equivalent basis. In order to support an annual economic/financial analysis, compliance costs are assigned to each model firm/project combination as an *annual* cost. For projects of greater than one year duration, the total compliance cost estimated for the given model project is divided by the model project's duration to convert the compliance cost to an annual equivalent cost. This treatment effectively assumes that costs are recognized uniformly over the life of the project. For model projects of one year or less, no adjustment is necessary as all of the model projects occur within one year.
2. Assignment of costs accounting for total number of model projects assigned for a given project start year. The annual equivalent costs for the model project are multiplied by the number of model projects that were assigned to the model firm in the project assignment algorithm assigned above. For example, if the model firm was assessed as capable of starting three model projects on an annual effective performance basis, then the firm would be assigned three *times* the annual equivalent compliance cost for the given model project.
3. Assignment of costs accounting for the total number of *years of* model projects *ongoing* in the current year. As described above, depending on model project duration and the model firm's operating model in terms of

delay between annual project starts, a model firm may have projects from more than one year of starts ongoing in a given year. Accordingly, to account correctly for the impact of compliance costs on the firms' current operations, it is necessary to account for the compliance costs from those projects that were begun in prior years and that remain ongoing in the analysis year. This is analogous to picking up the compliance costs in later years that were put off to a future year in step 26 of this cost assignment procedure.

Based on these concepts, the compliance costs assigned to a model firm for a given model firm/model project analysis combination are calculated as follows:

$$Total\_Compl\_Cost_{s,sctr,rr,\,p} = \frac{Compl\_Cost_{s,sctr,p}}{Project\_Duration_{p}} * N\_Projects_{s,sctr,rr,p} * N\_Yrs\_Projects_{s,sctr,rr,p} \quad (9)$$

Where:

$Total\_Compl\_Cost_{s,sctr,rr,p}$	=	Total annual compliance cost assigned to model firm *rr* in state *s* and sector *sctr* for project *p*
$Compl\_Cost_{s,sctr,p}$	=	Compliance cost for model project *p*, in state *s* and sector *sctr*
$Project\_Duration_{p}$	=	Duration in years for model project *p*, for projects of greater than one year duration
$N\_Projects_{s,sctr,rr,p}$	=	Number of model projects *p* in state *s* and sector *sctr* assigned to each model firm *rr*, from equation (8)
$N\_Yrs\_Projects_{s,sctr,rr,p}$	=	Number of years of model projects *p* ongoing for model firm *rr*, in state *s* and sector *sctr* assigned to each model firm *rr*

In this expression, for projects of greater than one year duration, *Number of Years of Projects* ongoing is calculated as follows:

$$N\_Yrs\_Projects_{s,sctr,rr,p} = \frac{Project\_Duration_{p}}{Project\_Start\_Lag_{d,rr}} \quad (10)$$

Where:

$N\_Years\_Projects_{s,sctr,rr,p}$	=	Number of years of model projects *p* ongoing for model firm *rr*, in state *s* and sector *sctr* assigned to each model firm *rr*
$Project\_Duration_{p}$	=	Duration in years for model project *p*, for projects of greater than one year duration
$Project\_Start\_Lag_{d,rr}$	=	The length of time between starts of model projects (or bundles of projects), for projects of duration *d* for model firms in revenue range *rr*; constrained to be less than or equal to the duration of the model project under analysis, but no less than one year.

The following section describes the analysis of the impact on the model firm of the assignment of model project compliance costs.

6.3 Estimating the Change in Model Firm Financial Performance and Condition

As described above, EPA developed model firm/model project combination analysis cases which underlie the assessment of the potential firm financial impacts of the C&D regulation. Annual compliance costs were assigned to each model firm in these combination cases, reflecting the number of model projects that the model firm was starting in a given year *and* the number of years of projects that the model firm has ongoing, given the assumed the project start lag for the model firm.

The impact assessments at the level of the model firms are used in *Section 6.4: Applying the Findings from the Model Firm Analysis to the Total Industry* to assess industry level effects, accounting for the numbers of firms represented by the model firm in each model firm/model project combination analysis case.

6.3.1 Impacts Analyzed

Three economic/financial impacts are used in the firm- and industry-level impact analysis:

1. A "screening level" impact measure based on comparison of annual compliance costs to revenue. EPA generally judges compliance costs that are less than one percent of revenue as not imposing a material economic/financial burden on affected businesses. Costs exceeding three percent of revenue are judged as potentially imposing a material economic/financial burden, while the findings for costs between one and three percent of revenue are generally viewed as inconclusive in terms of economic/financial burden. This assessment, which examines the frequency with which compliance costs exceed one and three percent of revenue, is also important for the small entity impact analysis.
2. Changes in two key measures of firm financial performance and condition, based on application of compliance costs to the model firm financial statements:
   - <u>Pre-Tax Income/Total Assets</u>, a key measure of the fundamental asset productivity and profit performance of a business. Businesses with weak return on assets will be unable to provide competitive returns to investors and will have difficulty attracting capital to support the ongoing business as well as any business expansion.
   - <u>Earnings before Interest and Taxes/Interest</u>, which indicates the extent to which pre-interest, pre-tax income exceeds interest obligations and thus is a key measure of the ability of an enterprise to meet its current interest obligations and as well the risk to a borrower for extending additional credit to the enterprise.[39]

   The assessment for these two financial measures estimates the fraction of firms in the various subsector and revenue ranges for which the financial measures decline – because of compliance outlays – to levels indicative of material financial weakness. The analysis uses the lower quartile of these financial measures as developed from the RMA statements *for a given sector for the General Business Conditions case*[40] as the threshold value of financial weakness.
3. Change in business value, based on application of compliance costs to the model firm financial statements, and the fraction of firms whose net business value becomes negative because of compliance outlays. This impact measure is used as an indicator of potential firm closures due to the regulation. EPA also estimated and reports the employment in firms that are potential closures. This employment is at risk from the potential closure of these facilities. In *Chapter 8,* EPA describes estimation of a potential employment effect resulting from contraction in C&D industry output due to the regulation. These potential employment effects are different in concept. The employment effect from *firm closures* results from some firms being marginal

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39 These are two of the financial measures reported by RMA for median, lower and upper quartiles by sector and business size that were used in constructing the baseline financial statements for the model firms.

40 That is, the threshold values that are used for assessing adverse financial impact are based on the General Business Conditions case estimates regardless of whether the analysis is being performed for the *General Business Conditions* case or the *Adverse Business Conditions* case.

financial performers that may cease business because of regulatory requirements. These potential job losses, if they do occur, are not necessarily *permanent* losses in the C&D industry but may be better thought of as *dislocations* as some firms cease operations but other, financially more healthy, firms increase activity and restore part or all of these job losses. On the other hand, the employment losses from potential *contraction* of C&D industry output, as described in *Chapter 8*, may be understood as permanent losses.

Assessments of impact for these three measures are performed under two analysis cases:

- Primary Impact Analysis Case: This case reflects EPA's best estimates of the likely impact of the C&D rule under *general* business conditions and is presented as the primary impact assessment. For this case, firms are assumed to pass on part of the compliance outlay to other parties. The extent of pass-through varies by subsector and is determined from the market level analysis outlined in *Chapter 8*. In addition, this case reflects the *General Business Conditions case* of baseline firm financial performance and condition.
- Adverse Impact Analysis Case: This case reflects more adverse business conditions – i.e., not business as usual – and is presented as an assessment of how the regulation might affect businesses during adverse business conditions. For this case, firms are assumed to absorb all of the compliance outlay within their current operating finances – i.e., unable to pass on any of the compliance outlay to customers or to the sellers of the land on which development occurs. In addition, this case reflects the *Adverse Business Conditions case* of baseline firm financial performance and condition. The findings from this analysis are presented in an appendix. EPA developed this analysis case in consideration of the challenges confronting the economy, in general, and the C&D industry, in particular, at the time of rule promulgation.

A third case – 100% cost pass-through – in which all compliance outlays are assumed to be passed on to other parties, is also possible. However, this case is not directly addressed in the firm-level impact analysis, since by definition, businesses experience no adverse financial impact under 100 percent cost pass-through.[41] This case *is assessed* in terms of potential regulation impacts on consumers (*Chapter 7)*.

6.3.2 Incorporating Compliance Cost Estimates into Baseline Financial Statements

Model-firm compliance cost estimates from *Section 6.2* are incorporated into the baseline income statement and balance sheet for each model firm to assess how compliance costs change the key financial ratios and business value for the representative construction firms.

For the firm-level analysis, model firms are assumed to be in a steady state of operations in which a constant level of activity – project starts and project completions – subject to regulation occurs year-to-year. The financial impact of compliance outlays can be assessed as a one-time change to this steady state condition, based on the level of activity subject to regulation that is initiated in a given year. Key assumptions in this analysis include:

- Model firms are assumed to finance compliance outlays 80 percent from debt and 20 percent from equity capital.
- Model firms finance the compliance outlay for an assumed duration of financing, which depends on project duration and the point in project performance at which the firm is assumed to make the compliance outlay. For projects of less than two years duration, the duration of financing is specified as the duration of the project. For projects of two years or greater, the duration of financing is specified as

41 Complete pass-through of compliance costs to consumers would occur if the elasticity of demand for C&D industry outputs is zero. It is also important to note that, in this hypothetical case, there would be no contraction in the production of C&D industry outputs (as examined in Chapter 9), and thus no overall adverse impact on the C&D industry due to reduced total production.

the duration of the project less one year – i.e., the firm is assumed to make the compliance outlay at the beginning of the project's second year.

- For those cases in which a model firm has more than one year's projects ongoing at a time, the multiple years of ongoing projects is assumed to increase the total financing requirement that accrues to the firm's balance sheet. The total balance sheet effect accounts for the project financings required for the current year *and* the financings from projects begun in prior years that are still ongoing in the current year.
- In the *no cost pass-through analysis*, the compliance outlay affects the income statement as follows:
  - Cost of revenue is increased by the amount of the compliance outlay, in turn reducing business gross profit.
  - The total interest expense of the compliance outlay for a given project start year is calculated as the one-year interest value *times* the number of years of the duration of project financing, as described above, but is converted to a annual equivalent value by dividing the total interest charge by the project *duration* (except for projects of one year or less). For those cases in which a model firm has more than one year's projects ongoing at a time, the resulting one-year of project's interest expense is further multiplied by the number of years of ongoing projects to yield the total compliance interest expense charged for the current analysis year. The final interest value is recorded as increase in interest expense on the firm's income statement. Interest costs are calculated according to the business conditions case being analyzed.
  - Pre-tax income is reduced by the amount of the compliance outlay and interest expense.
  - The tax effect of the outlay is calculated as the model firm's tax rate *times* the compliance outlay and interest expense. This tax effect reduces the model firm's baseline tax liability; however, if the model firm's pre-tax income is less than the indicated tax effect of the compliance outlay and interest expense, the tax effect is limited so it does not exceed the baseline tax liability. Said another way, the tax effect of the compliance outlay and interest expense cannot generate a negative tax.
  - After-tax income, post-compliance, is calculated by subtracting the post-compliance adjusted tax value from the post-compliance adjusted pre-tax income value.
- In the no cost pass-through analysis, the compliance outlay affects the balance sheet as follows:
  - As described above, in those cases in which a model firm has more than one year's projects ongoing at a time, the multiple years of ongoing projects is assumed to increase the total financing requirement that accrues to the firm's balance sheet. The total financing requirement is calculated by multiplying the one-year compliance outlay *times* the number of years for which projects are ongoing in the model firm's steady state operating model.
  - The total compliance financing requirement for a given project start year (which may include financing requirements from prior years), including interest cost on debt financing is assumed to be recorded as an increase in non-current assets.
  - Debt is increased by the debt fraction of the compliance financing requirement for the project start year; equity is increased by the equity fraction of the outlay compliance financing requirement for the project start year.
- In the *partial cost pass-through analysis*, the analysis differs in that the compliance financing requirement for the project start year is assumed to be partially recovered through an increase in revenue, which in turn results in a lower reduction in net income on the income statement, a corresponding increase in current assets (due to the increase in cash from receipt of the increased revenue), and a lower increase in non-current assets on the balance sheet.

The changes in income statement and balance sheet translate into changes in the financial impact measures and also affect the business value analysis by reducing after-tax cash flow and increasing the liabilities that are subtracted away in calculating business net worth.

6.3.3 Assessing the Effect of Compliance Outlays on the Impact Measures

As described above, three impact concepts are accounted for in the firm impact analysis:

1. Occurrence of compliance costs exceeding one and three percent of revenue – a screening-level measure of financial impact.
2. Deterioration in measures of financial performance and condition to levels that would indicate financial stress to the enterprise.
3. Decline to a negative net worth business value, which is assumed to point to a risk of business closure.

6.3.3.1 Occurrence of Compliance costs Exceeding One and Three Percent of Revenue

The "screening level" cost-to-revenue measure is assessed as whether the total compliance outlay, including financing cost, exceeds thresholds of one and three percent of revenue.

This analysis is performed by comparing the total recorded compliance cost for a given analysis year (i.e., potentially reflecting multiple years of projects ongoing in a given year) for a given model firm/model project combination to revenue across the revenue range for model firm category. In this comparison, revenue over firms within a revenue range is assumed to be distributed uniformly over the range. Based on the assumption of a uniform distribution, EPA calculated the fraction of firms within the revenue range for which compliance cost exceeds a given cost-to-revenue threshold. Three cases are possible:

1. Cost-to-revenue at the low end of the revenue range is less than the cost-to-revenue threshold – in this case, the fraction of firms in the revenue range for which cost exceeds the indicated cost-to-revenue threshold is *zero*.
2. Cost-to-revenue at the high end of the revenue range exceeds the cost-to-revenue threshold – in this case, the fraction of firms in the revenue range for which cost exceeds the indicated cost-to-revenue threshold is *one*.
3. Cost-to-revenue at a revenue value within the revenue range equals the cost-to-revenue threshold – in this case, the fraction of firms in the revenue range for which cost exceeds the indicated cost-to-revenue threshold is calculated as the fraction of the revenue range lying below the revenue value at which cost-to-revenue equals the indicated impact threshold within the range, as follows:

$$Fraction\_Exceeding\_CTR_{s,sctr,rr,p} = \frac{\left(Revenue\_Critical_{s,sctr,rr,p} - Revenue\_Low_{rr}\right)}{\left(Revenue\_High_{rr} - Revenue\_Low_{rr}\right)} \qquad (11)$$

Where:

$Fraction\_Exceeding\_CTR_{s,sctr,rr,p}$	=	Fraction of firms within the model firm revenue range *rr* with cost-to-revenue exceeding the indicated cost-to-revenue threshold, for analysis combination of model firm *rr* and model project *p*, in state *s* and sector *sctr*
$Revenue\_Critical_{s,sctr,rr,p}$	=	Revenue with revenue range *rr* at which cost-to-revenue equals the indicated cost-to-revenue threshold, for analysis combination of model firm *rr* and model project *p*, in state *s* and sector *sctr*
$Revenue\_Low_{rr}$	=	The low end of revenue range *rr*

$Revenue\_High_{rr}$ = The high end of revenue range *rr*

The fraction of firms within the revenue range for which compliance cost exceeds one and/or three percent of revenue is recorded as an impact event for the particular model firm/model project combination analysis case.

This calculation is performed in two ways:

1. Using the unadjusted compliance cost. This metric indicates the potential burden of compliance costs in relation to revenue, without accounting for the likelihood that some of the compliance cost will be offset by increase revenue.
2. Using the compliance cost adjusted by the increase in revenue that is estimated to occur from passing on a part of the compliance cost increase to customers as a price increase. This measure may provide a more meaningful measure of potential compliance cost burden. In this calculation, the total compliance cost is simply reduced by the increase in revenue resulting from cost pass-through. The resulting comparison is of *net compliance cost burden* (i.e., after offsetting revenue increase) to baseline revenue.

6.3.3.2 Deterioration in Measures of Financial Performance

In the financial measures analysis, baseline and post-compliance values of the measures are calculated for the lower quartile, median, and upper quartile model firm financial statements within each subsector and revenue range. Impact findings are assessed in terms of the estimated fraction of firms by subsector and revenue range whose financial performance value declines below financial weakness thresholds as a result of compliance outlays. This analysis involves the following steps:

- For each financial performance measure, the baseline and post-compliance values of the *lower quartile, median, and upper quartile* values are used to construct baseline and post-compliance linear-segmented cumulative distributions. These distributions are developed separately by revenue range within each subsector.
- The baseline lower quartile value for each financial measure *over the entire subsector (i.e., all revenue size categories) and for the General Business Conditions case* is used as the *Critical Threshold Value* for assessing material financial weakness for a given subsector. Because the critical threshold value for a given impact metric is determined on the basis of the entire subsector – *and not by individual revenue range* – the critical threshold value will generally not lie at the 25th percentile for a specific revenue range.
- The baseline distribution is used to determine the fraction of firms, by revenue range and subsector, falling below the critical threshold value for each financial performance measure in the baseline – i.e., *before application of compliance costs*. In reaching this determination, EPA assumed that firms are uniformly distributed within the linear segments of the cumulative distribution of financial performance measure values. Because the analysis uses a critical threshold value that is determined at the subsector level and does not vary by revenue range within the subsector, the *baseline* percentage of firms falling below the threshold value varies by revenue range within the subsector. Typically, a fraction larger than 25 percent of firms in the smaller revenue ranges fall below the impact threshold value, while less than 25 percent of firms in the higher revenue ranges fall below the threshold value.
- The post-compliance distribution is developed from the financial performance values for the median, lower quartile, and upper quartile model firms, based on application of compliance costs to the model firms, as described in previous sections. In effect, the post-compliance distribution is a *shifted* version of the baseline distribution with the newly calculated median, lower quartile, and upper quartile values being lower than the values at these same percentile points on the baseline distribution.
- The post-compliance distribution is then used to determine the fraction of firms, by revenue range and subsector, falling below the critical threshold value for each financial performance measure. The

difference between the post-compliance and baseline percentages indicates the percentage of model firms in a given subsector and revenue range that move below the critical threshold value because of incurring compliance costs for a given regulatory option.

Key elements of these calculations are summarized in *Table 6-1*, below.

Table 6-1: Summary of Concepts in Developing Distributions of Financial Performance Measures and Calculating Performance Relative to Impact Thresholds

Percentile Value	Baseline Distribution and Values	Post-Compliance Distribution and Values
0^{th} Percentile	Determined by linear extrapolation from 25^{th} percentile value based on *slope* between 25^{th} and median percentile values	Determined by linear extrapolation from 25^{th} percentile value based on *slope* between 25^{th} and median percentile values
Threshold Value[1] lies between 0^{th} and 25th percentile	The baseline percentile of the critical threshold value is determined by linear interpolation between the 0^{th} and 25^{th} percentile measure values from the baseline distribution	The post-compliance percentile of the critical threshold value is determined by linear interpolation between the 0^{th} and 25^{th} percentile measure values from the post-compliance distribution
First Quartile (25^{th} percentile)	$Metric_{Q1}$ *assigned to baseline financial statement from RMA data, for firms by revenue range and sector*	$Metric_{Q1,post\text{-}compliance}$ *calculated after application of compliance costs*
Threshold Value lies between 25^{th} percentile and median	The baseline percentile of the critical threshold value is determined by linear interpolation between the 25^{th} percentile and median measure values from the baseline distribution	The post-compliance percentile of the critical threshold value is determined by linear interpolation between the 25^{th} percentile and median measure values from the post-compliance distribution
Median (50^{th} percentile)	$Metric_{Median}$ *assigned to baseline financial statement from RMA data, for firms by revenue range and sector*	$Metric_{Median,post\text{-}compliance}$ *calculated after application of compliance costs*
Threshold Value lies between median and 75^{th} percentile	The baseline percentile of the critical threshold value is determined by linear interpolation between the median and the 75^{th} percentile measure values from the baseline distribution	The post-compliance percentile of the critical threshold value is determined by linear interpolation between the median and the 75^{th} percentile measure values from the post-compliance distribution
Third Quartile (75^{th} percentile)	$Metric_{Q3}$ *assigned to baseline financial statement from RMA data, for firms by revenue range and sector*	$Metric_{Q3,post\text{-}compliance}$ *calculated after application of compliance costs*
Threshold Value lies between 75^{th} and 100^{th} percentile	The baseline percentile of the critical threshold value is determined by linear interpolation between the 75^{th} and 100^{th} percentile measure values from the baseline distribution	The post-compliance percentile of the critical threshold value is determined by linear interpolation between the 75^{th} and 100^{th} percentile measure values from the post-compliance distribution
100^{th} Percentile	If needed in analysis, determined by linear extrapolation from 75^{th} percentile value based on *slope* between median and 75^{th} percentile values	If needed in analysis, determined by linear extrapolation from 75^{th} percentile value based on *slope* between median and 75^{th} percentile values

[1] The Critical Threshold Value for a each financial impact metric is defined as the 25^{th} percentile value for the given metric from the RMA-based distribution of financial metrics for the *total* sector – i.e., independent of revenue range – and is based on the distribution of those metrics for the General Business Conditions case. As a result, the Critical Threshold Value will not generally lie at the 25^{th} percentile of the distribution of the financial metric for a *specific revenue range* within the sector.

Source: U.S. Environmental Protection Agency

As described above, the estimated *increase* in percentage of firms falling below a given threshold value is the measure of impact, for each financial measure for each model firm/model project analysis case, by state and subsector. EPA used the *greater* of the impact percentages for each financial measure, by revenue range and subsector, as a composite indicator of financial stress, by revenue range and subsector. These firms are assessed as potentially incurring material financial weakness as a result of regulatory requirements.

6.3.3.3 Occurrence of Negative Business Value

The analysis of change in business value is comparable in structure to the financial measures analysis, with baseline and post-compliance business value being calculated at median, lower quartile, and upper quartile model firm financial statements within each subsector and revenue range. These quartile values are again used to construct linear-segmented cumulative distributions of business value by subsector and revenue range. As described above, the baseline distribution of business value shifts as a result of compliance costs, leading to an increased fraction of firms, by subsector and revenue range, whose business value is assessed as negative, and thus at risk of closure. Impact findings are assessed in terms of the fraction and resulting number of firms whose net business value falls below zero as a result of compliance.

As described above, EPA interprets this impact measure as an indicator of potential closures due to the regulation.

6.4 Applying the Findings from the Model Firm Analysis to the Total Industry

EPA used the findings from the model firm/model project combination analyses by state and subsector to estimate the industry-level cost and impact of each regulatory option.

6.4.1 Estimating Industry Level Occurrence of Economic/Financial Impacts

Industry-level impacts are estimated by extending the findings from the model firm/model project analysis to the specific revenue ranges and subsectors that are represented by the model firms. The number of occurrences of adverse financial impacts for each model firm/model project analysis case – the estimated percentage of firms by revenue range with costs exceeding one or three percent of revenue, the estimated percentage of firms incurring financial stress due to regulatory requirements, or the estimated percentage of firms encountering negative business value due to regulatory requirements – by state and subsector, are multiplied by the number of firms represented by the relevant model firm/model project combination cases by state and subsector (from equation (6) at page 6-11) to estimate the total number of firms expected to incur the indicated financial impact. Estimation of the numbers of firms by state, subsector, and revenue range is described in the regulatory analysis baseline (see *Chapter **4***). As described in *Section 6.2*, EPA performed the firm and industry level analyses on a state-by-state, and sector-by-sector basis and aggregated the findings over states and construction subsectors to yield national level estimates. These calculations provide estimates of the number of firms (and percentage within all firms in a given sector) that are estimated to incur the various impact measures. In addition, for firms estimated to incur the various financial impacts, EPA assessed total potential employment at risk based on the employment totals reported in the SUSB/Economic Census data by subsector and revenue range.

Firms expected to experience financial stress may need to change their business operations, including potentially down-sizing or closing operations. However, the actual likelihood of these outcomes may be quite low given that these analyses are conditioned only on the so-called “less than full cost pass-through” cases. Furthermore, these business effects may not be noticeable within the ordinary course of business changes in the C&D industry, where year-to-year fluctuations in the level of business activity can be quite substantial as a result of changing macroeconomic conditions (e.g., interest rates, overall strength of the national economy) and/or changing local economic conditions (e.g., strength of local industries). Finally, the C&D industry is a relatively fluid industry, as documented in the industry profile, with low barriers to entry and considerable entry and exit activity from year to year. As a result, the potential employment losses or capital-idling effects of weakness in a specific firm are likely to be offset by changing levels of activity in other existing firms or entry of new firms into the local market.

In general, the estimated industry-level effects from this analysis in terms of number of firms experiencing negative business value and the associated potential revenue and employment loss (reported in *Section 6.7*, below), exceed the estimated reductions in industry output and employment effects from the partial equilibrium analysis of aggregate industry effects presented in *Chapter* **9**. This comparison indicates that the estimated potential closures and employment losses from the firm- and industry-level analysis *overstate* the expected aggregate loss from the regulation: the findings of the firm- and industry-level analysis are better interpreted as an indicator of stress – "transition friction" – among the marginal industry participants as the industry adjusts to the additional requirements and costs of the C&D regulation. As stated in the preceding paragraph, the C&D industry has historically been a highly fluid industry, with substantial year-to-year entry and exit, particularly among mid- and smaller size firms. As such, the estimated potential losses and idling of economic resources in affected firms would be expected to be absorbed to a substantial degree in increased activity among other existing and new industry participants.

6.4.2 Estimating Total Cost of Compliance and Total Acreage Incurring Compliance Costs

The estimate of total industry-level effects also yields an estimate of total annual compliance outlays and related project acreage by state and subsector and by model firm/model project analysis cases, and when aggregated, over all subsectors and revenue ranges, for a given regulatory option. This calculation is performed by simply aggregating the estimated compliance costs and acreage over the model firm/model project analysis cases, weighted by the number of firm analysis weights, by subsectors and states for a given regulatory option. Summing these values over subsectors and states yields national-level estimates of the annual costs for a given regulatory option and a given level of industry activity.

6.5 Assessing Potential Barriers to Entry of New Businesses to the C&D Industry

EPA examined the potential for the C&D regulation to pose a barrier to entry for new businesses seeking to enter the C&D industry. This analysis looked specifically at the extent to which the regulation would increase the capital required by firms of various revenue sizes to participate in the industry. A substantial increase in capital requirements could mean that some firms might not be able to assemble the capital necessary to participate in the industry.

For this assessment, EPA made the following assumptions:

- For any given revenue level, the capital required for entry to the industry is no different than the capital required by existing businesses for their continued participation in the industry.
- The total estimated compliance outlay would need to be financed by both existing businesses and new entrants to the industry.
- For any given revenue level, the total estimated compliance outlay would be the same for existing businesses and new entrants.

To assess the potential entry barrier effect, EPA compared the estimated financing requirement associated with compliance outlays to baseline total assets for each of the model firms, by industry subsector and revenue range (model firm specifications are defined in *Chapter 4: Developing the Analysis Baseline*). The comparison of the financing requirement to the model firm's assets assumes that the firm's compliance outlay would be financed and recorded on the model firm's balance sheet. To the extent that the compliance outlay is financed and recorded *not on the firm's baseline sheet but as part of a separate project-based financing for each individual project*, this comparison is likely to overstate, perhaps substantially, the incremental burden of financing in relation to the going concern asset base of the model firms.

In estimating the additional financing requirement for each model firm, EPA assumed that construction projects require the additional financing requirement to be carried on the firm's baseline sheet for a specified duration of time (i.e., until project completion) and the *steady state* increase in financing requirements is thus approximately equal to the annual project outlay times the assumed project duration. EPA estimated the average duration of the additional financing requirement separately for each regulatory option considered and for each broad C&D subsector (e.g., residential, non-residential, and transportation). For each option and subsector, the assumed financing duration is estimated as the average duration of all in-scope projects, at the national level, weighted by the total compliance outlays associated with each of the twelve project duration categories. If the resulting additional financing requirement is substantial in relation to baseline assets, then the additional requirement could pose a material entry barrier. *Table 6-2* presents the estimated financing duration for each subsector and regulatory option.

Table 6-2: Average Duration of Additional Financing for In-Scope Projects (years)

weighted by total compliance cost within each duration category, by sector and regulatory option

NAICS Sector	Residential	Non-Residential	Transportation
Option 1	1.68	1.07	1.68
Option 2	2.12	1.61	2.41
Option 3	2.03	1.46	2.18
Option 4	2.05	1.39	2.06

Source: EPA analysis

6.6 Uncertainties and Limitations

EPA has addressed some of the key uncertainties present in the firm and industry level analysis for the proposed rule by performing this analysis under two plausible alternative assumptions of business conditions for C&D firms and the overall industry: the *primary analysis case* and the *adverse analysis case*.

However, *within both of these overall analysis configurations*, additional key sources of uncertainty and limitations remain. These uncertainties and considerations are summarized below with reference to the more detailed discussions in previous sections of this chapter for more information:

- ***Determination of In-Scope Model Firm Revenue, Quantity of In-Scope Construction Activity and Incurrence of Compliance Cost.*** Several sources of uncertainty affect EPA's assessment of the firm revenue and construction activity estimated to be in-scope of the regulation and thus subject to compliance costs:
  - ***The Likelihood that Firms' Activities Would Incur Direct Compliance Costs.*** There is uncertainty with respect to the business configurations for performance of construction projects in which the rule will impose *direct costs* on C&D firms. Large construction projects, in particular, can be performed by multiple firms and those firms can be organized in multiple business configurations for any given project. For example, a single developer can sell "pieces" of a project to other independent firms. Under this configuration, the single developer would incur the *direct* costs of the regulation (the subsequent lot purchases may then incur *indirect* costs via cost pass through from the developer). Or, a configuration could exist where several firms undertake a project as a partnership, where all of the firms "share" the *direct* cost of the regulation in some way. Lacking information on the distribution of business configurations for projects undertaken by firms in the various C&D subsectors and revenue ranges, it is inherently difficult to account for these scenarios. The current analysis accounts for such possibilities in an indirect manner, by allowing model firms to participate in model projects that they would otherwise be incapable of performing, on a standalone basis, via the multiplier adjustment in the project performance feasibility test described at page 6-13. As described above, this multiplier adjustment increases the participation of smaller and mid-size firms in the performance of in-scope projects, and simulates the performance of in-scope projects by a group of firms – e.g., via joint

venture/partnership or subdivision of a larger project into several smaller projects – as opposed to requiring that a given model firm be capable of performing a given model project *by itself* in order to be assessed as capable of performing the model project. Whether this adjustment reasonably reflects the potential for firms of varying sizes to participate in, and thereby incur compliance costs for, in-scope projects is uncertain. As a result, EPA may be overestimating or underestimating the numbers of firms performing in-scope projects and incurring compliance costs (see *Section 6.2*).

- ***The Type of Construction Activity Performed by C&D Firms***. There is uncertainty with respect to the fraction of C&D firm revenue that is generated from potentially in-scope activities (i.e. *new* construction) versus revenue generated from activities that are not potentially in-scope (i.e. *additions or remodeling work*). When the Economic Census assigns C&D firms to NAICS industry sectors, they are assigned into the subsector from which the majority of their revenue is generated, and therefore, not all firm revenue is necessarily associated with activity in their assigned subsector. For example, a firm assigned to NAICS 236115 generates at least 51% of its revenue from *New Single-Family Residential Construction*, but *as much as* 49% of the firm's revenue could come from construction activities, such as remodeling, that would not be in-scope. In the analysis of regulatory options for the proposed C&D rule, EPA accounted for this in part, using the C&D subsector specialization data available from the 2002 Economic Census. Specifically, model firms' in-scope fraction of revenue was adjusted based on the Census-reported *average* specialization values for each NAICS sector assessed as being likely to perform in-scope projects. This adjustment had the effect of reducing the model firms' performance of in-scope construction activity and thereby reducing the potential compliance cost burden. For the analysis of the final regulation, EPA did not implement this adjustment and has, in effect, *maximized* the potential compliance cost burden and opportunity for adverse financial impact in its analysis of the model firm/model project combination cases as outlined above. As discussed at page 6-14, EPA judges this analysis to provide a reasonable basis for assessing the firm- and industry-level impact of the C&D rule. However, inevitably, considerable uncertainty remains in terms of the number of firms that would perform in-scope projects and the fraction of their annual project performance responsibility and revenue that would involve in-scope projects and thus incur compliance costs (see *Section 6.2*).

- ***C&D Firms' Project Performance Profile and Potential for Performing In-Scope Projects***. As outlined in *Section 6.2*, for each state and construction subsector, EPA developed model projects within a 144 model project matrix (12 model project sizes *by* 12 model project durations). EPA then assigned these model projects to model firms based on an estimated project performance capability calculation, which involves the concept of *acreage intensity* (project acreage *per* million dollars of project value/revenue), project duration and thus its annual effective performance requirement, and an assumed operating model of the model firm in terms of the frequency with which the model firm *restarts* an annual ongoing slate of projects. As described in *Section 6.2.1*, page 6-6, this framework supports an assessment of the feasibility of a given model firm to perform a given model project, and provides an estimate of the number of model projects of a given duration and size that a model firm is capable of undertaking in any year, *and the number of model projects that may remain ongoing from earlier years*. These determinations underlie the assignment of model projects and compliance costs to model firms, and the assessment of firm- and industry-level financial impacts. These assessments of project performance feasibility and assignments of model projects to model firms are subject to uncertainty in terms of the assumptions of the model firms' operating models, and the estimates of acreage intensity that are integral to the feasibility assessments and project responsibility assignments. For example, the acreage intensity values are estimated as averages from the best data that are available to calculate acreage intensity, but inevitably involve considerable uncertainty. In addition, the assumptions about the model firms' operating models are also subject to considerable uncertainty, in particular for the smaller and mid-size firms for which EPA assumed that the ongoing slate of projects would not necessarily be renewed annually. On the other hand, because the assumptions about the operating models increase the potential for smaller and mid-size firms to participate in in-scope projects, EPA judges that these assumptions will tend *not* to understate the potential impact of the regulation on smaller and mid-size firms, and thus that these assumptions provide a reasonable basis for assessing firm- and industry-level impacts. It is not possible to state whether, in the aggregate, these assumptions and the project assignment method will tend to overstate or understate firm- and industry-level impacts.

- ***Assignment of Model Projects to Model Firms for the Firm- and Industry-Level Impact Assessment.*** As described at page 6-13, for the firm- and industry-level impact assessment, EPA followed a particular algorithm in assigning model projects to model firms, which assigns larger size/shorter duration ("more difficult") projects to the relatively fewer *large* firms that are assessed as capable of performing these projects, before moving to the progressively "easier" projects for which more firms are assessed as capable of performance. This algorithm and the resulting model firm/model project analysis cases provide only one of numerous possible configurations for analyzing the financial impact of performing in-scope projects on model firms. However, as discussed at page 6-13, EPA views this assignment as reflecting basic realities about the kind of projects – in terms of size – that are likely to be performed by firms of a given size and project performance capacity. As such, EPA judges this assignment to be reasonable in capturing a plausible allocation of projects to industry firms for performance of the firm- and industry-level impact analysis. Nevertheless, other assignment methods could yield different findings in terms of the level of firm- and industry-level impacts and the kinds of firms that would incur those impacts.
- ***Assignment of Model Projects to Model Firms in such way as to Exhaust the Project Performance Capability of Model Firms.*** As discussed at page 6-14, EPA's assignment of model projects and associated compliance cost burden to model firms, and the subsequent analysis of the model firm/model project combinations, is performed in such way that, in each model firm/model project combination, the model firm performs only one specific model project and the impact analysis is structured so that the firm is assumed to perform the given model project to its full performance capacity. This project assignment approach maximizes the assignment of compliance costs to the model firm, and therefore maximizes the potential for adverse financial impact on the model firm in the analysis for each model project/model firm combination analysis case. However, as described, alternative project assignment and analysis algorithms could be implemented in which project performance responsibility *would not be assigned* to the extent that the firm's project performance is fully exhausted by the model project assignments. As a result, any individual firm would have a lower compliance cost burden, and thus lower likelihood of a finding of adverse impact in the analysis of model project/model firm combinations. At the same time, more firms would be estimated to incur compliance costs in performing in-scope projects. EPA acknowledges that substantial uncertainty in the overall model project and compliance cost assignment approach, but overall judges that this analysis approach provides a reasonable basis for assessing the firm- and industry-level impact of the C&D rule – in particular, given that the assignment approach maximizes the likelihood of impact on any given model firm.

➢ ***Determination and Interpretation of Firm Financial Stress and Potential Closure.*** EPA's analyses of the occurrence of financial stress and potential closures are based on movement of firms below specified thresholds of concern – below lower quartile values of the financial stress measures and below a zero business value for the potential closure measure. Because of data limitations, in particular, these analyses involve considerable simplifications both in determining the baseline and post-compliance financial performance/condition measures and in assessing the occurrence of the adverse impact conditions. A more rigorous financial analysis, based on detailed understandings of the financial status of affected firms might yield different impact findings. For example, the analysis of business value is based on a static, single time period, model of firm financial performance and condition. A more rigorous analysis would consider the change in financial performance and condition over time. For firms with a history, and expectations, of substantial growth, the simplified, static assessment would tend to understate, perhaps considerably, business value. Similarly, the use of the first quartile values of *Pre-Tax Income/Total Assets* and *Earnings before Interest and Taxes/Interest* in the financial stress analysis is also subject to considerable uncertainty. Although the first quartile values are, by definition, in the lower range of observed financial performance for the subject industries, the first quartile values are not necessarily strong differentiators between adequate and weak financial performance. EPA sought to mitigate this concern by using the average of first quartile values observed over the full data analysis period (see *Section 6.3.3*).

- ***Determination of Barriers to Entry.*** There is uncertainty with respect to the model firm's mechanism for absorbing compliance outlays. The comparison of the rule's financing requirement to the model firm's assets assumes that the compliance outlay would be financed and recorded on the model firm's balance sheet. To the extent that the compliance outlay is financed and recorded *not on the firm's baseline sheet but as part of a separate project-based financing for each individual project*, this comparison is likely to overstate, perhaps substantially, the incremental burden of financing in relation to the going concern asset base of the model firms (see *Section 6.5*).

6.7 Results of the Firm-Level Economic Analysis

The analysis outlined above is an assessment of the potential cost and economic/financial impact of alternative regulatory options on the subsectors and firms likely to face compliance requirements and incur compliance costs from a C&D industry regulation. This analysis yields estimates of the numbers of firms in the affected C&D industry subsectors that may incur adverse economic/financial effects: costs exceeding thresholds of concern relative to revenue, incurrence of financial stress from weakened financial performance and condition, and potential incurrence of negative business value, which may indicate a risk of business closure. This analysis also produces a first-order estimate (i.e., before accounting for potential market adjustment effects) of the resource cost of regulatory compliance (i.e., the cost of resources consumed by society in meeting regulatory requirements) and of the acreage affected by the regulatory options. Finally, this analysis supports an assessment of the potential for C&D regulatory options to pose a barrier to entry for new businesses seeking to enter the C&D industry

6.7.1 Firm-Level Cost and Impacts

Table 6-3, below, presents EPA's estimates of the cost and firm- and industry-level impact of the regulatory options. These results are based on the 2008-trend estimate of industry activity and are *before* possible reductions in the quantity of construction activity resulting from market adjustment to compliance cost-induced price increases. EPA performed this analysis for a primary impact analysis case and an adverse impact analysis case. The results presented below are for the *primary analysis case*. EPA presents that the primary case impact analysis as its best estimate of firm- and industry-level impacts under general, long-term business conditions for the construction industry. The results for the *adverse analysis case* are presented in *Appendix A*. Recall that the primary and adverse analysis cases are differentiated in the following ways:

- The *primary analysis case* assumes that firms in the C&D industry pass through some of the incremental compliance costs and uses the *general business conditions case* definition for model C&D firms. The general business conditions case is meant to reflect the financial performance and condition of C&D industry businesses during *normal* – neither excessively strong nor weak – economic conditions for the specific industrial segments. The financial performance and condition of the C&D industry businesses for this case is reflected in the RMA model-firm financial statements and their costs of debt and equity.

- The *adverse analysis case* assumes that firms in the C&D industry pass through *none* of the incremental compliance costs and uses the *adverse business conditions case* definition for model C&D firms. The adverse business conditions case is meant to reflect the financial performance and condition of C&D industry businesses during relatively weak economic conditions for the specific industrial segments. The financial performance and condition of the C&D industry businesses for this case is reflected in the relatively weaker RMA model-firm financial statements and by their relatively higher costs of debt and equity. In addition, the adverse analysis case assumes a contraction of the overall C&D industry relative to the primary analysis case.

Table 6-3, below, presents the results of these analyses of four regulatory options, which are described below:

- *Option 1*, which requires non-numeric effluent limitations for all sites, is EPA's least stringent policy option;
- *Option 2* requires active treatment systems (ATS) on sites disturbing 30 or more acres at one time and imposes a 13 NTU turbidity standard while requiring non-numeric effluent limitations on all sites and is similar to an option EPA proposed previously;
- *Option* 3, EPA's most stringent policy option, requires ATS on sites disturbing 10 or more acres at one time, imposes a 13 NTU turbidity standard on these sites, and requires non-numeric effluent limitations on all sites; and,
- *Option 4*, the option EPA has selected for the final rule, requires passive treatment systems on all sites disturbing 10 or more acres disturbed, and establishes a numeric turbidity standard of 280 NTU (based on passive treatment and expressed as a daily maximum value). In addition, all sites will be required to meet non-numeric effluent limitations.

The results are aggregated across the affected C&D subsectors and revenue ranges used in the analysis.

Table 6-3: Summary of Cost and Economic Impact Analysis for Final Rule Options

Impact Analysis Concept		Option 1	Option 2	Option 3	Option 4
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)					
Total Costs ($millions)		$176	$4,866	$9,090	$953
Total Acreage Incurring Cost		852,649	852,649	852,649	852,649
Number of Firms	All Firms	187,100	187,100	187,100	187,100
	Firms In-Scope	81,665	81,665	81,665	81,665
	Firms Incurring Cost	30,508	30,508	30,508	30,508
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact					
Costs Unadjusted for Effect of Cost Pass-Through					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	4,717	14,021	276
	% of All Firms	0.0%	2.5%	7.5%	0.1%
	% of Firms In-Scope	0.0%	5.8%	17.2%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	2,399	9,126	0
	% of All Firms	0.0%	1.3%	4.9%	0.0%
	% of Firms In-Scope	0.0%	2.9%	11.2%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	873	3,573	0
	% of All Firms	0.0%	0.5%	1.9%	0.0%
	% of Firms In-Scope	0.0%	1.1%	4.4%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	81	225	0
	% of All Firms	0.0%	0.0%	0.1%	0.0%
	% of Firms In-Scope	0.0%	0.1%	0.3%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance					
Firms Incurring Financial Stress	Number Incurring Effect	31	1,181	5,398	169
	% of All Firms	0.0%	0.6%	2.9%	0.1%
	% of Firms In-Scope	0.0%	1.4%	6.6%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)					
Firms with Negative Business Value (Potential Closures)	Number Incurring Effect	30	430	1,254	147
	% of All Firms	0.0%	0.2%	0.7%	0.1%
	% of Firms In-Scope	0.0%	0.5%	1.5%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.
EPA Estimates

The estimated levels of cost and resulting firm and industry impacts reported in *Table 6-3* vary substantially over the four primary regulatory options analyzed.

- For *Option 1*, the least costly of the four options, EPA estimates total annual costs of $176 million. A total of 30,508 firms are estimated to incur compliance costs under this option. Out of these 30,500 firms, none are estimated to incur costs exceeding 1 or 3 percent of revenue, while 31 firms are estimated to incur financial stress. These 31 firms represent 0.1 percent of all firms incurring cost, and essentially zero percent of all firms in the affected industry subsectors. A total of 30 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.
- For *Option 2*, EPA estimates total annual costs of $4,866 million. Out of the 30,500 firms estimated to incur costs, 4,717 are estimated to incur costs exceeding 1 percent of revenue, and 2,399 are estimated to incur costs exceeding 3 percent of revenue. The 4,717 firms incurring cost exceeding 1 percent of revenue represent about 15.5 percent of the firms that are estimated to incur costs, 5.8 percent of in-scope firms, and less than 3 percent of all firms in the affected industry subsectors. When the effect of cost pass-through is accounted for in the cost-to-revenue analysis – i.e., costs are reduced by the amount of estimated offsetting revenue increase – 873 firms are estimated to incur (*net*) costs exceeding 1 percent of revenue. A total of 1,181 firms are estimated to incur financial stress as a result of regulatory requirements. A total of 430 firms are estimated to experience negative business value as a result of

regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

- For *Option 3*, the most costly option, EPA estimates total annual costs of $9,090 million. Out of these 30,500 firms estimated to incur costs, 14,021 are estimated to incur costs exceeding 1 percent of revenue, and 9,126 are estimated to incur costs exceeding 3 percent of revenue. The 14,021 firms with cost greater than 1 percent of revenue represent 46 percent of firms estimated to incur costs, 17 percent of in-scope firms, and 7.5 percent of all firms in the affected industry subsectors. The 9,126 firms incurring cost greater than 3 percent of revenue represent 30 percent of firms estimated to incur costs and 11 percent of in-scope firms. When the effect of cost pass-through is accounted for in the cost-to-revenue analysis – i.e., costs are reduced by the amount of estimated offsetting revenue increase – 3.573 firms are estimated to incur (*net*) costs exceeding 1 percent of revenue. A total of 5,398 firms are estimated to incur financial stress as a result of regulatory requirements. These 5,398 firms represent 17.7 percent of all firms incurring cost, 6.6 percent of in-scope firms, and 2.8 percent of all firms in the affected industry subsectors. A total of 1,254 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

- For *Option 4*, EPA estimates total costs of $953 million. Out of the 30,500 firms estimated to incur costs, 276 are estimated to incur costs exceeding 1 percent of revenue, and zero are estimated to incur costs exceeding 3 percent of revenue. The 276 firms incurring cost exceeding 1 percent of revenue represent about 0.9 percent of the firms that are estimated to incur costs, 0.3 percent of in-scope firms, and about 0.1 percent of all firms in the affected industry subsectors. When the effect of cost pass-through is accounted for in the cost-to-revenue analysis – i.e., costs are reduced by the amount of estimated offsetting revenue increase – zero firms are estimated to incur (*net*) costs exceeding 1 percent of revenue. A total of 169 firms are estimated to incur financial stress as a result of regulatory requirements. These 169 firms represent 0.5 percent of all firms incurring cost, 0.2 percent of in-scope firms, and less than 0.1 percent of all firms in the affected industry subsectors. A total of 147 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

6.7.2 Barriers to Entry Analysis

Overall, the C&D industry is a dynamic industry, with a relatively high rate of entry and exit as compared to the national economy. At the outset, this observation suggests relatively low barriers to entry for the industry and may suggest that an increase in factors associated with barriers to entry would need to be substantial before a material barriers-to-entry effect would be observed. *Table 6-4* reports the total number of firm or establishment entries and exits for the construction industry and for the total U.S. economy for the nine-year period 1998 to 2006.[42] EPA compared these numbers to the total base of firms or establishments to determine the percentage of entries and exits for each year, and calculated the average of these values over the seven data years. As reported in *Table 6-4*, the percentage of entries and exits for the C&D industry is higher than the comparable values for all U.S. industries.

[42] U.S. SBA (2006) reports the U.S. total figures by the number of *firms* and reports the Construction sector figures by the number of *establishments*. Since the relevant comparison is based on the *percent* of entries/exits as compared to the total base, the difference in reporting does not inhibit the comparison. 2006 is the latest year for which data are available from SBA.

Table 6-4: Number and Percent of Firm/Establishment Entries and Exits

	Entry		Exit	
	Number	Percent	Number	Percent
Construction Sector [a,b]	89,968	14.7%	77,818	12.8%
U.S. Total [a,b]	751,617	11.8%	680,131	10.6%

Percentages are calculated as number of entries or exits divided by total firm/establishment base
a SBA reports the U.S. total by number of firms and reports the Construction sector by number of establishments.
b Average from 1998 to 2006
Source: SBA 2006

Table 6-5 summarizes the results from the barriers to entry analysis for the final regulatory options by business subsector and revenue range. As shown in *Table 6-5*, under all options except the most costly Option 3, nearly all model firms in the three lowest revenue ranges are expected to incur compliance outlays that would create no more than a minimal additional barrier to entry for firms in these revenue ranges.

Within the higher revenue ranges (generally Revenue Range 4 and up) in which firms are estimated to perform the majority of projects that will be subject to compliance requirements, the additional financing requirement varies considerably by regulatory option. For Option 4 (*Table 6-5*), the increase in financing requirement varies from approximately 0.0 percent to 4.1 percent of baseline assets over the business subsectors. In no instance for Option 4 is the estimated increase in financing requirements substantial in relation to baseline assets. This comparison assumes that the compliance outlay would be financed and recorded on the model firm's balance sheet. To the extent that the compliance outlay is financed and recorded *not on the firm's baseline sheet but as part of a separate project-based financing for each individual project*, this comparison is likely to overstate, perhaps substantially, the incremental burden of financing in relation to the going concern asset base of the model firms.

The variation by business subsector reflects differences in baseline assets in relation to revenue as reported in the Risk Management Association financial statements underlying the model firms, differences in the assumed average duration for the additional financing requirement, and differences in the proportion of compliance cost accruing to those business subsectors under different regulatory configurations.

It is important to note that EPA does not consider the estimated financing requirement and the relative burden of that requirement – additional financing requirement relative to baseline assets – to vary between existing C&D industry businesses and businesses seeking to enter the industry. As a result, EPA foresees no *differential* regulatory burden that would more adversely affect entering businesses than existing business and thus lead to a comparative barrier to entry for firms seeking to enter the industry.

Finally, the expectation of an increase in financing requirements occurs primarily among the larger revenue ranges in the analysis. Given their business size, the firms in these revenue ranges would be expected to have better access to financing – both for debt and equity capital – than firms in the lower revenue ranges. Thus, the burden of any additional financing is comparatively less than would have been the case if the regulation was expected to impose compliance requirements on smaller businesses, which, in general, have less favorable access to capital.

Relative to Option 4, the less costly Option 1 would impose a comparatively lower increase in financing requirements while the more costly Option 3 would impose a comparatively high increase in financing requirements.

Table 6-5: Compliance Outlay as a Percent of Total Assets[a]

NAICS Sector[b]	Revenue Ranges Range 1: $100 thousand - $1 million	Range 2: $1 million - $2.5 million	Range 3: $2.5 million - $5 million	Range 4: $5 million - $10 million	Range 5: $10 million - $50 million	Range 6: $50 million - $100 million	Range 7: $100 million and more
Option 1							
236115	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
236116	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.1%
236117	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
236210	0.2%	0.2%	0.3%	0.3%	0.4%	0.4%	0.5%
236220	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%
237310	0.7%	0.7%	0.7%	0.8%	0.8%	0.7%	0.8%
Option 2							
236115	0.0%	0.1%	0.5%	0.9%	1.6%	1.5%	1.1%
236116	0.2%	0.4%	2.0%	4.2%	8.7%	9.6%	6.9%
236117	0.1%	0.4%	1.5%	2.7%	5.8%	4.4%	5.9%
236210	0.2%	0.6%	2.6%	5.7%	11.8%	13.5%	17.8%
236220	0.2%	0.4%	1.8%	3.4%	6.3%	6.5%	6.2%
237310	0.8%	1.6%	7.0%	13.9%	25.4%	25.2%	32.9%
Option 3							
236115	0.1%	1.6%	3.1%	2.8%	2.9%	2.3%	1.6%
236116	0.5%	5.5%	12.8%	13.5%	16.0%	14.7%	9.8%
236117	0.3%	5.1%	9.1%	8.4%	10.4%	6.6%	8.2%
236210	0.9%	8.0%	17.4%	18.8%	22.4%	21.6%	26.4%
236220	0.5%	5.4%	11.9%	11.0%	11.9%	10.3%	9.1%
237310	2.1%	17.8%	35.6%	35.2%	36.9%	30.8%	37.3%
Option 4							
236115	0.0%	0.2%	0.3%	0.3%	0.3%	0.2%	0.2%
236116	0.2%	0.6%	1.2%	1.4%	1.7%	1.5%	1.0%
236117	0.1%	0.5%	0.9%	0.9%	1.1%	0.7%	0.8%
236210	0.3%	0.8%	1.6%	1.9%	2.3%	2.2%	2.6%
236220	0.2%	0.6%	1.1%	1.1%	1.2%	1.0%	0.9%
237310	0.7%	2.0%	3.6%	3.9%	4.1%	3.4%	4.0%

a Based on the median performance financial statement. Analysis assumes compliance-related outlays are financed from, and recorded on, the model firm's balance sheet and not financed as part of separate project financings for each individual projects. As a result, EPA estimates that this analysis may overstate substantially the financing burden in comparing the financing requirement to the firm's going concern assets instead of project assets that are financed separately from the model firm's balance sheet.

b NAICS 236115 is New Single-Family Housing Construction (except operative builders), NAICS 236116 is New Multifamily Housing Construction (except operative builders), NAICS 236117 is New housing Operative Builders, NAICS 236210 is Industrial Building Construction, NAICS 236220 is Commercial and Institutional Building Construction, NAICS 237310 is Highway, Street, and Bridge Construction

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7 Projection of Cost and Impacts Over Time

As described in *Chapter 4* of this document, EPA's primary economic analysis is based on an estimated level of industry activity for 2008 that is consistent with the industry's long-term trend. This analysis case reflects approximately the long-term steady-state condition of the industry and the level of compliance activity subject to the final regulation – *if the industry were operating at the long-term steady state as of 2008*. Because of the current economic downturn in the C&D industry and the U.S. economy generally, this level of activity exceeds the activity actually occurring in 2008 and anticipated for the near future.

This chapter analyzes the effects of the regulation over the period 2010 – 2025. EPA chose to analyze the economic effects of the regulation over this timeframe because it captures the short-term effects of the rule as it phases in, and also captures a period of full rule implementation that is sufficient for estimating the rule's long-term annual cost. The construction activity estimates underlying this analysis reflect the actual activity levels anticipated over this timeframe. EPA's analysis of future cost and impacts is presented for EPA's preferred final rule option, *Option 4*.

7.1 Projecting Aggregate C&D Industry Activity into the Future

EPA developed its projection of aggregate C&D industry activity over time by separating the entire time period, 2010 – 2025, into two time periods and analyzing them with different approaches. The first time period is 2010 – 2014 and the second is 2015 – 2025. These time periods were treated differently by EPA for two reasons. First, independent data sources provide relatively detailed information about the anticipated level of activity in the industry from 2010 – 2014, whereas the period 2015 – 2025 is much less certain. Second, the period 2010 – 2014 is different from the period 2015 – 2025 with respect to rule implementation and when projects in a state must be in compliance (as described below in *Section 7.2*).

C&D Industry Aggregate Activity: 2010 – 2014

EPA estimated the value of construction put in place, and the corresponding quantity of acreage developed, for each year from 2009 – 2014 and for the major in-scope C&D subsectors: Residential, Non-Residential, and Transportation. EPA used Global Insight's *July 2009 Housing and Construction Outlook* as the basis for these estimates (Global Insight, 2009). As shown below in *Table 7-1*, Global Insight provides the projected percentage change in the value of construction, by subsector and on a constant dollar basis, from 2008 levels for each year out to 2014.

Table 7-1: Projected Change in Value of Construction, Relative to Activity Base at 2008

Sector	2009	2010	2011	2012	2013	2014
Residential	-23.0%	-15.7%	8.5%	28.2%	36.6%	38.4%
Non-Residential	-17.9%	-29.6%	-26.9%	-16.7%	-7.0%	-1.4%
Transportation	-3.2%	1.3%	4.7%	6.5%	9.0%	10.8%

Source: Global Insight (2009)

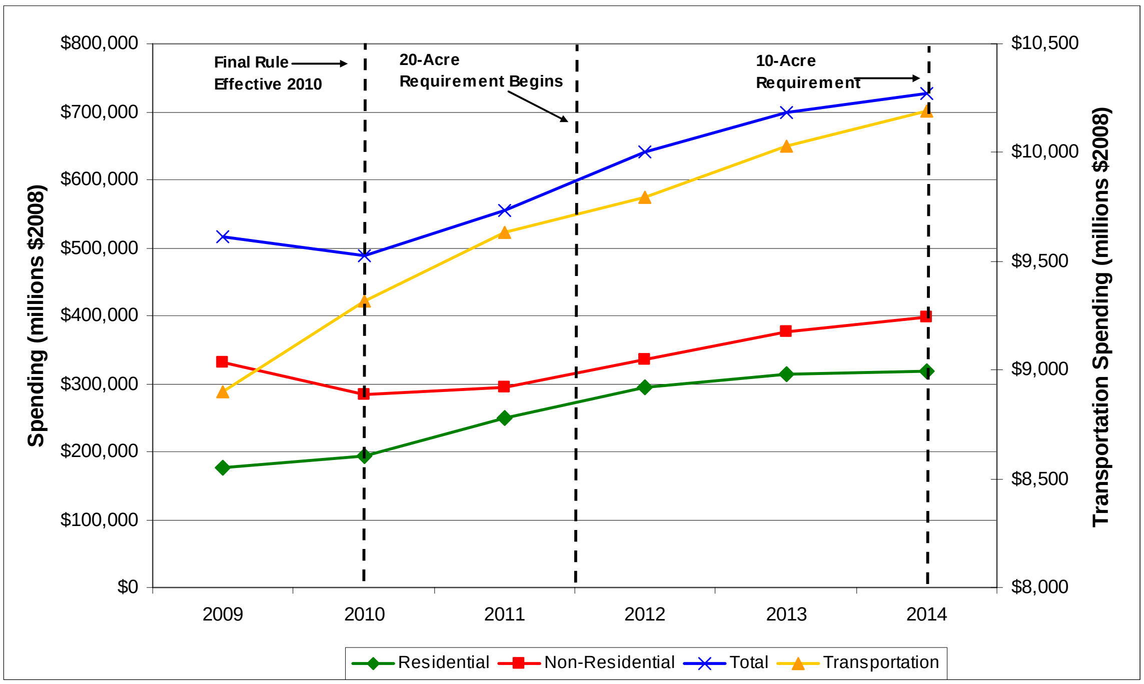
EPA used these projected percentage changes from 2008 levels of activity as the basis for estimating:

- ➢ The aggregate value of construction by in-scope C&D subsector and year;
- ➢ The aggregate quantity of acreage developed by in-scope C&D subsector and year, assuming constant acreage intensity (i.e., consistent with the approach described in *Chapter 4*, *Section 4.1.3*); and,

- The number of C&D firms and employees represented by each model C&D firm in the firm- and industry-level economic analysis, by C&D subsector, revenue range, and year. Since the percentage changes were applied uniformly to sector revenues, firms, and employees, EPA assumed that the average revenue per firm in constant dollars – by sector and revenue range – does not change over this period.

Figure 7-2 shows the resulting estimates of the level of industry activity, by subsector, from 2009 – 2014. Although aggregate C&D activity declines overall during 2009, total activity is expected to resume growth on a constant dollar basis during 2010 – the year of rule promulgation – and in each year thereafter. By both August 2011, when the rule's numeric limits would begin to apply to sites of at least 20 acres, and 2014, when the limits would be applicable to sites of at least 10 acres, the industry is projected to have resumed growth and achieved higher levels of activity than estimated at 2010, the year of rule promulgation.

Figure 7-2: Projection of Aggregate Construction Value, 2009 - 2014



Note that Total, Residential, and Non-Residential subsector activity is reported against the left vertical axis while Transportation subsector activity is reported against the right vertical axis.
Source: EPA Analysis, Global Insight (2009)

Developing the Disaggregated C&D Model Project Set: 2010 – 2014

After estimating the aggregate levels of activity for each project year, EPA developed the disaggregated model project set needed for the firm- and industry-level economic analysis framework. The approach for estimating the model project set for each projection year mirrors the approach for estimating the 2008-trend project set detailed in *Section 4.1* of *Chapter 4.* To summarize, this process includes three key steps:

1. The quantity of acreage in each year is distributed across states and C&D industry subsectors using the same approach for distributing the 2008-trend quantity, as described in *Section 4.2.1* of *Chapter 4*;
2. The quantity of acreage in each year is distributed across 144 model project categories for which compliance costs were estimated in developing the C&D final rule. The approach for this step is the same as that described previously in *Section 4.2.2* of *Chapter 4.*

3. The initial acreage distribution results for each year were then adjusted to produce the final model project set, using the approach described in *Section 4.2.3* of *Chapter 4*.

C&D Industry Aggregate Activity: 2015 – 2025

Next, EPA extended this time series of aggregate industry construction value to the year 2025. EPA extended the time series by assuming a uniform annual growth rate in aggregate construction value from 2015 to 2025 of 3.0% per year. This value is based on the industry's average annual growth rate of construction value – on a constant dollar basis – from Census' *Annual Value of Construction Put in Place* for the most recent 15-year period, 1994 – 2008 (Census 2009a).

7.2 Projecting Total Cost and Economic Impacts into the Future

Based on the profile of aggregate activity, model firms, and model projects developed in *Section 7.1*, EPA then executed the firm- and industry-level analysis framework described in *Chapter 6* to estimate total compliance costs and economic impacts for each year, 2010 – 2014. However, unlike the steady-state analysis, EPA made two major adjustments to the firm- and industry-level analyses of these years in order to capture how the effects of the final rule are expected to phase in over time.

Accounting for the Phase-In of Compliance Requirements

This year-by-year projection analysis accounts explicitly for how the technical requirements of the final option, *Option 4,* phase-in over time:

- From February 2010 through July 2011, all construction sites are required to implement BMPs. Numeric limits are not applicable during this period;
- From August 2011 through January 2014, sites of at least 20 acres will be subject to the rule's numeric limits will apply to. Sites below 20 acres will continue to implement BMPs only.
- Beginning in February 2014 (4 years after the effective date of the rule), sites of at least 10 will be subject to the rule's numeric limits. Sites below 10 acres will continue to implement BMPs only.

Accounting for the Phase-In of State Compliance

Each state is required to implement the final rule upon the first renewal of its Construction General Permit (CGP) after rule promulgation. States renew their CGPs each five years with individual states scheduled to renew in different years over the five year renewal window. Therefore, although 2010 is the rule's first effective year, 2014 is the first year in which all states are expected to have renewed their CGPs and the rule would be effective across all states. EPA accounted for the anticipated phase-in of states over this five-year period by analyzing the firm- and industry-level impacts in each year only for the states expected to have renewed their CGPs by a given year. *Table 7-2* shows which states are scheduled to have renewed their CGPs and thus construction projects be subject to compliance requirements during each of these years. This determination is based on when each state's CGP first expires after the effective date of the final rule.

Table 7-2: Anticipated State CGP Renewal

2010	2011	2012	2013	2014
Mississippi	Delaware	Colorado	Alabama	Alaska
Oregon	District of Columbia	Hawaii	Arizona	California
Tennessee	Idaho	Iowa	Arkansas	Louisiana
Washington	Kansas	Kentucky	Connecticut	North Dakota
	Massachusetts	Missouri	Florida	Virginia
	Montana	Nebraska	Georgia	
	New Hampshire	Nevada	Illinois	
	New Mexico	New Jersey	Indiana	
	South Carolina	Oklahoma	Maine	
	Vermont	South Dakota	Maryland	
	Wisconsin	Utah	Michigan	
	Wyoming	West Virginia	Minnesota	
			New York	
			North Carolina	
			Ohio	
			Pennsylvania	
			Rhode Island	
			Texas	

Source: EPA Analysis

Projecting Total Compliance Cost Beyond 2014

For the period 2015 – 2025, EPA projected total compliance costs based on the assumption that compliance costs will change in proportion to aggregate activity, as described in *Section 7.1* (i.e., assuming a uniform annual growth rate of 3.0% per year in aggregate compliance cost).

Tallying Total Compliance Cost Over the Period 2010-2025

Lastly, EPA calculated the total present value of annual compliance costs over the period 2010 – 2025, and calculated the corresponding annualized value over the 16-year period, using both 3% and 7% discounting rates. The present value and annualized costs calculations state the rule's costs as of 2010, the rule's promulgation date.

7.3 Uncertainties and Limitations

- ***Projections of Industry Activity and Structure are Uncertain.*** EPA's projection of in-scope activity and therefore compliance costs out to the year 2025 inevitably embeds an unknown, and potentially substantial, amount of uncertainty. The actual nature and quantity of construction activity, and the fraction of that activity that would be subject to compliance requirements, in any future year will be determined by overall economic and industry conditions, which can vary substantially over time. In addition, it is possible that the composition of construction activity will change in response to the regulation, itself – for example, by a shift in the mix of construction site sizes to move some sites below the in-scope acreage threshold. EPA's estimates of future in-scope acreage and cost are therefore considerably uncertain, particularly as these projections move farther into the future. Also, the structure of the industry is assumed not to change as a result of this regulation, which could influence the number of firms overall, and by size range, that would face compliance requirements and therefore alter the character of economic/financial impact occurring in the industry.
- ***Assumption of Constant Acreage Intensity over Time.*** EPA based the projected estimates of in-scope acreage on an assumption that acreage intensity (e.g., acres developed per million dollars of project value) is constant over time. Although statistical analysis of current acreage intensity data support this assumption, it is possible that this relationship will change in the future due to several factors, including changes in productivity, the mix and cost of construction inputs, the mix of construction activity, and the

decline in the availability of raw, undeveloped land (and hence the tendency to use land more parsimoniously in construction projects of a given development value over time). These factors point to the possibility that acreage intensity will decline over the long-run. As a result, because EPA's projections of in-scope acreage, and therefore compliance cost, are based, at the outset, on estimates of the dollar value of activity, these activity and cost estimates may be overstated to the extent that acreage intensity declines over time.

7.4 Results of the Cost and Impact Projection Analysis

As described above, EPA projected the cost and economic effects of the final rule through the year 2025, accounting for: (1) the expected levels of in-scope activity during the years in which the regulation will begin to be implemented, (2) the phase-in of the rule's requirements during the initial years following promulgation, and (3) the phase-in of rule applicability as states renew their Construction General Permits. This projection relies primarily on a recent forecast of total construction industry activity over the next several years developed by Global Insight. Unlike the other cost and impact analyses described in this document, this projection analysis is presented only for the final rule option, *Option 4*.

As reported in Chapter 6, *Table 6-3*, the primary estimate of total compliance cost of Option 4, is $953 million. The results – cost and impacts – presented below differ from this estimate in three important ways:

- The projection analysis accounts for the anticipated activity levels in each year from 2010 – 2014;
- The projection analysis accounts for the phase-in of the rule's requirements from 2010 – 2014; and,
- The projection analysis accounts for the phase-in of compliance from 2010 – 2014 as states renew their CGPs.

Because 2014 is the first year of full rule implementation, the cost value reported for 2014, $810 million (2008$), reflects the near-term cost of the rule under steady state-like conditions – i.e., the rule's requirements are fully effective to all covered site sizes, and the rule is anticipated to have been implemented over all states. EPA's primary estimate of $953 million (from Chapter 6) differs from this value because the primary value reflects the cost of the rule in 2008 constant dollars, at a long-term, steady-state activity level. EPA presents this cost estimate as an appropriate basis for understanding the long-term annual costs of the rule, in constant 2008 dollars, because it reflects EPA's estimate of the long-term, steady state activity level in the industry. As reported in *Table 2-3*, this long-term, steady-state activity level and compliance cost value, as estimated in Chapter 6, would not actually occur until the year 2020.

Table 2-2 and *Table 7-4* report the costs and impacts associated with the final rule over the period 2010 – 2014, as aggregate industry activity increases, the requirements of the rule become applicable, and additional states come into compliance. *Table 2-2* reports the total costs and impacts over this period on a *cumulative* basis as additional states come into compliance in each year following rule promulgation – i.e., the effects cannot be summed across years. *Table 7-4* differs from *Table 2-2* in reporting the incremental increase in total costs and impacts from year to year over this period.

Table 7-3: Cumulative Cost and Economic Impacts for the Final Rule, 2010 - 2014

Impact Analysis Concept		2010	2011	2012	2013	2014
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)						
Total Costs ($millions, 2008$)		$8	$63	$204	$538	$810
Total Acreage Incurring Cost		36,212	107,646	603,875	603,875	729,384
Number of Firms	All Firms	132,701	155,728	180,028	194,442	200,163
	Firms In-Scope	53,078	59,581	67,571	73,056	75,578
	Firms Incurring Cost	781	2,522	5,826	17,515	20,918
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact						
Costs Unadjusted for Effect of Cost Pass-Through						
Exceeding 1% of Revenue	Number Incurring Effect	0	2	48	136	224
	% of All Firms	0.0%	0.0%	0.0%	0.1%	0.1%
	% of Firms In-Scope	0.0%	0.0%	0.1%	0.2%	0.3%
Exceeding 3% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]						
Exceeding 1% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Exceeding 3% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance						
Incurring Financial Stress	Number Incurring Effect	1	7	27	79	141
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.1%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.1%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)						
Negative Business Value (Potential Closures)	Number Incurring Effect	2	6	21	61	128
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.1%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.1%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

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Table 7-4: Incremental Cost and Economic Impacts for the Final Rule, 2010 - 2014

Impact Analysis Concept		2010	2011	2012	2013	2014
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)						
Total Costs ($millions, 2008$)		$8	$55	$141	$334	$122
Total Acreage Incurring Cost		36,212	71,433	377,643	377,643	125,509
Number of Firms	All Firms	132,701	23,027	24,300	14,414	5,721
	Firms In-Scope	53,078	6,503	7,990	5,485	2,522
	Firms Incurring Cost	781	1,740	3,304	11,690	3,403
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact						
Costs Unadjusted for Effect of Cost Pass-Through						
Exceeding 1% of Revenue	Number Incurring Effect	0	2	46	88	20
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.1%	0.1%	0.0%
Exceeding 3% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]						
Exceeding 1% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Exceeding 3% of Revenue	Number Incurring Effect	0	0	0	0	0
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.0%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance						
Incurring Financial Stress	Number Incurring Effect	1	6	20	52	22
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.1%	0.0%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)						
Negative Business Value (Potential Closures)	Number Incurring Effect	2	5	15	40	41
	% of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%	0.0%	0.1%	0.1%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

EPA Estimates

For the years beyond 2014, EPA extended the time series of aggregate industry construction value, cost, and acreage to the year 2025 by assuming a uniform annual growth rate in aggregate construction value from 2015 to 2025 of 3.0% per year. This value is based on the industry's average annual growth rate of construction value – on a constant dollar basis – from Census' *Annual Value of Construction Put in Place* for the most recent 15-year period, 1994 – 2008 (Census 2009a). *Table 2-3* presents the values for 2010-2014 and for the specific years 2020 and 2025, along with an estimate of total compliance cost as a percentage of total construction value. As evidenced in the table, the total compliance costs associated with the final rule are expected to represent about one-tenth of one percent of total construction value in the C&D industry over the long-term.

Table 7-5: Total Value of Construction Activity and Cost, by Year (millions, 2008$)

	2010	2011	2012	2013	2014	2020	2025
Total Value of Construction	$487,534	$554,457	$641,041	$699,860	$726,669	$866,895	$1,004,210
Total Estimated Acreage	495,930	561,710	646,022	703,565	729,894	870,742	1,008,667
Total Compliance Cost	$7.8	$75.2	$253.3	$538.1	$809.9	$966.1	$1,119.2
as a % of total value	0.00%	0.01%	0.04%	0.08%	0.11%	0.11%	0.11%

EPA Estimates

Lastly, EPA calculated the annualized cost of the final rule from 2010 – 2025, using both a 3% and 7% discount rate. Using a 3% discount rate, the annualized cost of Option 4 is approximately $725 million. Using a 7% discount rate, the annualized cost of Option 4 is approximately $667 million.

8 Analysis of Single-Family Housing Affordability Impacts

8.1 Defining the Concept of a Housing Affordability Impact

Because the residential subsector comprises over one-third of the overall construction acreage subject to the regulation and the C&D rule may increase the cost of housing construction and, as a result, the price (or rent) of housing, the regulation has the potential to adversely affect consumers of newly constructed housing. Given this potential effect, EPA performed a regional-level analysis (i.e., level of Metropolitan Statistical Areas (MSA)) to estimate the number and fraction of potential single-family home buyers whose purchasing decisions may be affected by the potential increase in the price of newly constructed, single-family housing. The results of the analysis are reported in the last section of this chapter at the national level by aggregating the number of potentially affected households across the MSAs in each state.[43]

An MSA-level affordability analysis is more robust than a regional- or national-level analysis because it can capture the high variability in housing market prices and household incomes across and within states. For this analysis, EPA used MSA-level single-family new home prices and household income distributions to determine the number of *prospective home-purchasing* households that are at or above the income level estimated to be necessary to qualify for the financing of a newly constructed single-family home. This analysis involved the following steps:

1. Calculating *critical income values* for the *median price* new home, *lower quartile price* new home, and an hypothesized *lowest price* home in each MSA, based on standard home-loan underwriting criteria and estimates of the total monthly housing payment, including mortgage loan, property tax, and property insurance. Property tax and property insurance are estimated by MSA. The critical income value is the value at which a household could just afford the median, lower quartile, or "lowest price" home according to traditional underwriting criteria.

   EPA performed these analyses at different housing price levels to account for differences in the number of households across the household income distribution that would potentially be affected by regulation-induced housing price increases. In creating the housing price cases, EPA recognized that the affordability impact of a housing price change could be qualitatively different for homes at prices in the *interior* of the housing price distribution – e.g., the median and lower quartile priced homes – than for a theoretical so-called lowest price new home – i.e., at the bottom tail of the housing price distribution. Households seeking to buy a home in the interior of the housing price distribution have the option of looking at a lower priced home if they no longer qualify to purchase the median and lower quartile price home because of regulation-induced housing price changes (among other potential impact mitigation responses, as described in *Section 8.5* of this chapter). However, for a household seeking to purchase the "lowest price home," no *new* home is theoretically available for a price lower than the lowest price. In addition, the households that are more likely to purchase a lowest priced new home than a lower quartile or median priced new home price are likely to come from the lower end of the income distribution, other things being equal. If this portion of the income distribution is denser,[44] there is the potential for a larger number of households to be affected. For these reasons, EPA defined and analyzed this additional case (not performed for the proposed rule analysis) assessing the impact of the regulation on the hypothesized *lowest priced* home in each MSA. Because no data are available on the

[43] The state-level results and presentation of the top 15 affected MSA's for each option are presented in Appendix D.

[44] That is, more households per household income range.

"actual lowest price" home by MSA, EPA chose $100,000 and $50,000 as hypothesized "lowest prices" to illustrate the potential impact on affordability at this price level.

2. Calculating the increase in home prices *due to the compliance costs* of the regulatory options and the new critical income values for the median, lower quartile, and lowest price homes, by MSA. To provide a worst case assessment, the increase in new home price assumes that 100 percent of compliance costs will be passed through in increased home prices.[45]

   The analyses of firm- and industry-level impact presented in the preceding chapter rely on very different, essentially contradictory, assumptions of "partial" cost pass-through and "no" cost pass-through. In those analyses, only part, or none, of the increase in construction costs is assumed to be passed through to customers, and affected construction industry businesses are assumed to bear all or a substantial fraction of the compliance costs of the C&D regulatory options. For there to be material effects in the firm and industry impact analysis, costs must not be fully passed through to consumers, and some cost and economic impact burden must remain at the level of the industry's business participants. And, conversely, for there to be material effects in the affordability analysis, costs must be passed through to consumers. Accordingly, both sets of analysis assumptions, and as a result, the potential impact findings, cannot occur at the same time in a given market: that is, adverse effects on the industry's business participants will mean less potential for adverse affordability effects, and adverse affordability effects will mean less potential for adverse effects on the industry's business participants.

   EPA's review of the literature on the U.S. housing market suggests that a substantial part, *but not all*, of the regulation's compliance costs will eventually be recovered in increased prices at the new market equilibrium. Moreover, in periods of housing market weakness such as have occurred in U.S. housing markets since late 2006, an even smaller share of compliance costs may be recovered in increased prices.[46] Either way, the assumption of 100 percent compliance cost pass-through may substantially overstate the price effect, and therefore the critical income required to afford the new, post-compliance, home.

3. Calculating the numbers of *prospective home-purchasing* households, for the median, lower quartile, and lowest price homes, by MSA, whose purchasing decision is potentially affected by the increase in housing price. The number of potentially affected households is calculated from the MSA-based household income distributions by first determining the number of prospective home-purchasing households that *just* qualify to purchase the median, lower quartile, and lowest-price homes at the baseline price, and then subtracting from these values, the number of households that just qualify to purchase at the higher, post-compliance-based prices. This difference is the number of households that were qualified to the purchase the new home in the baseline, according to standard income-based home purchase and financing criteria, but that fail to meet those criteria at the assumed post-compliance price. These households would need to adjust their purchase decision, financing terms, etc., in order to continue with a transaction in the post-regulation new home market (these potential adjustments and their consequence to the household are discussed in *Section 8.5*).

   In performing these calculations, EPA accounted for several factors that determine the number of households whose housing purchase decision could be *practically* affected by a C&D regulation:

   - Only a fraction of households are actively "in the market" for purchasing a home at any given time. Although all *new* homes are expected to be in-scope of the regulation, nearly 87.5% of all *new and*

[45] For each regulatory option, the price change per single-family housing unit was applied as a direct add-on to the median, lower quartile, and lowest new home prices.

[46] Due potentially to a more price-elastic demand for housing.

existing single-family homes available in the market *would not* be expected to incur cost under the regulatory options.[47]

- Further, only a fraction of these "in the market" households would likely purchase, or even seek to purchase, a new home whose price is likely to be directly affected by the C&D regulation.
- The likelihood of a household's participation in the market for new housing could vary by household income.

Given these considerations, EPA based its analysis on the number of households and distribution of household income, by MSA, for those households that purchase a new home. For this analysis, EPA used data on the number of households and household income distribution from the 2007 American Housing Survey[48] for households that purchased a *new* home in 2006-2007, by MSA and/or state. Further, EPA scaled this distribution to reflect the fraction of new home purchases in 2006 or 2007 that would have been in-scope of the C&D regulation (specific to each regulatory option).

4. <u>Adjusting the number of affected households to account for those households that purchase and finance houses in a manner that they fall outside the affected household set.</u> The analysis outlined above identifies potentially affected households under the assumption that buyers of the median, lower quartile, and lowest new home purchase the baseline-price new home *just at* the payment-to-income ratio of 29 percent. Thus, all prospective new home-purchasing households that lie within the *affected* household income range – households that qualified to finance the new home purchase at the baseline price but that fail to qualify at the post-compliance home price – are assessed as potentially affected by the regulation-induced increase in housing prices. However, based on data from the 2007 American Housing Survey, a substantial percentage of households purchase homes such that financing and other payments yield a payment-to-income ratio *below* 29 percent. This occurs for either or both of two reasons.

   - Some households finance at terms that would permit them to increase their payments in response to the regulation-induced price increase without exceeding the 29 percent recommended financing criterion. These households often do so by making a larger than 20 percent downpayment.
   - Some households in the otherwise critical income range purchase lower-priced new homes than the price under analysis, such that they would remove themselves from the set of potentially affected households.

   Regardless of the mechanism, the effect on these households is different from that of the household impact underlying the primary analysis. Although the purchase decision of these households would be affected by a regulation-induced housing price increase, they would be able to increase their housing payment to offset the regulation-induced increase in home prices. For this reason, EPA also estimated and reports the estimated number of affected households accounting for this factor.

The overall objective of this analysis is to account for the possibility that an increase in the price of a new, in-scope single-family home may increase the income necessary to qualify for a mortgage to purchase the home and, therefore, potentially influence the purchasing decision of likely home buyers. However, a finding of a marginal affordability effect for likely home buyers does not mean that these households would be unable to afford a home. Rather, the analysis indicates that some households *may* need to adjust the *preferential dimensions* of their housing purchase, or the *timing* of the purchase, to accommodate the higher price that could result from the C&D industry regulation. For example, to purchase a new, in-scope single-family home, the housing purchaser might

[47] Based on 2007 home sales data, EPA estimates the approximately 715,000 new, single-family home sales may incur cost under the regulatory options out of a total of approximately 5.7 million single-family home sales.

[48] The most recent year for which American Housing Survey data are available.

avoid the increase in the monthly mortgage payment by changing some housing attribute to offset the increase in price from regulation compliance, or by increasing their initial down payment. Alternatively, the prospective new home purchaser might decide to purchase a home whose price is not affected by regulation's compliance requirements. These interpretive considerations are discussed in more detail following the results presented in *Section 8.5* of this chapter.

8.2 Estimating Critical Income Values for Single-Family New Home Purchases

The critical income value is the income at which a household can *just* afford the median, lower quartile, or lowest-price home. The first step in estimating this baseline income value is to establish the price for the median and lower quartile new single-family home, by MSA. As described above, EPA assumed lowest new home prices of $50,000 and $100,000 to test the affordability effect at the level of a "lowest price" home.

Median and lower quartile home prices from the Census Bureau's *2007 American Community Survey* (ACS) and specified lowest price homes serve as the baseline home prices (2007 was chosen because it is the most recent year for which the required MSA-level data are available from the Census). The ACS provides the median *new* home price (homes built in 2005 or later) as well as the median and lower quartile home price for *all existing* homes. Since the lower quartile *new* home price is not available, EPA estimated the lower quartile price of a *new* home by adjusting the median *new* home prices. This adjustment was based on the proportional relationship between the median and lower quartile prices *for existing homes* – i.e., EPA assumed that the relationship between median and lower quartile *new* home prices would be the same as that observed for prices of *existing* homes at the median and lower quartile levels. Since the 2007 ACS is a household survey, self-reporting bias may be present in the home price data. For example, a National Association of Home Builders (NAHB) study estimated that owners may overestimate the values of their homes in government surveys by *as much as eight percent* (Kiel and Zabel, 1999).[49] However, EPA judges that the degree of over- or under-statement for the home prices relied upon for this analysis is likely to be small given that these estimates are for *new* homes purchased very recently – i.e., between 2005 and 2007. Since homeowners were reporting the value of a home they purchased within the past two years, it is not likely that homeowners would substantially err in estimating the value of their home. Other sources of new, single-family home price data are available from the Census; however, EPA identified the ACS data as the highest quality source given the relatively large sample size – approximately three million housing units – and the additional benefit of being available for nearly 510 MSAs across the country.[50] As noted above, obtaining MSA-level home price data significantly improves the analysis because it allows EPA to account for the high variability in housing prices across and within states.[51]

Table 8-1 reports the distribution – 5th percentile, 95th percentile – of newly constructed, single-family home prices *among MSA's* from the set of median and lower quartile prices used in the analysis.[52] This table further

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[49] It should be noted that the study by Kiel and Zabel (1999) examined data from the Census-HUD American Housing Survey for years 1978 – 1991. It is not clear whether and to what extent the observations of Kiel and Zabel (1999) are also present in the American Community Survey.

[50] For example, the Census' monthly Survey of Construction is an alternate source; however, this data are available only at the national level and by Census region. In addition, these data are based on a small sample, relative to ACS, of approximately 5,000 respondents representing 28,000 buildings.

[51] For example, among the 510 MSAs included in the analysis, median new home prices in individual MSAs range from about $52,000 to just over $1,000,000.

[52] These price distributions are not presented for the lowest home price analyses since these are pre-selected values of $100,000 and $50,000 and a distribution is not applicable. Because no data are available on the "actual lowest price" home by MSA, EPA chose $100,000 and $50,000 as hypothesized "lowest prices" to illustrate the potential impact on affordability at this price level. EPA believes these two prices account for the potential lowest home prices across most MSAs.

illustrates the high variability in housing market prices – and therefore, critical income values – across and within states, and highlights the desirability of performing this analysis at the MSA-level (as opposed to a state or national-level analysis, which would ignore this variability).

Table 8-1: Baseline New Single-Family Home Prices (2007$)

	5th Percentile MSA	95th Percentile MSA
Median Baseline New Home Price	$117,400	$498,000
Lower Quartile Baseline New Home Price	$70,726	$371,776

Source: U.S. Census Bureau. 2007 American Community Survey.

The second step in estimating the baseline critical income values is to establish the monthly housing payment for the median, lower quartile, and lowest-price new single-family home in each MSA. The baseline monthly housing payments are based on standard home loan underwriting criteria and include the mortgage loan, property tax, and property insurance, as follows:

- Estimate the monthly loan payment for purchase of new housing assuming that buyers finance approximately 79% of the new home purchase price using a 30-year conventional fixed rate mortgage with an interest rate of 7.32%. The 79% loan to value ratio is derived from the Federal Housing Finance Board's *Terms on Conventional Single Family Mortgages, Fixed-Rate 30-Year and 15-Year Non-jumbo Loans* average percentage (since 1990) of the financing amount to the total home purchase (FHFB, 2007). The 7.32% interest rate is derived from Freddie Mac's *Primary Mortgage Market Survey: Conventional, Conforming 30-Year Fixed-Rate Mortgage Series Since 1971* average interest rate since 1990 (Freddie Mac, 2009). As of the time of this analysis, home mortgage loan interest rates for loans meeting these criteria are somewhat lower (e.g., around 5.0%) than the longer term average reported above. EPA judges that use of the longer term average provides a better indication of the potential affordability effects of the C&D rule over the period of rule implementation and market adjustment.
- Estimate monthly property taxes by determining the percent of the monthly property tax payment to the median, lower quartile, and lowest-priced new home value for each MSA. The 2007 ACS provides the median annual property tax payment for each MSA. The monthly value was compared to the median home value for each MSA to derive monthly property taxes as a percentage of the median home value. This same percentage was used to develop the monthly property tax payment for the lower quartile and lowest priced home analysis.
- Estimate the monthly insurance payment by determining the percent of the monthly insurance premium to the median, lower quartile, and lowest new home value for each state. The Insurance Information Institute (III, 2007) provides the average annual insurance premium for each state. The monthly premium was compared to the median home value for each state to derive the percent of the monthly insurance premium compared to the median home value. This same percentage was used to develop the monthly insurance premium for the lower quartile and lowest priced home analysis.

Private Mortgage Insurance is not included in the monthly payment calculation since this analysis assumes a loan to value ratio of 79%, which means that the loan would not require mortgage insurance.

Using the above parameters, the monthly mortgage payment is calculated as follows:

$$PI = \frac{F * P * [r/12 * (1 + r/12)^{360}]}{(1 + r/12)^{360} - 1} \quad (1)$$

$$T = t * P \quad (2)$$

$$I = s * P \tag{3}$$

$$PITI = PI + T + I \tag{4}$$

Where:

PI	=	Monthly Principal and Interest
P	=	New Home Purchase Price
F	=	Proportion of New Home Cost that is financed
r	=	Annual Mortgage Interest Rate
T	=	Monthly Tax Payment
t	=	Monthly Tax Rate as a Percentage of the New Home Purchase Price
I	=	Monthly Insurance Premium
s	=	Monthly Insurance Rate as a Percentage of the New Home Purchase Price
PITI	=	Principal, Interest, Taxes, and Insurance

Based on the FHA's underwriting guidance that a homeowner's total housing purchase payment should not exceed 29% of income (FHA, 2009), the calculation of total housing payment, as outlined above, supports the calculation of the annual income necessary to purchase a home at the median, lower quartile, and assumed lowest prices for each MSA. *Table 8-2*, summarizes the key input parameters used in this part of the analysis.

Table 8-2: Terms for 30-Year Conventional Fixed-Rate Mortgage

Duration of mortgage (years)	30
Payments per year	12
Percent of home value financed	78.9%
Annual interest rate	7.32%
Private Mortgage Insurance	N/A
Share of gross income available for housing	29%

8.3 Estimating the Change in New Single-Family Home Prices due to the Regulation

The estimate of potential affordability effects – i.e., the change from baseline conditions due to the regulation – begins by calculating the increase in home prices *due to the compliance costs* of the proposed regulatory options and the new critical income values for the median, lower quartile, and lowest price homes, by MSA. For each regulatory option, the estimated price effect for each housing unit due to the rule's compliance costs was added on to the median, lower quartile, and lowest new home prices.

The price change per single-family unit is calculated by first assigning state-specific compliance cost per acre values to each MSA. An MSA overlaps more than one state in approximately fifty instances. In these cases, EPA allocated the households within the MSA to the separate states using county-level housing data from the U.S. Census. The Census provides the county names within each MSA and the number of households within each county (U.S. Census, 2007b). For each MSA, the total number of ACS reported households was apportioned to each state within the MSA based on the proportion of each state's percent of total households for the counties applicable to each MSA.

The number of households *within MSAs for each state* was summed and compared to the total reported number of households *for each state*. In some instances – i.e., for those states in which all households fall within an MSA – the number of households within the MSAs for each state *equaled* the total number of households for each state. However, in most instances, the number of households within the MSAs for each state was *less than* the total number of households for each state. Ultimately, EPA compared the total number of U.S. households found *within MSAs* to the *total reported number of households by state*, and found that 77 percent of *all* households fall within MSAs. Therefore, in order to present results for the U.S. as a whole, EPA scaled the MSA-level results based on the state household totals to determine the national results.

Once all MSA households are appropriately assigned to states, EPA then assigned each MSA the state's compliance cost per acre for each regulatory option. EPA calculated compliance cost, by state, as the acreage-weighted values of compliance cost for the homebuilding subsectors from the state-specific model project and compliance cost matrix described in *Chapter **4***.

EPA converted the cost per acre by state into a price effect per single-family home. The conversion is performed by dividing the cost per acre by the national *median* number of single-family units per acre – to estimate cost per unit – and then multiplying that cost per unit by the single-family project cost multiplier derived from the project-level analysis. Multiplying the cost by the previously estimated cost multiplier accounts for the possibility that cost increases at a single-family residential housing project can translate into an increase in the asking price of a new home by more than the direct compliance cost increase (see Appendix G). From the Census Bureau's *Characteristics of New Housing (2009)*, the 2008 median number of units per acre (for both attached and detached single-family units) is 4.92. For the lower quartile analysis, EPA performed the analysis using 4.92 units per acre, but also performed an alternative analysis in which the cost per unit is based on the median number of units per acre for *attached* single-family homes only, which is approximately 14.7 units per acre. EPA performed this alternative analysis to account for the fact that lower price homes are more likely to be attached single-family homes and more likely to sit on lots smaller than the median lot over all single-family homes. In addition, Census data indicate that lot size generally declines as sales price declines and therefore the denser configuration of *attached* single-family homes may better represent a typical lot size for the lower price homes (as opposed to the median lot size of both attached and detached homes). For the lowest home price analysis, EPA used the median number of units per acre for *attached* single-family homes only. The results of this alternative analysis are discussed in the later sections of this chapter.

In using the lot size data from the Census Bureau's *Characteristics of New Housing,* EPA recognized that these data sources do not account for road development associated with a building's construction. As a result, the reported lot size values from these datasets would understate actual area subject to the regulation for any given housing unit. To address this omission, EPA applied a 13% multiplier to scale-up the lot size values to account for the typical road development "overhead" associated with new construction activity. EPA derived this multiplier from information in the Center for Watershed Protection's *Impervious Cover and Land Use in the Chesapeake Bay Watershed* (Capiella and Brown, 2001).

8.4 Estimating the Number of Potentially Affected Single-Family Home Buyers

After the median, lower quartile, and lowest housing prices are adjusted to reflect the incremental compliance cost of the regulatory options, EPA then calculated the numbers of *prospective home-purchasing* households, for the median, lower quartile, and lowest price homes, by MSA, whose purchasing decision is potentially affected by the increase in housing price.

To estimate the number of potentially affected households – i.e., those whose income is now below the new, post-compliance critical income value for the median, lower quartile, or lowest-priced home – EPA used household income distribution data from the American Community Survey's *2007 Statistics of Household Income.* The ACS reports the number of households falling in ten income ranges: $0-$10,000, $10,000-$14,999, $15,000-$24,999, $25,000-$34,999, $35,000-$49,999, $50,000-$74,999, $75,000-$99,999, $100,000-$149,999, $150,000-$199,999, and $200,000 or more.

Households in the income ranges *below* the range that contains the estimated critical income value for the median, lower quartile or lowest-priced new home before the addition of compliance costs are already considered to be unable to afford the home in that MSA and therefore cannot experience an affordability effect for that particular home. The number of households present in the distribution *below* the range containing the critical income value is estimated as follows:

$$N\ Households_{inc} = N\ Households_{ir^*,\,inc} + \sum_{ir=1}^{ir^*-1} N\ Households_{ir} \tag{5}$$

Where:

N Households $_{inc}$	=	Number of households over all income ranges with income below critical income value (*inc*)
Inc	=	Critical Income Value, i.e., the income at which a household can *just* afford the median, lower quartile, or lowest-price home
N Households $_{ir^*,\ inc}$	=	Number of households in Income Range *ir** with income below critical income value (*inc*), where Income Range *ir** contains the critical income value *inc*
N Households $_{ir}$	=	Number of households in Income Ranges *ir* below Income Range *ir**

The Census does not provide information on how household income is distributed *within* the Census-reported income ranges. In all likelihood, the critical income value necessary to qualify for mortgage will fall *within*, and not at the edge of, a Census income range. Accordingly, it is necessary to estimate the fraction of households *within* a Census income range that fall below the critical income value. For this analysis, EPA assumed that households are uniformly distributed *over the income values* within an income range. As a result, the fractional point at which the critical income value lies within an income range is also the fraction of households within that income range that fall below the critical income value.

The *uniform-distribution-of-households-within-range* assumption inevitably involves error and could overstate or understate the fraction of households within an income range that fall below a critical income value, depending on the change in slope of the density distribution over the income range. Nevertheless, EPA considers the assumption of a uniform distribution with an income range to be a reasonable approach. The numbers of households that fall *within* the range containing the critical income value are estimated as shown within Equation (6).

$$N\ Households_{ir^*,\,inc} = {(Inc_{critical income} - Inc_{ir^*,\,mn})}\Big/{(Inc_{ir^*,\,mx} - Inc_{ir^*,\,mn})} \times N\ Households_{ir^*} \tag{6}$$

Where:

N Households $_{ir^*,\ inc}$	=	Number of households in Income Range *ir* *with income below the critical income value (*inc*), where Income Range *ir** contains the critical income value *inc*
Inc $_{critical\ income}$	=	Critical income value
Inc $_{ir^*,\ mn}$	=	Minimum value of Income Range *ir**
Inc $_{ir^*,\ mx}$	=	Maximum value of Income Range *ir**
N Households $_{ir^*}$	=	Total number of households in Income Range *ir**

The above steps produce an estimate of (1) the change in household income needed to qualify for financing to purchase the now-higher-priced housing unit and (2) the corresponding reduction in the number of households with income sufficient to be able to *just* purchase either the median, lower quartile, or lowest priced housing unit in each MSA.

In performing these calculations, EPA recognized that, at any given time, the number of households that are actually "in the market" for purchasing a home is significantly less than the number of households in an MSA. EPA further recognized that the number of these households whose purchasing decision might be *practically* affected – i.e., seek to purchase a new single-family house whose price is affected by a given regulatory option – is smaller again than the number of households seeking to purchase a home. Accordingly, EPA based its analysis of potential affordability effects on the distribution of households, by MSA, who purchased a *new*, in-scope home in 2006 or 2007 (specific to each regulatory option).

To develop the household income distributions, EPA gathered the Department of Housing and Urban Development's 2007 American Housing Survey (AHS) *national* household income distribution for households that purchased a *new* home in 2006-2007. EPA combined this distribution with *MSA-level* household income distribution for *all* households, gathered from the 2007 American Community Survey (ACS). The resulting distributions describe the fractions and numbers of households – *by income range within each MSA* – for households that purchased a *new* home in 2006-2007. In developing this combined distribution, EPA assumed that the percentages of new housing purchasers, by household income, observed at the national level would also apply at the MSA level. EPA further modified the resulting MSA-level distributions to reflect the fraction and number of households, by income range, purchasing a new, *in-scope* home in 2006 or 2007 (specific to each regulatory option). This *in-scope adjustment* is based on all new housing, regardless of price and income level of the purchaser, and thus assumes that the profile of in-scope housing to total newly constructed housing is the same, over all prices of new construction activity and income ranges of the purchasing household.[53]

EPA expects that the households that could experience an affordability effect from the regulation are those that are *in the market* for a newly built, single-family home incurring compliance costs under the regulation. Therefore, EPA used the household income distribution for households that purchased a *new*, in-scope home in 2006 or 2007 (specific to each regulatory option) to determine the fraction of total households whose purchasing decision could be affected by a regulatory option. Furthermore, because the MSA-level results are only represent of approximately 77 percent of the total U.S. households, EPA scaled the MSA-level results based on the state household totals to in order to determine the national results.

Additionally, as described in the introduction to this chapter, EPA recognized that some of these households otherwise identified as being in the affected household set, purchase and finance homes at terms that would cause a different, and less consequential, affordability affect than the concept underlying the preceding analysis. Specifically, based on data from the 2007 American Housing Survey, a substantial percentage of households purchase homes with financing and other payments yielding a payment-to-income level *below* 29 percent. This observation would occur for either or both of two reasons.

- Some households finance at terms that would permit them to increase their payments in response to the regulation-induced price increase without exceeding the 29 percent recommended financing criterion. These households often do so by making a larger than 20 percent downpayment.
- Some households in the otherwise critical income range purchase lower-priced new homes than the price under analysis, such that they would remove themselves from the set of potentially affected households.

Either way, these households would experience a qualitatively different affordability effect than assessed above, and it is appropriate to remove these households from the set of affected households identified in the preceding analysis. Regardless of the price of the new home purchased, they would be able to absorb the additional payment resulting from the regulation while still remaining at or below the financing threshold.

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53 To determine the number of new single family home sales that are expected to incur compliance costs, EPA estimated the percentage, for each regulatory option, of in-scope residential construction acreage to total residential construction acreage from the firm-level analysis (i.e., for businesses in NAICS sectors 236115, 236116, and 236117).

To assess the potential consequence of this consideration, EPA derived from the 2007 AHS household income distribution data a *joint* distribution – by household income range and the percent of household income spent on housing – for households that purchased a *new* home in 2006-2007. EPA used this joint distribution to provide insight on the fraction of households, by household income range, purchasing housing according to terms that would permit them to increase their purchasing payments *and still remain below the FHA recommended total-payment-to-income ratio of 29 percent*. EPA recognizes that these households still experience an affordability effect as a result of potentially higher housing prices, but they do not experience an affordability effect in which they can no longer afford a new home, and would be able to purchase the "same" new home as otherwise purchased in the baseline with no purchase delay or other modifications to purchase preference by increasing their monthly payment – and still remain within the 29 percent underwriting guidance.

To determine the percentage of households that may offset the affordability impact by increasing their monthly housing payment while still remaining below the FHA recommended total-payment-to-income ratio of 29 percent, EPA performed the following calculation for each MSA:

1. Calculate the gross income required to qualify for purchase of housing at the *post-compliance* price, at a total payment-to-income ratio of 29 percent.
2. Calculate the *baseline* percentage of income spent on housing, assuming that the *post-compliance* percentage of income spent on housing is 29 percent. Because the baseline payment is less than the post-compliance payment, this percentage will be less than 29 percent. This is the percentage of income spent on housing that the purchaser would need to be at or below, *in the baseline*, to be able to increase the housing payment in response to the regulation-induced increase, without exceeding the 29 percent underwriting guidance at the post-compliance price.
3. Determine the household income range containing the post-compliance critical income, i.e., the income level necessary to qualify for financing the post-compliance newly constructed single-family home, at the 29 percent payment-to-income threshold.
4. For the household income range containing the *post-compliance* critical income value, determine the percentage of households that spend less than the percentage of income spent on housing at the *baseline* housing price, assuming that the *post-compliance* percentage of income spent on housing is 29 percent, from the 2007 AHS *joint* distribution of percentage of household income spent on recently purchased, new housing,[54] by household income range.
5. Multiply the previously determined number of households whose purchasing decision could be practically affected by a regulatory option, by the percentage of households that spend *above* the baseline percent of income spent on housing, for the critical household income range.

$$Gross\_Income\_Qualifying_{pc} = {Annual\_PITI\ pc}\Big/{0.29} \tag{7}$$

$$Percent\_Spent_{bl} = {Annual\_PITI_{bl}}\Big/{Gross\_Income\_Qualifying_{pc}} \tag{8}$$

$$Adjusted\_Num\_HHs\_Affected = (Initial\_Num\_HHs\_Affected) * (1 - Pct\_HH - Under\_Baseline) \tag{9}$$

Where:

[54] Based on owner-occupied households that purchased a new home in 2006 or 2007.

$Gross\_Income\_Qualifying_{pc}$	=	Gross Income necessary to qualify for the mortgage of a new, single family home at the post-compliance price (*pc*), assuming that 29 percent of income is spent on housing.
$Annual\_PITI_{pc}$	=	Monthly Principal, Interest, Taxes, and Insurance at the *post-compliance* housing price, multiplied by 12 to determine annual PITI.
$Percent\_Spent_{bl}$	=	Percentage of income spent on housing at the *baseline* housing price, assuming that the percentage of income spent on housing at the *post-compliance* price is 29 percent.
$Annual\_PITI_{bl}$	=	Monthly Principal, Interest, Taxes, and Insurance at the *baseline* housing price, multiplied by 12 to determine annual PITI.
Pct_HH_Under Baseline	=	Percent of households that spend under $Percent\_Spent_{bl}$ within the household income range containing the post-compliance critical income, i.e. the income level necessary to qualify for the financing of the post-compliance newly constructed single-family home.
Initial_Num_HHs_Affected	=	Number of total households whose purchasing decision could be affected by a regulatory option, before the 29 percent financing adjustment
Adjusted_Num_HHs_Affected	=	Number of total households whose purchasing decision could be affected by a regulatory option, adjusted to account for households whose observed purchase terms indicate the ability to increase housing payments and remain under 29% housing payment-to-income ratio.

This calculation determines the fraction and number of total households whose purchasing decision could be affected by a regulatory option, adjusted to account for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio. These households are able to absorb the additional payment resulting from the regulation while still remaining at or below the financing threshold. Therefore, although their housing purchase decision and purchase terms are affected by the potentially higher housing price, these households do not experience the same affordability effect as do those households that are no longer at or above the qualifying income level.

The results section of this chapter (*Section 8.7*) presents the findings from the affordability analysis both without and with accounting for this effect.

8.5 Assessing the Practical Impact on the New Home Purchaser: Opportunities for Offsetting Potential Price Effects

The single-family housing affordability analysis likely overstates the practical impact on home buyers prospectively purchasing an in-scope home because purchasers have a number of avenues through which any price increase due to the regulation might be mitigated:

- ***Price negotiation.*** The home buyer may be able to offset the price increase through negotiation of the sales price. Any price reduction would be borne by the seller.
- ***Attribute substitution.*** The home buyer may be able to mitigate the effect of the price increase through substitution (e.g., purchasing a new home with marginally different attributes, or effectively the same new home in a marginally different location). New home buyers are often able to select from a range of options for their new home, thereby adjusting the final price of the home. By forgoing the more expensive option for a secondary attribute, such as countertops or carpeting, the buyer could mitigate the price increase without sacrificing a primary attribute such as square footage, lot size, or location. These households can always choose to make forgone upgrades later. In effect, they are trading off a short run welfare reduction for a later welfare increase.

- ***Purchase deferment.*** The home buyer may be able to mitigate the effect of the regulation by increasing the down payment so that the there is no change in what would have otherwise been the monthly payment. If the home buyer lacks the financial resources to increase the down payment *at the preferred time of purchase*, the increase in the down payment might be achieved by delaying the purchase and saving from current income to reach the needed down payment value. The analysis results presented in *Section 8.7: Results of the Single-Family Housing Affordability Analysis*, assess the implications of delaying a purchase to increase the down payment to offset the otherwise resulting increase in monthly payment requirements. These households are trading off a short run welfare reduction during the deferment period against other welfare reductions such as attribute substitution.
- ***Purchase an out-of-scope home.*** Each of the preceding adjustments involves changes to purchase the desired new, in-scope home. However, the prospective home buyer may be able to mitigate the effect of the price increase, entirely, by purchasing a new or existing home whose price does not directly increase as a result of the regulation.[55]

EPA cannot determine with certainty whether and to what extent these mechanisms will be employed by likely single-family home buyers. But, to the extent that otherwise affected home buyers *do* mitigate the regulation's impact via these mechanisms, the previous methodology will overstate the magnitude of single-family housing affordability effects.

8.6 Uncertainties and Limitations

Certain qualifications and uncertainties in this analysis are critical for properly understanding the practical implications of whether and to what extent households will be affected by the regulation:

- ***Housing Affordability is Currently at a Record High.*** Housing affordability has been increasing rapidly since the housing boom of 2005-2006, when housing was relatively less affordable compared to longer term measures of housing affordability: the average Housing Affordability Index for 2006 was 107.6, 17.3 points below the average of 124.9 (average since 1973) (NAR, 2009d).[56] After rising steadily since 2006, housing affordability decreased during the summer and early fall of 2009 – largely due to increased housing prices – suggesting that the housing market may be in recovery. As the housing market recovers, one would expect gradually rising home prices, which will gradually lower housing affordability unless there is also an increase in household incomes. Regardless, even though affordability has decreased slightly in recent months due to the market recovery, affordability is still at historically high levels. Compared to the peak housing affordability of 178.8 in April, the July index is approximately 20 points lower, but is still 34 points above the long-term average of 124.9. *Figure 8-1*, below, shows the historical trend of housing affordability since 1990.

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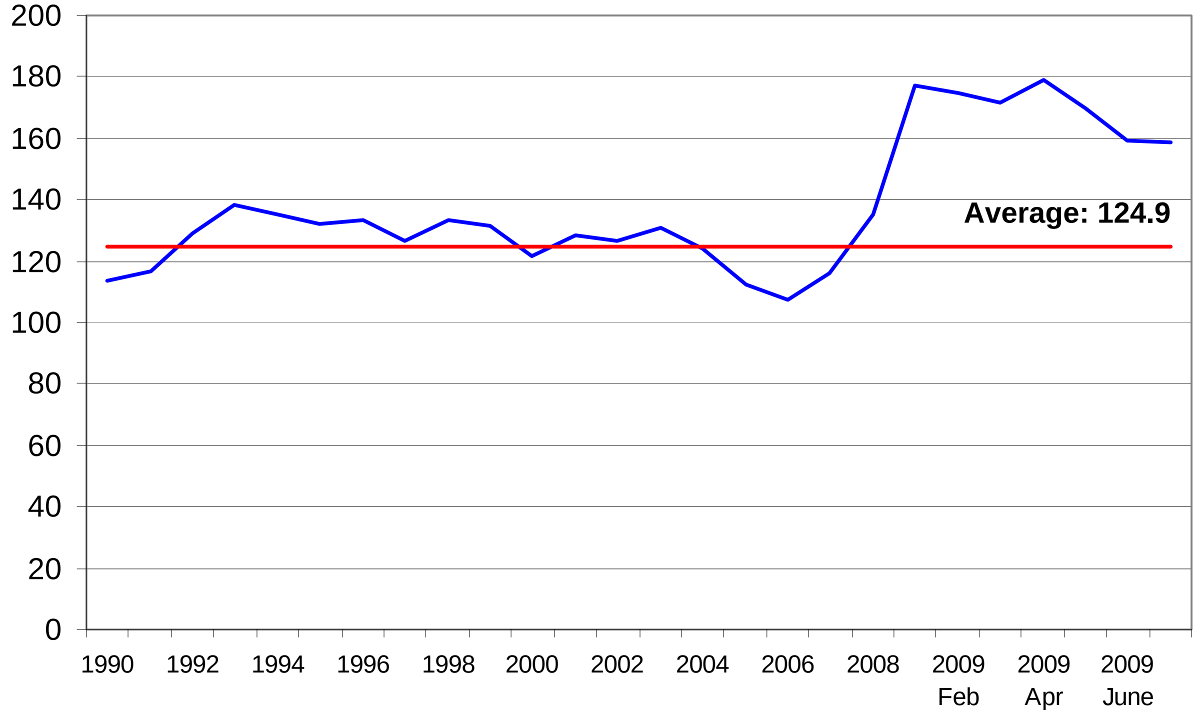
[55] Such substitutes are expected to be readily available given that nearly 87.5% of single-family homes available in the market *would not* be expected to incur cost under the regulatory options. (Based on 2007 home sales data, EPA estimates the approximately 715,000 new, single-family home sales may incur cost under the regulatory options out of a total of approximately 5.7 million single-family home sales.)

[56] "The Housing Affordability Index is a relative index where a value of 100 means that a family with the median income has exactly enough income to qualify for a mortgage on median priced existing single-family home, taking into account the relationship between median home price, average effective interest rate for loans closed on existing homes, and median family homes. The higher the index, the better housing affordability is for buyers" (NAR, May 2009a).

Figure 8-1: NAR Housing Affordability Index: Annually From 1990 – 2008; Monthly From January to July 2009



Source: NAR, 2009d

- ***Cost Pass-Through Potential Varies with Prevailing Market Conditions.*** To provide a worst case assessment, the increase in new home price assumes 100 percent pass-through of compliance costs, as a market condition. This extent of housing price effect is not likely to persist over the long-term due to several factors, including (1) the availability of substitutes for any given home, and (2) the determination that the C&D rule is expected to affect only the equivalent of about 12.5% of the total number of single-family home sales. And, in periods of housing market weakness, such as have occurred in U.S. housing markets over the past few years, the assumption of 100 percent compliance cost pass-through may overstate substantially the price effect, and therefore critical income value effect, from the regulatory options.

- ***Compliance Cost and Any Related Potential Price Increase are Likely to Decline with the Baseline Sales Price of the Affected Property.*** An important factor to be accounted for in the analyses for the lower quartile and lowest price homes is that the compliance cost burden and potential home price increase will typically be less for these homes than for the median price home. As a result, simply carrying forward the same price effect as used for the median price analysis will overstate the typical impact. This occurs because, as indicated by Census data, lot size typically declines with price for new single-family homes, thereby reducing the compliance cost burden, which is directly associated with lot size, and the resulting price impact per home. EPA presents an alternative price impact case in which a smaller lot size – and therefore smaller housing price impact given a fixed value of compliance cost per acre – for the lower quartile and lowest price home analyses.

- ***Assumption of a Uniform Distribution of Households within Income Ranges.*** For this analysis, EPA assumes that households are uniformly distributed *over the income values* within an income range. The *uniform-distribution-of-households-within-range* assumption inevitably involves error and could overstate or understate the fraction of households within an income range that fall below a critical income value, depending on the change in slope of the density distribution over the income range.

- ***Price and Character of In-Scope Homes is Unknown.*** EPA has no basis for determining which homes along the home price distribution for any given state will actually incur costs, and therefore a potential price effect, under the regulation. The regulatory options specify the number and character of *in-scope projects***,** but the kind and price of homes that are most likely to be built *within* in-scope projects is unknown. Therefore, EPA *may* be overstating affordability effects for some or all of the home price affordability analyses.
- ***EPA's analysis of affordability impacts focuses on the potential effect on homes whose prices would be directly affected by the C&D regulation, namely new, in-scope homes; however, the impact on home prices could extend beyond those homes that are directly affected by the regulation.*** The analysis presented in this chapter considers the price impact on only new, in-scope homes. However, regulation-induced price increases in the new, in-scope home segment of the housing market could spill over into other housing market segments – new, *not in-scope* homes and existing homes – that are substitutes for new, in-scope homes in the home purchase market. EPA judges that its focus on the new, in-scope home price effect is appropriate for this analysis because of the typically small share of total homes on the market, and home sales represented by new homes in any year. As described above, the C&D regulation is expected, in general, to apply directly to only about 12.5 percent of home sales. Given the relatively small share of total home sales expected to be affected directly by the C&D rule, EPA expects that there will be little spill-over price effect from the in-scope segment to the broader market. In fact, EPA judges that the large share of total sales represented by the *not* in-scope segments of the market will tend to dampen the potential price increase and affordability effect of the C&D rule.

8.7 Results of the Single-Family Housing Affordability Analysis

This analysis estimates, by Metropolitan Statistical Area, the potential change in price for newly constructed single-family homes, and the associated number of prospective home buyers whose purchasing decisions may be affected by the potential increase in new home prices due to compliance requirements.

The results of the analysis are *produced* at the MSA-level and *reported* at the national-level by aggregating the total number of impacted households across all MSAs. Detailed state-level results are presented in the Appendices chapter. As described above, EPA performed this analysis at three home price levels: the median price, lower quartile price, and specified lowest prices for new single-family homes, by MSA. For this analysis, EPA assumed that compliance costs would be *fully passed through* to consumers in increased housing prices. This assumption is effectively contradictory to the assumptions of *partial* and *no cost pass-through* that underlie the analysis of firm and industry-level regulatory impacts.

8.7.1 Results of the Median Price Single-Family Home Analysis

Table 8-3 shows, by regulatory option, the estimated dollar value and percentage change in the price for a new single-family home and the number of households in the market for a new, median price single family home whose purchasing decision may be affected by the price change. The price increase assumes: (1) a compliance cost based on the median lot size, 0.20 acres, for *all* new single-family housing as reported in the Census of Housing and (2) that compliance costs are fully passed through as an increased price to the new home purchaser.[57]

[57] The 0.20 acre lot size is the median value for new single-family housing as reported in the Census' *2008 Characteristics of New Housing*, adjusted for additional land development associated with roadways, which is not accounted for in the Census' lot size data.

This table also shows (1) the number of affected households as a percentage of the total number of home-purchasing households that also qualify to purchase the median price home, before compliance cost effect, and (2) the fraction and number of total households whose purchasing decision could be practically affected by a regulatory option, adjusted to account for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio. The key conclusion from this analysis is that, for all regulatory options, the total number of households incurring an affordability effect is small in comparison to the number of all likely single-family home buyers in any given year who can also afford the same home. For Option 4, this percentage is less than 0.2 percent.

Table 8-3: National Results from the MSA-Level Affordability Median New Home Price Analysis - Price and Household Affordability Effects (2008$) - based on Owner-Occupied Households that Recently Purchased a New, Option In-Scope, Home[d]

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Weighted Average Baseline Median New Home Price[a]		$355,893	$355,893	$355,893	$355,893
National Average Price Change per New Single-Family Home[b]	Price Change[b]	$59	$2,231	$4,093	$415
	Percent Change[c]	0.02%	0.63%	1.15%	0.12%
Number of Households Whose Purchasing Decision for a New Single-Family Median Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices	Number of Households	239	9,757	17,222	1,667
	As % of SF home buyers qualifying for the new, option-in-scope, median-priced home	0.03%	1.05%	1.86%	0.18%
	As % of SF home buyers qualifying for the median-priced home	0.01%	0.30%	0.53%	0.05%
Number of Affected Households (from above), Adjusted to Account for Estimated Number of Households Whose Empirically Observed Purchase Terms Indicate Ability to Increase Housing Payments and Remain Under 29% Housing Payment-to-Income Ratio	Number of Households	69	2,992	5,259	480
	As % of SF home buyers qualifying for the new, option-in-scope, median-priced home	0.01%	0.32%	0.57%	0.05%
	As % of SF home buyers qualifying for the median-priced home	0.00%	0.09%	0.16%	0.01%

[a] This value, the weighted average based on the number of households and home prices across MSAs, is not directly used in the analysis; it is presented here for reference only.
[b] These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.
[c] The national average percent change in home price is estimated using the national average price change and the weighted-average home price across all MSAs.
[d] Values listed as 0.00% are greater than zero but are rounded to 0.00% for reporting purposes.
EPA Estimates

Table 8-4 shows the effect of the estimated national average change in home prices on a typical monthly payment by comparing the baseline and post-compliance monthly payments for each option. For example, the median home price analysis shows increases in monthly payments of $1 for *Option 1*, $16 for *Option 2*, $29 for *Option 3,* and $3 for *Option 4*. In each case, the percentage increase in the monthly payment due to regulatory requirements is low – for example, 0.14 percent for Option 4.

Table 8-4: National Results from the MSA-Level Affordability Median New Home Price Analysis - Change in Monthly Mortgage Payment (2008$)

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Weighted Average Baseline Monthly Mortgage Payment[a]		$1,953	$1,953	$1,953	$1,953
Weighted Average New Monthly Mortgage Payment[a]	Monthly Payment	$1,954	$1,969	$1,982	$1,956
	Percent Change	0.02%	0.80%	1.45%	0.14%

a These values are weighted by the number of households within each state.
EPA Estimates

The marginal affordability effects for likely buyers of newly constructed, single-family homes – in this case, a median price home – as illustrated in *Table 8-3* and *Table 8-4*, do not mean that these households would be unable to afford a single-family home, or even not be able afford the exact same new single-family home. Any potentially affected home buyer has a number of ways to mitigate any price increase due to the regulation. See *Section 8.5*, for a description of these options.

One option referred to as the *purchase deferment* option, is when the purchaser delays the new home purchase long enough to save the requisite increase in the down-payment. Depending on a household's income and the amount of time over which the household saves the additional funds, the impact on a given household's disposable income will vary. For example, *for any given amount to be saved*, the fraction of income that would have to be set-aside over a 3-month period is twice the fraction of income set-aside if savings are accrued over a six-month deferment period.[58]

Table 8-5, below, presents the fraction of household income required to be saved, to offset the effect of the regulation on the monthly mortgage payment via an increase in the initial down-payment. The table shows the savings over 3, 6, and 12 month periods. In each case, the income used in the calculation is the income at which the prospective home buyer would just be able to purchase the home at the baseline price under conventional financing criteria. The results show, for example, that under Option 4, a household would need to set-aside 0.9% of its income over a 6-month period to offset the regulation's effect on the mortgage payment. The fraction of income required to be saved decreases, *for any savings time period*, for households that earn income in excess of this minimum income requirement. Therefore, the required increases in down payment in this table are overstated to the extent that the income of households interested in purchasing the median price home exceeds the minimum income threshold value.

Table 8-5: National-Level Change in Down-Payment Required to Offset Effect of the Regulation for the Median Home Price (2008$)

	Baseline	EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Income necessary to pay baseline mortgage PITI	$97,695				
Required increase in down payment to offset regulation price effect	$0	$60	$2,234	$4,098	$416
Percent of income required to be saved to accumulate marginal increase in down payment over:					
12 months	0.0%	0.1%	2.3%	4.2%	0.4%
6 months	0.0%	0.1%	4.6%	8.4%	0.9%
3 months	0.0%	0.2%	9.1%	16.8%	1.7%

EPA Estimates

8.7.2 Results of the Lower-Quartile-Priced Single-Family Home Analysis

The mitigating factors described in *Section 8.5* also apply to the lower quartile home price analysis and are likely to reduce the ultimate *practical effects* of the regulation on single-family home buyers. But in addition, other qualifications in this analysis are critical for properly understanding the practical implications of whether and to what extent households – in particular low/moderate-income households and first-time home buyers – could be affected by the regulation:

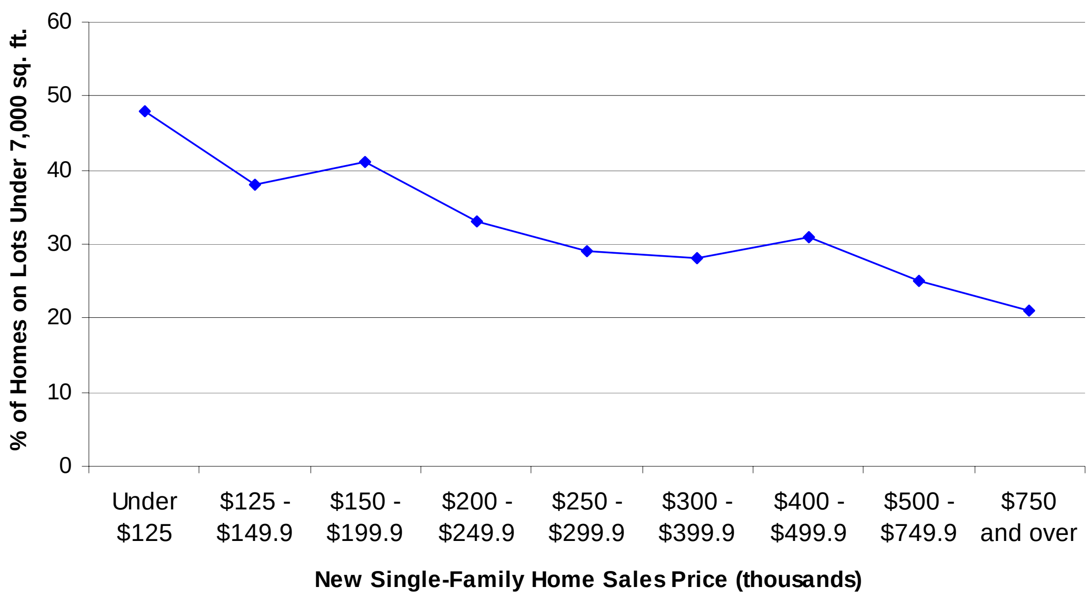
- ***Home price changes due to the regulation are likely to decrease with baseline home sales price.*** An important factor to be accounted for in the analysis for the lower quartile price home is that the compliance cost burden and potential home price increase will typically be less for the lower quartile price home than for the median price home. As a result, simply carrying forward the same price effect as

58 With no allowance for interest earned on the savings during the accumulation period.

used for the median price analysis will overstate the typical impact. This occurs because, as shown in Census data, lot size typically declines with price for new single-family homes, thereby reducing the compliance cost burden, which is directly associated with lot size, and the resulting price impact per home. As shown in *Figure 8-2*, Census data indicate that about half of new, lower priced single-family homes are constructed on lots *less than* 7,000 square feet, and this fraction declines as home price increases. Based on the Census data, lower priced homes will often have lot sizes that are smaller than the median value used in the preceding analysis.[59] To account for this factor, EPA performed the affordability analysis for the lower quartile price home under two compliance cost/price effect cases:

- Using the median lot size for *all* new single-family housing, 0.20 acres
- Using a smaller lot size that is based on the Census-reported median lot size of *attached* new single-family housing, 0.07 acres, which yields a compliance cost and price effect that is approximately 67 percent less than under the median lot size case (see *Table 8-6*, below).

Figure 8-2: Percentage of New Single Family Homes Sold with Lot Sizes Under 7,000 Square Feet, by Price Range

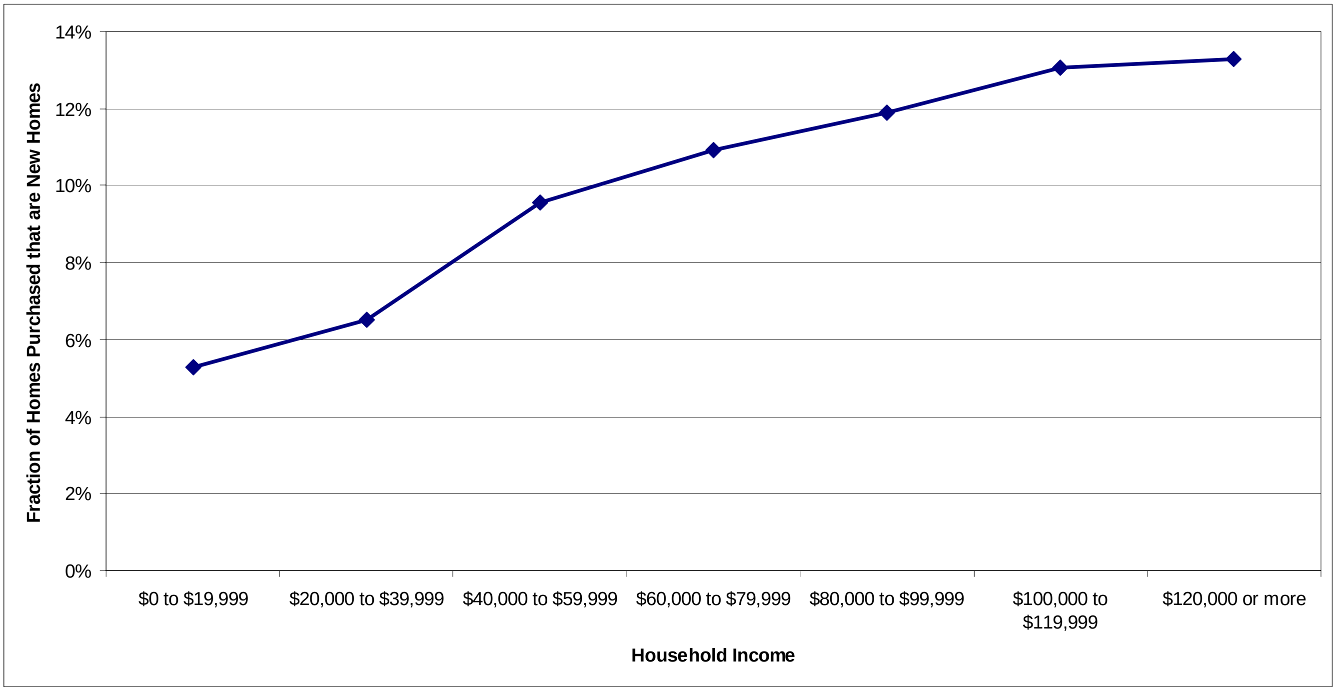


Source: U.S. Census Characteristics of New Housing (2009)

- ***Low/moderate-income home buyers are less likely to purchase newly constructed single-family homes than higher income home buyers.*** The practical impact of the regulation on low/moderate-income (and first-time home buyers, to the extent these home buyers are more likely to have low/moderate incomes) is not as significant because these households are less likely to purchase newly constructed housing than higher income home buyers. As reported in the 2005 American Housing Survey (HUD, 2006a), in any given income range, the fraction of home purchases that are new, generally increases with income (see *Figure 8-3*). This information indicates that, in general, households with higher incomes are more likely to purchase a new home than households with lower income.

[59] The home price and lot size resolution for this analysis are limited by the data ranges reported by the Census: "$125,000 and below" and is the lowest home price range reported, and "7,000 square feet and below" is the lowest lot size range reported.

Figure 8-3: Fraction of Homes Purchased that are New Homes, by Income Range



Source: U.S. Department of Housing and Urban Development (2006)

In addition to these specific considerations for low/moderate-income and first-time home buyers, it is also important to emphasize again that this affordability analysis assumes 100 percent cost pass through of compliance costs from builders to consumers. This assumption implies that the demand for new housing is highly *inelastic* (all costs pass through as a price increase with no change in the equilibrium quantity of new housing sold or rented). Such conditions would generally be expected to prevail during relative "boom" periods in the market for housing (e.g., most recently in 2005 - 2006).[60] While it is possible that a substantial fraction of compliance costs could be passed through to housing consumers, the actual fraction is expected to be *less than* 100 percent *in the steady state*. Moreover, during periods of housing market weakness, such as have occurred over the past few years, the ability of home builders to pass through compliance costs could be *considerably* curtailed. The key point is that cost pass-through, which is ultimately reflected in the supply and demand price elasticity for new housing, is – in the steady state – expected to be less than 100 percent due to several factors, including (1) the availability of substitutes for any given home, and (2) the determination that the rule is expected to affect only a small fraction of the total number of single-family home sales. As such, to the extent that actual cost pass-through is less than 100 percent, the potential affordability effects for all home-buyers are overstated.

Below, *Table 8-6* through *Table 8-8* present the results of the affordability analysis for the lower quartile priced home. *Table 8-6* reports, by regulatory option and for the two lot size cases outlined above, the estimated dollar value and percentage change in the price for a new single-family home and the number of households whose purchasing decision for a new single-family lower quartile priced home would be affected by a regulation-induced increase in housing prices, before and after the adjustment to account for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio. As expected, the number of households annually estimated to incur the affordability

[60] It should be noted that EPA's use of 2007 home prices for the analysis is therefore consistent with the analysis' assumption of 100% cost pass-through given that "peak" market conditions generally prevailed during 2006 and the earlier part of 2007. It would have been a relatively poor assumption to associate 100% cost-pass-through with the current price and market conditions.

effect is smaller under the smaller lot size case of 0.07 acres (based on the median lot size for attached new single-family housing) than under the larger lot size of 0.20 acres (based on the median lot size for all new single-family housing): under Option 4, the estimated number of affected households declines from 2,066 to 690, (not accounting for the adjustment for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio). As described above, EPA judges that the smaller lot size provides a better basis for assessing the affordability effect for the lower quartile price analysis than the larger lot size used in the analysis for the median price. Regardless of the lot size case, the number of affected home buyers is small in relation to the number of single-family new home purchasers who qualify to purchase the lower quartile price home in the baseline (e.g., about 0.02% to 0.15% of such households for Option 4, depending on the lot size case and if the adjustment to the number of households is made).

Table 8-6: National Results from the MSA-Level Affordability Lower Quartile New Home Price Analysis - Price and Household Affordability Effects (2008$) - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home[d]

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Using Median Lot Size (0.07 acres) for Attached New Single-Family Housing as Basis for Compliance Cost					
Weighted Average Baseline Lower Quartile New Home Price[a]		$251,471	$251,471	$251,471	$251,471
National Average Price Change per New Single-Family Home[b]	Price Change[b]	$20	$745	$1,367	$139
	Percent Change[c]	0.01%	0.30%	0.54%	0.06%
Number of Households Whose Purchasing Decision for a New Single-Family Lower Quartile Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices	Number of Households	98	3,969	7,095	690
	As % of SF home buyers qualifying for the new, option-in-scope, lower quartile-priced home	0.01%	0.30%	0.53%	0.05%
	As % of SF home buyers qualifying for the lower quartile-priced home	0.01%	0.24%	0.43%	0.04%
Number of Affected Households (from above), Adjusted to Account for Estimated Number of Households Whose Empirically Observed Purchase Terms Indicate Ability to Increase Housing Payments and Remain Under 29% Housing Payment-to-Income Ratio	Number of Households	34	1,419	2,505	237
	As % of SF home buyers qualifying for the new, option-in-scope, lower quartile-priced home	0.00%	0.11%	0.19%	0.02%
	As % of SF home buyers qualifying for the lower quartile-priced home	0.00%	0.09%	0.14%	0.01%
Using Median Lot Size (0.20 acres) for All New Single-Family Housing as Basis for Compliance Cost					
Weighted Average Baseline Lower Quartile New Home Price[a]		$251,471	$251,471	$251,471	$251,471
National Average Price Change per New Single-Family Home[b]	Price Change[b]	$59	$2,231	$4,093	$415
	Percent Change[c]	0.02%	0.89%	1.63%	0.17%
Number of Households Whose Purchasing Decision for a New Single-Family Lower Quartile Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices	Number of Households	295	11,881	21,242	2,066
	As % of SF home buyers qualifying for the new, option-in-scope, lower quartile-priced home	0.02%	0.89%	1.58%	0.15%
	As % of SF home buyers qualifying for the lower quartile-priced home	0.00%	0.08%	0.15%	0.01%
Number of Affected Households (from above), Adjusted to Account for Estimated Number of Households Whose Empirically Observed Purchase Terms Indicate Ability to Increase Housing Payments and Remain Under 29% Housing Payment-to-Income Ratio	Number of Households	102	4,294	7,591	711
	As % of SF home buyers qualifying for the new, option-in-scope, lower quartile-priced home	0.01%	0.32%	0.57%	0.05%
	As % of SF home buyers qualifying for the lower quartile-priced home	0.00%	0.03%	0.05%	0.00%

a This value, the weighted average based on the number of households and home prices across MSAs, is not directly used in the analysis; it is presented here for reference only.

b These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.

c The national average percent change in home price is estimated using the national average price change and the weighted-average home price across all MSAs.

d Values listed as 0.00% are greater than zero but are rounded to 0.00% for reporting purposes.

EPA Estimates

Table 8-7 shows the effect of the estimated national average change in lower quartile home prices on the total monthly payment by comparing the baseline and post-compliance monthly payments for each option and for the two lot size cases outlined above. The analysis shows small increases in monthly payments, ranging from 0.07% - 0.21% for Option 4, depending on the lot size case.

Table 8-7: National Results from the MSA-Level Affordability Lower Quartile New Home Price Analysis - Change in Monthly Mortgage Payment (2008$)

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Using Median Lot Size (0.07 acres) for Attached New Single-Family Housing as Basis for Compliance Cost					
Weighted Average Baseline Monthly Mortgage Payment[a]		$1,351.7	$1,351.7	$1,351.7	$1,351.7
Weighted Average New Monthly Mortgage Payment[a]	Monthly Payment	$1,351.9	$1,356.9	$1,361.2	$1,352.7
	Percent Change	0.01%	0.38%	0.70%	0.07%
Using Median Lot Size (0.20 acres) for All New Single-Family Housing as Basis for Compliance Cost					
Weighted Average Baseline Monthly Mortgage Payment[a]		$1,351.7	$1,351.7	$1,351.7	$1,351.7
Weighted Average New Monthly Mortgage Payment[a]	Monthly Payment	$1,352.1	$1,367.3	$1,380.1	$1,354.5
	Percent Change	0.03%	1.15%	2.10%	0.21%

a These values are weighted by the number of households within each state.

EPA Estimates

Lastly, *Table 8-8* presents the fraction of household income required to be saved to offset the effect of the regulation on the monthly mortgage payment via an increase in the initial down-payment. The results for Option 4 show that a household would need to set-aside between 0.4% and 1.2% of its income over a 6-month period to offset the regulation's effect on the mortgage payment.

Table 8-8: National-Level Change in Down-Payment Required to Offset Effect of the Regulation for the Lower Quartile Home Price (2008$)

	Baseline	EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Using Median Lot Size (0.07 acres) for Attached New Single-Family Housing as Basis for Compliance Cost					
Income necessary to pay baseline mortgage PITI	$69,031				
Required increase in down payment to offset regulation price effect	$0	$20	$746	$1,369	$139
Percent of income required to be saved to accumulate marginal increase in down payment over:					
12 months	0.0%	0.0%	1.1%	2.0%	0.2%
6 months	0.0%	0.1%	2.2%	4.0%	0.4%
3 months	0.0%	0.1%	4.3%	7.9%	0.8%
Using Median Lot Size (0.20 acres) for All New Single-Family Housing as Basis for Compliance Cost					
Income necessary to pay baseline mortgage PITI	$69,031				
Required increase in down payment to offset regulation price effect	$0	$60	$2,234	$4,098	$416
Percent of income required to be saved to accumulate marginal increase in down payment over:					
12 months	0.0%	0.1%	3.2%	5.9%	0.6%
6 months	0.0%	0.2%	6.5%	11.9%	1.2%
3 months	0.0%	0.3%	12.9%	23.7%	2.4%

EPA Estimates

8.7.3 Results of the Lowest Priced Single-Family Home Analysis

In addition to the median and lower quartile price home analyses, EPA developed an alternative analysis demonstrating the impact of the regulation on an assumed *lowest priced* home. This analysis accounts for the theoretical possibility that no other "lower priced" home is available to be purchased *if the household just qualified to purchase the lowest price home but the price of that home increased as a result of regulatory requirements*. This analysis looks at households at the lower, and more statistically dense, segment of the household income distribution. Therefore, potentially more households could be affected by housing price increases because of the higher mass of the household income distribution present in the lower income ranges. At the same time, low-income home buyers are less likely to purchase newly constructed single-family homes than higher income home buyers (see *Section 8.7.2* and *Figure 8-3*).

The mitigating factors described in *Section 8.5* also apply to the lowest price home analysis and are likely to reduce the ultimate *practical effects* of the regulation on the buyers of the hypothesized lowest price home. In addition, as described above in the results section for the lower quartile home price analysis, the compliance cost burden and potential home price increase will typically be less for lower price homes than for both the lower quartile and median price homes. As a result, EPA performed the affordability analysis for the lowest price home under the cost/price effect case using *only* the smaller lot size, based on the Census-reported median lot size of *attached* new single-family housing, 0.07 acres.

Because no data are available on the “actual lowest price” home by MSA, EPA chose $100,000 and $50,000 as hypothesized “lowest prices” to illustrate the potential impact on affordability at this price level. EPA believes these two prices account for the potential lowest home prices across most MSAs.

Below, *Table 8-9* through *Table 8-11* present the results of the affordability analysis for the $100,000 lowest home price analysis. *Table 8-9* reports, by regulatory option, the estimated dollar value and percentage change in the price for a new single-family home and the number of households whose purchasing decision for a new single-family lowest priced home would be affected by a regulation-induced increase in housing prices, before and after the adjustment to account for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio. Although this analysis looks at households in the denser part of the household income distribution, the number of households estimated to incur annually the affordability effect (680 for Option 4) is slightly less than the number from both the median and lower quartile home price analyses (prior to the financing adjustment). After the 29 percent financing adjustment, the number of households estimated to incur annually the affordability effect (324 for Option 4) is slightly more than the number for the lower quartile home price analysis because lower income households generally spend near their maximum housing price to income level and therefore do not have much room for movement. Regardless of the household case, the number of affected home buyers is small in relation to the number of single-family new home purchasers who qualify to purchase the lowest priced home in the baseline (e.g., about 0.02% to 0.03% of such households for Option 4).

Table 8-9: National Results from the MSA-Level Affordability Lowest New Home Price Analysis ($100,000) - Price and Household Affordability Effects - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home[d]

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Weighted Average Baseline Lowest New Home Price[a]		$100,000	$100,000	$100,000	$100,000
National Average Price Change per New Single-Family Home[b]	Price Change[b]	$20	$745	$1,367	$139
	Percent Change[c]	0.02%	0.75%	1.37%	0.14%
Number of Households Whose Purchasing Decision for a New Single-Family Lowest Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices	Number of Households	97	3,953	7,064	680
	As % of SF home buyers qualifying for the new, option-in-scope, lowest-priced home	0.00%	0.20%	0.36%	0.03%
	As % of SF home buyers qualifying for the lowest-priced home	0.00%	0.05%	0.09%	0.01%
Number of Affected Households (from above), Adjusted to Account for Estimated Number of Households Whose Empirically Observed Purchase Terms Indicate Ability to Increase Housing Payments and Remain Under 29% Housing Payment-to-Income Ratio	Number of Households	46	1,896	3,403	324
	As % of SF home buyers qualifying for the new, option-in-scope, lowest-priced home	0.00%	0.10%	0.17%	0.02%
	As % of SF home buyers qualifying for the lowest-priced home	0.00%	0.02%	0.04%	0.00%

a Fixed values are used for each MSA and are not brought into 2008 dollars but are left as the actual values (i.e. 50,000; 75,000; 100,000).
b These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.
c The national average percent change in home price is estimated using the national average price change and the weighted-average home price across all MSAs.
d Values listed as 0.00% are greater than zero but are rounded to 0.00% for reporting purposes.
EPA Estimates

Table 8-10 shows the effect of the estimated national average change in lowest home prices on the total monthly payment by comparing the baseline and post-compliance monthly payments for each option. The analysis shows small increases in monthly payments, 0.14% for Option 4, less than the lower quartile home price analysis.

Table 8-10: National Results from the MSA-Level Affordability Lowest New Home Price Analysis ($100,000) - Change in Monthly Mortgage Payment (2008$)

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Weighted Average Baseline Monthly Mortgage Payment[a]		$681.0	$681.0	$681.0	$681.0
Weighted Average New Monthly Mortgage Payment[a]	Monthly Payment	$681.1	$686.2	$690.5	$682.0
	Percent Change	0.02%	0.76%	1.39%	0.14%

a These values are weighted by the number of households within each state.
EPA Estimates

Table 8-11 presents the fraction of household income required to be saved to offset the effect of the regulation on the monthly mortgage payment via an increase in the initial down-payment. The results for Option 4 show that a household would need to set-aside 1.0% of its income over a 6-month period to offset the regulation's effect on the mortgage payment, again, less than the lower quartile home price analysis.

Table 8-11: National-Level Change in Down-Payment Required to Offset Effect of the Regulation for the Lowest Home Price ($100,000) (2008$)

	Baseline	EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Income necessary to pay baseline mortgage PITI	$28,028				
Required increase in down payment to offset regulation price effect	$0	$20	$746	$1,369	$139
Percent of income required to be saved to accumulate marginal increase in down payment over:					
12 months	0.0%	0.1%	2.7%	4.9%	0.5%
6 months	0.0%	0.1%	5.3%	9.8%	1.0%
3 months	0.0%	0.3%	10.6%	19.5%	2.0%
EPA Estimates					

Below, *Table 8-12* through *Table 8-14* present the results of the affordability analysis for the $50,000 lowest home price analysis. This analysis accounts for an even lower home price, which may not be relevant for many MSAs. However, this analysis accounts for those households that do not have as many, if any, possibilities through which a price increase due to the regulation might be mitigated. At the same time, these households are less likely to be in the market for a new single-family home (see *Section 8.7.2* and *Figure 8-3: Fraction of Homes Purchased that are New Homes, by Income Range)*. *Table 8-12* reports, by regulatory option, the estimated dollar value and percentage change in the price for a new single-family home and the number of households whose purchasing decision for a new single-family lowest priced home would be affected by a regulation-induced increase in housing prices, before and after the adjustment to account for those households whose empirically observed purchase terms indicate an ability to increase their housing payments and remain under 29% housing payment-to-income ratio. The number of households estimated to incur the affordability effect is smaller under this lowest home price case compared to the $100,000 lowest price case presented above. Regardless of the financing adjustment, the number of affected home buyers is small in relation to the number of single-family new home purchasers who qualify to purchase the lowest home price in the baseline (e.g., about 0.01% of such households for Option 4).

Table 8-12: National Results from the MSA-Level Affordability Lowest New Home Price Analysis ($50,000) - Price and Household Affordability Effects (2008$) - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home[d]

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Weighted Average Baseline Lowest New Home Price[a]		$50,000	$50,000	$50,000	$50,000
National Average Price Change per New Single-Family Home[b]	Price Change[b]	$20	$745	$1,367	$139
	Percent Change[c]	0.04%	1.49%	2.73%	0.28%
Number of Households Whose Purchasing Decision for a New Single-Family Lowest Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices	Number of Households	22	928	1,652	155
	As % of SF home buyers qualifying for the new, option-in-scope, lowest-priced home	0.00%	0.04%	0.08%	0.01%
	As % of SF home buyers qualifying for the lowest-priced home	0.00%	0.01%	0.02%	0.00%
Number of Affected Households (from above), Adjusted to Account for Estimated Number of Households Whose Empirically Observed Purchase Terms Indicate Ability to Increase Housing Payments and Remain Under 29% Housing Payment-to-Income Ratio	Number of Households	9	395	728	65
	As % of SF home buyers qualifying for the new, option-in-scope, lowest-priced home	0.00%	0.02%	0.03%	0.00%
	As % of SF home buyers qualifying for the lowest-priced home	0.00%	0.00%	0.01%	0.00%

a Fixed values are used for each MSA and are not brought into 2008 dollars but are left as the actual values (i.e. 50,000; 75,000; 100,000).
b These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.
c The national average percent change in home price is estimated using the national average price change and the weighted-average home price across all MSAs.
d Values listed as 0.00% are greater than zero but are rounded to 0.00% for reporting purposes.
EPA Estimates

Table 8-13 shows the effect of the estimated national average change in lowest home prices on the total monthly payment by comparing the baseline and post-compliance monthly payments for each option. The analysis shows small increases in monthly payments, 0.28% for Option 4, which is the highest percentage price change of all the home price analyses because the baseline price is so low. Therefore, the *percent* change is higher, although the *actual* price change is lower.

Table 8-13: National Results from the MSA-Level Affordability Lowest New Home Price Analysis ($50,000) - Change in Monthly Mortgage Payment (2008$)

		EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Weighted Average Baseline Monthly Mortgage Payment[a]		$340.5	$340.5	$340.5	$340.5
Weighted Average New Monthly Mortgage Payment[a]	Monthly Payment	$340.6	$345.7	$350.0	$341.4
	Percent Change	0.04%	1.52%	2.79%	0.28%

a These values are weighted by the number of households within each state.
EPA Estimates

Lastly, *Table 8-14* presents the fraction of household income required to be saved to offset the effect of the regulation on the monthly mortgage payment via an increase in the initial down-payment. The results for Option 4 show that a household would need to set-aside 2.0% of its income over a 6-month period to offset the regulation's effect on the mortgage payment, which, again, is the highest among the four home price analyses. However, this is expected because these households are in the lowest household income range and would therefore need to save a larger *percent* of income, although a smaller *absolute dollar amount*.

Table 8-14: National-Level Change in Down-Payment Required to Offset Effect of the Regulation for the Lowest Home Price ($50,000) (2008$)

	Baseline	EPA Option 1	EPA Option 2	EPA Option 3	EPA Option 4
Income necessary to pay baseline mortgage PITI	$14,014				
Required increase in down payment to offset regulation price effect	$0	$20	$746	$1,369	$139
Percent of income required to be saved to accumulate marginal increase in down payment over:					
12 months	0.0%	0.1%	5.3%	9.8%	1.0%
6 months	0.0%	0.3%	10.6%	19.5%	2.0%
3 months	0.0%	0.6%	21.3%	39.1%	4.0%
EPA Estimates					

The key conclusion from the single-family housing affordability analysis is that, for all regulatory options and among all home price analyses, the total number of households incurring an affordability effect is small in comparison to the number of all likely single-family home buyers in any given year who can also afford the same home. For Option 4, this percentage ranges from 0.01 to 0.18 percent.

9 Analysis of Social Cost

This analysis estimates the cost of the regulation from the perspective of society as a whole. The total social cost of the regulation is comprised of (1) the quantity-adjusted resource cost of compliance, (2) the additional social welfare loss due to construction market adjustments, and (3) government administrative costs for reviewing and processing discharge monitoring reports (DMR) and other start-up costs. The estimates of cost presented previously in Chapters 6 and 7 capture the unadjusted resource cost of compliance to the industry.

Markets vary in the level of activity, structure of the industry, and ultimately cost pass-through potential, from state to state and region to region. The modeling approach described in this section captures such regional variation in the impacts of the proposed regulatory options by estimating *partial equilibrium* models at the state level for the residential and non-residential (i.e., commercial and industrial) building construction sectors.

EPA applied the partial equilibrium models using national-level estimates of the elasticity of market supply and demand to estimate the impact of incremental costs on the supply curve and, thus, on prices and quantities of construction products under post-compliance conditions. In this framework, part of the increased costs may raise the price of new housing (or commercial space), with the balance of increased costs being absorbed by the builder, depending on the relative elasticities of supply and demand. A partial equilibrium analysis assumes that the final regulation will only *directly* affect a single industry; in this case, the construction and development industry. Holding other industries “constant” in this way is generally appropriate since the compliance costs of the proposed regulatory options are expected to result in only marginal changes in prices and quantities and the rule does not *directly* affect the other industries (HUD, 2006).

Economic impacts in the *directly* affected industry can trigger further output and employment effects in the broader U.S. economy via inter-industry linkages. For the industries *indirectly* affected by the proposed rule, a multi-sector input-output or general equilibrium modeling approach is more appropriate (HUD, 2006). A traditional approach for assessing such cross-industry effects is an input-output (I/O) model. For its analysis of the C&D regulation, EPA used input-output-based multipliers to estimate the indirect impacts on economic output and employment in the broader U.S. economy.[61]

The partial equilibrium analysis of state- and national-level economic impacts includes five broad steps:

1. Establish the baseline market equilibrium for each construction subsector at the state-level;
2. Establish the post-compliance market equilibrium for each construction subsector at the state-level after accounting for compliance costs of the final regulation; this produces an estimate of the change in the quantity of C&D market output;
3. Estimate the total resource cost of the final regulation and the value of lost C&D output, after adjusting for the quantity effect of the regulation, for each state;
4. Aggregate the resource cost (an increase in demand for society’s resources) and lost economic output (a reduction in demand for society’s resources) across states to obtain a national-level estimate of direct economic impacts; and,
5. Apply national-level final demand multipliers, from the Bureau of Economic Analysis’s Regional Input-Output Modeling System (RIMS II), to the resource cost of the regulation *and* the direct change in C&D

[61] The analysis of economy-wide effects is presented in the next chapter, *Chapter 10: Analysis of Economy-Wide Output and* Employment Impacts.

output. The application of RIMS multipliers produces an estimate of the total inter-industry economic value and employment effects of the final regulation.

The remainder of this section is organized as follows:

- *Section 9.1* presents the methodology for estimating each partial equilibrium market model;
- *Section 9.2* describes the models' data inputs; and,
- *Section 9.3* presents the methodology for estimating the resource cost of compliance, the value of lost C&D output, and the additional social welfare loss.

9.1 Summary of the Partial Equilibrium C&D Market Models

This section describes the methodology for estimating the pre- and post-compliance market equilibrium for a given C&D subsector using the partial equilibrium market model. This methodology is applied at the state-level separately to the residential and non-residential building construction subsector.

9.1.1 Estimating the Baseline Construction Market Equilibrium

EPA assumes a linear partial equilibrium market model. The assumption that compliance costs of the final regulation will result in only small marginal changes in prices and quantities provides the basis for assuming that the supply and demand curves are linear in the relevant range of market effect. The data inputs required to estimate the baseline market equilibrium for each model include the baseline construction unit price (e.g., the price of a housing unit or a given quantity of commercial/industrial space), the baseline quantity of construction activity (e.g., the number of new housing units constructed or the quantity of new commercial/industrial space constructed), and the assumed elasticities of supply and demand for the construction subsector being analyzed. The intersection of the baseline quantity and baseline price serves as the baseline market equilibrium.

The baseline supply curve for a given construction market, in a given state, is approximated by:

$$Q^s = \alpha + \beta \mathrm{P} \qquad (1)$$

Where:

Q^s	=	Annual number of new construction unit permits issued
P	=	Price of a new construction unit
α	=	Intercept calibrated from the baseline equilibrium price and quantity $\left[= Q_0 - \beta \mathrm{P}_0\right]$
β	=	Supply coefficient on price $\left[= \mathrm{E}_s * \left(\frac{Q_0}{\mathrm{P}_0}\right)\right]$
E_s	=	Supply elasticity of new construction units (> 0)

Similarly, the state-level baseline demand curve is given by:

$$Q^d = \sigma + \gamma \mathrm{P} \qquad (2)$$

Where:

Q^d	=	Annual number of new construction unit permits issued
σ	=	Intercept calibrated from the baseline equilibrium price and quantity $\left[= Q_0 - \gamma P_0\right]$
γ	=	Demand coefficient on price $\left[= E_d * \left(\frac{Q_0}{P_0}\right)\right]$
E_d	=	Demand elasticity of new construction units (> 0)

EPA assumes that the baseline condition for each market being analyzed is in equilibrium, and so, the initial *supply* and *demand* quantity values (Q^s and Q^d) in these two equations are equal.

9.1.2 Estimating the Post-Compliance Construction Market Equilibrium

The incremental unit cost of compliance to comply with the final regulation increases builders' costs and causes an upward shift on the supply curve (and creating a new, "shocked" supply intercept). This shift drives changes in prices, which increase, and quantities, which decrease. A key assumption in the model is that the changes in production cost on the supply side are not enough to change the price elasticities or substitution on the demand side. In effect, the supply curve shifts by the amount of the per-unit incremental compliance cost, without any change in the demand curve.

The post-compliance supply intercept (α_s) is given by:

$$\alpha_s = Q_0 - \beta(P_0 + TIC) \tag{3}$$

Where, TIC is the toal per-unit incremental cost effect (i.e., The per-unit incremental cost of compliance, marked-up by the project-level compliance cost multiplier to account for debt cost and equity cost considerations. Refer to Appendix G for a description of the project-level carrying cost multiplier).

The new construction market price (P_N) is then given by:

$$P_N = \frac{\alpha_s - \sigma}{\gamma - \beta} \tag{4}$$

And the post-compliance equilibrium quantity is then recalculated using the new price:

$$Q_N^d = \sigma + \gamma P_N \tag{5}$$

The cost pass-through rate is the ratio of the elasticity of supply divided by the difference in the elasticity of supply and the elasticity of demand ($E_s/(E_s - E_d)$). The cost pass-through rate can also be calculated by dividing the change in the price of a construction unit in the market by the adjusted per unit incremental cost of compliance, or $((P_N – P_0)/ESC)$.

9.2 Inputs to the Partial Equilibrium C&D Market Models

EPA estimated the above partial equilibrium model for the residential and non-residential construction subsectors. The data sources for each model are discussed in the sub-sections below.

9.2.1 Construction Market Quantities

9.2.1.1 Residential

The quantity of new residential construction in the single and multi-family construction subsectors is measured by the number of new units authorized. The U.S. Census reports the number of new single and multi-family units authorized by permits on an annual basis at the state level. EPA estimated each state's average annual number of new single- and multi-family housing units authorized for the years 2002 – 2008, and then summed these average annual quantities to arrive at the baseline quantity of the total number of new housing units authorized, on average, per state per year.

9.2.1.2 Non-Residential

Since the Census Bureau discontinued collection of non-residential building permit information in 1994, EPA sought an alternative measure of new non-residential construction activity to serve as the quantity metric for the partial equilibrium models. In the absence of other information, EPA has opted to use the sum of the annual quantity of commercial and industrial acreage developed according to the 2008-trend baseline detailed in *Chapter 4*.

9.2.2 Construction Market Prices

9.2.2.1 Residential

The state-level median price of new single-family home serves as the basis for the new home price in the single-family market. The U.S. Census *American Community Survey 2007* reports the median price, at the state-level, for owner-occupied units constructed since 2005.

Separate price series for multi-family housing units are not reported by the Census. EPA instead calculated the ratio of multi-family housing unit prices to single-family housing unit prices using data available from the National Association of Realtors (NAR). The NAR's *Metropolitan Area Existing-Home Prices* data series includes data for existing single-family home sales as well as sales prices for condos by metro market. EPA calculated a weighted-average value of the ratio of multi-family unit prices to single-family unit prices of approximately 71%. This ratio was used to adjust the state-level median single-family home price series published by the Census to approximate 2007 multi-family unit prices for each state.

EPA then estimated an aggregate new housing unit price as the average of the new single- and multi-family housing unit prices, weighted by the quantity of new single- and multi-family units authorized, on average, per year.

9.2.2.2 Non-Residential

Rental rates, in dollars per square foot per year, are closely watched indicators of demand for commercial space and serve as the price for the commercial market model. Grubb & Ellis reports rental rates for Class A and Class B office space for 71 metropolitan areas in the United States (Grubb & Ellis, 2009). Rental rate data refer to asking rents for space that is available on the market at the end of the first quarter of 2009. Rates are per square foot, quoted on an annual basis. Grubb & Ellis adheres to the BOMA[62] guidelines for office building classifications. Class A properties are the most prestigious buildings competing for premier office users with rents above average for the area, Class B properties compete for a wide range of users with rents in the average range for the area, and Class C buildings (not reported) compete for tenants requiring functional space at rents below the area average.

Grubb & Ellis also reports rental rates for retail market space in 51 metropolitan areas in the United States (Grubb & Ellis, 2009). Rental rate data refer to asking rents for space that is available on the market at the end of the summer of 2009. Rental rate data refer to in-line shop space in a grocery-anchored center, 3,000-square-foot national credit tenant, newly developing suburban trade area, first generation space, white-box build-out. Rates are per square foot, quoted on an annual basis.

EPA estimated the average commercial space rental rate in each state as the average of Class A, Class B, and retail rates across all of the metropolitan areas reported for each state. EPA used the average rental rate for other states in the same Census division for states for which no metropolitan areas are reported. There are 15 states with no reported data: Alaska, Arkansas, Hawaii, Idaho, Kentucky, Louisiana, Maine, Mississippi, North Dakota, Rhode Island, South Dakota, Utah, Vermont, West Virginia, and Wyoming.

In order to use this data describing the average "annual rental rate per square foot per year" as the metric of the price of commercial space in the partial equilibrium model, EPA converted this rate into units of "annual rental rate per acre per year." This is required because EPA is using the quantity of acreage developed per year as the quantity metric. To convert the "per square foot" value for commercial space into a "per acre" value, EPA used the Reed Construction database to estimate the average quantity of commercial square footage constructed on any given acre land developed for commercial purposes. This value, estimated to be approximately 14,200 square feet per acre, is multiplied by the Grubb & Ellis rental rate to estimate an annual commercial rental price per acre per year for each state.

Rental rates, in dollars per square foot per year, are also closely watched indicators of demand for industrial space and serve as the price for the industrial market.Grubb & Ellis reports rental rates for industrial space classified as "warehouse-distribution" or "R&D-flex" in 69 and 66 metropolitan areas in the United States, respectively (Grubb & Ellis, 2009). Rental rate data refer to space that is available on the market at the end of the first quarter 2009. Rates for available space are expressed in dollars per square foot per year in most parts of the country and dollars per square foot per month in areas of California and selected other markets.

EPA estimated the average industrial space rental rate in each state as the average of the two data series (Class A and B) across all of the metropolitan areas reported for each state. EPA used the average rental rate for other states in the same Census division for states for which no metropolitan areas are reported. There are 17 states with no reported data: Alaska, Arkansas, Connecticut, Hawaii, Idaho, Kentucky, Louisiana, Maine, Mississippi, New Hampshire, North Dakota, Rhode Island, South Dakota, Utah, Vermont, West Virginia, and Wyoming.

EPA estimated an aggregate measure of the average "annual rental rate per square foot per year" for the non-residential as the average of the commercial and industrial rates, weighted by the estimated annual quantity of acreage developed in the commercial and industrial subsectors, by state. In order to subsequently use this price metric in the partial equilibrium model, EPA converted this rate into units of "annual rental rate per acre per year." This is required because EPA is using the quantity of non-residential acreage developed per year as the quantity metric. To convert the "per square foot" value for non-residential space into a "per acre" value, EPA used the Reed Construction database to estimate the average quantity of commercial and industrial square footage constructed on any given acre land developed for industrial purposes. This value, estimated to be approximately

[62] BOMA was formerly known as Building Owners and Managers Association (http://www.boma.org)

14,000 square feet per acre, is multiplied by the non-residential rental rate to estimate an annual non-residential rental price per acre per year for each state.

9.2.3 Incremental Compliance Cost Effect per Construction Unit

Each state-level construction market is shocked with the estimated compliance costs associated with the final regulation. The residential partial equilibrium market model requires compliance costs on a per-construction-unit basis in order to be consistent with the measures of price and quantity in the market models. In addition, the incremental compliance costs per construction unit must be adjusted to account for the additional costs beyond the direct compliance outlay (e.g., cost of financing) associated with each unit of construction. Consequently, the final magnitude of the shift in the supply curve for each construction market will be greater than simply the incremental compliance costs for a given residential unit or non-residential acre. The non-residential partial equilibrium market model requires compliance costs in terms of a per-acre annual rent-recovery value since the price metric is rent per acre and the quantity metric is acres of non-residential development. These compliance cost concepts are detailed below.

9.2.3.1 Residential

The total state-level dollar value of price effect per housing unit (i.e., the magnitude of supply curve shift) in the residential market model is measured by the adjusted incremental compliance cost per unit of new housing in each state:

$$TIC = \left(\frac{IC_{acre}}{Units_{acre}} \right) * COST \tag{6}$$

Where:

TIC	=	Total incremental cost effect per construction unit
IC_{acre}	=	State-specific weighted average incremental compliance cost per acre for the residential sector and regulatory option
$Units_{acre}$	=	Estimated number of new housing units per acre, which is estimated as the weighted average units per acre for single and multi-family construction sectors in the project-level multiplier analysis (see Appendix G)
$COST_x$	=	Indirect project cost multiplier, which indicates the dollar change in the price of a housing unit for each dollar of incremental compliance cost, after accounting for overhead, debt cost, and equity cost considerations (value of multiplier is 1.38, see Appendix G).

9.2.3.2 Non-Residential

The total state-level dollar value of price effect (i.e., magnitude of supply curve shift) in the non-residential market models needs to be a measure of the incremental increase in the annual rental price for an acre's-worth of new non-residential space, given the price and quantity metrics previously outlined. EPA therefore converted the non-residential incremental compliance cost per acre for each state and regulatory option into an annualized value to be recovered through rent over the useful life of the non-residential property. This approach is appropriate because the developer of new non-residential space will not attempt to recover the entirety of the incremental compliance cost *every* year, nor will the developer attempt to recover the cost though a *single* year's rental fee since that would presumably increase the rental price to such an extent that the property is less attractive relative to other available properties for potential renters.

EPA calculated the annual compliance cost recovery value for each state and option by amortizing the incremental per-acre cost assuming a 20-year recovery period, a 7% cost of debt, 13.54% cost of equity, and 75% loan-to-value ratio (i.e., 75% of the cost is financed through debt, 25% using developer equity). Such expenditures on non-residential property development would be depreciated over a 39-year useful life; however, EPA has alternatively assumed a more aggressive 20-year recovery period to be conservative in the analysis.

9.2.4 Elasticity of Supply and Demand

A review of the literature indicates that, in contrast to demand elasticity research, less is known about the behavior of supply (HUD, 2006). There are three key empirical difficulties identified in the housing supply elasticity literature. First, estimated housing supply elasticities vary widely. Second, price does not seem to be a sufficient statistic, and other market indicators are quite important in explaining supply (e.g., land availability, land-use and other regulatory restrictions, and demographic characteristics). Third, construction levels seem to respond quite sluggishly to construction costs and output prices (DiPasquale, 1999; Hwang and Quigley, 2006; Green, Malpezzi and Mayo, 2005).

EPA's review of the literature indicates that the supply of residential and non-residential construction space is generally elastic, although there can be significant variability across specific markets or regions. For example, an MSA-level analysis of residential supply elasticity found statistically significant elasticity values ranging from 1.43 – 21.6 (Green, Malpezzi and Mayo, 2005). Green, Malpezzi and Mayo (2005) estimate separate supply elasticities for individual U.S. Metropolitan Statistical Areas (MSAs) using annual data for 45 MSAs and over 18 years (1979-1996). Their analysis developed 45 first-stage regressions to recover supply elasticities for the MSAs, where the dependent variable in each regression is the number of housing units for which building permits were issued, multiplied by an average household size of 2.5, divided by population and the independent variable is the lagged first difference in the natural logs of the Fannie Mae repeat-sales index of house prices for the MSA. The resulting estimated supply elasticities were found to be statistically significant and greater than zero in 22 of 45 cases. Based on the results in Green, Malpezzi and Mayo (2005), EPA assumed that 4.01 is a reasonable assumption for the price elasticity of residential supply.

For non-residential construction, EPA has referred to the analysis of Benjamin, Jud, and Winkler (1998), which similarly analyzed price elasticity at the MSA-level. Their analysis employed data for 19 MSAs covering years 1986 – 1995. Based on the statistically significant results of Benjamin, Jud and Winkler (1998), EPA has assumed a non-residential price elasticity value of 0.49.

Estimates of the price elasticity of demand for both residential and non-residential construction are more consistent within the literature relative to estimates of the price elasticity of supply. A key factor that determines demand elasticity in a given market is the availability of close substitutes. If a homebuyer has the option of substituting existing housing, rental housing, other new housing, or manufactured housing, demand will be relatively more elastic. On the other hand, housing is a necessity, which tends to make demand inelastic (HUD, 2006). A review of the literature indicates a somewhat inelastic demand for new housing and non-residential space (HUD, 2006; DiPasquale, 1999; Benjamin, Jud and Winkler, 1998), ranging nationally from about -0.1 to -1.0. Based on the literature, EPA has assumed a residential price elasticity of demand of -0.7, and a price elasticity of non-residential demand of -0.2.

9.3 Estimating the Resource Cost, Welfare Loss, and Output Loss Due to the Final Rule

Chapter 6 described EPA's estimation of the *first order* resource cost of compliance within each C&D industry subsector and for each of the proposed regulatory options. This estimate of resource cost produced in the firm-level analysis, however, does not account for the potential affect of the final regulation on the quantity of construction activity performed in the various C&D markets. The partial equilibrium analysis considers the potential for the regulation to shift up the supply curve in each market (i.e., via increased production costs), resulting in a higher price per unit and, depending on market response, a lower quantity of output. A primary output of the partial equilibrium analysis is to estimate the change in market quantity expected on average in each market. EPA estimated this quantity-effect using the methodology outlined above for calculating the pre- and post-compliance market equilibrium. The estimated change in quantity is then used not only to adjust the firm-level resource cost for the quantity-effect of the regulation, but also to compute the direct output (revenue) changes in the construction industry subsectors themselves. The resource cost and output loss, in turn, have ripple effects in the rest of the economy, which are measured using RIMS II input-output multipliers developed by the Bureau of Economic Analysis (BEA) in *Chapter 10*

9.3.1 Estimating Resource Cost and Additional Social Welfare Loss

Adjusting the firm-level estimate of the regulation's resource cost to account for the anticipated C&D market-effect is relatively simple. EPA reduces the state-level estimate of resource cost from the firm- and industry-level analysis by the anticipated percentage change in the quantity of output with each state, as estimated by the partial equilibrium market model.

$$RC_{Adj} = \%\Delta Q * RC_{Un-adj} \qquad (7)$$

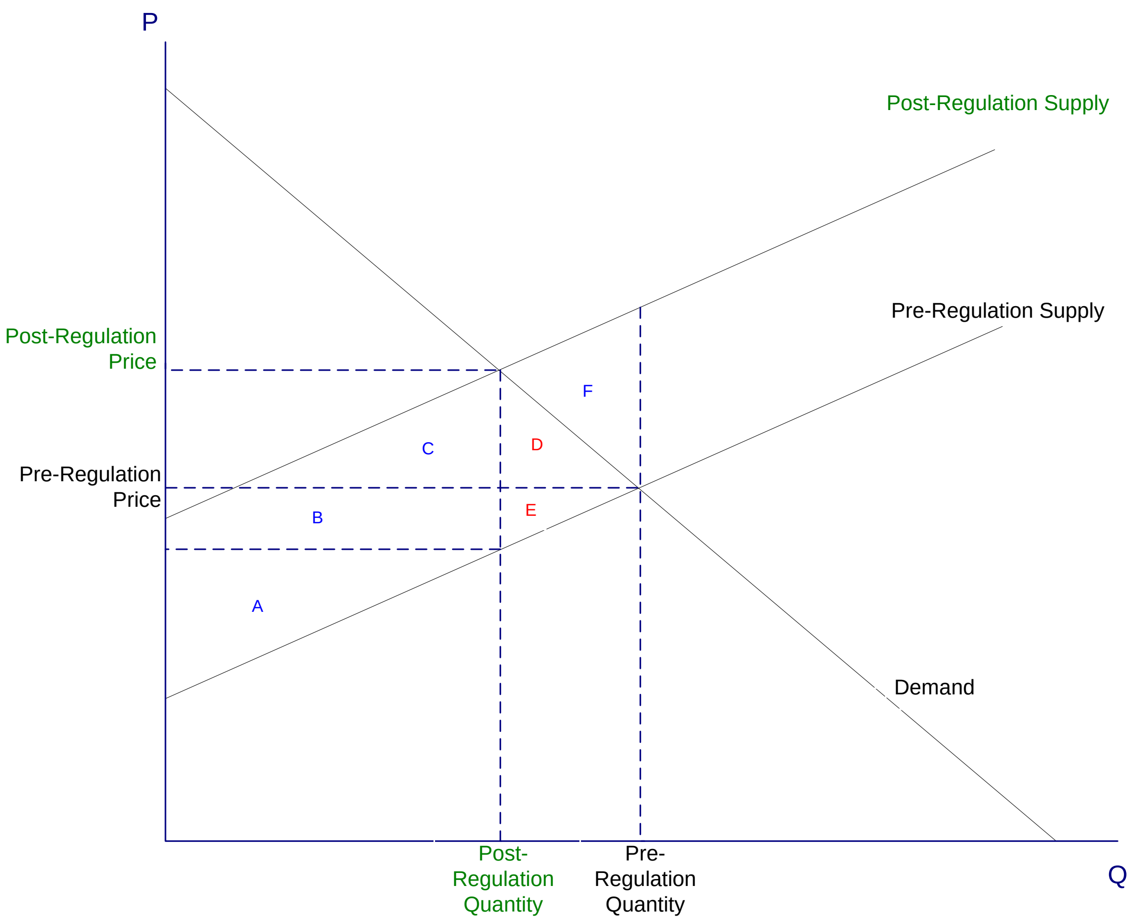
Where:

RC_{Adj}	=	Market-effect adjusted measure of resource cost in each state and market
$\%\Delta Q$	=	Percentage change in state-level quantity of construction from baseline to post-compliance from the partial equilibrium analysis
$RC_{Un\text{-}adj}$	=	Unadjusted, firm-level measure of resource cost in each state and market

The diagram below (which exaggerates the magnitude of the market impact for purposes of illustration) shows conceptually these alternate measures of resource cost. The firm- and industry-level analysis previously outlined produces an estimate of the regulation's resource cost equal to the sum of area A, B, C, D, E, and F in the diagram; this measure of the resource cost is based on an assumption that the quantity of C&D industry output does not change as a result of the cost of the regulation. However, the partial equilibrium analysis indicates that, given the relationship between supply and demand, the upward shift in the supply curve in a given C&D market will result in a post-compliance market equilibrium with a lower quantity of production, and each unit of production has a higher price. Therefore, the true resource cost of compliance, accounting for this quantity-effect, is the sum of areas A, B, and C. The difference between the un-adjusted and adjusted measure of resource cost is captured by the sum of areas D, E, and F. Areas D and E represent the additional social welfare loss of the regulation for a given C&D subsector, which is simply one-half of the sum of areas D, E, and F since EPA has assumed linear supply and demand curves in the partial equilibrium model.

The partial equilibrium model has a number of implications for the welfare of society. When the supply curve shifts as a result of incremental compliance costs, consumers lose some of their benefits from the product in absorbing those compliance costs. The result is a change in consumer surplus, part of which eventually makes its way to the entities whose services are purchased to implement the requirements of the regulation, and part of which becomes the consumer contribution to the social welfare loss of the regulation. There is also a change in producer surplus. Some producer surplus is similarly transferred to other producers whose services are purchased to implement the regulation due the partial absorption of compliance costs, and another portion of producer surplus is contributes the social welfare loss of the regulation.

EPA estimates the adjusted resource cost and DWL for the residential and non-residential subsector and each state. For the transportation subsector, EPA assumes inelastic demand (i.e., no quantity effect), and therefore relies on the firm- and industry-level measure of resource cost for this subsector instead of a quantity-adjusted resource cost measure. The sum of resource cost and additional welfare loss across all states and C&D subsectors comprises the majority of the social cost of the regulation. The *total* social cost of the regulation also includes government administrative and monitoring costs.



9.3.2 Estimating the Loss in C&D Output

EPA estimates the state-level change in C&D industry revenues by multiplying the baseline construction unit price by the difference between the pre- and post-compliance quantity of construction units:

$$R_{loss} = \Delta Q * \mathrm{P}_0 \tag{8}$$

Where:

R_{loss}	=	Decline in revenue for the C&D sector in a given state
ΔQ	=	Change in state-level quantity of construction from baseline to post-compliance ($Q_N - Q_0$)
P_0	=	Baseline state-level construction unit price

The sum of the C&D output loss across all states and C&D markets is the total value of output loss associated with the regulation.

9.3.3 Price-Effects in C&D Markets

As noted above and illustrated in the above figure, the partial equilibrium analysis indicates that the upward shift in the C&D market supply curve will result in a post-compliance market equilibrium with a *lower quantity of production*, and a *higher price per unit* of production. It is important to note, however, that the expected increase in market price is actually *less than* the magnitude of the vertical shift in the supply curve. The supply curve shifts upward by the amount of the per unit compliance cost, but – as seen the figure above – the supply and demand elasticity responses to this compliance cost result in a quantity-reduction that causes the price to ultimately rise by less than the amount of compliance cost.

In the next chapter, the aggregate measure of C&D market output loss and total resource cost are separately analyzed using input-output multipliers in order to estimate the total (e.g., direct and indirect) economic effects of the regulation.

9.4 Uncertainties and Limitations

Key uncertainties and limitations in this analysis include:

- ***Elasticities of Supply and Demand Vary.*** EPA estimated the state-level partial equilibrium models using *national-level* estimates of the elasticity of market supply and demand. These elasticity values are used to estimate the impact of incremental costs on the supply curve and, thus, on prices and quantities of construction products under post-compliance conditions. However, the extent to which increased construction costs manifest as higher sales prices and rents – and changes in market quantity – depend on supply and demand elasticities *in specific construction product markets*. Elasticities may vary substantially both over time, across regional markets, and within regional markets according to supply and demand conditions in specific product segments and other important market indicators (e.g., land availability, land-use and other regulatory restrictions, and demographic characteristics). To the extent that EPA's national-level elasticity values vary across the states, over time, and do not specifically reflect the conditions within the market for *new* construction, EPA may be over- or under-estimating the potential market effect on the prices and quantities of C&D market output.
- ***Impacts on Markets for Existing Construction Are Not Evaluated.*** There is uncertainty with respect to how the market for *existing* construction may factor into the ultimate effect of the regulation on prices for *new* construction subject to the regulation, and vice versa.
  - Increased project costs and associated pressure on project prices for <u>new</u> finished product may spill over into price effects – as increased sales prices or rents, in the present and in the future – for <u>existing</u> finished product not subject to the regulation's requirements.
  - Conversely, the presence of existing finished product and new product not impacted by the rule serves as competition for newly constructed finished product and can thus limit the potential for upward pricing pressure on both existing finished product and new finished product subject to the regulation's requirements. The presence of existing finished product provides a buffer against price and rent increases to C&D industry product consumers.

  Given that the new construction expected to be subject to the regulation represents a very small fraction of all available construction product (both existing and new), EPA believes that the latter effect is, in general, likely to prevail. Therefore, price effects on new residential and non-residential construction product may be overstated. In this case, over the longer term, the cost and economic impact of the regulation may more likely be borne by owners of undeveloped land as property developers adjust construction cost estimates to reflect regulatory requirements and correspondingly adjust the prices to be paid for the land on which project development will occur. This effect would be particularly important in those instances in which otherwise similar undeveloped properties in the same market have different compliance requirements due, for example, to differences in soil and run-off characteristics, or property size. However, this differential treatment is socially optimal in the sense that an environmental externality has been internalized.

- ***Assumption of Uniform Impact on the Supply of C&D Output.*** The partial equilibrium market analysis considers the potential for the regulation to shift the supply curve upward in each market (i.e., via increased production costs), resulting in a higher price per unit and, depending on market response, a lower quantity of output. In this analysis, EPA assumes that in-scope C&D output is *distributed uniformly* across the pre-regulation supply curve, resulting in a parallel shift of the supply curve. However, EPA has no basis for knowing with certainty exactly which segments of the C&D supply curve in any given market will actually be in-scope, and more importantly, where in-scope segments sit relative to the pre-regulation market equilibrium. *To the extent that the marginal – and hence price-determining – supply of C&D output for a given market segment does not incur costs because of the regulation*, the increase in production cost for other, infra-marginal, segments of the supply schedule may have no or little effect on the market price. As a result, EPA may be overstating the change in market equilibrium point due to the regulation.

9.5 Results of the Social Cost Analysis

This assessment of the total social cost of the regulation reflects the potential for changes in the total output of the affected C&D industries as a result of cost-induced price increases in construction product markets. The reduction in construction industry activity and output reduces the resource cost of compliance estimated in the firm- and industry-level analysis (the so-called “first-order” estimate). However, the reduction in construction industry activity and output also reduces the net economic welfare to society from production and consumption of C&D industry output. The estimates of impact on industry output are based on an analysis of market response to the regulatory options undertaken on a state-by-state basis.

The social cost estimate reported from this analysis accounts for both the output reduction and the loss in net economic welfare from production and consumption of C&D industry output. The social cost estimate also accounts for expected Federal, State, and local government administrative costs for reviewing and processing discharge monitoring reports (DMRs), which are required for each in-scope project (the estimation of these costs is detailed in Chapter 14). The values presented below are *annual* values based on the trend-estimated levels of construction and compliance activity, as described in *Chapter 4: Developing the Analysis Baseline*.

EPA developed a state-by-state linear partial equilibrium market model for the residential and non-residential C&D building subsectors to evaluate these potential market effects. EPA’s assumption that compliance costs will result in only small marginal changes in prices and quantities provides the basis for assuming that the supply and demand curves are linear in the relevant range of market effect. The estimated change in the quantity of output produced in each market model is then used to not only adjust the firm-level resource cost of compliance, but also to compute the economic value of the reduction in C&D output, and estimate the total additional loss of consumer and producer surplus.

The total social cost of the regulation is comprised of (1) the quantity-adjusted resource cost of compliance, (2) the additional social welfare loss due to construction market adjustments, and (3) government administrative costs for reviewing and processing discharge monitoring reports (DMR) and other start-up costs. The results of the social cost analysis are presented in *Table 9-1*.

For the *Option 4,* the total social cost is approximately $959 million.. For comparison, other regulatory options considered have estimated social costs of $176 million, $4.86 billion, and $9.08 billion, respectively, for Options 1, 2, and 3.

Table 9-1: Total Annual Social Cost of the Final Regulation, ($millions)

	Option 1	Option 2	Option 3	Option 4
Total Costs, Adjusted for Quantity Effect	$176	$4,856	$9,059	$952
Total Costs, Unadjusted for Quantity Effect	$176	$4,866	$9,090	$953
Change in Costs Due to Quantity Effect	$0.01	$10	$31	$0.29
Additional Social Welfare Loss	$0.0	$5.0	$15.5	$0.15
Government Administrative Costs for DMR Processing	$0.0	$2.2	$6.2	$6.2
Total Social Cost of the Regulation	$176	$4,863	$9,081	$959
Total Acreage Incurring Cost	852,615	851,253	850,249	852,418

EPA Estimates

10 Analysis of Economy-Wide Output and Employment Impacts

In addition to economic effects in C&D markets (described in previous *Chapter 9*), there are economic effects in the broader economy that arise from both the resource cost of compliance outlays and the direct decrease in C&D industry output. Resource cost outlays to comply with the regulation lead to increased production of services from those sectors that provide the services needed for compliance. Those sectors, in turn, require inputs from a myriad of other sectors to produce any given unit of output. The increased economic activity derived from the outlays required for compliance should be thought of as the total increase in the demand for society's resources necessary for compliance to occur, where, the value-added component of all the increased activity is equal to the resource cost of compliance. It is important to emphasize that this value it is not a "benefit" of the rule, but rather, a measure of the sum of inter-industry transfers that arise from the compliance outlays required by the regulation.

The loss in C&D industry output also produces inter-industry economic effects. In this case, the reduction in C&D output means fewer materials and services are required from sectors in the economy that typically provide inputs to the C&D sector. Those sectors, in turn, require fewer inputs from the sectors that supply them. It is important to emphasize that neither set of inter-industry economic effects (i.e., resource cost-*related* or output loss-*related* impacts) is the social cost of the regulation. Rather, these effects are manifestations of social cost.

10.1 Economy-Wide Economic Effects Arising from Resource Cost of Compliance Outlays

The resource cost of compliance represents the dollar value of goods and services that will be purchased from sectors that make or install the environmental controls or provide other services related to regulatory compliance. EPA estimates that approximately 45% of these services will be provided by engineering service firms, 40% will be provided by firms related to the production or rental of water treatment equipment, and about 15% of the resource cost will be used to purchase chemicals for treatment.

As the first step in estimating the inter-industry output effects of the regulation, EPA allocated the total estimated resource cost to these three key industries in proportion to the fraction of compliance services expected to come from each industry. EPA next used multipliers from the U.S. Bureau of Economic Analysis' 2006 Regional Input-Output Modeling System (RIMS II) for these key industry sectors to estimate the total economy effects of the purchases of goods and services required for regulatory compliance.[63] The RIMS II final-demand multipliers are defined as follows:

- *Economic output multiplier.* The output multiplier for any given sector represents the total dollar loss in output that occurs in all sectors for each dollar of output not delivered to final demand by that sector.
- *Earnings multiplier.* The earnings multiplier for any given sector represents the total dollar loss in earnings of households employed by all sectors for each dollar of output not delivered to final demand by that sector.
- *Employment multiplier.* The employment multiplier for any given sector represents the total potential job loss/disruption that occurs in all sectors for each additional $1 million of output not delivered to final demand by that sector.

[63] EPA used RIMS sectors 230000 Construction, 333111-33399A Machinery Manufacturing, 325110-325998 Chemical Manufacturing, and 541100-5419A0 Professional, scientific, and technical services to represent the construction, water treatment equipment, chemical, and engineering industries, respectively.

Multiplying the RIMS output multiplier for each key industry sector by its assigned proportion of resource cost yields the total value of economic activity associated with providing the services necessary for compliance with the option being analyzed. The sum of the multiplier effects across the three key industry sectors is the aggregate, national inter-industry economic output effect due to the resource cost of the regulation. Since the regulatory options *require* outlays and additional economic activity from society, although this value has a positive sign, it is not a benefit to society.

EPA also estimated the potential number of jobs that is associated with the additional economic activity required to produce the services for regulatory compliance using the RIMS II employment multipliers.

10.2 Economy-Wide Economic Effects Arising from the Direct Loss in C&D Industry Output

The compliance-induced reduction in C&D output means that the C&D industry purchases fewer inputs from other economic sectors compared to the pre-compliance level of activity. The value of this reduction in purchases from other sectors is represented by the direct change in C&D output. When the C&D industry reduces the value of purchases from other sectors, those sectors, in turn, require fewer inputs from the sectors that supply them.

EPA estimated the national, inter-industry economic output and potential employment impacts associated with the direct reduction of output in the C&D industry using the same methodology as *Section 10.1*, except that this analysis uses multipliers for the C&D industry itself. These total economy effects represent the total reduction in demand for society's economic resources resulting from the estimated contraction in C&D industry output.

10.3 Results of the Economy-Wide Analysis

The analysis of total economic effects is intended to account for inter-industry linkages in the national economy by estimating the magnitude of output and employment changes derived from (1) the resource cost of compliance, (2) the direct change in C&D industry output, and (3) the output and employment effects resulting from administrative costs associated with activities performed by Federal, State, and Local governments (government costs are described in *Chapter 14*). EPA used RIMS multipliers from BEA to estimate the total economic effects of the regulation on the overall U.S. economy. The results are presented in *Table 10-1*.

Table 10-1: Total Economic Output and Employment Effects, ($millions)

	Option 1	Option 2	Option 3	Option 4
Output Effects				
Total Change in Economic Output Arising from Compliance Cost Outlays	$529	$14,608	$27,253	$2,865
Change in C&D Industry Output	($39)	($1,621)	($2,786)	($269)
Total Change in Economic Output from Reduced C&D Industry Output	($127)	($5,241)	($9,009)	($869)
Total Change in Economic Output Arising from Government Cost	$0	$7	$19	$19
Total Effect on Economic Output	**$401**	**$9,373**	**$18,263**	**$2,015**
Employment Effects				
Total Change in Employment Arising from Compliance Cost Outlays (jobs)	3,296	91,071	169,908	17,861
Direct Employment Effect from Reduced C&D Industry Output (jobs)	(83)	(3,370)	(5,802)	(560)
Total Change in Employment from Reduced C&D Industry Output (jobs)	(988)	(40,612)	(69,810)	(6,734)
Total Change in Employment Arising from Government Cost (jobs)	0	60	167	167
Total Effect on Employment (jobs)	**2,309**	**50,519**	**100,266**	**11,295**

EPA Estimates. Values may n ot sum due to rounding.

It is important to emphasize that the total economic effects reported above, whether derived from resource cost outlays or the contraction in C&D industry output, are *not costs in addition to* the social cost of the rule. The reported total output and employment effects are manifestations of the rule's social cost. For example, the reported *increases* in employment from *Compliance Cost Outlays* as reported in *Table 10-1* reflect the use of labor as a factor input for producing the goods and services required for compliance with the regulation. The reported *reductions* in employment from *Change in C&D Industry Output* – both direct and indirect – reflect the contraction in total industry output due to the estimated changes in the prices of industry's output.

Another way to more generally interpret this table is that it indicates how the rule will reallocate society's resources essentially from construction activity to compliance-related activity.

11 Benefits Assessment Methodology and Results

This chapter provides an overview of the potential benefits to society related to reduced sediment discharges from construction sites that will result from the C&D regulation. A more detailed discussion of EPA's methodology and results from the benefits assessment can be found in the *Environmental Impact and Benefits Assessment for Final Effluent Guidelines and Standards for the Construction and Development Category* (USEPA 2009), hereafter referred to as the *Environmental Assessment Document*.

Sediments and other pollutants from construction sites may have a wide range of effects on water resources located in the vicinity of construction sites. These environmental changes affect economic productivity (e.g., navigation, water storage, and water treatment) as well as environmental services valued by humans (e.g., recreation, public and private property ownership, existence services such as aquatic life, wildlife, and habitat designated uses). Related market benefits (e.g., avoided costs of producing various market goods and services) and non-market benefits are additive (Freeman 2003). In all cases, benefits are conceptualized and estimated based on established welfare theoretic models (Freeman 2003; Just et al. 2004).

EPA considered four categories of quantifiable monetary benefits from the C&D Regulation:

- *Benefits to Navigation (Section 11.1)* – Navigable waterways are often dredged to maintain their navigable depth and width. Reduced sediment settling in navigable channels is expected to reduce the cost of dredging in these channels, as it is related to the amount of sediment dredged;
- *Benefits to Water Storage (Section 11.2)* – Water storage facilities (reservoirs) may also be dredged in order to regain capacity lost to sediment build-up. Reduced sediment settling in reservoirs is expected to reduce the cost of dredging in reservoirs that are dredged;
- *Benefits to Drinking Water Treatment (Section 11.3)* – Drinking water must be treated for sediment and turbidity, among other things, and the treatment costs are related to the sediment and turbidity levels of the influent water. Reducing sediment and subsequently the turbidity that must be treated by drinking water treatment plants reduces the amount of chemicals needed for treatment, and also the amount of sludge generated from this treatment that must be disposed, lowering the cost of drinking water treatment; and,
- *Water Quality Benefits (Section 11.4)* – Reducing sediment levels in U.S. waterways has the general effect of improving water quality, as suspended sediment is one of the determinants of water quality. Increased water quality has both explicit and implicit value to users of water bodies, which was quantified using willingness-to-pay estimates based on a meta-analysis of existing willingness-to-pay studies for water quality improvements.

The first three benefit categories are *avoided costs* – i.e., the C&D regulatory options are expected to reduce a cost otherwise incurred by society resulting from the presence of sediments in discharges from construction sites. The fourth category, water quality benefits, is conceptually different in that it reflects the estimated value to society for the water quality improvements resulting from reduced sediment discharges from construction sites. Looking across these categories, EPA estimates that water quality improvements will contribute substantially greater benefits than those expected from the other benefit categories because this category represents values of both noncommercial users and nonusers, ths sum being a larger population.

The total benefits resulting from the reduced sediment and turbidity levels in U.S. waters induced by this regulation are calculated as the sum of monetary benefits for these four categories. Total benefits are summarized in *Section 11.5*. Lastly, *Section 11.6* summarizes the key uncertainties and limitations underlying the analyses.

More details of the conceptual framework underlying this benefits assessment and a discussion of additional benefits categories not monetized can be found in *Chapter 4* of the *Environmental Assessment Document*. EPA used the SPARROW (**SPA**tially **R**eferenced **R**egressions **O**n **W**atershed attributes) model (USGS 2008) to predict changes in sediment loadings and concentrations resulting from expected reductions in construction site sediment discharges brought about by this regulation. Details of SPARROW can be found in *Chapter 6* and *Appendix B* of the *Environmental Assessment Document*.

11.1 Analysis of Benefits to Navigation

This section presents a summary of EPA's analysis of the navigable waterway maintenance costs that would be avoided by implementation of the C&D regulation. Further details of this analysis and an expanded discussion of its results can be found in *Chapter 7* of the *Environmental Assessment Document*.

The analysis of benefits to navigation includes four primary steps:

- Identify navigable waterways that are regularly dredged and estimate the frequency of dredging in each waterway;
- Estimate the navigable waterway maintenance cost per cubic yard of sediment dredged;
- Estimate the total cost of navigable waterway maintenance under the baseline and post-compliance scenarios and,
- Estimate avoided costs from decreased dredging of navigable waterways due to the reduction in sediment discharged from construction sites.

This analysis presents low, midpoint, and high estimates for the baseline dredging that will be affected by this regulation in order to provide a range of benefits values. This range of values was determined by varying certain assumptions made about current and future dredging activity in U.S. navigable waterways. The details of the assumptions made for each range are summarized in *Chapter 7* of the *Environmental Assessment Document*.

The avoided costs for each post-compliance scenario are calculated as the difference in total annualized dredging costs between the baseline and each post-compliance scenario, and will be considered as the benefits to navigation resulting from the C&D regulation. *Table 11-1, Table 11-2, Table 11-3,* and *Table 11-4* present annualized avoided cost estimates for navigable waterway dredging for each of the Agency's regulatory options by EPA Region, including low, midpoint, and high estimates for cost reductions under each of these scenarios. Each of these estimates was calculated using both 3 and 7 percent annual discount rates to discount and annualize costs. Because the discount rate does not substantially affect the overall avoided costs, all values discussed are those calculated assuming a 3 percent discount rate.

Annualized savings from reduced dredging activity range from $1.0 to $3.4 million, with Option 4, representing a savings of $2.9 million in the midpoint estimate. EPA estimates that Regions 4 and 6 will benefit from the most substantial reductions in dredging costs under all policy options. This is due to a large amount of baseline dredging activity in these regions, and a large percentage reduction in sediment runoff expected as a result of the regulation. Due to the lack of significant dredging activity in Region 8, no noticeable benefits are expected in this region.

Option 1, which requires non-numeric effluent limitations for all sites, is EPA's least stringent policy option. It is predicted to produce a range of avoided costs between $1.0 and $1.3 million with a midpoint estimate of slightly less than $1.3 million. EPA predicts that this option would prevent 8.5 million cubic yards of sediment from entering navigable waters each year.

Option 2 requires ATS on sites with 30 or more acres disturbed at one time and imposes a 13 NTU turbidity standard while requiring non-numeric effluent limitations on all sites and is similar to the option EPA proposed previously. This option will prevent an estimated 17.6 million cubic yards of sediment from entering navigable water bodies and requiring dredging. The midpoint estimate for avoided costs under this option is $2.6 million per year, ranging from $2.1 to $2.8 million between the low and high estimates.

Option 3, EPA's most stringent policy option, requires ATS on sites with 10 or more acres disturbed at one time, imposes a 13 NTU turbidity standard on these sites, and requires non-numeric effluent limitations on all sites. This option would prevent approximately 22.0 million cubic yards of sediment from building up in navigable waterways each year. Avoided costs from this action range from $2.7 to $3.4 million, with a midpoint of $3.3 million.

Option 4 requires passive treatment systems on all sites with 10 or more acres disturbed at one time, and establishes a numeric turbidity standard of 280 NTU (expressed as a daily maximum value) for sites required to implement passive treatment. In addition, all sites will be required to meet non-numeric effluent limitations. Avoided costs from Option 4 range between $2.4 and $3.0 million, with a midpoint estimate of $2.9 million. The requirements of Option 4 produce larger reductions in dredged sediment than those of Option 2, as turbidity treatment is required on more sites. Option 4 is not as effective as Option 3 in reducing sediment in navigable waters, since the two options have the same criteria for disturbed acres, but Option 4 has a less stringent turbidity standard. The total reduction in sediment dredged from navigable waters is expected to be 20.0 million cubic yards under Option 4.

Table 11-1: Annualized Reductions in Dredging and Costs Under Option 1

EPA Region	Reduction in Sediment Dredged (thousands of yd^3)			Avoided Costs Using 3% Discount Rate (thousands of 2008$)			Avoided Costs Using 7% Discount Rate (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High
1	0.3	1.0	1.3	$0.3	$0.8	$0.9	$0.3	$0.8	$0.9
2	16.4	21.3	24.2	$7.6	$10.4	$10.9	$7.4	$10.1	$10.5
3	40.7	51.5	55.0	$20.0	$25.0	$25.6	$19.7	$24.4	$24.9
4	871.5	1,001.7	1,058.3	$262.5	$320.0	$329.8	$258.1	$312.5	$322.3
5	21.0	31.5	50.9	$8.3	$12.7	$18.3	$8.2	$12.4	$17.9
6	5,901.7	6,660.6	6,739.7	$628.8	$739.1	$769.7	$611.5	$720.8	$754.8
7	5.2	9.3	10.6	$0.8	$1.6	$1.7	$0.7	$1.5	$1.6
8	0.0	0.0	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
9	56.4	81.6	95.5	$28.7	$41.3	$43.3	$28.2	$40.0	$41.9
10	486.8	614.8	795.1	$69.7	$106.2	$131.8	$68.3	$102.9	$127.5
Total	**7,400.0**	**8,473.3**	**8,830.6**	**$1,026.7**	**$1,257.2**	**$1,331.9**	**$1,002.4**	**$1,225.3**	**$1,302.4**

EPA Estimates

Table 11-2: Annualized Reductions in Dredging and Costs Under Option 2

EPA Region	Reduction in Sediment Dredged (thousands of yd^3)			Avoided Costs Using 3% Discount Rate (thousands of 2008$)			Avoided Costs Using 7% Discount Rate (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High
1	0.7	2.1	2.7	$0.7	$1.7	$1.9	$0.7	$1.6	$1.8
2	33.8	43.8	49.9	$15.6	$21.4	$22.4	$15.2	$20.7	$21.7
3	84.5	106.7	114.0	$41.4	$51.9	$53.0	$40.8	$50.7	$51.7
4	1,806.7	2,076.3	2,193.3	$543.1	$661.9	$682.2	$534.0	$646.4	$666.7
5	43.2	65.0	105.1	$17.1	$26.2	$37.6	$16.8	$25.5	$36.8
6	12,309.2	13,891.9	14,056.6	$1,311.4	$1,541.4	$1,605.1	$1,275.4	$1,503.1	$1,574.1
7	10.8	19.4	22.0	$1.6	$3.2	$3.6	$1.5	$3.1	$3.4
8	0.0	0.1	0.1	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
9	116.9	168.5	197.4	$59.5	$85.4	$89.4	$58.5	$82.6	$86.6
10	990.2	1,251.4	1,618.7	$141.8	$216.1	$268.1	$138.8	$209.4	$259.4
Total	**15,395.9**	**17,625.0**	**18,359.8**	**$2,132.1**	**$2,609.2**	**$2,763.4**	**$2,081.7**	**$2,543.0**	**$2,702.2**

EPA Estimates

Table 11-3: Annualized Reductions in Dredging and Costs Under Option 3

EPA Region	Reduction in Sediment Dredged (thousands of yd^3)			Avoided Costs Using 3% Discount Rate (thousands of 2008$)			Avoided Costs Using 7% Discount Rate (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High
1	0.9	2.6	3.4	$0.8	$2.1	$2.3	$0.8	$2.0	$2.2
2	42.1	54.5	62.1	$19.4	$26.7	$27.9	$18.9	$25.8	$27.0
3	105.3	132.9	142.0	$51.6	$64.7	$66.0	$50.8	$63.1	$64.5
4	2,251.4	2,587.4	2,733.0	$676.6	$824.5	$849.8	$665.2	$805.1	$830.4
5	53.8	81.0	130.8	$21.2	$32.6	$46.9	$20.9	$31.8	$45.7
6	15,356.2	17,330.6	17,536.2	$1,636.0	$1,922.9	$2,002.4	$1,591.0	$1,875.1	$1,963.7
7	13.5	24.1	27.5	$2.0	$4.0	$4.5	$1.9	$3.8	$4.3
8	0.0	0.1	0.1	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
9	145.7	209.8	245.9	$74.2	$106.3	$111.3	$72.9	$102.9	$107.8
10	1,229.5	1,554.0	2,010.3	$176.0	$268.4	$333.0	$172.4	$260.0	$322.1
Total	**19,198.2**	**21,977.0**	**22,891.2**	**$2,657.7**	**$3,252.1**	**$3,444.1**	**$2,594.9**	**$3,169.7**	**$3,367.8**

EPA Estimates

Table 11-4: Annualized Reductions in Dredging and Costs Under Option 4

EPA Region	Reduction in Sediment Dredged (thousands of yd^3)			Avoided Costs Using 3% Discount Rate (thousands of 2008$)			Avoided Costs Using 7% Discount Rate (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High	Low	Mid	High
1	0.6	1.7	2.3	$0.6	$1.4	$1.6	$0.6	$1.3	$1.5
2	33.7	43.5	49.6	$15.5	$21.3	$22.3	$15.1	$20.6	$21.6
3	92.1	115.9	123.8	$45.2	$56.5	$57.7	$44.5	$55.2	$56.3
4	1,964.1	2,252.6	2,374.9	$574.7	$699.0	$720.3	$565.1	$682.8	$704.1
5	43.4	67.2	107.2	$16.9	$26.1	$37.2	$16.7	$25.5	$36.3
6	14,395.8	16,242.8	16,434.8	$1,531.7	$1,800.0	$1,874.4	$1,489.6	$1,755.3	$1,838.3
7	12.4	22.3	25.3	$1.8	$3.7	$4.2	$1.8	$3.5	$3.9
8	0.0	0.1	0.1	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
9	127.8	174.1	205.7	$65.1	$88.3	$92.6	$64.0	$85.6	$89.9
10	815.4	1,043.3	1,351.7	$116.0	$178.8	$222.5	$113.6	$173.1	$215.1
Total	**17,485.3**	**19,963.5**	**20,675.5**	**$2,367.5**	**$2,875.1**	**$3,032.8**	**$2,310.9**	**$2,802.9**	**$2,967.1**

EPA Estimates

11.2 Analysis of Benefits to Water Storage

This section provides a summary of EPA's analysis to estimate the benefits to water storage facilities from reduced sediment discharge. A more detailed description of this analysis can be found in *Chapter 8* of the *Environmental Assessment Document*.

The analysis of these benefits includes the following steps:

- Estimating the unit cost of sediment removal from reservoirs assumed to be dredged;
- Estimating the sediment accumulation in reservoirs under the baseline scenario and the post-compliance regulatory scenarios and the amount expected to be dredged;
- Estimating the cost of dredging this volume of sediment, assuming a period of 2, 6, or 10 years between sediment removal activities, and discounting and annualizing this cost for the baseline and post-compliance regulatory scenarios, and;
- Estimating the avoided costs from decreased dredging of reservoirs due to the reduction in sediment discharged from construction sites.

Due to a lack of data on the frequency of reservoir dredging, EPA varied the assumed frequency of dredging between 2, 6, and 10 years to produce a range of avoided cost estimates. More details of this sensitivity analysis can be found in *Chapter 8* of the *Environmental Assessment Document*.

The difference between the anticipated dredging costs under the baseline and a particular post-compliance scenario represents the avoided costs of that particular scenario. *Table 11-5, Table 11-6*, *Table 11-7,* and *Table 11-8* present reductions in sedimentation and subsequent avoided costs from reduced reservoir dredging for the post-compliance regulatory scenarios, including low, midpoint, and high estimates under each of these scenarios. All values discussed below assume a 3 percent rate for discounting and annualization.

Avoided costs from a reduction in reservoir sedimentation range from $1.3 to $3.8 million, depending on the policy option and the assumed frequency of reservoir dredging. Option 4 represents avoided costs of $3.2 million. The largest savings are predicted in Region 6 under all options, as SPARROW predicts the largest overall reductions in sediment accumulation in this region. Region 4 is also expected to benefit substantially relative to other regions due to both large reductions in construction discharges in this region and a relatively high unit cost of dredging (estimated from USACE data).

Option 1, which requires non-numeric effluent limitations for all sites, is EPA's least stringent policy option. This option is expected to reduce reservoir sedimentation by about 560 thousand cubic yards nationally every year, which is estimated to save between $1.3 and $1.5 million in dredging costs per year, with a midpoint estimate of $1.4 million.

Option 2 requires ATS on sites with 30 or more acres disturbed at one time and imposes a 13 NTU turbidity standard while requiring non-numeric effluent limitations on all sites and is similar to the option EPA proposed previously. This action is estimated to prevent about 1.2 million cubic yards of sediment from building up in reservoirs each year. This reduction represents between $2.7 and $3.0 million in annual savings, with a midpoint estimate of $2.9 million.

Option 3, EPA's most stringent policy option, requires ATS on sites with 10 or more acres disturbed at one time, imposes a 13 NTU turbidity standard on these sites, and requires non-numeric effluent limitations on all sites. Its reduction in sediment deposition in reservoirs is estimated to be 1.5 million cubic yards annually. The monetized value of reduced dredging costs is estimated to be between $3.3 and $3.8 million with a midpoint estimate of $3.6 million.

Option 4 requires passive treatment systems on all sites with 10 or more acres disturbed at one time, and establishes a numeric turbidity standard of 280 NTU (expressed as a daily maximum value) for sites required to implement passive treatment. In addition, all sites will be required to meet non-numeric effluent limitations. Because Option 4 requires passive rather than active treatment of sediment and has a higher turbidity standard, the estimated reductions in reservoir sediment buildup are lower than those from Option 3. However, the estimated reductions from Option 4 are still greater than those expected from Option 2, as that option requires treatment on fewer sites. Expected avoided costs from Option 4 are estimated to be $3.2 million for the midpoint estimate, ranging between $3.0 and $3.4 million. Regions 4 and 6 together account for more than half of the monetized benefits of reduced reservoir sedimentation, due to the expected reductions in construction discharges in these regions. Option 4 is estimated to reduce reservoir sedimentation by 1.3 million cubic yards annually.

Table 11-5: Reduction in Reservoir Dredging and Costs Under Option 1

EPA Region	Reduction in Sediment (yd^3)	Avoided Costs (thousand 2008$)					
		3% Discount Rate			7% Discount Rate		
		Low	Mid	High	Low	Mid	High
1	1,422.5	$13.0	$13.8	$14.7	$10.8	$12.5	$14.4
2	534.6	$3.4	$3.6	$3.8	$2.8	$3.2	$3.7
3	2,554.2	$15.5	$16.5	$17.5	$12.8	$14.9	$17.1
4	98,832.2	$471.7	$501.6	$532.8	$391.4	$453.6	$522.5
5	7,877.6	$32.2	$34.3	$36.4	$26.8	$31.0	$35.7
6	408,507.4	$640.5	$681.1	$723.4	$531.4	$615.9	$709.4
7	24,767.9	$56.3	$59.8	$63.6	$46.7	$54.1	$62.3
8	2,165.2	$8.5	$9.0	$9.6	$7.0	$8.2	$9.4
9	4,832.7	$27.3	$29.0	$30.8	$22.6	$26.2	$30.2
10	7,293.4	$23.2	$24.7	$26.2	$19.3	$22.3	$25.7
Total	**558,787.8**	**$1,291.5**	**$1,373.4**	**$1,458.7**	**$1,071.6**	**$1,241.9**	**$1,430.5**

EPA Estimates

Table 11-6: Reduction in Reservoir Dredging and Costs Under Option 2

EPA Region	Reduction in Sediment (yd^3)	Avoided Costs (thousand 2008$)					
		3% Discount Rate			7% Discount Rate		
		Low	Mid	High	Low	Mid	High
1	2,876.1	$26.3	$28.0	$29.7	$21.8	$25.3	$29.1
2	1,095.8	$6.9	$7.3	$7.8	$5.7	$6.6	$7.6
3	5,277.7	$32.0	$34.0	$36.1	$26.5	$30.7	$35.4
4	205,148.0	$979.1	$1,041.2	$1,105.8	$812.4	$941.5	$1,084.5
5	16,291.7	$66.7	$70.9	$75.3	$55.3	$64.1	$73.9
6	851,211.4	$1,334.6	$1,419.2	$1,507.4	$1,107.4	$1,283.3	$1,478.2
7	51,567.6	$117.2	$124.6	$132.3	$97.2	$112.7	$129.8
8	4,475.7	$17.5	$18.6	$19.8	$14.5	$16.8	$19.4
9	9,992.4	$56.4	$60.0	$63.7	$46.8	$54.2	$62.5
10	14,804.0	$47.1	$50.1	$53.2	$39.1	$45.3	$52.2
Total	**1,162,740.5**	**$2,683.8**	**$2,853.8**	**$3,031.2**	**$2,226.8**	**$2,580.6**	**$2,972.6**

EPA Estimates

Table 11-7: Reduction in Reservoir Dredging and Costs Under Option 3

EPA Region	Reduction in Sediment (yd3)	Avoided Costs (thousand 2008$)					
		3% Discount Rate			7% Discount Rate		
		Low	Mid	High	Low	Mid	High
1	3,567.2	$32.6	$34.7	$36.9	$27.1	$31.4	$36.1
2	1,362.7	$8.5	$9.1	$9.7	$7.1	$8.2	$9.5
3	6,572.8	$39.8	$42.3	$45.0	$33.0	$38.3	$44.1
4	255,705.5	$1,220.4	$1,297.7	$1,378.4	$1,012.6	$1,173.5	$1,351.7
5	20,293.0	$83.1	$88.3	$93.8	$68.9	$79.9	$92.0
6	1,061,735.4	$1,664.7	$1,770.2	$1,880.2	$1,381.2	$1,600.7	$1,843.8
7	64,312.0	$146.1	$155.4	$165.0	$121.2	$140.5	$161.9
8	5,574.7	$21.8	$23.2	$24.7	$18.1	$21.0	$24.2
9	12,445.8	$70.2	$74.7	$79.3	$58.3	$67.5	$77.8
10	18,375.4	$58.5	$62.2	$66.1	$48.5	$56.2	$64.8
Total	**1,449,944.6**	**$3,345.8**	**$3,557.9**	**$3,778.9**	**$2,776.1**	**$3,217.2**	**$3,705.9**

EPA Estimates

Table 11-8: Reduction in Reservoir Dredging and Costs Under Option 4

EPA Region	Reduction in Sediment (yd3)	Avoided Costs (thousand 2008$)					
		3% Discount Rate			7% Discount Rate		
		Low	Mid	High	Low	Mid	High
1	2,126.0	$19.4	$20.7	$22.0	$16.1	$18.7	$21.5
2	1,021.6	$6.4	$6.8	$7.2	$5.3	$6.2	$7.1
3	5,497.1	$33.3	$35.4	$37.6	$27.6	$32.0	$36.9
4	226,511.9	$1,081.1	$1,149.6	$1,221.0	$897.0	$1,039.5	$1,197.4
5	17,171.7	$70.3	$74.7	$79.4	$58.3	$67.6	$77.9
6	984,436.6	$1,543.5	$1,641.3	$1,743.3	$1,280.7	$1,484.2	$1,709.6
7	59,072.2	$134.2	$142.7	$151.6	$111.4	$129.1	$148.7
8	4,697.2	$18.4	$19.6	$20.8	$15.3	$17.7	$20.4
9	10,504.9	$59.3	$63.0	$67.0	$49.2	$57.0	$65.7
10	11,827.7	$37.6	$40.0	$42.5	$31.2	$36.2	$41.7
Total	**1,322,866.8**	**$3,003.6**	**$3,193.9**	**$3,392.4**	**$2,492.1**	**$2,888.1**	**$3,326.8**

EPA Estimates

11.3 Analysis of Benefits to Drinking Water Treatment

This section summarizes the estimation of total baseline expenditures to remove sediments from drinking water and the avoided costs expected with the reduction of sediment discharges anticipated from the C&D regulation. Further details of this analysis and an expanded discussion of its results can be found in *Chapter 9* of the *Environmental Assessment Document.* The cost of drinking water treatment followed the following steps:

- Identifying rivers and streams modeled by SPARROW that are sources for drinking water treatment plants;
- Determining TSS reductions in these reaches;
- Estimating the chemical cost of treating the turbidity caused by TSS in these reaches;
- Estimating the cost of disposing of the sludge generated from this turbidity treatment;
- Estimating the total costs of drinking water treatment under the baseline and post-compliance scenarios; and,

- Estimating the avoided costs from decreased drinking water treatment costs due to the reduction in sediment discharged from construction sites.

To address uncertainty in its assumptions, EPA conducted a sensitivity analysis that varies assumptions about the treatment of highly turbid influent water[64] and the cost of chemical inputs, and the results of the following analyses present low, midpoint, and high benefits estimates (see *Chapter 9* of the *Environmental Assessment Document* for details).

The total avoided costs from lowered turbidity resulting from lower TSS concentrations in drinking water influent was estimated as the reduction in drinking water turbidity treatment costs between the baseline and post-compliance scenarios. Reductions in drinking water treatment costs for the three post-compliance regulatory scenarios are presented in *Table 11-9*, *Table 11-10*, *Table 11-11,* and *Table 11-12*.

The anticipated savings from reduced TSS and turbidity treatment at drinking water facilities are between $978,400 and $2.1 million, varying between the least and most stringent policy options and less dramatically between the low and high estimates. Policy Option 4 is expected to reduce TSS and turbidity treatment costs for drinking water facilities by between $1.5 and $1.9 million. Region 5 benefits most significantly from the TSS reductions expected from this regulatory action. The avoided costs in Region 5 under Option 1 account for more than half of the total national savings. Other regions receive a larger portion of benefits under Options 2 through 4, though Region 5 still accounts for the greatest proportion of the cost reductions, though Regions 4 and 6 also show significant savings under Options 2 through 4.

Option 1, which requires non-numeric effluent limitations for all sites, is EPA's least stringent policy option. Average turbidity reductions are less than 1 NTU for this policy option, and its monetized benefits range between $978,400 and $1.3 million, with a midpoint estimate of $1.2 million in reduced drinking water treatment costs.

Option 2 requires ATS on sites with 30 or more acres disturbed at one time and imposes a 13 NTU turbidity standard while requiring non-numeric effluent limitations on all sites and is similar to the option EPA proposed previously. This option reduces turbidity between 0.4 and 1.3 NTU, translating to $1.4 million to $1.9 million in savings, with a midpoint estimate of $1.8 million.

Option 3, EPA's most stringent policy option, requires ATS on sites with 10 or more acres disturbed at one time, imposes a 13 NTU turbidity standard on these sites, and requires non-numeric effluent limitations on all sites. This option reduces treated turbidity by an average of 0.7 NTU in the midpoint, ranging from 0.4 to 1.4 between the low and high estimates. Total avoided costs for this option are between $1.7 and slightly more than $2.1 million, with a midpoint estimate just below $2.1 million.

Option 4, the option EPA has selected for the final rule, requires passive treatment systems on all sites with 10 or more acres disturbed at one time, and establishes a numeric turbidity standard of 280 NTU (expressed as a daily maximum value) for sites required to implement passive treatment. In addition, all sites will be required to meet non-numeric effluent limitations. National average turbidity reductions from Option 4 range from 0.4 NTU to 1.3 NTU, with a midpoint estimate of 0.6 NTU. Total avoided costs for Option 4 range between $1.5 and $1.9 million, with a midpoint estimate of $1.8 million. While Option 4 is less stringent than Option 3, it is estimated to reduce turbidity in drinking water sources by nearly as much and to produce similar monetized benefits.

As construction site discharge is more likely to contain smaller particles that contribute less to TSS and more to turbidity, the high estimates for Options 2, 3, and 4 may be more relevant because EPA uses a conversion factor

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64 Influent turbidities exceeding 1,000 NTU are assumed to be allowed to settle, and the effectiveness of this process is varied between a 90% reduction in the low estimate and a 30% reduction in the high estimate, since a greater reduction means lower treatment costs and hence a lower estiamte

between TSS and turbidity that takes this into account. The high estimate for turbidity reductions under Option 2 is 1.3 NTU nationwide. Under Option 3, the high estimate is on average around 1.4 NTU nationwide. For Option 4, the selected option, nationwide reductions are 1.4 NTU. In Region 5, high estimates of reductions under all options are 4.1 NTU.

Table 11-9: Reduction in Drinking Water Treatment Costs Under Option 1

EPA Region	Average Reduction in Treated Turbidity (NTU)[a]			Avoided costs (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High
1	0.0	0.0	0.0	$4.0	$5.0	$5.8
2	0.1	0.5	1.8	$44.1	$91.2	$129.8
3	0.0	0.0	0.1	$8.0	$9.2	$9.3
4	0.4	0.5	1.0	$136.2	$161.1	$164.5
5	1.2	1.9	3.9	$515.0	$603.4	$616.6
6	0.3	0.5	1.1	$162.4	$194.1	$201.0
7	0.1	0.2	0.4	$11.3	$14.1	$15.8
8	0.0	0.0	0.0	$1.1	$1.3	$1.4
9	0.1	0.1	0.2	$7.6	$9.9	$11.3
10	0.1	0.2	0.3	$88.7	$110.4	$110.4
Total	**0.2**	**0.4**	**0.9**	**$978.4**	**$1,199.8**	**$1,265.9**

[a] Average Turbidity reductions shown as 0.0 are not actually zero, but not sufficiently large to show at this level of significant digits

EPA Estimates

Table 11-10: Reduction in Drinking Water Treatment Costs Under Option 2

EPA Region	Average Reduction in Treated Turbidity (NTU)[a]			Avoided costs (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High
1	0.0	0.0	0.1	$8.2	$10.2	$11.7
2	0.1	0.6	1.8	$50.8	$99.4	$138.4
3	0.1	0.1	0.2	$24.0	$27.7	$27.8
4	0.7	1.0	1.9	$258.9	$307.6	$318.3
5	1.2	2.0	4.1	$526.6	$618.4	$633.7
6	0.7	1.1	2.3	$341.5	$408.3	$422.5
7	0.2	0.4	0.8	$23.5	$29.3	$33.0
8	0.0	0.0	0.1	$2.2	$2.7	$2.9
9	0.1	0.2	0.4	$15.8	$20.5	$23.3
10[b]	0.2	0.3	0.6	$195.9	$244.9	$244.9
Total	**0.4**	**0.6**	**1.3**	**$1,447.4**	**$1,769.1**	**$1,856.6**

a Average Turbidity reductions shown as 0.0 are not actually zero, but not sufficiently large to show at this level of significant digits

EPA Estimates

Table 11-11: Reduction in Drinking Water Treatment Costs Under Option 3

EPA Region	Average Reduction in Treated Turbidity (NTU)			Avoided costs (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High
1	0.0	0.1	0.1	$10.2	$12.7	$14.6
2	0.1	0.6	1.8	$54.1	$103.7	$143.2
3	0.1	0.1	0.2	$31.8	$36.6	$36.7
4	0.8	1.2	2.2	$312.7	$370.7	$383.2
5	1.2	2.0	4.1	$532.4	$626.4	$643.0
6	0.9	1.4	2.8	$428.6	$513.1	$531.2
7	0.3	0.5	1.0	$29.3	$36.6	$41.2
8	0.0	0.0	0.1	$2.7	$3.4	$3.7
9	0.1	0.2	0.5	$20.1	$26.9	$31.4
10[a]	0.3	0.4	0.7	$237.0	$320.3	$320.3
Total	**0.4**	**0.7**	**1.4**	**$1,658.9**	**$2,050.5**	**$2,148.5**

EPA Estimates

Table 11-12: Reduction in Drinking Water Treatment Costs Under Option 4

EPA Region	Average Reduction in Treated Turbidity (NTU)			Avoided costs (thousands of 2008$)		
	Low	Mid	High	Low	Mid	High
1	0.0	0.0	0.1	$6.8	$8.5	$9.7
2	0.1	0.6	1.8	$50.3	$98.8	$137.8
3	0.1	0.1	0.2	$25.6	$29.6	$29.6
4	0.7	1.1	2.0	$281.1	$333.5	$344.8
5	1.2	2.0	4.1	$526.8	$618.8	$634.2
6	0.8	1.3	2.6	$396.9	$474.5	$490.6
7	0.2	0.4	0.9	$27.0	$33.7	$37.8
8	0.0	0.0	0.1	$2.2	$2.8	$3.1
9	0.1	0.2	0.4	$16.4	$21.5	$24.7
10[a]	0.2	0.2	0.4	$145.5	$181.9	$181.9
Total	**0.4**	**0.6**	**1.3**	**$1,478.7**	**$1,803.5**	**$1,894.3**

EPA Estimates

11.4 Analyzing the Benefits of Water Quality Improvement

As discussed in the preceding sections of this chapter, sediments and other pollutants from construction sites are expected to have a wide range of effects on water resources in the vicinity of construction sites. The changes in the cost of providing key market-valued services that are affected by sediment discharges are monetized in the preceding sections. In addition to the reductions in the costs of providing these market-valued services to society, non-market benefits or existence services such as aquatic life, wildlife, and habitat designated use (Freeman 2003), which accompany improvements in water quality, need to be considered as part of a comprehensive assessment of the expected benefits of the C&D regulation.

To link water quality changes from reduced sediment runoff to effects on human uses and support for aquatic and terrestrial species habitat, this analysis utilizes a water quality index (WQI). The WQI used in this analysis builds on McClelland's work, and the methodology developed by Dunnette (1979), which was subsequently updated by Cude (2001) to better account for spatial and morphologic variability in the natural characteristics of streams . The WQI developed by Cude (2001) does not explicitly account for turbidity associated with water quality impacts from TSS and eutrophication. This index is linked to specific pollutant levels, which in turn are linked to the presence of aquatic species and suitability for particular recreational uses. The WQI allows the use of objective water quality parameters (e.g., dissolved oxygen concentrations) to characterize ecosystem services or uses provided by a given water body. The WQI is measured on a scale from 0 to 100, where 0 is poor quality and 100 is excellent. The complete description and associated equations and tables can be found in *Chapter 10* of the *Environmental Assessment Document*.

This section describes the use of meta-analysis of previous surface water valuation studies to provide a basis for estimating benefits of water quality improvements resulting from the C&D regulation. The technical details involved in the estimation of original meta-analyses are presented in *Chapter 10* and *Appendix A* of the *Environmental Assessment Document* as well as in sources such as Johnston et al. (2005; 2006), Bateman and Jones (2003), Shrestha et al. (2007), Rosenberger and Phipps (2007), and U.S. EPA (2004c).

11.4.1 Estimated Changes in Water Quality (ΔWQI) from the C&D Regulation

To estimate benefits of water quality improvements expected from the C&D regulation, EPA estimated WQI values for each regulatory option. In calculating the post-compliance WQI value, the Agency used option-specific TSS concentrations from the SPARROW output. The sediment loading estimates for each regulatory option reflect the expected reduction in sediment runoff under the regulatory options. EPA also estimated total nitrogen (TN) and total phosphorus (TP) concentrations using ratios relating TN and TP to sediment concentrations. This calculation allows EPA to estimate benefits resulting from reduced concentrations of these nutrients in surface water as they also factor into the WQI calculation. The other contributing parameters to the WQI were held constant for all regulatory options.

Each RF1 reach that has an improved WQI value from the baseline scenario to a regulatory option contributes to the estimated economic benefits. Based on the estimated WQI value under the baseline scenario, EPA categorized each RF1 reach using four WQI ranges (WQI < 25, 25≤WQI<50, 50≤WQI<70, and 70≤WQI). These ranges represent water that is not even suitable for boating (<25), suitable for boating and rough fishing (25-50), suitable for game fishing (50-70), and suitable for swimming (>70). For each WQI category under the baseline scenario and regulatory options in a given state, EPA estimated weighted average WQI using river miles as weights.

The difference in WQI between baseline conditions and a given rulemaking scenario is a measure of the change in water quality attributable to the regulatory option. To monetize benefits of the C&D regulation, EPA used three ranges of water quality improvements ΔWQI≤0.1, 0.1<ΔWQI≤0.5, 0.5< ΔWQI. For each combination of the baseline water quality category and the improvement range, the Agency estimated average ΔWQI and the corresponding percentage of total river miles in the state.

Table 11-13, Table 11-14, Table 11-15, and *Table 11-16* summarize changes in ambient water quality resulting from the C&D regulation. *Appendix H* of the *Environmental Assessment Document* provides more detail on water quality improvements by the baseline WQI range.

EPA estimated that Option 1 will have the least water quality improvements across all EPA regions. Households in all regions are expected to benefit from water quality improvements under this option. EPA Region 4 is expected to the have the greatest improvements in water quality under this option. Option 2 is estimated to improve ambient water quality in 17.9 percent of RF1 river miles included in the analysis. Regions 4 and 6 are estimated to see improvements in water quality in more than 30 percent of their total RF1 river miles. Policy Option 3 yields the most significant results overall in terms of RF1 miles expected to improve under the post-compliance scenario. The estimated scale of improvements ranges from 3.2 percent to 55.6 percent of total RF1 river miles in Region 8 and 4, respectively. Option 4 is estimated to generate improvements in 18.2 percent of river miles nationally, with improvements in more than 50 percent of reaches in Region 4 and in more than 30% of reaches in Region 6.

Table 11-13: Estimated Water Quality Improvements Under Option 1

EPA Region	Baseline Scenario		Water Quality Improvements by WQI Change											
			0.01 < ΔWQI < 0.1			0.1 < ΔWQI < 0.5			0.5 < ΔWQI			Total Improved Reaches		
	RFI Miles Receiving Constructio n Discharges	Miles of River in RF1 Network	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles
1	16,182	18,324	1,696	10.48%	9.25%	31	0.19%	0.17%	29	0.18%	0.16%	1,756	10.85%	9.58%
2	15,140	16,110	415	2.74%	2.57%	0	0.00%	0.00%	0	0.00%	0.00%	415	2.74%	2.57%
3	28,904	33,617	1,539	5.33%	4.58%	114	0.39%	0.34%	0	0.00%	0.00%	1,653	5.72%	4.92%
4	90,435	94,525	26,210	28.98%	27.73%	3,172	3.51%	3.36%	529	0.59%	0.56%	29,911	33.07%	31.64%
5	68,285	71,550	2,931	4.29%	4.10%	132	0.19%	0.18%	4	0.01%	0.01%	3,067	4.49%	4.29%
6	95,098	98,681	17,902	18.82%	18.14%	4,227	4.44%	4.28%	1,227	1.29%	1.24%	23,355	24.56%	23.67%
7	60,909	60,909	4,196	6.89%	6.89%	562	0.92%	0.92%	168	0.28%	0.28%	4,926	8.09%	8.09%
8	130,311	130,311	495	0.38%	0.38%	64	0.05%	0.05%	362	0.28%	0.28%	921	0.71%	0.71%
9	54,228	56,492	1,360	2.51%	2.41%	134	0.25%	0.24%	151	0.28%	0.27%	1,646	3.03%	2.91%
10	68,189	69,524	3,541	5.19%	5.09%	1,322	1.94%	1.90%	542	0.79%	0.78%	5,404	7.93%	7.77%
National Total	**627,679**	**650,043**	**60,285**	**9.60%**	**9.27%**	**9,757**	**1.55%**	**1.50%**	**3,012**	**0.48%**	**0.46%**	**73,054**	**11.64%**	**11.24%**

Source: EPA Estimates

Table 11-14: Estimated Water Quality Improvements Under Option 2

EPA Region	Baseline Scenario		Water Quality Improvements by WQI Change											
			0.01 < ΔWQI < 0.1			0.1 < ΔWQI < 0.5			0.5 < ΔWQI			Total Improved Reaches		
	RFI Miles Receiving Construction Discharges	Miles of River in RF1 Network	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles
1	16,182	18,324	3,035	18.75%	16.56%	235	1.45%	1.28%	41	0.25%	0.22%	3,310	20.46%	18.06%
2	15,140	16,110	1,527	10.09%	9.48%	5	0.03%	0.03%	0	0.00%	0.00%	1,532	10.12%	9.51%
3	28,904	33,617	4,483	15.51%	13.34%	108	0.37%	0.32%	30	0.10%	0.09%	4,621	15.99%	13.74%
4	90,435	94,525	37,936	41.95%	40.13%	6,594	7.29%	6.98%	1,288	1.42%	1.36%	45,817	50.66%	48.47%
5	68,285	71,550	5,889	8.62%	8.23%	409	0.60%	0.57%	85	0.12%	0.12%	6,383	9.35%	8.92%
6	95,098	98,681	21,442	22.55%	21.73%	7,185	7.56%	7.28%	2,912	3.06%	2.95%	31,540	33.17%	31.96%
7	60,909	60,909	6,719	11.03%	11.03%	1,000	1.64%	1.64%	261	0.43%	0.43%	7,980	13.10%	13.10%
8	130,311	130,311	1,365	1.05%	1.05%	90	0.07%	0.07%	367	0.28%	0.28%	1,821	1.40%	1.40%
9	54,228	56,492	2,088	3.85%	3.70%	219	0.40%	0.39%	186	0.34%	0.33%	2,493	4.60%	4.41%
10	68,189	69,524	4,295	6.30%	6.18%	1,592	2.33%	2.29%	1,044	1.53%	1.50%	6,931	10.16%	9.97%
National Total	**627,679**	**650,043**	**88,779**	**14.14%**	**13.66%**	**17,436**	**2.78%**	**2.68%**	**6,214**	**0.99%**	**0.96%**	**112,429**	**17.91%**	**17.30%**

Source: EPA Estimates

Table 11-15: Estimated Water Quality Improvements Under Option 3

EPA Region	Baseline Scenario		Water Quality Improvements by WQI Change											
			0.01 < ΔWQI < 0.1			0.1 < ΔWQI < 0.5			0.5 < ΔWQI			Total Improved Reaches		
	RFI Miles Receiving Construction Discharges	Miles of River in RF1 Network	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles
1	16,182	18,324	3,717	22.97%	20.29%	301	1.86%	1.64%	41	0.25%	0.22%	4,059	25.08%	22.15%
2	15,140	16,110	2,142	14.15%	13.29%	5	0.03%	0.03%	0	0.00%	0.00%	2,147	14.18%	13.33%
3	28,904	33,617	6,084	21.05%	18.10%	163	0.56%	0.48%	30	0.10%	0.09%	6,277	21.72%	18.67%
4	90,435	94,525	40,092	44.33%	42.41%	8,244	9.12%	8.72%	1,610	1.78%	1.70%	49,945	55.23%	52.84%
5	68,285	71,550	7,228	10.59%	10.10%	630	0.92%	0.88%	85	0.12%	0.12%	7,943	11.63%	11.10%
6	95,098	98,681	23,679	24.90%	24.00%	8,228	8.65%	8.34%	3,487	3.67%	3.53%	35,395	37.22%	35.87%
7	60,909	60,909	7,473	12.27%	12.27%	1,300	2.13%	2.13%	319	0.52%	0.52%	9,092	14.93%	14.93%
8	130,311	130,311	3,677	2.82%	2.82%	111	0.09%	0.09%	376	0.29%	0.29%	4,164	3.20%	3.20%
9	54,228	56,492	2,834	5.23%	5.02%	282	0.52%	0.50%	222	0.41%	0.39%	3,338	6.16%	5.91%
10	68,189	69,524	4,405	6.46%	6.34%	1,812	2.66%	2.61%	1,170	1.72%	1.68%	7,387	10.83%	10.63%
National Total	**627,679**	**650,043**	**101,332**	**16.14%**	**15.59%**	**21,075**	**3.36%**	**3.24%**	**7,340**	**1.17%**	**1.13%**	**129,747**	**20.67%**	**19.96%**

Source: EPA Estimates

Table 11-16: Estimated Water Quality Improvements Under Option 4

EPA Region	Baseline Scenario		Water Quality Improvements by WQI Change											
			0.01 < ΔWQI < 0.1			0.1 < ΔWQI < 0.5			0.5 < ΔWQI			Total Improved Reaches		
	RFI Miles Receiving Construction Discharges	Miles of River in RF1 Network	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles	River Miles	% of River Miles Receiving Construction Discharges	% of Total River Miles
1	16,182	18,324	2,338	14.45%	12.76%	156	0.96%	0.85%	29	0.18%	0.16%	2,522	15.59%	13.77%
2	15,140	16,110	1,433	9.47%	8.90%	5	0.03%	0.03%	0	0.00%	0.00%	1,438	9.50%	8.93%
3	28,904	33,617	4,620	15.98%	13.74%	108	0.37%	0.32%	30	0.10%	0.09%	4,758	16.46%	14.15%
4	90,435	94,525	38,507	42.58%	40.74%	7,159	7.92%	7.57%	1,465	1.62%	1.55%	47,130	52.12%	49.86%
5	68,285	71,550	5,979	8.76%	8.36%	377	0.55%	0.53%	85	0.12%	0.12%	6,441	9.43%	9.00%
6	95,098	98,681	21,693	22.81%	21.98%	7,819	8.22%	7.92%	3,313	3.48%	3.36%	32,825	34.52%	33.26%
7	60,909	60,909	6,860	11.26%	11.26%	1,205	1.98%	1.98%	280	0.46%	0.46%	8,345	13.70%	13.70%
8	130,311	130,311	1,282	0.98%	0.98%	90	0.07%	0.07%	367	0.28%	0.28%	1,739	1.33%	1.33%
9	54,228	56,492	2,166	3.99%	3.83%	197	0.36%	0.35%	186	0.34%	0.33%	2,548	4.70%	4.51%
10	68,189	69,524	3,894	5.71%	5.60%	1,380	2.02%	1.99%	943	1.38%	1.36%	6,217	9.12%	8.94%
National Total	**627,679**	**650,043**	**88,772**	**14.14%**	**13.66%**	**18,495**	**2.95%**	**2.85%**	**6,696**	**1.07%**	**1.03%**	**113,963**	**18.16%**	**17.53%**

Source: EPA Estimates

11.4.2 Benefits of Water Quality Improvements

To estimate non-market benefits of water quality improvements resulting from the C&D regulation, EPA used a benefits transfer function based on meta-analysis results presented in *Appendix G* of the *Environmental Assessment Document*. The general approach follows standard methods illustrated by Johnston et al. (2005) and Shrestha et al. (2007), among many others (see Rosenberger and Phipps 2007). This function allows the Agency to forecast WTP based on assigned values for model variables, chosen to represent a resource change in the C&D policy context.

Table 11-17 presents mean values and confidence interval boundaries of household WTP for water quality improvements resulting form reduced sediment discharges from construction sties by EPA region and regulatory option.

Table 11-17 :Average Household Willingness to Pay[a] for Water Quality Improvement by Region (2008$)

EPA Region	Option 1 Lower 10% Bound	Option 1 Mean	Option 1 Upper 90% Bound	Option 2 Lower 10% Bound	Option 2 Mean	Option 2 Upper 90% Bound	Option 3 Lower 10% Bound	Option 3 Mean	Option 3 Upper 90% Bound	Option 4 Lower 10% Bound	Option 4 Mean	Option 4 Upper 90% Bound
1	$0.14	$0.87	$1.96	$0.36	$2.13	$4.74	$0.50	$2.94	$6.54	$0.30	$1.82	$4.08
2	$0.04	$0.30	$0.66	$0.17	$1.10	$2.45	$0.25	$1.63	$3.66	$0.16	$1.08	$2.42
3	$0.09	$0.56	$1.24	$0.28	$1.71	$3.79	$0.40	$2.40	$5.31	$0.29	$1.76	$3.90
4	$1.14	$4.39	$9.07	$1.90	$7.05	$14.37	$2.17	$7.87	$15.96	$1.96	$7.23	$14.73
5	$0.09	$0.49	$1.07	$0.21	$1.13	$2.45	$0.27	$1.43	$3.09	$0.22	$1.16	$2.51
6	$1.19	$3.98	$7.87	$1.88	$5.83	$11.28	$2.16	$6.59	$12.68	$2.05	$6.23	$11.98
7	$0.42	$1.62	$3.32	$0.70	$2.63	$5.34	$0.82	$2.97	$5.98	$0.76	$2.80	$5.64
8	$0.45	$0.80	$1.25	$0.47	$0.93	$1.52	$0.54	$1.29	$2.29	$0.47	$0.91	$1.48
9	$0.17	$0.64	$1.30	$0.26	$0.98	$2.01	$0.30	$1.16	$2.37	$0.26	$0.99	$2.02
10	$0.64	$2.20	$4.41	$0.98	$3.04	$5.93	$1.10	$3.33	$6.42	$0.84	$2.68	$5.26
National	**$0.49**	**$1.85**	**$3.78**	**$0.83**	**$3.10**	**$6.33**	**$0.97**	**$3.63**	**$7.41**	**$0.86**	**$3.17**	**$6.45**

[a] EPA used the Krinsky and Robb (1986) procedure to estimate the lower and upper bound value of the total WTP for each region, based on the results of the total WTP regression model. The Agency notes that this analysis provides confidence limits for WTP estimates related to the covariance matrix of meta-analysis parameter estimates.

EPA Estimates

As shown in *Table 11-17*, the estimated national average household WTP for water quality improvements resulting from the regulation range from $1.85 to $3.49 per household. The estimated WTP values vary greatly across EPA regions depending on the policy option and the level of construction stormwater discharge and improvement in a given region.

EPA estimates that Option 1 will have the least water quality improvements across all EPA regions. Households in all regions are expected to benefit from water quality improvements under this option. EPA Region 4 is expected to the have the greatest improvements in water quality under this option. The estimated WTP per household in Region 4 has a 10^{th} percentile value of $1.14 per household and a 90^{th} percentile value of $9.07 per household, with an average WTP of $4.39. Region 2 has the smallest household WTP, with a mean value of $0.30 per household. Nationwide, household WTP has a mean value of $1.85 and 80 percent confidence interval bounds ranging from $0.49 to $3.78.

Option 2 is estimated to improve ambient water quality in 17.9 percent of RF1 river miles included in the analysis. The estimated national average WTP for water quality improvements resulting from the regulation is $3.10 per household per year. Regions 4 and 6 are estimated to see improvements in water quality in more than 30 percent of their total RF1 river miles. EPA's analysis suggests that Region 4 households would be willing to pay the most ($7.05per household per year) for water quality improvements resulting from the proposed regulation.

Region 6 has the second largest household WTP of $5.83. Conversely, households located in Region 2 are estimated to have the lowest WTP for water quality improvements from the regulation, $1.10.

Policy Option 3 yields the most significant results overall in terms of RF1 miles expected to improve under the post-compliance scenario. The estimated scale of improvements ranges from 3.2 percent to 55.6 percent of total RF1 river miles in Region 8 and 4, respectively. Nationwide, the 90th percentile value for the estimated per-household WTP has a 10th percentile value of $0.97 and a 90th percentile value of $7.41, with a mean value of $3.63.

Option 4 is estimated to generate improvements in 18.2 percent of river miles nationally. These improvements result in a national average household WTP is $3.17 with 80 percent confidence interval bounds ranging from $0.86 to $6.45 As with the other options, Region 4 has the largest average household WTP value ($7.23). Conversely, EPA Region 8 has the lowest value with a mean of $0.91.

11.4.3 Estimating Total WTP for Water Quality Improvements

For each regulatory option, EPA calculated state-level WTP as follows. First, EPA estimated mean state-level per-household WTP for each combination of the baseline water quality category ($WQI_{baseline}$) and the expected change in WQI (ΔWQI). The Agency then assigned each affected reach a mean household WTP value based on reach location, baseline water quality, and change in water quality. The WTP was then multiplied by the number of households in a given state in 2006 and the percentage of river miles in that state that comprise a given reach. The number of households per state was calculated by taking U.S. Census Bureau population estimates for 2006 for each state and dividing by the average number of people per household for a given state as reported in U.S. Census Bureau (2006a, 2006b). The total WTP equation for each reach is provided below (Equation 1):

$$TWTP_{reach} = WTP(WQI_{baseline}, \Delta WQI) \times StateHH \times PercentRiverMiles) \qquad (1)$$

Where:

$TWTP_{reach}$	=	the reach-level welfare change from improved water quality
WTP	=	the estimated state-level per-household WTP for water quality improvement for a given combination of the baseline water quality category ($WQI_{baseline}$) and the expected change in water quality under the post-compliance scenario (ΔWQI)
StateHH	=	the number of households in a given state
PercentRiverMiles	=	the percentage of total river miles that are comprised of a given reach

Finally, EPA aggregated reach-level benefits to the regional level. The regional benefits for the 10 EPA regions were then combined to calculate the national benefit of the regulation. *Table 11-18* presents estimated benefits of the C&D regulation by EPA region and regulatory option.

Table 11-18 :Regional Willingness to Pay for Water Quality Improvement (Millions 2008$)

EPA Region	Option 1			Option 2			Option 3			Option 4		
	Lower 10% Bound	Mean	Upper 90% Bound	Lower 10% Bound	Mean	Upper 90% Bound	Lower 10% Bound	Mean	Upper 90% Bound	Lower 10% Bound	Mean	Upper 90% Bound
1	$0.81	$4.93	$11.10	$2.06	$12.07	$26.84	$2.84	$16.67	$37.03	$1.71	$10.32	$23.09
2	$0.45	$3.10	$6.94	$1.76	$11.50	$25.67	$2.63	$17.14	$38.36	$1.71	$11.30	$25.35
3	$1.07	$6.45	$14.23	$3.27	$19.70	$43.59	$4.58	$27.61	$61.08	$3.36	$20.30	$44.94
4	$26.41	$101.44	$209.34	$43.94	$162.70	$331.84	$50.10	$181.69	$368.63	$45.36	$167.04	$340.13
5	$1.78	$9.92	$21.64	$4.27	$22.97	$49.85	$5.43	$29.01	$62.88	$4.37	$23.52	$51.02
6	$15.62	$52.44	$103.61	$24.72	$76.74	$148.49	$28.45	$86.74	$166.91	$27.01	$82.05	$157.72
7	$2.28	$8.86	$18.12	$3.84	$14.37	$29.15	$4.49	$16.24	$32.67	$4.17	$15.27	$30.81
8	$1.76	$3.17	$4.91	$1.85	$3.66	$5.97	$2.12	$5.08	$9.03	$1.84	$3.60	$5.83
9	$2.67	$9.95	$20.26	$4.04	$15.32	$31.28	$4.72	$18.09	$36.97	$4.08	$15.43	$31.47
10	$2.90	$10.01	$20.09	$4.45	$13.86	$27.03	$5.03	$15.16	$29.25	$3.82	$12.21	$23.97
National	**$55.75**	**$210.27**	**$430.24**	**$94.19**	**$352.90**	**$719.72**	**$110.39**	**$413.41**	**$842.81**	**$97.44**	**$361.04**	**$734.34**

EPA Estimates

From this analysis, EPA estimates that the mean values for total annual benefits of water quality improvements resulting from reduced sediment discharge from construction sites range from $210.27 million under Option 1 to $397.17 million under Option 3. The estimated mean regional benefits vary from $3.10 to $173.33 million per year, depending on the level of construction activity and average rainfall in a given region and stringency of the policy option.

As shown in *Table 11-18,* Option 1 generates the least water quality improvements of the four regulatory options. Thus, this option yields the smallest benefits at the regional and national levels. The national benefits of water quality improvements under this option have a 10^{th} percentile estimate of $55.75 million, a 90^{th} percentile estimate of $430.24 million, and a national average of $210.27 million. Region 4 gains the most benefit from water quality improvement, with a total value of $101.44 million (48.2 percent of the total national benefits). Region 6 has the second largest benefits ($52.44 million), which account for 24.9 percent of the total national benefits.

Under Option 2, the average national benefits are $352.90 million. The 90^{th} percentile value has a 10^{th} percentile value of $94.19 million and a 90^{th} percentile estimate of $719.72 million. Region 4 gains the most from water quality improvements resulting from the regulation ($162.70million). EPA Region 8 receives the smallest benefits, $3.66 million.

Under Option 3, the estimated mean national benefits of water quality improvement from the regulation are $413.41 million with a 10^{th} percentile estimate of $110.39 and a 90^{th} percentile value of $842.81 million. As with the other policy options Region 4 receives the largest benefits from water quality improvements, accounting for 46.1 percent ($181.69 million) of the total national benefits. Region 8 is anticipated to gain least under this Option 3, with the total regional benefits estimated at $5.08 million per year.

Option 4 is expected to generate national benefits of $361.04 million with a 10^{th} percentile estimate of $97.44 million and a 90^{th} percentile estimate of $734.34 million. EPA Region 4 gains the largest benefits, with a total of $167.04 million. Region 8 has the smallest improvements in water quality under this option, with improvements in only 1.33 percent of river miles, and thus has the smallest benefits with only $3.60 million.

11.5 Estimating Total Monetized Benefits

EPA estimated the total benefits under each post-compliance regulatory scenario by summing the benefits estimated for each of the first four sections of this chapter. *Table 11-19* presents low, midpoint, and high estimates of benefits under each policy option, consisting of benefits to navigation, water storage, drinking water treatment, and WTP. It should be noted that these tables incorporate 10^{th}, 50^{th}, and 90^{th} percentiles from the WTP analysis into the low, mid, and high sensitivity analyses performed for the avoided cost estimates. Though these are conceptually different, they are both intended to present a range of values to account for some of the uncertainty inherent in these estimates. The sensitivity analyses create a range by varying EPA's assumptions underlying the analysis, while the confidence interval presents high and low bounds from the meta-analysis regression.

All tables present benefits for navigable waterway and reservoir dredging calculated using both 3 and 7 percent discount rates. Because the discount rate only applies to two of the four monetized benefits categories (drinking water avoided costs and willingness-to-pay are estimated on a single-year basis), which represent at most 5 percent of total benefits, varying it has little effect on the total benefits estimate. The remaining discussion presents the benefits estimates assuming a 3 percent discount rate; the associated tables present results for both discount rates. EPA calculated benefits for drinking water treatment and WTP using a single-year timeframe, which did not require discounting or annualizing. All benefits presented reflect annual values.

Total national benefits vary significantly among the three regulatory options. Under Option 1, the estimated benefits range from approximately \$59.0 million to approximately \$434.3 million, with a midpoint estimate of \$214.1 million. Estimated avoided costs range from \$3.3 million to \$4.1 million, with a midpoint of \$3.8 million, and WTP varies between \$55.8 and \$430.2 million at the 10 and 90 percent confidence intervals, with a mean estimate of \$210.3 million.

For Option 2, the estimated benefits range from \$100.5 million to \$727.4 million, with a midpoint estimate of \$360.1 million. The estimated WTP for water quality improvements from reduced sediment discharges from construction sites under Option 2 ranges from \$94.2 to \$719.7 million, with a mean value of \$352.9 million. Estimated avoided costs range from \$6.3 million to \$7.7 million per year, with a midpoint estimate of \$7.2 million.

Under Option 3, total benefits are estimated to be between \$118.0 and \$852.2 million, with a midpoint estimate of \$422.3 million. The avoided costs are estimated to be between \$7.7 and \$9.4 million per year, with a midpoint estimate of \$8.9 million. WTP under Option 3 ranges between \$110.4 million and \$842.8 million at the 10 and 90 percent confidence intervals, with a mean value of \$413.4 million.

Under Option 4, the estimated benefits range from \$104.3 million to \$742.7 million, with a midpoint estimate of \$368.9 million. Nonmarket benefits estimated based on household WTP for surface water quality improvements account for 93, 98, and 99 percent of total benefits from the regulation in the low, mid, and high estimates, respectively. The estimated WTP for water quality improvements from reduced sediment discharges from construction sites under Option 4 ranges from \$97.4 to \$734.3 million, with a mean value of \$361.0 million. The estimated avoided costs to industry and government through reduced costs of navigable waterway maintenance, reservoir dredging, and drinking water treatment range from \$6.8 million to \$8.3 million per year, with a midpoint estimate of \$7.9 million. Under Option 4, avoided cost benefits account for 7, 2, and 1 percent of total benefits in the low, mid, and high estimates, respectively. Because this option requires passive treatment at sites with more than 10 acres of land disturbed and establishes a numeric effluent limit, its benefits are more than double those of Option 1, which does not establish numeric criteria for sediment discharge. It also produces more benefits than Option 2, which requires active treatment of sediment but on fewer sites. Benefits under Option 4 are nearly as high as those under Option 3, which would require active sediment treatment on the same sites where Option 4 requires passive treatment, the latter being burdensome.

Table 11-19 Total National Benefits by Benefit Category (million 2008$)

Benefit Category	3% Discount Rate			7% Discount Rate		
	Low	Mid	High	Low	Mid	High
Option 1						
Navigation	$1.0	$1.3	$1.3	$1.0	$1.2	$1.3
Water Storage[a]	$1.3	$1.4	$1.5	$1.1	$1.2	$1.4
Drinking Water[a]	$1.0	$1.2	$1.3	$1.0	$1.2	$1.3
Avoided Costs	*$3.3*	*$3.8*	*$4.1*	*$3.1*	*$3.7*	*$4.0*
WTP[a]	$55.8	$210.3	$430.2	$55.8	$210.3	$430.2
Total[b]	**$59.0**	**$214.1**	**$434.3**	**$58.8**	**$213.9**	**$434.2**
Option 2						
Navigation	$2.1	$2.6	$2.8	$2.1	$2.5	$2.7
Water Storage[a]	$2.7	$2.9	$3.0	$2.2	$2.6	$3.0
Drinking Water[a]	$1.4	$1.8	$1.9	$1.4	$1.8	$1.9
Avoided Costs	*$6.3*	*$7.2*	*$7.7*	*$5.8*	*$6.9*	*$7.5*
WTP[a]	$94.2	$352.9	$719.7	$94.2	$352.9	$719.7
Total[b]	**$100.5**	**$360.1**	**$727.4**	**$99.9**	**$359.8**	**$727.2**
Option 3						
Navigation	$2.7	$3.3	$3.4	$2.6	$3.2	$3.4
Water Storage[a]	$3.3	$3.6	$3.8	$2.8	$3.2	$3.7
Drinking Water[a]	$1.7	$2.1	$2.1	$1.7	$2.1	$2.1
Avoided Costs	*$7.7*	*$8.9*	*$9.4*	*$7.0*	*$8.4*	*$9.2*
WTP[a]	$110.4	$413.4	$842.8	$110.4	$413.4	$842.8
Total[b]	**$118.0**	**$422.3**	**$852.2**	**$117.4**	**$421.8**	**$852.0**
Option 4						
Navigation	$2.4	$2.9	$3.0	$2.3	$2.8	$3.0
Water Storage[a]	$3.0	$3.2	$3.4	$2.5	$2.9	$3.3
Drinking Water[a]	$1.5	$1.8	$1.9	$1.5	$1.8	$1.9
Avoided Costs	*$6.8*	*$7.9*	*$8.3*	*$6.3*	*$7.5*	*$8.2*
WTP[a]	$97.4	$361.0	$734.3	$97.4	$361.0	$734.3
Total[b]	**$104.3**	**$368.9**	**$742.7**	**$103.7**	**$368.5**	**$742.5**

[a] These savings were calculated for a one-year timeframe and that did not require discounting, and are equal under both discount rates
[b] Totals may not equal sum of categories due to rounding

EPA Estimates

Table 11-20, *Table 11-21*, *Table 11-22,* and *Table 11-23* detail total monetized benefits (including benefits to navigation, water storage, drinking water, and water quality) by region. Region 4 benefits the most from this regulation under all policy options, as it experiences the most widespread changes in terms of improved river miles and the most significant reductions in sediment concentrations in these river miles. This leads to higher WTP estimates in Region 4, which account for the largest proportion of benefits. Region 6 benefits second most, though monetized benefits in this region are about half of those in Region 4. Regions 4 and 6 together account for more than half of the benefits for all of the options. For Region 4, midpoint benefits estimates are $102.4, $164.7, $184.2, and $169.2 million, respectively under the four policy options. For Region 6, midpoint benefits estimates for the four options are $54.1, $80.1, $90.9, and $86.0 million, respectively.

Reductions in sediment pollution originating from construction site stormwater discharges are anticipated to reduce TSS and turbidity levels in waterbodies across the country, reducing costs of dredging navigable waterways and reservoirs and of drinking water treatment, as well as leading to improvements in water quality that benefit the general public. The value of these improvements derives directly from the magnitude of the sediment and turbidity reduction in waterbodies receiving construction site stormwater effluent.

Table 11-20 Total National Benefits Under Option 1 by EPA Region (million 2008$)

EPA Region	3% Discount Rate			7% Discount Rate		
	Low	Mid	High	Low	Mid	High
1	$0.8	$5.0	$11.1	$0.8	$5.0	$11.1
2	$0.5	$3.2	$7.1	$0.5	$3.2	$7.1
3	$1.1	$6.5	$14.3	$1.1	$6.5	$14.3
4	$27.3	$102.4	$210.4	$27.2	$102.4	$210.3
5	$2.3	$10.6	$22.3	$2.3	$10.6	$22.3
6	$17.1	$54.1	$105.3	$16.9	$54.0	$105.3
7	$2.3	$8.9	$18.2	$2.3	$8.9	$18.2
8	$1.8	$3.2	$4.9	$1.8	$3.2	$4.9
9	$2.7	$10.0	$20.3	$2.7	$10.0	$20.3
10	$3.0	$10.2	$20.3	$3.0	$10.2	$20.3
Total[a]	**$59.0**	**$214.1**	**$434.3**	**$58.8**	**$213.9**	**$434.2**

[a] Totals not equal to sum of regional data because the WTP model estimates the national values independently rather than summing regional values

EPA Estimates

Table 11-21: Total National Benefits Under Option 2 by EPA Region (million 2008$)

EPA Region	3% Discount Rate			7% Discount Rate		
	Low	Mid	High	Low	Mid	High
1	$2.1	$12.1	$26.9	$2.1	$12.1	$26.9
2	$1.8	$11.6	$25.8	$1.8	$11.6	$25.8
3	$3.4	$19.8	$43.7	$3.4	$19.8	$43.7
4	$45.7	$164.7	$333.9	$45.5	$164.6	$333.9
5	$4.9	$23.7	$50.6	$4.9	$23.7	$50.6
6	$27.7	$80.1	$152.0	$27.4	$79.9	$152.0
7	$4.0	$14.5	$29.3	$4.0	$14.5	$29.3
8	$1.9	$3.7	$6.0	$1.9	$3.7	$6.0
9	$4.2	$15.5	$31.5	$4.2	$15.5	$31.5
10	$4.8	$14.4	$27.6	$4.8	$14.4	$27.6
Total[a]	**$100.5**	**$360.1**	**$727.4**	**$99.9**	**$359.8**	**$727.2**

[a] Totals not equal to sum of regional data because the WTP model estimates the national values independently rather than summing regional values

EPA Estimates

Table 11-22: Total National Benefits Under Option 3 by EPA Region (million 2008$)

EPA Region	3% Discount Rate			7% Discount Rate		
	Low	Mid	High	Low	Mid	High
1	$2.9	$16.7	$37.1	$2.9	$16.7	$37.1
2	$2.7	$17.3	$38.5	$2.7	$17.3	$38.5
3	$4.7	$27.8	$61.2	$4.7	$27.7	$61.2
4	$52.3	$184.2	$371.2	$52.1	$184.0	$371.2
5	$6.1	$29.8	$63.7	$6.0	$29.7	$63.7
6	$32.2	$90.9	$171.3	$31.9	$90.7	$171.2
7	$4.7	$16.4	$32.9	$4.6	$16.4	$32.9
8	$2.1	$5.1	$9.1	$2.1	$5.1	$9.1
9	$4.9	$18.3	$37.2	$4.9	$18.3	$37.2
10	$5.5	$15.8	$30.0	$5.5	$15.8	$30.0
Total[a]	**$118.0**	**$422.3**	**$852.2**	**$117.4**	**$421.8**	**$852.0**

[a] Totals not equal to sum of regional data because the WTP model estimates the national values independently rather than summing regional values

EPA Estimates

Table 11-23: Total National Benefits Under Option 4 by EPA Region (million 2008$)

EPA Region	3% Discount Rate			7% Discount Rate		
	Low	Mid	High	Low	Mid	High
1	$1.7	$10.4	$23.1	$1.7	$10.4	$23.1
2	$1.8	$11.4	$25.5	$1.8	$11.4	$25.5
3	$3.5	$20.4	$45.1	$3.5	$20.4	$45.1
4	$47.3	$169.2	$342.4	$47.1	$169.1	$342.4
5	$5.0	$24.2	$51.8	$5.0	$24.2	$51.8
6	$30.5	$86.0	$161.8	$30.2	$85.8	$161.8
7	$4.3	$15.4	$31.0	$4.3	$15.4	$31.0
8	$1.9	$3.6	$5.8	$1.9	$3.6	$5.8
9	$4.2	$15.6	$31.6	$4.2	$15.6	$31.6
10	$4.1	$12.6	$24.4	$4.1	$12.6	$24.4
Total[a]	**$104.3**	**$368.9**	**$742.7**	**$103.7**	**$368.5**	**$742.5**

[a] Totals not equal to sum of regional data because the WTP model estimates the national values independently rather than summing regional values

EPA Estimates

11.6 Sources of Uncertainty and Limitations

Total national benefit estimates of the C&D regulation are subject to the limitations and uncertainties inherent in the valuation approaches used for assessing benefits to navigation, water storage, drinking water treatment, and non-market benefits of water quality improvement. Because the combined effect of these limitations and uncertainties is likely to underestimate national level of benefits of this regulation, the estimated benefits should be interpreted in the context of these limitations. Additional uncertainties and limitations specific to each category of monetized benefits are subsequently discussed.

11.6.1 Water Quality Model Limitations

To estimate benefits of reduced sediment loadings to surface water, EPA relied on SPARROW (**SPA**tially **R**eferenced **R**egressions **O**n **W**atershed attributes). The SPARROW model for suspended sediments has a number of limitations, some of which are inherent to the methodology and some the result of the particular model application. The key model limitations are:

- **Reliance on the Reach File 1 network**. While the RF1 network provides reasonably comprehensive national coverage of major rivers, streams and other surface water bodies, coverage is limited in certain important respects. RF1 network coverage is limited to the conterminous United States, thus excluding Alaska and Hawaii. In addition, while RF1 1:500,000-scale network reaches have associated data or estimates of stream discharge and velocity that are required to specify the SPARROW model, the network excludes the majority of the nation's total stream mileage, and smaller streams in particular. The linear coverage of the RF1 network is approximately 700,000 miles (www.epa.gov/waterscience/basins/metadata/rf1.htm). By contrast, coverage of the USGS National Hydrographic Dataset, at 1:24,000 - 1:100,000 scale, is currently over 7 million miles (USGS 2007). Given that RF1 accounts only for 10% of the total river miles, the impacts of construction-related sediment on smaller stream reaches are likely to be significantly understated. As construction activities may be concentrated along lower-order streams not included in the RF1 network, the relative share of total sediments contributed by construction activities may be high on these reaches during active construction phases. By contrast, the specific impacts of construction activities may diminish in importance relative to contributions from spatially extensive and diffuse land uses, including agriculture, at the level of RF1 reaches.

- **Estimation of changes in nutrient concentrations associated with changes in sediment loading.** The approach used to estimate changes in nutrient concentration resulting from reduction in sediment loadings is based on modeled long-term relationships between sediment and nutrient loadings within each of the modeled watersheds. This assumption follows observations from case studies discussed in Chapter 3 of the *Environmental Assessment Document*, which suggest a correlation between sediment loadings from construction sites and elevated nitrogen and phosphorus loadings. By using a fixed relationship, the approach assumes that nutrients are bound to the sediments and that methods used to reduce sediment runoff from construction sites are equally effective in reducing nitrogen and phosphorus runoff from these sites. There is currently insufficient information to assess the extent to which actual reductions may differ from this assumption. While phosphorus is often attached to the sediment and therefore may be more readily addressed by control measures that retain sediments on site, nitrogen is typically found in soluble forms, and sediment control measures may be less effective in reducing nitrogen loading.
- **Omission of all ponds and lakes and reservoirs located off the RF1 network from water quality analysis.** All lakes, ponds, and reservoirs located off RF1 network are not included in the SPARROW model and thus are excluded from estimation of monetized benefits. The 2002 *National Water Quality Inventory: Report to Congress* (U.S. EPA 2007) reports 40.6 million acres of lakes and reservoirs in the conterminous U.S. The RF1 network includes approximately 3.9 million acres or 9.5 % of the total lakes and reservoir acres in the U.S.[65] (U.S. EPA 2007). Omission of these water body types from the analysis of monetized benefits is likely to lead to understatement of benefits in three benefit categories: (1) nonmarket benefits of water quality improvements resulting from the C&D regulation, (2) reservoir dredging, and (3) drinking water treatment.
- **Restriction of the water quality analysis to the description of long-term mean water quality conditions**. Construction activities are, by definition, transient in nature, extending over weeks or months. Construction activities (unlike agricultural activities) are spatially compact, so they are sub-grid phenomena with respect to the specification of the national scale of the sparrow model. The restriction to mean water quality conditions precludes an analysis accounting for the frequency with which conditions of extreme sediment transport conditions occur (e.g., after a heavy storm event during the active construction period). Although the predicted changes in average water quality conditions may be small, the expected changes in sediment concentrations under extreme sediment transport conditions may be significant. The analysis also predicts average water quality conditions in a reach that are representative of the center line of that reach. TSS concentrations near shore are likely to be higher and the expected changes in ambient water quality conditions near shore are likely to be greater.

11.6.2 Focus on Selected Pollutants of Concern (Sediment and Nutrients)

- Existing case studies of environmental impacts associated with construction activities demonstrated that a number of pollutants are found in construction site discharges, including turbidity, BOD, metals, toxic organics, trash and debris, and other pollutants. However, EPA's analysis of benefits from reduced construction site discharges focuses only on water quality improvements resulting directly from reductions in total suspended solid, turbidity, and nutrient loadings. It does not include improvements resulting from reductions in other pollutant loadings, nor does it include improvements in water quality indicators indirectly associated with pollutant loadings. This is likely to result in underestimation of the expected water quality changes resulting from the proposed regulation because the combined impact of several pollutants on ambient water quality conditions is likely to be greater than the sum of the individual impacts of reducing concentrations of sediments and nutrients.

[65] The estimated total lake and reservoir acres do not include the Great Lakes.

11.6.3 Benefits to Navigation

- The USACE dredging database identifies dredging jobs by name, which is usually the name of the water body dredged. However, the data lack standardized naming conventions, so it is possible that the same water body is dredged under different names. This may result in the exclusion of dredging job names that only appear once in the database, but in fact were carried out in the same water bodies as a differently named job, which would result in a downward bias in EPA's dredging frequency calculations and the project costs.
- The navigable waterway data provide latitude/longitude information for some dredging jobs, which are used to link dredging jobs to RF1 reaches, but these data are incomplete. In cases where latitude/longitude information was not available for a particular job, EPA matched it to an RF1 reach using the job name. This is a potential source of inaccuracy, as the job name is often the waterway name, and may not be very specific (in cases such as the Mississippi or Colorado rivers). It is unclear whether this would lead to an over- or underestimate of benefits.

11.6.4 Benefits to Water Storage

- There is uncertainty as to the uniformity of sediment density, as it is related to the type of soil in the area. Using a single density to convert volume to weight for all sediment may reduce the accuracy of the resulting cost estimates. However, the direction of this potential bias is uncertain.
- The lack of data on reservoir dredging results in uncertainty as to the types of reservoirs that are dredged and the cost of this dredging.
- Though sediment pools are built to accumulate sediment and preserve the useful capacity of the reservoir, they may also fill up more rapidly than anticipated at their initial construction, increasing the sediment buildup in a reservoir and increasing the cost of dredging it. It is also possible that these sediment pools themselves may be dredged. This analysis assumes that to maintain the current water storage capacity in the United States, all influent sediment will have to be removed in some manner, or replaced. Building replacement capacity is environmentally disruptive and may be more costly than sediment removal by dredging, therefore this analysis assumes that dredging will be used to maintain reservoir capacity.

11.6.5 Benefits to Drinking Water Treatment

- Sediment filtration systems and pre-sedimentation (allowing water to sit and sediment to filter out before treatment) at drinking water treatment facilities reduce the sediment concentration of the water before it enters chemical treatment, so that the turbidity level of the water entering the facility is not the turbidity level that is eventually treated with coagulants. Assuming that the differential between pre- and post-compliance sediment concentration is proportional to the differential between pre- and post-compliance turbidity treatment introduces uncertainty, as the lower sediment levels may be more or less affected by the pre-sedimentation and filtration processes. EPA's analysis attempts to account for this uncertainty by varying the effectiveness of pre-sedimentation basins, and thus amount of TSS and turbidity treated by a drinking water treatment facility.
- If a drinking water treatment facility produces sludge that is toxic (due to other pollutants in the water besides sediment), its disposal costs may be significantly higher because toxic sludge disposal is more restricted and costly. If the facility cannot separate the sludge generated by sediment treatment from the sludge generated by treatment of toxics (which is likely the case), then all of its sludge will be characterized as toxic. This analysis will understate the cost of disposal (and thus understate the avoided costs of smaller quantities of sludge to be disposed of) for facilities that generate toxic sludge.

11.6.6 Omission of Several Benefit Categories from the Analysis of Monetized Benefits

Due to data limitations, EPA did not estimate benefits in several benefit categories. Although the magnitude of benefits in the omitted categories is uncertain, they may be substantial. *Chapter 4* of the *Environmental Assessment* provides a qualitative discussion of the omitted benefit categories. A brief summary of the omitted benefit categories is provided below:

- **Market values of properties located near water bodies.** Reducing sediment discharges from construction sites is likely to increase market values of properties located in the vicinity of construction sites by enhancing the aesthetic quality of the affected land and water resources (e.g., reducing erosion of river banks and improving water clarity).[66] This value would accrue to the owners of the benefiting properties, but like the avoided costs such as reduced dredging expense, is nevertheless an economic benefit to society.
- **Flood damages.** Reducing sediment discharges from construction sites is expected to reduce flooding damages by decreasing sedimentation of river beds and improving river capacity. Clark et al. (1985) estimated flooding damages attributable to sediment discharges to be $1.5 billion (2008$), annually. Therefore, even a small reduction in the frequency and severity of flooding is likely to generate significant benefits.
- **Ditch maintenance.** The proposed regulation is expected to reduce the costs of ditch maintenance by reducing the amount of sediment deposited in ditches.
- **Industrial water use.** The proposed regulation is expected to benefit industrial water users, as high levels of sediment increase wear on equipment. Reducing sediment concentrations in source waters will thus increasing the useful life of industrial equipment using these waters.
- **Agricultural water use.** The proposed regulation is expected to benefit agricultural producers. High sediment concentrations in surface water used for agricultural irrigation can harm crops by reducing absorption, inhibiting soil aeration, and creating dried layers of silt that may prevent seedlings from emerging. By reducing sediment discharges and, as a result, sediment deposition on farm land; this rule would lead to improvements in land productivity and enhanced marketability of agricultural products.
- **Commercial fishing:** Sediment runoff from construction sites has been documented to reduce standing fish crops and shellfish populations in receiving waterbodies, which may reduce the size of commercial harvest with negative market implications for both firms and consumers. Reducing sediment discharges can therefore allow for increased commercial harvests of fish and shellfish.

11.6.7 Willingness to Pay Estimate

A number of issues are common to all benefit transfers. Benefit transfer involves adapting research conducted for another purpose in the available literature to address the policy questions at hand. Because benefits analysis of environmental regulations rarely affords enough time to develop original stated preference surveys that are specific to valuing the policy effects, benefit transfer is often the only option to inform a policy decision. As a result, they are nearly universal in benefit-cost analyses (Smith et al. 2002).

- Benefit transfers are by definition characterized by a difference between the context in which resource values are estimated and that in which benefit estimates are desired (Rosenberger and Phipps 2007). The ability of meta-analysis to adjust for the influence of study, economic, and resource characteristics on

[66] The nonmarket component (i.e., increased satisfaction with the property) is implicitly accounted for in WTP for improvements in environmental services provided by surface waters affected by construction site discharges.

WTP can minimize, but not eliminate, potential biases (Rosenberger and Stanley 2006; Rosenberger and Phipps 2007; Smith et al. 2002). As is typical in applied benefit transfers, the meta-analysis model used in this analysis provides a close, but not perfect, match to the context in which values are desired. Some related and additional limitations inherent to the meta-analysis model and the subsequent benefit transfer include:

- It is difficult to identify accurately the beneficiary (human) population and characterize how household values attenuate with distance from the resource. The population considered in the benefits analysis of the C&D regulation does not represent all the households that are likely to hold values for water resources in a given state. Residents of other states may hold values for water resources outside of their home state, in particular if such resources have personal, regional or national significance.
- The Agency notes, as detailed by Loomis (1996; Loomis et al. 2000) and Bateman et al. (2006), among others, that there are numerous uncertainties and associated assumptions required to aggregate WTP across spatial jurisdictions. While these uncertainties are well known, the literature does not agree on appropriate, standardized guidance for benefit aggregations, and applied benefit-cost analysis almost universally requires simplifying assumptions in order to generate defensible welfare aggregations. In an ideal context, analysts would have information necessary to estimate spatially referenced distance decay relationships for all changes resulting from policies under consideration (cf. Bateman et al. 2006). However, the Agency notes that even the most advanced literature provides only simple illustrations of such issues, and none methodologically sufficient to support regulatory analysis. As a result, the population considered in the benefits analysis of the C&D regulation does not represent all the households that are likely to hold values for water resources in a given state. Residents of other states may hold values for water resources outside of their home state, in particular if such resources have personal, regional, or national significance.
- Some resource valuation studies have found that respondents in the typical contingent market situation may overstate their WTP compared to their likely behavior in a real-world situation. However, the magnitude of hypothetical bias on the estimated WTP is uncertain. Following standard benefit transfer approaches, including meta-analytic transfers, this analysis proceeds under the assumption that each source study provides a valid, unbiased estimate of the welfare measure under consideration (cf. Moeltner et al. 2007; Rosenberger and Phipps 2007). To minimize potential hypothetical bias EPA set independent variable values to reflect best benefit transfer practices.
- The estimation of WTP may be sensitive to differences in the environmental water quality measures. Studies that did not use the WQI were mapped to the WQI so a comparison could be made across studies. The dummy variable *(WQI)* captures the effect of a study using *(WQI*=1) or not using the WQI *(WQI*=0). It was found that studies that did not use the WQI had lower WTP values. This may indicate that there may have been some systematic biases in the mapping of studies that did not use the WQI. In analyzing, benefits of this regulation, EPA set WQI to one reduce uncertainty in WTP estimates associated with studies that did not include WQI as a native survey instrument.
- Transfer error may occur when benefit estimates from a study site are adopted to forecast the benefits of a policy site. Rosenberger and Stanley (2006) define transfer error as the difference between the transferred and actual, generally unknown, value. While meta-analysis is fairly accurate for estimating a benefit function, transfer error may be a problem in cases where the sample size is small. While meta-analyses have been shown to outperform other function-based transfer methods in many cases, this result is not universal (Shrestha et al. 2007). This notwithstanding, results reviewed by Rosenberger and Phipps (2007) are “very promising” for the performance of meta-analytic benefit transfers relative to alternative transfer methods.

12 Social Costs and Benefits of the Proposed Rule

This chapter brings together the total social costs, discussed in *Chapter 9,* and monetized total benefits, discussed in *Chapter 11,* to directly compare the estimated costs and benefits of the regulatory options.

12.1 Summary of Social Cost

Total social costs include:

- The quantity-adjusted resource cost of compliance to the private sector and to governments;
- The additional social welfare loss of the rule due to construction market effects; and,
- Government administrative costs for reviewing and processing discharge monitoring reports (DMR) and other start-up costs.

The resource cost to society of each regulatory option refers to the required cost of compliance having adjusted for the expected C&D market contraction due to the regulation. The regulation may have the effect of reducing C&D market output because the incremental cost of compliance for each option has the effect of increasing builders' costs, causing an upward shift in the market's supply curve. Part of the increased costs may raise the price of new housing, with the balance of increased costs being absorbed by the builder, depending on the relative elasticities of supply and demand. The resulting shift in market equilibrium may reduce the quantity of construction units produced. This quantity-adjusted measure of the resource cost of compliance is the primary contributor to total social cost for all four regulatory options.

The C&D market adjustments that arise from incurring the resource cost of compliance have a number of implications for the welfare of society. When the supply curve shifts as a result of incremental compliance costs, consumers lose some of their benefits from the product. The result is called a change in consumer surplus, and part of that loss eventually makes its way to the entities whose services are purchased to implement the requirements of the rule, and part of that loss becomes the consumer contribution to the additional welfare loss of the rule. There is also an analogous change in producer surplus. Some producer surplus is similarly transferred to other producers whose services are purchased to implement the regulation due the partial absorption of compliance costs, and another portion of producer surplus contributes to the additional welfare loss of the rule.

The last component of total social cost includes the administrative costs associated with state governments' administration of federal rule requirements to regulated entities within their jurisdictions. EPA assumed for the current analysis 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. However, EPA does expect an additional administrative burden to state government entities under the final rule. State governments will incur costs for processing and analyzing discharge monitoring reports (DMR's) for projects that incur cost under the rule as well as for other start-up activities discussed in *Chapter 14*.

As shown in *Table 12-1*, these three elements of cost sum to the total social cost of each regulatory option.

12.2 Summary of Partially Monetized Benefits

The reduction of sediment and other pollutants entering surface waters from construction sites as a result of the C&D regulation will have a wide range of market and nonmarket benefits, as described in *Chapter 11*. As noted previously in *Chapter 11* and emphasized here, EPA's estimate of total monetized benefits does not represent the full-range and magnitude of benefits expected from this rule because certain categories of benefits are not monetized.

EPA's partial monetization of benefits includes the following categories:

- Benefits to navigation;
- Benefits to water storage;
- Benefits to drinking water treatment; and,
- Benefits to water quality.

Benefits to navigation include reduced sediment settling in navigable channels, which in turn reduces the cost of dredging in these channels. Benefits to water storage include reduced sediment settling in reservoirs, which in turn reduces the cost of dredging in reservoirs that are currently dredged to recapture lost capacity. Benefits to drinking water treatment include reduced sediment, a reduction in the amount of chemicals needed for treatment, and a reduction in the amount of sludge generated from this treatment that must be disposed. Furthermore, reducing sediment levels in U.S. waterways has the general effect of improving water quality, as suspended sediment and turbidity are two of the determinants of water quality. Nutrients such as Nitrogen and Phosphorus that are bound to sediment will also be reduced along with sediment levels, and these nutrients are also determinants of water quality. Increased water quality has both explicit and implicit value to users of water bodies, which was quantified using willingness-to-pay estimates from a meta-analysis of existing WTP studies for water quality. The WTP estimate provides an estimate of the monetary value of use and nonuse benefits of water quality improvements, including swimming, fishing, boating, and other outings. And while property value increases stemming from water quality improvements and reduced flood risk due to decreased sediment were not monetized, general satisfaction with property and living conditions are implicit in the WTP estimate. However, all estimates of monetized benefits are subject to a degree of uncertainty resulting from limitations in the data EPA obtained on current dredging activity and drinking water treatment, as well as uncertainty inherent in WTP valuation. These uncertainties are described in detail in *Chapter 11, Section 11.6*. The estimates of monetized benefits presented in *Table 12-1*, below, are mid-point estimates from the ranges presented previously in *Table 2-12*.

EPA did not include benefits to commercial fishing and shell fishing or benefits to industrial and agricultural water use in its monetized benefits estimate due to insufficient data available, although these benefits may be substantial. The following categories of benefits were not able to be monetized (see *Chapter 11, Section 6.6*, or *Chapter 4* of the *Environemental Assessment Document* for more detail):

- Increased real estate values of properties located near waterbodies
- Reduced flood risk and damages
- Ditch maintenance
- Industrial water use
- Agricultural water use
- Benefits to commercial fishing

12.3 Comparison of Social Cost and Monetized Benefits

The elements of social cost and monetized benefits and the net monetized benefits are presented in *Table 12-1*.

Anticipated social costs are greater than the monetized benefits for all options, except option 1. It is important to emphasize once again that *Chapter 11* discusses several other classes of benefits that could not be monetized but are likely to provide real social benefits, and therefore, the estimate of monetized benefits is not as complete an estimate as that of total social cost.

Table 12-1: Comparison of Social Costs and the Monetized Portion of Benefits ($millions)

	Option 1	Option 2	Option 3	Option 4
Social Costs				
Resource Cost of Compliance	$176	$4,856	$9,059	$952
Government Administrative Cost	$0.0	$2.2	$6.2	$6.2
Additional Social Welfare Loss	$0.0	$5.0	$15.5	$0.15
Total Social Cost of the Regulation	$176	$4,863	$9,081	$959
Monetized Benefits[a]				
Benefits to Navigation	$1.3	$2.6	$3.3	$2.9
Benefits to Water Storage	$1.4	$2.9	$3.6	$3.2
Benefits to Drinking Water Treatment	$1.2	$1.8	$2.1	$1.8
Avoided Cost Subtotal	*$3.8*	*$7.2*	*$8.9*	*$7.9*
Water Quality Benefits	$210.3	$352.9	$413.4	$361.0
Total Monetized Benefits[b]	**$214.1**	**$360.1**	**$422.3**	**$368.9**
Net Benefit (Benefits minus Cost)	**$38**	**-$4,503**	**-$8,659**	**-$590**

[a] Based on a 3% social discount rate, (see *Chapter 11)*.

Totals may not sum due to rounding

Source: EPA Estimates

13 Assessing the Impact of the C&D Regulatory Options on Small Entities – Regulatory Flexibility Act (RFA) Analysis

The Regulatory Flexibility Act (RFA, 5 U.S.C. et seq., Public Law 96-354), amended by the 1996 Small Business Regulatory Enforcement Fairness Act (SBREFA), requires EPA to consider the economic impact that a new rule will have on small entities. The purpose of the RFA and SBREFA laws is to ensure that, in developing rules, agencies identify and consider ways to avoid undue impacts on small entities that will be affected by the regulation, whether as small entities that will be subject to regulatory requirements or as small governments that will be responsible for complying with or administering the regulation. Impacts on small governments are presented in the UMRA analysis, Chapter 14 in this document. While the RFA does not require an agency to minimize a rule's impact on small entities if there are legal, policy, factual, or other reasons for not doing so, it does require that agencies:

- Determine, to the extent feasible, the economic impact on small entities subject to the rule;
- Explore regulatory options for reducing any significant economic impact on a substantial number of such entities; and,
- Explain the ultimate choice of regulatory approach.

For any notice-and-comment rule it promulgates, EPA must either certify that the rule "will not, if promulgated, have a significant economic impact on a substantial number of small entities" ("SISNOSE") or prepare a Regulatory Flexibility Analysis if the Agency cannot make this certification. Small entities include small businesses and small organizations as defined by SBA, and governmental jurisdictions with populations of less than 50,000.

To evaluate the potential impact of the regulation on small entities, EPA conducted an RFA/SBREFA Screening Analysis, which includes:

- Determining the number of C&D firms subject to the rule within each NAICS industry and associated revenue range; and
- Estimating the potential economic impacts on small entities based on a cost-to-revenue analysis.

13.1 Definition of Affected Small Entities

The RFA defines a "small entity" as a small business (which is defined at the parent or firm level, not the establishment level), small not-for-profit organization, or small governmental jurisdiction. EPA expects that the principal impact of the C&D options on small entities will fall on small businesses that undertake C&D activities and small governmental units involved in complying with or permitting C&D activities.

The RFA provides that EPA generally define small businesses according to the size standards established by SBA. SBA establishes criteria for identifying small businesses based on either the number of employees or annual revenues (13 CFR 121). These size standards vary by NAICS (North American Industrial Classification System)code. Qualifying revenue levels differ among NAICS industries, and within the C&D industry under analysis are as follows:

- NAICS 236 (*Construction of Buildings*): $33.5 million
- NAICS 237 (*Heavy and Civil Engineering Construction*), except 2372: $33.5 million
- NAICS 2372 (*Land Subdivision* of NAICS 237): $7.0 million

13.2 Determining the Number of In-Scope Small C&D Firms

The SBA's *Statistics of U.S. Businesses* (SUSB) 2002 data provide the primary basis for estimating the number of small businesses potentially subject to the rule. As described in the industry profile (*Chapter 3*), a number of adjustments and exclusions were performed to determine the baseline universe of firms, revenue, employees, and average firm revenue for the C&D sectors that EPA estimates will be affected by the regulation. The baseline reflects only those sectors that can perform activities that result in land disturbance that are NPDES permitees and those with sufficient data for analysis. Based on the estimates of the number of firms by revenue size range within each of the relevant NAICS sectors, EPA used the small business revenue-size standards to estimate the number of small firms that could be within the scope of the C&D rule. The reported estimates of small business firms by NAICS sector are "best reasonable approximations" accounting for two considerations:

1. As described in *Chapter 4*, to support the the firm- and industry-level analysis, EPA allocated the Land Subdivision sector (NAICS 23721) among the four primary building construction sectors: NAICS 236115 – New single-family housing construction (except operative builders); NAICS 236116 – New multifamily housing construction (except operative builders); NAICS 236210 – Industrial building construction; and NAICS 236220 – Commercial and institutional building construction. As a result, this sector, which has a lower small business size criterion of $7.0 million, is blended in with sectors with a higher small business size criterion of $33.5 million. For the estimation of number of small entities potentially affected by the regulation and the assessment of potential impacts on those entities, EPA used the $33.5 million cut-off for separating small businesses and large businesses. As a result, EPA's implicit estimate of the number of small businesses in the Land Subdivision will likely overstate the actual number of small businesses in this sector, by including firms with revenue greater than $7.0 million in the small business count.
2. The small business size criterion used in this analysis ($33.5 million) lies within the SUSB/Economic Census revenue range of $10 to $50 million. As a result, it is not possible to estimate precisely from the SUSB firm data the number of those firms that are small businesses, according to the SBA business size criterion. Including *all* of the relevant revenue size range in the small firm count will overstate the number of small firms while including *none* of the relevant revenue size range in the small firm count will understate the small firm count. If firms were distributed uniformly by revenue size within this revenue range, then approximately 59 percent of the firms would qualify as small business.[67] However, based on the distribution of the *reported* numbers of firms by the *reported* revenue ranges for these industries – in which the larger numbers of firms lie in the lower revenue ranges – EPA expects that firms will not be uniformly distributed by revenue in this revenue range, and instead that firms will be disproportionately concentrated at the lower end of the range. Based on this expectation, for this analysis, EPA assumed that 75 percent of the firms in the $10 to $50 million revenue range would be small businesses.

As described in *Chapter 3*, a very large share of total C&D industry firms and a large absolute number of firms are likely to be defined as small businesses and will likely undertake activities within the scope of the C&D rule. Overall, EPA estimates that a total of 187,079 firms are in the C&D industry sectors of concern for this regulation. Of this total, EPA estimates that approximately 182,545 firms, or nearly 98 percent, are defined as small businesses (see *Table 13-1*, below).

Although a large percentage of C&D industry businesses are defined as small business, many of these firms work only on projects too small to be subject to the regulatory requirements of this rule. EPA assessed whether small businesses would likely perform projects of sufficient size to be within the scope of the C&D regulation using the methods described in *Chapter 6* for the firm- and industry-level analysis. EPA considers firms that are capable of completing at least the theoretically easiest of the 144 model project-types (i.e., a 1-acre project over a 3-year

[67] ($33.5 million -$10 million) ÷ ($50 million - $10 million) = 0.5875.

duration) to be within the potential scope of a C&D regulation. As detailed previously, this capability assessment is performed for each model firm category, and is a function of the project size and duration, and also the model firm's revenue, acreage intensity, and estimated number of projects going on at any one time. *Table 13-1* lists the total number of firms and small firms by sector, and also identifies the number of firms by sector and size classification that EPA estimates are capable of performing this project, based on the above factors. As shown in *Table 13-1*, EPA estimates that a much smaller number of small businesses, – approximately 77,115 firms – are capable of performing in-scope projects than the total of small businesses – approximately 182,000 – in the total C&D industry.

Table 13-1: Total Number of Small and Large Firms in the C&D Industry

NAICS Code	Sector[a]	Small		Large		Total
		Number	Percent of Total Firms in NAICS	Number	Percent of Total Firms in NAICS	
All Firms in Potentially Affected C&D Sectors						
236115	New single-family housing construction (except operative builders)	69,077	99.7%	215	0.3%	69,292
236116	New multifamily housing construction (except operative builders)	5,869	97.7%	141	2.3%	6,009
236117	New housing operative builders	29,491	97.2%	861	2.8%	30,351
236210	Industrial building construction	3,854	92.6%	309	7.4%	4,163
236220	Commercial and institutional building construction	64,798	96.4%	2,440	3.6%	67,238
237310	Highway, street, and bridge construction	9,471	94.3%	576	5.7%	10,047
Total		**182,560**	**97.6%**	**4,540**	**2.4%**	**187,100**
In-Scope Firms: Firms Estimated Capable of Completing a Single Project of at Least One Acre Size Over Three-Years or Less[b]						
236115	New single-family housing construction (except operative builders)	18,054	98.8%	215	1.2%	18,269
236116	New multifamily housing construction (except operative builders)	2,008	93.5%	141	6.5%	2,148
236117	New housing operative builders	15,180	94.6%	861	5.4%	16,040
236210	Industrial building construction	1,443	82.4%	309	17.6%	1,752
236220	Commercial and institutional building construction	30,959	92.7%	2,440	7.3%	33,399
237310	Highway, street, and bridge construction	9,471	94.3%	576	5.7%	10,047
Total		**77,115**	**94.4%**	**4,540**	**5.6%**	**81,655**

a Firms within NAICS 237210 – Land Subdivision – are allocated over the NAICS 236115, 236116, 236210, and 236220 building construction categories.
b.The in-scope test is based on an assumption of a 1-year lag between starting a new construction project (see *Chapter 6* for additional detail)
Note: Numbers do not necessarily add to totals due to rounding.
Source: U.S. SBA (2004), U.S. SBA (2008), U.S. Census Bureau's Economic Census (2005a), and EPA Analysis

13.3 Estimating Economic Impacts on Small C&D Firms

EPA assessed the impacts on small businesses by examining the ratio of estimated compliance costs to firm-level revenue based on model firm analysis of firm- and industry-level impacts. Impacts are determined by the number and percentage of businesses incurring costs that exceed 1 percent and 3 percent of revenue. EPA believes that, for the C&D industry, a SISNOSE determination should not be based primarily on the absolute number of small entities affected due to the nature of this industry. This judgment is based on the fact that (1) this industry is comprised of a very large number of firms *and* (2) virtually all of these firms (98 percent) are small firms, according to SBA size criteria. Rather than rely on the absolute number of affected small firms, EPA believes the *percentage* of small entities that are impacted provides a better basis for determining whether a given regulatory option can meet the criteria for a *no*-SISNOSE determination.

The potential for impacts to small businesses was an important consideration for EPA in developing and analyzing regulatory options for the C&D rule. In the end, the regulatory options that EPA focused on as the principal candidates for the final regulation are all expected to exclude the majority of C&D industry small entities from direct regulatory requirements and incurrence of costs to comply with the rule. For all four of the options presented in this analysis, no more than 35 percent of the estimated 77,115 in-scope small businesses are expected to incur costs. These small businesses comprise about 15 percent of all small businesses in the regulated construction sectors.

Finally, EPA emphasizes that the final regulation includes no requirements – in terms either of regulatory coverage or of the technical requirements for compliance – that would affect small firms more adversely than large firms: that is, the regulation does not confer a competitive advantage to large firms. There are no significant economies of scale associated with the compliance technologies, and small firms are generally expected to have more opportunity to utilize BMPs since they tend to work on more small projects compared to large firms.

EPA's methodology for estimating the percentages of firms within each revenue range that are estimated to incur compliance costs exceeding one or three percent of revenue is detailed in *Chapter 6.* In that analysis, the cost-to-revenue calculation is performed in two ways:

1. <u>Using the unadjusted compliance cost.</u> This metric indicates the potential burden of compliance costs in relation to revenue, without accounting for EPA's assessment that some of the compliance cost will be offset by increased revenue as some costs may be passed on.
2. <u>Using the compliance cost adjusted by the increase in revenue that is estimated to occur from passing on a part of the compliance cost increase to customers as a price increase</u>. This measure may provide a more meaningful measure of potential compliance cost burden. In this calculation, the total compliance cost is reduced by the increase in revenue resulting from cost pass-through. The resulting comparison is of *net compliance cost burden* (i.e., after the offsetting revenue increase) to baseline revenue.

In both instances, the analysis assumes that some of the compliance cost will be passed through to consumers and thus offset by increased revenue. However in the first instance, the calculation of the cost-to-revenue ratio does not account for this effect; in the second instance, the calculation does account for the estimated revenue increase as an offset to compliance cost.

Table 13-2, presents the findings from the small business impact assessment. In addition to presenting the results from the cost-to-revenue analysis, Table 13-2*,* also presents results for two other measures of firm-level effects: (1) the number and percent of small firms potentially incurring "financial stress" because of compliance requirements and (2) the number and percent of small firms whose business value is expected to become negative because of the regulation. These analyses are similar to those described in Chapter 6, except that the analysis here is only for the set of small firms.

As reported in Table 13-2*,* the cost to small business of the regulation is less than the total cost of the regulation as reported in the preceding chapter. As reported in *Chapter 6*, total annual costs for *all firms* under Option 4 are approximately $953 million. In comparison, the total estimated costs for small businesses under Option 4 is approximately $403 million (42 percent of the all-firms total). That is, less than half of the total compliance costs would be borne by small firms, despite the fact that small firms comprise 98 percent of the industry.

The impacts of the final regulatory option on small businesses are summarized below:

- For Option 4, EPA estimates that approximately 27,420 small businesses may incur costs, representing about 15 percent of all estimated small businesses in the affected C&D sectors and 36 percent of those small businesses estimated capable of performing the minimal model project (in terms of size and duration) within the scope of the final regulation. EPA estimates that none of these small businesses incur costs exceeding 1 or 3 percent of revenue when the expected increased revenue offset to compliance costs is accounted for in the cost-to-revenue comparison. Without accounting for this cost-pass-through effect, EPA estimates that 230 small firms will incur costs exceeding 1 percent of revenue, but no small firms are expected to incur costs exceeding 3 percent of revenue. In these 27,420 firms, EPA estimates that 135 will potentially incur financial stress as a result of the regulation and 122 would potentially incur negative net business value – an indicator of potential closure. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact are not additive. The number of small businesses estimated to incur financial stress or potential closure, represent less than 0.1 percent of the total small businesses in the C&D sectors and about 0.2 percent of those estimated potentially in-scope small businesses.

Overall, EPA estimates the small business impacts of the regulation are neither significant nor substantial on the basis of the small percentages of total small businesses and estimated small businesses that would potentially be adversely affected by the regulation. Although EPA estimates that Option 4 may cause approximately up to 230 firms to incur costs exceeding 1 percent of revenue, EPA does not judge this impact to be so substantial or so significant as to warrant a SISNOSE finding. The number of affected firms represents a small percentage of all small businesses (0.1 percent) and all small in-scope businesses (0.3 percent) in the C&D industry sectors of concern. The estimated effects relative to the 3 percent of revenue threshold is zero firms. Thus, EPA does not judge the number of adversely affected small businesses to be *substantial*. Moreover, if the expected pass-through of these compliance costs is accounted for in the cost-to-revenue analysis, then the number of adversely affected firms falls to zero under both cost-to-revenue impact thresholds. On this basis, EPA further concludes that the adverse impact is *not significant*.

Table 13-2: Summary of Small Business Cost and Impact Analysis for C&D Rule Options

Impact Analysis Concept		Option 1	Option 2	Option 3	Option 4
Resource Cost of Compliance and Affected Acreage and Firms					
Total Costs in Small Businesses ($millions)		$74	$1,498	$3,827	$403
Total Small Business Activity Acreage Incurring Cost		332,981	332,981	332,981	332,981
Number of Small Firms	All Small Firms	182,560	182,560	182,560	182,560
	Small Firms In-Scope	77,115	77,115	77,115	77,115
	Small Firms Incurring Cost	27,420	27,420	27,420	27,420
Small Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact					
Costs Unadjusted for Effect of Cost Pass-Through					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	3,454	11,889	230
	% of All Small Firms	0.0%	1.9%	6.5%	0.1%
	% of Small Firms In-Scope	0.0%	4.5%	15.4%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	1,843	8,106	0
	% of All Small Firms	0.0%	1.0%	4.4%	0.0%
	% of Small Firms In-Scope	0.0%	2.4%	10.5%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	593	3,008	0
	% of All Small Firms	0.0%	0.3%	1.6%	0.0%
	% of Small Firms In-Scope	0.0%	0.8%	3.9%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	60	187	0
	% of All Small Firms	0.0%	0.0%	0.1%	0.0%
	% of Small Firms In-Scope	0.0%	0.1%	0.2%	0.0%
Small Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance					
Small Firms Incurring Financial Stress	Number Incurring Effect	24	1,024	5,112	135
	% of All Small Firms	0.0%	0.6%	2.8%	0.1%
	% of Small Firms In-Scope	0.0%	1.3%	6.6%	0.2%
Small Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)					
Small Firms with Negative Business Value Because of Regulation (Potential Closures)	Number Incurring Effect	25	301	1,007	122
	% of All Small Firms	0.0%	0.2%	0.6%	0.1%
	% of Small Firms In-Scope	0.0%	0.4%	1.3%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

EPA Estimates

13.4 Consideration of Small Entity Impacts in Regulatory Option Selection

As described above, EPA carefully considered the potential impact of the regulation on small businesses in developing and analyzing regulatory options. In particular, EPA set aside from further consideration those regulatory options that would have extended regulatory coverage to project sizes that would more likely be within the performance capability of small businesses (e.g., acreage thresholds below 10 acres, such as 1, 3 and 5 acres). The result of this effort is a Final Option that EPA judges will have a small effect, overall, on small businesses based on any of the relevant measures of small business impact assessment. For example, the results for Option 4 indicate the following:

- Number and percentage of small businesses estimated to incur compliance costs out of the total of small businesses in the C&D industry and potential in-scope small businesses:
  - Approximately 27,420 small businesses are estimated to incur costs, which represent 15 percent of all estimated small businesses in the affected C&D sectors and 36 percent of potentially in-scope small businesses.
- Number and percentage of small businesses estimated to incur compliance costs exceeding cost-to-revenue impact thresholds out of the total of potential in-scope small businesses and of the total of small businesses estimated to be within the scope of the regulation:
  - 230 small businesses are estimated to incur costs exceeding 1 percent of revenue, or only 0.1 percent of all small C&D sector firms and 0.3 percent of estimated potentially in-scope small businesses
  - 0 small businesses are estimated to costs exceeding 3 percent of revenue.
- Number and percentage of small businesses estimated to incur other measures of adverse economic impact – financial stress and/or potential business closure – again out of the total of in-scope small businesses and of the total of small businesses estimated to incur compliance costs from the regulation:
  - 135 small businesses are estimated to potentially incur financial stress, or less than 0.1 percent of all small C&D sector firms, and 0.2 percent of in-scope small firms.
  - 122 small businesses are assessed as potential closures, or again less than 0.1 percent of all small C&D sector firms, and 0.2 percent of in-scope small firms.

14 Assessing the C&D Regulatory Options in Accordance with Unfunded Mandates Reform Act (UMRA) Requirements

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 104-4, requires federal agencies to assess the effects of their regulatory actions on state, local, and tribal governments and the private sector. Under section 202 of UMRA, EPA generally prepares a written statement, including a cost-benefit analysis, for proposed and final rules with "federal mandates" that may result in expenditures by state, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more in any one year.

Before EPA promulgates a rule for which a written statement is needed, section 205 of UMRA directs EPA to consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective or least burdensome alternative if the Administrator publishes with the proposed rule an explanation of why that alternative was not adopted.

In addition, before EPA establishes any regulatory requirements that might significantly or uniquely affect small governments, including tribal governments, the Agency is to develop a small government agency plan pursuant to section 203 of UMRA. The purpose of the plan is to provide for notifying potentially affected small governments, thus enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant federal mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

Lastly, UMRA requires the statutory authority for the rule to be cited. A detailed discussion of the objectives and legal basis for the proposed rule will be presented in the Federal Register preamble for the final regulation.

In accordance with these UMRA requirements, EPA evaluated the impact of the Final C&D regulation on (1) government entities, (2) small governments, and (3) private entities.

14.1 Assessing Costs to Government Entities

The purpose of this part of the UMRA analysis is to estimate the regulatory burden of the C&D regulation on State, Local, and Tribal governments. For this assessment, EPA considered two concepts of government burden:

- **Administrative Costs.** Administrative costs are those costs associated with state governments' administration of federal rule requirements to regulated entities within their jurisdictions.
- **Compliance Costs.** Governments build or hire contractors to perform construction and development activities on a material quantity of developed space in any given year. These government projects will need to comply with the final rule just as private sector projects will, and therefore, governments are assumed to incur some incremental compliance costs.

The total of the incremental administrative costs and the compliance costs estimated to apply to government are the total costs to government.

The following sections discuss EPA's methodology for assessing these costs to governments.

14.1.1 Administrative Costs

EPA assumed for the current analysis that the NPDES Phase I and Phase II stormwater permit programs are fully implemented and that any new regulatory requirements from this rule would be superimposed on these programs. However, EPA expects an additional administrative burden to state government entities under the final rule. State governments will incur costs for:

1. Processing and analyzing discharge monitoring reports (DMRs) for projects that incur cost under the final rule, and
2. Reviewing the regulation, developing a plan for implementation, dissemminating information to relevant parties, and potentially updating DMR data management systems.

The cost to state governments for processing and analyzing DMRs is a function of the following:

- *Number of projects requiring DMRs*. Option 1 does not include a DMR requirement. Option 2 requires a monthly DMR for each project greater than 30 acres in size that incurs cost under the final rule. EPA's analysis indicates that, in the steady state, there are approximately 6,045 of these projects per year. Option 3 and Option 4 require a monthly DMR for each project greater than 10 acres in size that incurs cost under the final rule. EPA's analysis indicates that, in the steady state, there are approximately 21,279 such projects started each year.
- *Number of DMRs expected per project*. The numer of monthly DMRs per project is a function of the duration of each project. However, since a monthly DMR is not expected to be required for every month of a construction project, *Table 14-1* presents EPA assumed number DMRs expected per project by project duration category.[68]

Table 14-1: Number of DMR-Months per Project, by Duration Category

Project Duration (months)	Number of DMRs per Project
1	1
2	2
4	4
7	6
10	8
13	10
16	13
19	15
22	16
27	21
32	26
36	30

- *Hourly burden and labor rate for processing each DMR*. EPA assumes the processing each DMR will require an average of 0.55 labor hours. The labor rate for state government employees, $39.25 per hour, is based on the Department of Labor's Bureau of Labor Statistics *Employer Costs for Employee Compensation* (U.S. DOL, 2008).

EPA also estimated the cost to state governments associated with expected start-up activities on an average annual basis over a ten year period. This component of state government cost includes:

[68] DMRs are not expected to be required during every month for some projects because EPA assumes the quantity of acreage disturbed on the site will not exceed the regulatory threshold for the entire duration.

- *Data management systems upgrades.* Although not all state government entities will need to upgrade their data management systems for managing DMRs, EPA made the conservative assumption that all entities would incur $25,000 of equipment costs (this cost was annualized over a ten year period).
- *Regulation review and training.* EPA assumed that each state government would also incur 160 hours of review and training to implement the rule, where each hour is assigned the state employee wage of $39.25 per hour.

Table 14-2 presents the 10-year average annual state government administrative cost, by regulatory option, including both the DMR and start-up cost component.

Table 14-2: Average Annual State Government Administrative Burden ($million)

	Option 1	Option 2	Option 3	Option 4
Annual State Government Cost	$0.0	$2.2	$6.2	$6.2
Annual State Government Burden Hours	0	52,823	153,854	153,854

Source: U.S. EPA (2005), U.S. DOL (2008), FedJobs (2009), and EPA Estimates

14.1.2 Compliance Costs

Governments will likely bear some of the compliance costs associated with the final regulation, assuming that these costs are passed on from developers and builders. EPA estimated the compliance costs potentially incurred by government entities based on the value of construction work done by government agencies (federal, state, and local) as a percentage of the total value of construction, as reported in the U.S. Census publication, *Construction Spending* for 2002. *Table 14-3* shows total compliance costs by general construction activity category, and broken between the private sector and various public sectors. *Table 14-4* provides the same breakout of total acreage incurring costs.

Table 14-3: Total Compliance Costs[a] ($millions)

	Option 1	Option 2	Option 3	Option 4
Total Compliance Costs by Government Unit and by General Industry Sector				
Residential Sector				
Private	$59.5	$2,303.1	$4,178.0	$428.8
Public	$0.9	$34.8	$63.1	$6.5
Federal	$0.3	$9.7	$17.7	$1.8
State and Local	$0.6	$25.0	$45.4	$4.7
Total	**$60.4**	**$2,337.9**	**$4,241.1**	**$435.3**
Non-Residential Sector				
Private	$55.9	$1,216.4	$2,461.2	$259.3
Public	$32.1	$698.9	$1,414.1	$149.0
Federal	$2.8	$61.2	$123.9	$13.0
State and Local	$29.3	$637.7	$1,290.2	$135.9
Total	**$88.0**	**$1,915.3**	**$3,875.3**	**$408.2**
Transportation Sector				
Private	$2.2	$48.8	$76.4	$8.8
Public	$25.1	$553.9	$866.7	$100.0
Federal	$0.7	$16.2	$25.3	$2.9
State and Local	$24.4	$537.7	$841.4	$97.1
Total	**$27.4**	**$602.7**	**$943.0**	**$108.9**
Total Compliance Costs by Government Unit and Across All Industry Sectors				
Private	$117.6	$3,568.3	$6,715.6	$696.9
Public	$58.1	$1,287.6	$2,343.9	$255.5
Federal	$3.8	$87.1	$166.9	$17.7
State and Local	$54.3	$1,200.4	$2,177.0	$237.7
Total	**$175.7**	**$4,855.9**	**$9,059.5**	**$952.4**

a Based on the value of construction work done by government entity

Source: U.S. Census (2008a), U.S. Census Bureau's Government Organization (2002), EPA Estimates

Table 14-4: Total Acreage Incurring Cost[a]

	Option 1	Option 2	Option 3	Option 4
Total Acreage by Government Unit and by General Industry Sector				
Residential Sector				
Private	314,002	312,955	312,101	313,868
Public	4,739	4,723	4,711	4,737
Federal	1,327	1,323	1,319	1,326
State and Local	3,412	3,401	3,392	3,411
Total	**318,741**	**317,679**	**316,811**	**318,605**
Non-Residential Sector				
Private	290,804	290,718	290,628	290,789
Public	167,082	167,032	166,981	167,073
Federal	14,635	14,631	14,626	14,634
State and Local	152,447	152,401	152,355	152,439
Total	**457,886**	**457,750**	**457,609**	**457,863**
Transportation Sector				
Private	6,156	6,156	6,156	6,156
Public	69,832	69,832	69,832	69,832
Federal	2,036	2,036	2,036	2,036
State and Local	67,796	67,796	67,796	67,796
Total	**75,988**	**75,988**	**75,988**	**75,988**
Total Acreage by Government Unit and Across All Industry Sectors				
All Industry Sectors				
Private	610,962	609,829	608,885	610,814
Public	241,653	241,588	241,523	241,643
Federal	17,998	17,990	17,982	17,997
State and Local	223,655	223,598	223,542	223,645
TOTAL	**852,615**	**851,417**	**850,409**	**852,456**

a Based on the value of construction work done by government entity

Source: U.S. Census (2008a), U.S. Census Bureau's Government Organization (2002), EPA Estimates

14.1.3 Total Government Costs and Impacts

Table 14-5 reports total compliance and administrative costs estimated to be incurred by Federal, State and Local government entities. *Table 14-6* reports the findings from comparing the total compliance and administrative costs with three baseline measures: total government revenue, capital outlay, and capital outlay for construction only.

Table 14-5: Total Government Compliance and Administrative Costs ($millions)

	Option 1	Option 2	Option 3	Option 4
Compliance Costs				
Federal	$3.8	$87.1	$166.9	$17.7
State[a]	$8.1	$178.1	$323.0	$35.3
Local[a]	$46.2	$1,022.3	$1,854.0	$202.4
Administrative Costs				
State	$0.0	$2.2	$6.2	$6.2
Total Costs				
Federal	$3.8	$87.1	$166.9	$17.7
State[a]	$8.1	$180.3	$329.2	$41.5
Local[a]	$46.2	$1,022.3	$1,854.0	$202.4

a State and Local compliance costs were split-out from the State and Local total based on the proportion of total project value in state and local governments from Reed Construction Data.

Source: Reed (2008), U.S. Census Bureau's Government Organization (2002), EPA Estimates

Table 14-6: Impacts of Regulatory Option Compliance and Administrative Costs on State and Local Government Baseline Revenues ($millions)

	Option 1	Option 2	Option 3	Option 4
State Governments Impact Analysis Concepts				
Total Revenues	1,097,829	1,097,829	1,097,829	1,097,829
Total Costs as % of Total Revenues	0.00%	0.02%	0.03%	0.00%
Capital Outlay	89,919	89,919	89,919	89,919
Total Costs as % of Total Capital Outlay	0.01%	0.20%	0.37%	0.05%
Construction Outlay Only	71,035	71,035	71,035	71,035
Total Costs as % of Total Construction Outlay	0.01%	0.25%	0.46%	0.06%
Local Governments Impact Analysis Concepts				
Total Revenues	1,083,129	1,083,129	1,083,129	1,083,129
Total Costs as % of Total Revenues	0.00%	0.09%	0.17%	0.02%
Capital Outlay	142,209	142,209	142,209	142,209
Total Costs as % of Total Capital Outlay	0.03%	0.72%	1.30%	0.14%
Construction Outlay Only	107,588	107,588	107,588	107,588
Total Costs as % of Total Construction Outlay	0.04%	0.95%	1.72%	0.19%

Source: Reed (2008), U.S. Census Bureau's Compendium of Government Finances (2005c), U.S. Census Bureau's Government Organization (2002), EPA Estimates

14.2 Assessing Costs and Impacts on Small Government Entities

In addition to looking at total outlays by governments for the final C&D regulation, in accordance with UMRA requirements, EPA also considered the extent to which these outlays would fall specifically on small governmental entities and the potential impact on these entities. The assessment of impacts on small governmental entities involved two steps: (1) identifying small government entities (i.e., those serving populations of less than 50,000, (5 USC 601[5])), (2) estimating the share of total government costs for the regulatory options that is incurred by small governments, and (3) estimating the potential impact from these costs based on comparison of small government outlays with small government revenue and outlays.

The smallest unit of government potentially affected by the rule is at the sub-county (i.e., municipal or township) government level. The evaluation of potential impact on these entities began by estimating the share of local-government compliance and administrative costs (as described in previous section) incurred by small governments, as follows:

- EPA identified the sub-set of local-government entities determined to be small government entities. The determination is based on a national estimate – from the U.S. Census – of the population served by local jurisdictions with fewer than 50,000 population (i.e., of the total population in local jurisdictions, the percentage of that population in local jurisdictions with fewer than 50,000 people);
- Based on the proportion of *population* served by small governments out of total population in local jurisdictions, EPA allocated local-government compliance and administrative costs to the sub-set of local-government entities determined to be small. This allocation assumes that government construction activity and incurrence of compliance and administrative costs are proportional to population. Approximately 92 percent of the total U.S. population in 2002 lived in areas governed by a municipality or town/township. Of those served by these sub-county governments, approximately 51 percent lived in areas served by municipal or town/township governments with populations of less than 50,000. Therefore, EPA estimated that 51 percent of local government compliance costs affect projects undertaken by small government entities.
- EPA compared the local government share of compliance and administrative costs against several baseline indicators to assess the extent of potential impacts on small governmental entities. The indicators include total government revenue, capital outlay, and capital outlay for construction only. The comparisons indicate how material the compliance and administrative outlays are in relation to the baseline government revenue and outlay levels.

Table 14-7 reports total compliance and administrative costs estimated to be incurred by small government entities and the findings from comparing these outlays with the three baseline measures.

Table 14-7: Impacts of Regulatory Option Compliance and Administrative Costs on Small Government Units ($millions)

	Option 1	Option 2	Option 3	Option 4
Compliance Costs				
Federal	$3.8	$87.1	$166.9	$17.7
State[a]	$8.1	$178.1	$323.0	$35.3
Local[a]	$46.2	$1,022.3	$1,854.0	$202.4
Small Government Entities	$21.7	$480.5	$871.4	$95.1
Administrative Costs				
State	$0.0	$2.2	$6.2	$6.2
Small Government Entities	$0.0	$0.0	$0.0	$0.0
Total Costs				
Federal	$3.8	$87.1	$166.9	$17.7
State[a]	$8.1	$180.3	$329.2	$41.5
Local[a]	$46.2	$1,022.3	$1,854.0	$202.4
Small Government Entities	$21.7	$480.5	$871.4	$95.1
Small Government Impact Analysis Concepts				
Total Revenues	$125,515	$125,515	$125,515	$125,515
Total Costs as % of Total Revenues	0.02%	0.38%	0.69%	0.08%
Capital Outlay	$13,455	$13,455	$13,455	$13,455
Total Costs as % of Total Capital Outlay	0.16%	3.57%	6.48%	0.71%
Construction Outlay Only	$8,529	$8,529	$8,529	$8,529
Total Costs as % of Total Construction Outlay	0.25%	5.63%	10.22%	1.12%

a State and Local compliance costs were broken out from the State and Local total based on the proportion of total project value in state and local governments from Reed Construction Data.

Source: Reed (2008), U.S. Census Bureau's Compendium of Government Finances (2005c), U.S. Census Bureau's Government Organization (2002), EPA Estimates

For Option 4, the total of administrative and compliance costs to small government entitites is $95.1 million annually. This represents less than one-tenth of one percent of total government revenue, less than one-tenth of one percent of total capital outlays, and just over one percent of construction outlays. As such, EPA does not consider these costs to impose a substantial impact on a significant number of small government entitites.

14.3 Assessing Costs and Impacts on Private Entities

The potential economic impacts for private entities that were analyzed were divided into two major groups:

- Impacts on the individual projects, establishments, and firms in the construction industries, and
- Impacts at the national level and on the national economy.

EPA's analysis of impacts on private entities are detailed previously detailed in *Chapter 6*.

Appendix A: Adverse Analysis Case Results for the Firm- and Industry-Level Impact Analysis

EPA estimated firm- and industry-level impacts under an *adverse analysis case,* which is intentded to illustrate the potential industry-level impact of the regulatory options during periods when the C&D industry is operating under adverse business conditions. The *adverse analysis case* differs from the *primary analysis case* as follows (see also *Section 4.5* of *Chapter 4*):

1. Model firms are defined on the basis of financial statements taken from an adverse performance period, as outlined below. The baseline financial condition and performance are thus *weaker* than the baseline condition and performance as used for the primary analysis case.
2. Model firms are assigned a higher cost of capital, reflecting more difficult credit and equity financing conditions during a period of business weakness, than the cost of capital used in the primary analysis case.
3. Model firms are assumed to recover none of the cost of compliance through product price increases (i.e., no cost pass-through).
4. The total operating level of the C&D industry and total construction activity subject to regulatory requirements are assumed to be less than the baseline activity estimates, as described in this appendix.

Defining Adverse Model Firm Financial Condition

To perform this analysis, EPA adjusted the baseline financial statements for each of the model firms, by C&D sector and revenue range to reflect relatively adverse business conditions.

Residential

Developing an Adjustment to the RMA Baseline Financial Data to Reflect the Current Financial Performance in the C&D Industry

To support its analysis of the potential economic impact of the final regulation, EPA collected financial statement data from Risk Management Association's (RMA) eStatement Studies to provide the baseline financial statements. EPA assigned baseline financial characteristics – balance sheet, income statement, and metrics of financial performance and condition – to each of the model firms as defined by NAICS sector and revenue size range, from financial statement information reported by RMA.[69] To develop the Adverse Business Conditions case models, RMA data from the worst financial performance year in the 6-year period 2002 through 2007, *as indicated in the RMA data for each sector*, were used initially as the basis of the firm-level model financial statements. For the residential construction sectors, 2006 began a period of weakness; RMA data with fiscal closing dates of April 2007 through March 2008 was initially collected for this case.[70] However, the residential sector experienced even worse business conditions during 2008 while residential spending continued to fall.

[69] *Chapter 4* provides more details regarding the assignment of baseline financial information to firms.

[70] For the non-residential sectors, 2003 began a period of weakness; RMA data with fiscal closing dates of April 2003 through March 2004 was used for this case, as described more fully later in this appendix.

Because the RMA data currently available only grasps a small portion of the 2008 conditions for a fraction of the reporting firms,[71] EPA looked to additional data sources to extend the residential RMA financial data into 2008.

Description of the Value Line Dataset Used to Determine Adjustment Factors

The dataset chosen by EPA to adjust the adverse residential sector baseline financial statement data to reflect the current financial performance in this sector was the Value Line Investment Survey (VL). The general company dataset of VL reports summary financial information for nearly all (approximately 7,000) publicly traded companies in the United States for a 16-year period, 1993-2008.[72] By including financial results for full-year 2008, the dataset comes as close as possible to the present and thus would provide a basis for adjusting facility baseline financial data to essentially current conditions.[73]

VL identifies and groups companies in a business content classification scheme that approximates 4-digit NAICS classifications. These business classifications support identification of firms within the Construction and Development industries at a level of sector detail sufficient for this analysis. The dataset is by company instead of by aggregate groups and the business classifications are defined by practical business content instead of in a rigid SIC or NAICS classification scheme. The VL dataset reports key accounting items that will readily support calculation of the five financial metrics, *net worth to total capital*, *sales to total assets*, *debt to net worth*, *pre-tax profit to total assets*, and *earnings before interest and taxes*, that match the principal financial metrics underlying the Construction and Development impact analysis.

EPA recognizes that the VL dataset, by definition, excludes firms that are not publicly traded. The studied industries include private, non-publicly traded firms, for which no comparable database of financial information is available. As a result, use of the VL dataset in this analysis could yield findings that are not representative of the overall industry, including the non-publicly traded firms, to the extent that non-public firms in the studied industries faced materially different business conditions or achieved materially different business performance than publicly traded firms in the same industries. Overall, EPA expects that the business conditions faced by, and performance achieved by, non-public firms in the studied industries are not likely to have been materially different from those of the public firms. As a result, EPA judges that use of the VL dataset for this analysis is appropriate and likely to yield reasonably representative findings for to overall industries, including publicly traded and non-traded firms.

As discussed above, VL organizes firms by industry groups, which, in most instances, approximate 4-digit NAICS classifications. From review of the VL industry groups and the Construction and Development industries, EPA selected two VL industry groups – *Homebuilding* and *Heavy Construction* – and the 44 firms within these industry groups as candidates for this analysis.[74] Following review of the firms within these industry groups, EPA retained 33 firms for use in this analysis. Key considerations in selecting the firms are as follows:

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[71] RMA's 2008-2009 eStatement Studies data reports financial data for companies with fiscal closing dates ranging from April 1, 2007 to March 31, 2008. Therefore, the earliest 12-month period covered is April 1, 2006 to March 31, 2007 and the latest 12-month period covered is April 1, 2007 to March 31, 2008. Among the six years of data and six NAICS codes, an average of approximately 83 percent of firms have *fiscal closing dates* in the latter 6-month period of the range (October 1, 2007 to March 31, 2008). Therefore, most data covers the calendar year of 2007.

[72] At any time, VL reports only 10 years of data for firms in its data serves. The dataset used for this analysis reflects two separate VL datasets that were combined to provide data for the 16 years of analysis.

[73] The firms in the VL dataset report data for each fiscal year, 2008 being the latest. Of the 33 firms under analysis, 22 of the firms report a fiscal closing date of 12/31/2008. Ten of the remaining 11 firms report a fiscal closing date within 3 months of 12/31/2008 and one firm reports a fiscal closing date within 6 months of 12/31/2008.

[74] EPA also selected one company, Tutor Perini Corp., from the VL *Industrial Services* industry.

- Within the industry groups, only those firms whose business operations reasonably match the profile of business activities of the two Construction and Development industries, *Building Construction* and *Heavy Construction*, were considered candidates for the analysis. In the industry groups, some firms included in the VL industry groups were excluded from the analysis because they were not engaging in the activities applicable to the scope of the Construction and Development regulation.
- EPA retained only those firms that are based in the United States.
- EPA retained only those firms for which the necessary data were available for 2007 and 2008. In addition, for the *debt to net worth*, *pre-tax profit to total assets*, and *earnings before interest and taxes* metrics, firms that did not report the necessary values for either 2007 or 2008 were not included in the adjustment calculation for that metric.

EPA organized the 33 firms selected for the analysis into two industry groups: the *Residential Construction* industry includes 22 firms and the *Non-Residential/Non-Building Construction* industry includes 11 firms. The *Residential Construction* industry is comprised of single-family and multifamily designers, developers, homebuilders, and sellers. The *Non-Residential/Non Building Construction* industry is comprised of companies specializing in the design, engineering, project management, and construction of non-residential buildings and infrastructure.

Description of the Residential Adjustment Concept

The general objective of this analysis was to develop an adjustment to the 2007 RMA baseline *net worth to total capital*, *sales to total assets*, *debt to net worth*, *pre-tax profit to total assets*, and *earnings before interest and taxes* to yield values for the firm impact analysis that more closely reflect current financial performance in the residential sector of the C&D industry. The overall approach to the analysis was to analyze, for this industry group, the trend of financial performance over the 2007-2008 analysis period. The 2007 to 2008 change in the financial metrics were then compared with the 2007 RMA values to determine the extent to which the RMA data should be adjusted to reflect the current financial performance in this C&D sector. *Table A-1* presents the calculations and the use of the adjustment factors applied to the 2007 RMA-reported values to develop the "Adverse Business Conditions" Case financial statement values.

Table A-1: Calculation and Use of Adjustments Applied to 2007 RMA-Reported Values to Develop "Adverse Business Conditions" Case Financial Statement Values for Use in Firm Impact Analysis

Variable	Calculation to Determine Variable from VL Data	Calculation of Adjustment Factors	Use of Adjustment Factors Applied to 2007 RMA Data
Net Worth / Total Capital	Ratio calculated by dividing Shareholder Equity by Total Assets	Calculated as 2008 value divided by 2007 value for each company. The revenue-weighted average adjustment factors were determined for each industry.	Adjustment applied as multiplicative factor to net worth percentage from RMA; other capital components were then adjusted to offset decrease in new worth.
Sales / Total Assets	Ratio calculated by dividing Revenue by Total Assets	Calculated as 2008 value divided by 2007 value. The revenue-weighted average adjustment factors were determined for each industry.	Adjustment applied as multiplicative factor to Sales / Total Assets values, by quartile, from RMA.
Debt / Net Worth	Ratio calculated by dividing Long-Term Debt by Shareholder Equity	Calculated as 2008 value divided by 2007 value. The revenue-weighted average adjustment factors were determined for each industry.	Adjustment applied as multiplicative factor to Debt / Net Worth values, by quartile, from RMA. If pre-adjustment RMA value was negative, no adjustment was applied.
Pre-Tax Profit / Total Assets	Ratio calculated by dividing Pre-Tax Profit (Net Profit / (1 - Income Tax Rate)) by Total Assets	Calculated as 2007 value *minus* 2008 value. The revenue-weighted average adjustment factors were determined for each industry.	Adjustment applied as an additive factor to Pre-Tax Profit / Total Assets values, by quartile, from RMA, to allow adjustment to negative pre-adjustment RMA values.
Earnings Before Interest and Taxes / Interest	Operating Income used a direct variable	Calculated as 2008 value divided by 2007 value. The revenue-weighted average adjustment factors were determined for each industry.	Adjustment applied as multiplicative factor to Earnings Before Interest and Taxes (EBIT) / Interest values, by quartile, from RMA. If pre-adjustment RMA value was negative, no adjustment was applied. This adjustment assumes that Interest expense is constant, year-to-year, and that all change in EBIT / Interest is due to change in Pre-Interest Income.

In the calculation of the revenue-weighted adjustment factors, EPA retained only those firms for which the necessary data were available for 2007 and 2008. Four firms did not report any of the data necessary for the calculation of the variables for either 2007 or 2008. In addition, for the *debt to net worth*, *pre-tax profit to total assets*, and *earnings before interest and taxes* metrics, firms that did not report the necessary values for either 2007 or 2008 were not included in the adjustment calculation for that metric.[75]

Given the calculations as presented above, the below table presents the revenue weighted adjustment factors developed from the VL data that were applied to the 2007 RMA-reported values for the residential construction sectors. Given that the Non-Residential and Non-Building sectors were found to have financial performance during the selected adverse RMA data period (2003) that was worse than the current period and the predicted trend financial performance for the 2008 period, EPA concluded that the Value Line adjustment factors would *only* be applied to the residential 2007 RMA financial statements.

Table A-2: Revenue Weighted Adjustment Factors Applied to RMA-Reported Values from 2007

	Ratios				
Industry Description	Net Worth/ Total Capital	Sales/ Total Assets	Debt/ Net Worth	Pre-Tax Profit / Total Assets	Earnings Before Interest and Taxes/ Interest
Residential Construction	0.77	0.77	1.89	-4.9	0.93

Source: VL, 2009 and EPA Analysis

Non-Residential and Non-Building

For the non-residential sector, EPA used value of construction data from the Census for each from 1990 to 2007 to select the adverse business conditions year underlying the model firm financial statements and also to estimate an average deviation from trend during adverse performance years.[76]

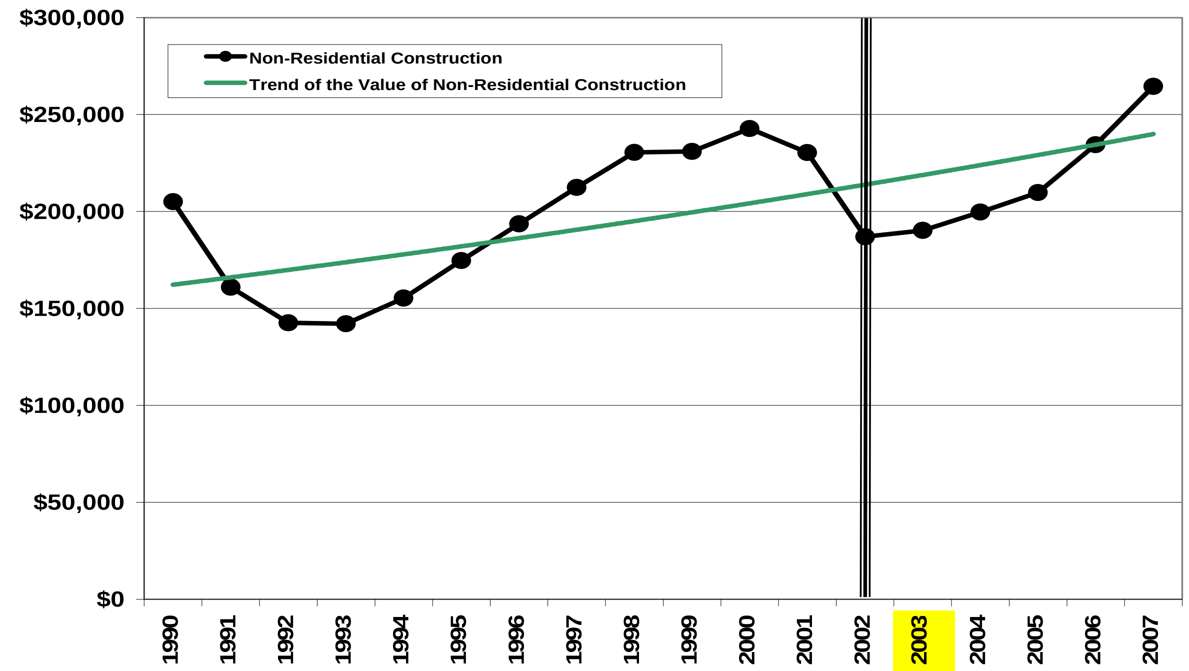
Figure A-1 through *Figure A-2* present the actual and estimated trend values[77] of construction from 1990 to 2007 for the non-residential and non-building sector. *Figure A-3* through *Figure A-4* present the average annual growth of construction and the actual percent change in construction value from the previous year from 1990 to 2007 for the non-residential and non-building sector. As described previously, Risk Management Association provides financial statement data by industry sector and revenue range for the data years following the line drawn during the 2002 period. The yellow-highlighted data years –2003 for both the non-residential and non-building sectors – are the RMA data-years used to define the model firm financial statements for the adverse analysis case.

75 Two, twelve, and one firms did not report either the 2007 or 2008 necessary data to determine the variables *debt to net worth*, *pre-tax profit to total assets*, and *earnings before interest and taxes,* respectively.

76 For the non-residential and non-building sector, 2008 was an above-trend year and therefore this year is not a candidate for selection among the below-trend years for these sectors (also see Figures 4-2 and 4-3 in Chapter 4 for illustration).

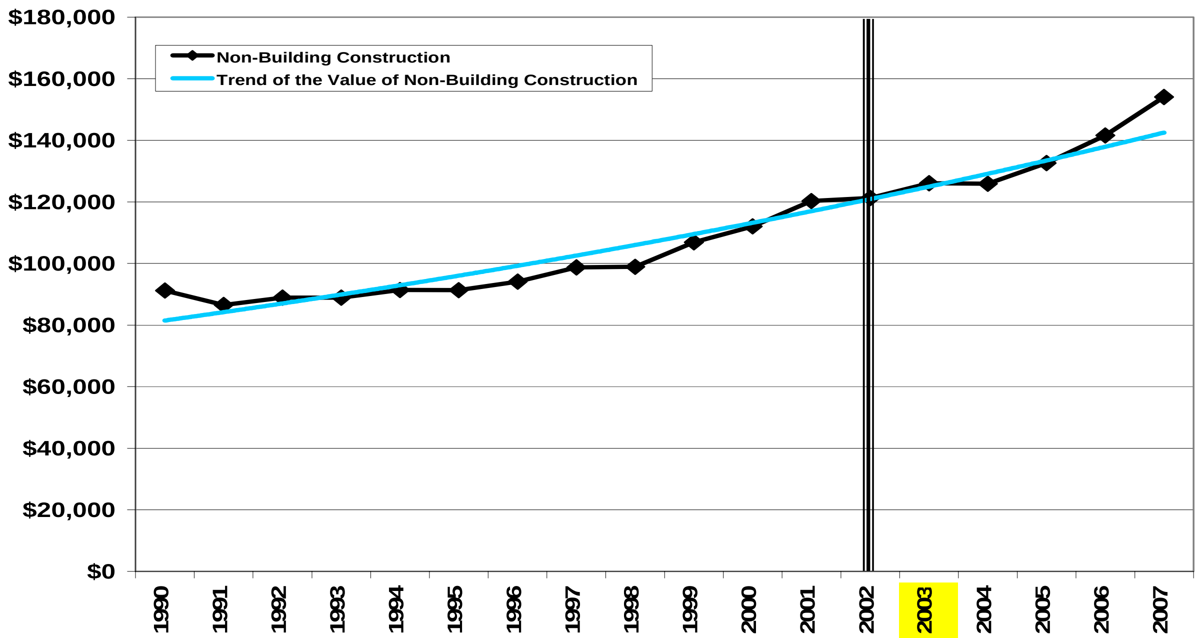
77 Based on an estimated exponential growth trend of constant dollar activity.

Figure A-1: Non-Residential Actual and Estimated Trend Values of Construction Put in Place (2006 $Millions)



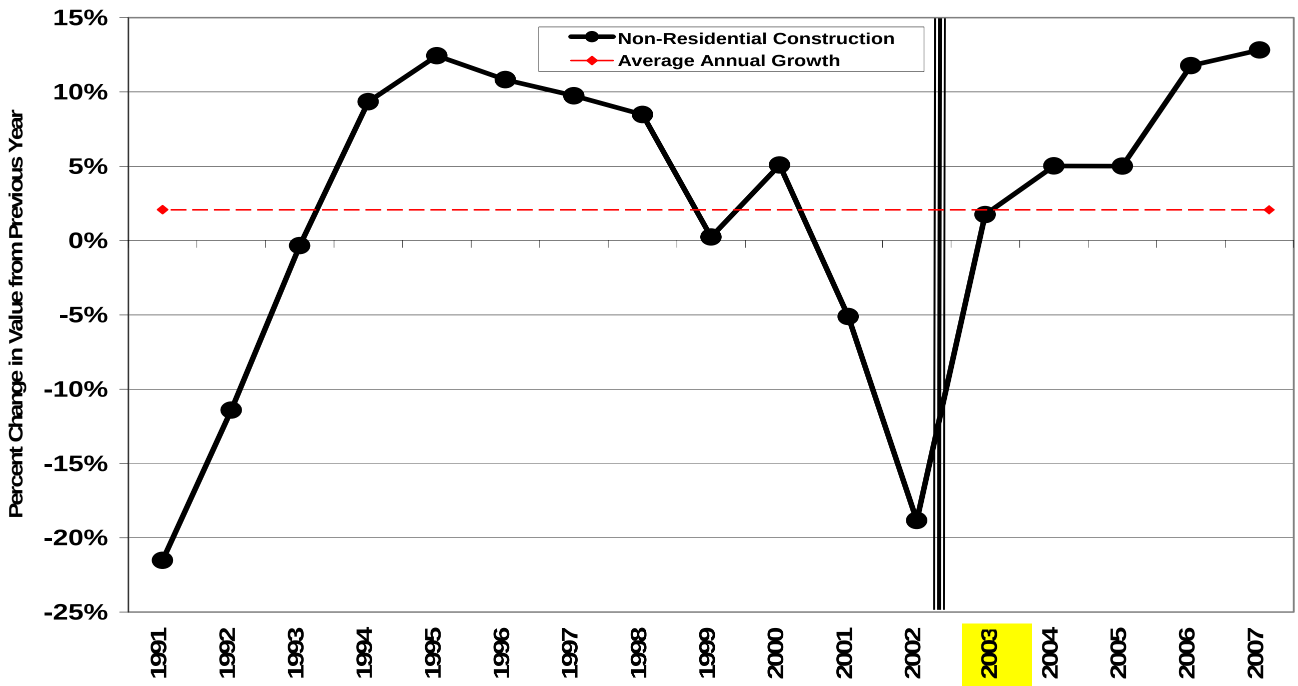
Source: U.S. Census Bureau's Construction Spending (2008a)

Figure A-2: Non-Building Actual and Estimated Trend Values of Construction Put in Place (2006 $Millions)



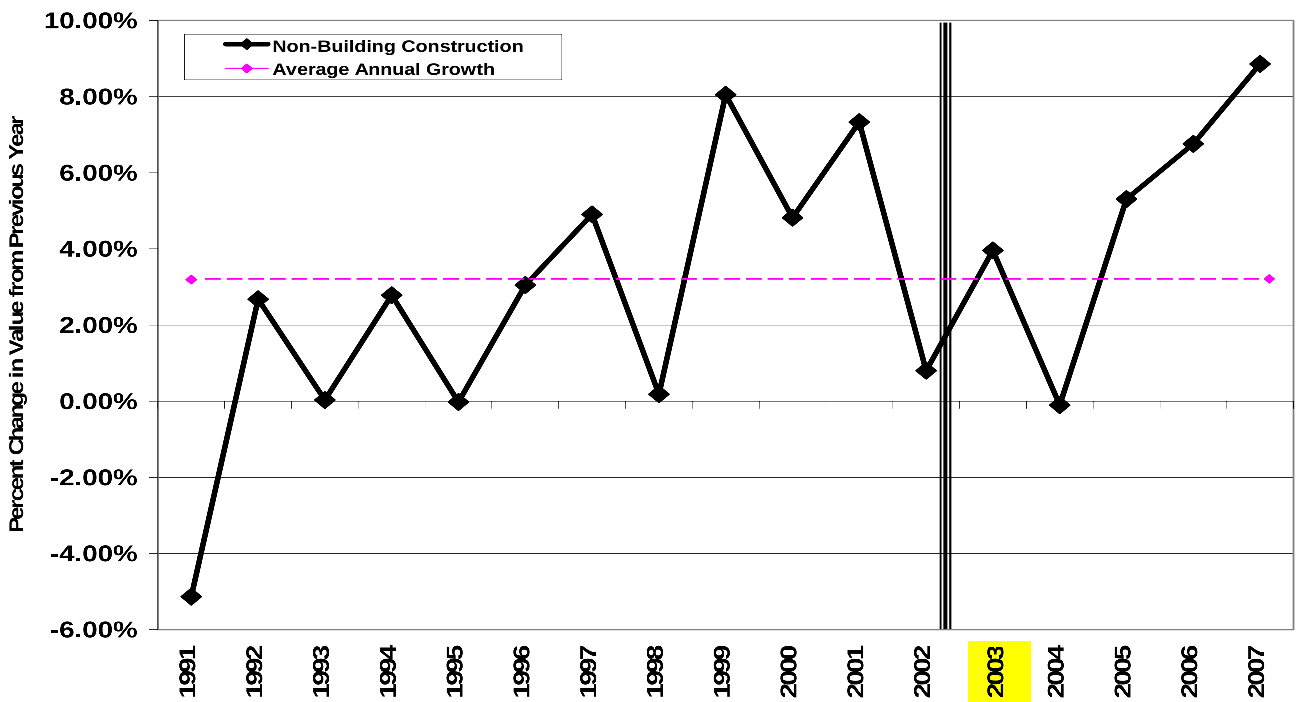
Source: U.S. Census Bureau's Construction Spending (2008a)

Figure A-3: Non-Residential Actual and Average Annual Growth of Construction Put in Place



Source: U.S. Census Bureau's Construction Spending (2008a)

Figure A-4: Non-Building Actual and Average Annual Growth of Construction Put in Place



Source: U.S. Census Bureau's Construction Spending (2008a)

Table A-3 through *Table A-4* present the data used to determine the *adverse analysis case* variables for the non-residential and non-building sector. RMA provides financial statement data for the years in bold. The highlighted data year (i.e. 2003) is the year used to define the *adverse analysis case*.

Each table presents, by year, the actual value of construction as reported by Census. EPA estimated an exponential trend line from the actual values and, for each year, determined the percent deviation from the trend based on the difference between the actual value and the estimated trend line value. EPA then assigned years into categories of *at trend*, *above trend*, and *below trend* based on a *deviation from trend* value that assigned an approximately equal number of years from the 18-year period into each of the performance categories. This assignment is the primary basis for determining the *adverse performance* years.

EPA also looked at the difference in actual year-to-year growth from average growth over the period as a secondary indicator of *adverse performance* years. In the same way as described for the *difference from trend* determination, EPA assigned years into *at trend growth*, *above trend growth*, and *below trend growth* categories based on a *deviation from trend* value that assigned an approximately equal number of years from the 17 years of year-to-year growth values into each of the performance categories. The average growth rate for each sector is reported in *Table A-5*.[78] Similar to determining whether a data year is at, above, or below the trend line, a deviation variable allowing for an approximately equal distribution of at, above, and below data years is introduced to determine the years that are at, above, or below average growth.

Based on this information, EPA elected chose 2003 as the adverse analysis case year for the non-residential and non-building sectors. Each of years 2002, 2003, and 2004 show weak performance for the non-residential sector and the non-building sector's performance is relatively *on-trend* for the entire RMA data period. EPA based its choice of 2003 as the adverse case year for the non-residential and non-building sectors on inspection of the RMA data and determination that this year generally showed the weakest financial performance and condition metrics for all of the revenue ranges in these sectors.

78 The average growth rate is an average of the annual percent change in the actual value of construction from 1990-1991 to 2006-2007.

Table A-3: Actual and Estimated Trend Values for the Non-Residential Construction Sector (2006 $Millions)

Year	Actual Value of Construction	Estimated Trend Line Value of Construction	Deviation from Trend Line	Annual Percent Change in the Actual Value of Construction	Difference from Annual Percent Change in the Actual Value of Construction to Average Growth of 2.08%	At, Above, or Below Trend Line[a]	At, Above, or Below Average Growth[b]
1990	$205,026	$162,215	26.4%			Above	
1991	$160,914	$165,990	-3.1%	-21.52%	-23.59%	At	Below
1992	$142,558	$169,852	-16.1%	-11.41%	-13.48%	Below	Below
1993	$142,067	$173,803	-18.3%	-0.34%	-2.42%	Below	At
1994	$155,343	$177,847	-12.7%	9.35%	7.27%	Below	Above
1995	$174,668	$181,985	-4.0%	12.44%	10.36%	At	Above
1996	$193,580	$186,219	4.0%	10.83%	8.75%	At	Above
1997	$212,423	$190,552	11.5%	9.73%	7.66%	Above	Above
1998	$230,435	$194,985	18.2%	8.48%	6.40%	Above	Above
1999	$230,989	$199,522	15.8%	0.24%	-1.83%	Above	At
2000	$242,740	$204,164	18.9%	5.09%	3.01%	Above	At
2001	$230,329	$208,914	10.3%	-5.11%	-7.19%	At	Below
2002	**$186,938**	**$213,775**	**-12.6%**	**-18.84%**	**-20.91%**	**Below**	**Below**
2003	**$190,196**	**$218,749**	**-13.1%**	**1.74%**	**-0.33%**	**Below**	**At**
2004	**$199,745**	**$223,839**	**-10.8%**	**5.02%**	**2.94%**	**Below**	**At**
2005	**$209,743**	**$229,046**	**-8.4%**	**5.01%**	**2.93%**	**At**	**At**
2006	**$234,414**	**$234,376**	**0.0%**	**11.76%**	**9.69%**	**At**	**Above**
2007	**$264,459**	**$239,829**	**10.3%**	**12.82%**	**10.74%**	**Above**	**Above**

a Given a deviation variable of 10.26 percent; i.e. if the deviation from the trend line was ± 10.26 percent from zero, the year was considered to be "at" the trend.

b Given a deviation variable of 3.5 percent; i.e. if the difference from the annual percent change in the actual value of construction to the average was ± 3.5 percent from zero, the year was considered to be "at" average growth.

Source: U.S. Census Bureau's Construction Spending (2008a) and EPA Estimates

Table A-4: Actual and Estimated Trend Values for the Non-Building Construction Sector (2006 $Millions)

Year	Actual Value of Construction	Estimated Trend Line Value of Construction	Deviation from Trend Line	Annual Percent Change in the Actual Value of Construction	Difference from Annual Percent Change in the Actual Value of Construction to Average Growth of 3.19%	At, Above, or Below Trend Line[a]	At, Above, or Below Average Growth[b]
1990	$91,242	$81,478	12.0%			Above	
1991	$86,556	$84,203	2.8%	-5.14%	-8.33%	Above	Below
1992	$88,873	$87,020	2.1%	2.68%	-0.51%	Above	At
1993	$88,897	$89,930	-1.1%	0.03%	-3.16%	At	Below
1994	$91,369	$92,938	-1.7%	2.78%	-0.41%	At	At
1995	$91,349	$96,047	-4.9%	-0.02%	-3.21%	Below	Below
1996	$94,136	$99,259	-5.2%	3.05%	-0.14%	Below	At
1997	$98,757	$102,579	-3.7%	4.91%	1.72%	Below	At
1998	$98,940	$106,010	-6.7%	0.19%	-3.01%	Below	Below
1999	$106,904	$109,556	-2.4%	8.05%	4.86%	Below	Above
2000	$112,055	$113,220	-1.0%	4.82%	1.63%	At	At
2001	$120,267	$117,007	2.8%	7.33%	4.14%	Above	Above
2002	**$121,232**	**$120,920**	**0.3%**	**0.80%**	**-2.39%**	**At**	**Below**
2003	**$126,033**	**$124,965**	**0.9%**	**3.96%**	**0.77%**	**At**	**At**
2004	**$125,904**	**$129,145**	**-2.5%**	**-0.10%**	**-3.29%**	**Below**	**Below**
2005	**$132,588**	**$133,464**	**-0.7%**	**5.31%**	**2.12%**	**At**	**Above**
2006	**$141,548**	**$137,928**	**2.6%**	**6.76%**	**3.57%**	**Above**	**Above**
2007	**$154,087**	**$142,541**	**8.1%**	**8.86%**	**5.67%**	**Above**	**Above**

a Given a deviation variable of 2 percent; i.e. if the deviation from the trend line was ± 2 percent from zero, the year was considered to be "at" the trend.

b Given a deviation variable of 2 percent; i.e. if the difference from the annual percent change in the actual value of construction to the average was ± 2 percent from zero, the year was considered to be "at" average growth.

Source: U.S. Census Bureau's Construction Spending (2008a) and EPA Estimates

Defining the Aggregate Level of C&D Activity for the Adverse Business Conditions Case

Under adverse business conditions, EPA assumes that the total operating level of the C&D industry and total construction activity subject to regulatory requirements will be less than the 2008-trend baseline activity estimates. This section describes how EPA developed an estimate of the aggregate level of activity that reflects what the industry might have looked like during 2008 if all three broad C&D sectors were experiencing adverse business conditions.

The approach for estimating the level of industry activity under adverse 2008 conditions mirrors the approach for estimating the 2008-trend level of activity detailed in *Section 4.1* of *Chapter 4.* The one material difference in these approaches concerns the assumed value of construction performed by sector, which forms part of the basis for estimating an activity level.

For the non-residential and non-building sectors – which were not in particularly adverse condition during 2008 – EPA draws on the same data presented above in *Table A-3* and *Table A-4.* These data were also used to determine the average percentage deviation from the trend in the *below trend line* years by sector. EPA used these percentage values, presented in *Table A-5*, in the *adverse analysis case* to adjust downward the baseline level of activity for the non-residential and non-building sector (i.e., to simulate adverse conditions during 2008 in these sectors, the percentages were applied as a deviation from the 2008-trend level of activity).

Table A-5: Average Growth, Estimated Trend, and the Typical Deviation in Below Trend Years

	Non-Residential	Non-Building
Average Growth	2.08%	3.19%
Estimated Trend	2.30%	3.29%
Average Deviation in Below Trend Years	-13.89%	-4.23%

Source: U.S. Census Bureau's Construction Spending (2008a) and EPA Estimates

For the residential construction sector, rather than rely on the average annual deviation from trend during relatively adverse years, EPA elected to simply use the reported value of construction during 2008 for this sector. This value results in a more adverse condition for this sector (i.e., less activity) than would be generated if EPA relied on the deviation from trend method.

Once the value of construction is specified for each sector, the approach for estimating aggregate acreage is identical to the approach utilized in *Section 4.1* of *Chapter 4*. That is, value is combined with acreage intensity to produce an estimate of aggregate acreage, by sector, in the 2008-adverse year. *Table A-6* indicates that the aggregate quantity of acreage used to support the adverse analysis case is approximately 592,000 acres.[79]

Table A-6: Value of Construction Basis for Estiamting Adverse-Case Level of C&D Activity

	Value of Construction Basis	Year Basis	Acreage Intensity	Acres
Residential	$230,216	2008 actual	0.860	223,721
Commercial	$319,848	Negative 13.89% deviation from 2008-trend	0.911	309,012
Industrial	$29,649	Negative 13.89% deviation from 2008-trend	0.911	28,645
Non-Building	$8,811	Negative 4.23% deviation from 2008-trend	3.522	31,028

Source: U.S. Census Bureau's Construction Spending (2008a) and EPA Estimates

79 Recall that the Proposed Rule economic analysis was a 2002 analysis with respect to the composition of the C&D industry, and performed on the basis of approximately 590,000 acres, which reflects the average annual level of acreage developed during the period 1991 – 2001. Thus, the level of activity developed to support the current adverse analysis case, coincentially, implies a level of activity on par with what was occurring during approximately the mid-1990s.

Next, to complete the definition of industry activity for the adverse analysis case, EPA followed the following process:

1. The quantity of 2008-adverse acreage is distributed across states and C&D industry sectors using the same approach for distributing the 2008-trend quantity, as described in *Section 4.2.1* of *Chapter 4*. In this case, the activity allocation factors were based on the 2008-adverse firm universe developed by EPA (number 4 below).
2. The quantity of 2008-adverse acreage is distributed across 144 model project categories for which compliance costs were estimated in developing the C&D final rule. The approach for this step is the same as that described previously in *Section 4.2.2* of *Chapter 4.*
3. The intial acreage distribution results were then adjusted, using the approach described in *Section 4.2.3* of *Chapter 4*.
4. The 2002 C&D firm universe data set was adjusted to reflect 2008-adverse conditions using the same approach to adjust this data set to 2008-trend conditions, as described in *Section 4.4* of *Chapter 4*.

Adverse Analysis Case Results

As described above, the adverse analysis case assumes that firms in the C&D industry pass through none of the incremental compliance costs and uses the adverse business conditions case definition for model C&D firms. In addition, the adverse analysis case also reflects a lower overall level of activity in the C&D industry relative to the steady-state, general conditions analysis case. As a result of the contraction in the number of firms and total activity, total estimated compliance costs and economic impacts are lower than those under the general conditions analysis case when there is an assumption of no cost pass-through. Essentially, the contraction in industry activity estimated under the adverse business conditions case outweighs the effect of poorer firm financial performance and the cost pass-through effect. Relative to the general conditions analysis case *with cost pass-through*, economic impacts under the adverse conditions analysis case are larger. The results for the adverse analysis case are presented in *Table A-7*.

With respect to the firms incurring costs that exceed 1 and 3 percent of revenues, the impacts under the adverse analysis case are exactly the same *regardless of whether one accounts for the effect of cost pass-through*. This is simply because the cost pass-through fraction is assumed to be 0% in the adverse case, and thus, the effect is the same as though cost pass-through had not been taken into account.

Table A-7: Summary of Analysis for Final Rule Options – Adverse Business Conditions Analysis

Impact Analysis Concept		Option 1	Option 2	Option 3	Option 4
Resource Cost of Compliance and Affected Acreage and Firms[a]					
Total Costs ($millions)		$125	$3,316	$6,184	$654
Total Acreage Incurring Cost[a]		591,772	591,772	591,772	591,772
Number of Firms	All Firms	154,048	154,048	154,048	154,048
	Firms In-Scope	58,931	58,931	58,931	58,931
	Firms Incurring Cost	17,491	17,491	17,491	17,491
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact					
Costs Unadjusted for Effect of Cost Pass-Through					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	2,037	6,960	105
	% of All Firms	0.0%	1.3%	4.5%	0.1%
	% of Firms In-Scope	0.0%	3.5%	11.8%	0.2%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	751	3,401	0
	% of All Firms	0.0%	0.5%	2.2%	0.0%
	% of Firms In-Scope	0.0%	1.3%	5.8%	0.0%
Costs Adjusted for Effect of Cost Pass-Through					
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	2,037	6,960	105
	% of All Firms	0.0%	1.3%	4.5%	0.1%
	% of Firms In-Scope	0.0%	3.5%	11.8%	0.2%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	751	3,401	0
	% of All Firms	0.0%	0.5%	2.2%	0.0%
	% of Firms In-Scope	0.0%	1.3%	5.8%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance					
Firms Incurring Financial Stress	Number Incurring Effect	71	3,163	8,168	315
	% of All Firms	0.0%	2.1%	5.3%	0.2%
	% of Firms In-Scope	0.1%	5.4%	13.9%	0.5%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)					
Firms with Negative Business Value Because of Regulation	Number Incurring Effect	180	1,041	2,966	547
	% of All Firms	0.1%	0.7%	1.9%	0.4%
	% of Firms In-Scope	0.3%	1.8%	5.0%	0.9%

EPA Estimates

- For *Option 1*, the least costly of the four options, EPA estimates total annual costs of $125 million. A total of about 17,500 firms are estimated to incur compliance costs under this option. Out of these firms, none are estimated to incur costs exceeding 1 or 3 percent of revenue, while 71 firms are estimated to incur financial stress. A total of 180 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

- For *Option 2*, EPA estimates total annual costs of $3,316 million. Out of the 17,500 firms estimated to incur costs, 2,037 are estimated to incur costs exceeding 1 percent of revenue, and 751 are estimated to incur costs exceeding 3 percent of revenue. A total of 3,163 firms are estimated to incur financial stress as a result of regulatory requirements, and a total of 1,041 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

- For *Option 3*, the most costly option, EPA estimates total annual costs of $6,184 million. Out of these 17,500 firms estimated to incur costs, 6,960 are estimated to incur costs exceeding 1 percent of revenue, and 3,401 are estimated to incur costs exceeding 3 percent of revenue. A total of 8,168 firms are estimated to incur financial stress as a result of regulatory requirements, and a total of 2,966 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

- For *Option 4*, EPA estimates total costs of $654 million under the adverse business conditions case. Out of the 17,500 firms estimated to incur costs, 105 are estimated to incur costs exceeding 1 percent of revenue, and zero are estimated to incur costs exceeding 3 percent of revenue. A total of 315 firms are estimated to incur financial stress as a result of regulatory requirements, and 547 firms are estimated to experience negative business value as a result of regulatory requirements. Some of the firms estimated to incur financial stress may also be estimated to experience negative business value, and as a result, these two measures of financial impact may not be additive.

Appendix B: Detailed Results for the Firm- and Industry-Level Analysis

Table B-1 through *Table B-8* report the detailed results for the firm- and industry-level impact analysis for Options 1, 2, 3, and 4. The results reported are for the general business conditions case.

Table B-1: Option 1 Results by Firm Revenue Size Range and Estimated Total for All Firms in NAICS Sectors

	Firm Revenue Size Range, Based on SUSB/Economic Census Data ($000)								
	$100 - $1,000	$1,000 - $3,000	$3,000 - $5,000	$5,000 - $10,000	$10,000 - $50,000	$50,000 - $100,000	$100,000 - $1,000,000	All Firms	Small Firms
Total Firms in Revenue Ranges (from SUSB and Economic Census)									
Number of Firms	110,381	38,237	19,197	8,475	8,341	1,021	1,427	187,079	182,545
Total Revenue in Range (millions $2008)	$49,415	$67,110	$72,150	$69,532	$190,276	$71,202	$307,191	$826,875	$400,914
Estimated Employment	315,430	282,052	235,071	192,867	413,537	123,226	587,652	2,149,835	1,335,572
Total Firms in Revenue Ranges Estimated to Incur Costs									
Number of Firms	2,788	6,958	8,406	4,756	6,017	634	950	30,508	27,420
Total Annual Compliance Acreage and Cost									
Total Indicated Compliance Acreage	2,023	20,101	53,179	69,554	250,831	82,101	374,860	852,649	332,981
Total Indicated Cost (millions $2008)	$0.5	$4.3	$12.0	$15.5	$55.3	$16.8	$71.3	$175.8	$73.8
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures									
Composite Result (calculated as the greater of the separate estimate values)									
Estimated Number of Firms	1	3	6	0	18	1	1	31	24
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%	0.1%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.1%	0.1%	0.0%	0.3%	0.1%	0.1%	0.1%	0.1%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)									
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue									
Number exceeding 1.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
with Compliance Costs Unadjusted for Cost Pass-Through Effect									
Number exceeding 1.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Change in Business Value (valued on the basis of cash flow to total capital)									

Table B-1: Option 1 Results by Firm Revenue Size Range and Estimated Total for All Firms in NAICS Sectors

	Firm Revenue Size Range, Based on SUSB/Economic Census Data ($000)								
	$100 - $1,000	**$1,000 - $3,000**	**$3,000 - $5,000**	**$5,000 - $10,000**	**$10,000 - $50,000**	**$50,000 - $100,000**	**$100,000 - $1,000,000**	**All Firms**	**Small Firms**
Firms With Negative Net Worth Because of Regulation									
Number of Firms	0	3	6	7	11	1	1	30	25
Percentage of All Firms	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.1%	0.1%	0.1%
Number of Employees in Firms with Negative Business Value	1	20	79	161	563	119	521	1464	683

Table B-2: Option 1 Results by NAICS Sector Aggregated over Firm Revenue Size Ranges

	NAICS Sectors						All
	236115	**236116**	**236117**	**236210**	**236220**	**237310**	**Sectors**
Total Firms in Sectors (from SUSB and Economic Census)							
Number of Firms	69,288	6,005	30,347	4,159	67,235	10,044	187,079
Total Revenue in Sector (millions $2008)	$115,846	$28,356	$166,722	$56,447	$385,876	$73,628	$826,875
Estimated Employment	283,166	51,753	305,734	232,245	1,005,280	271,657	2,149,835
Total Firms in Sectors Estimated to Incur Costs							
Number of Firms	11,570	933	5,994	623	10,408	980	30,508
Total Annual Compliance Acreage and Cost, based on Adjusted Total Firms in Sectors							
Total Indicated Compliance Acreage	118,632	27,303	172,834	57,548	400,344	75,988	852,649
Total Indicated Cost (millions $2008)	$22.5	$5.3	$32.6	$11.2	$76.8	$27.4	$175.8
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures							
Composite Result (calculated as the greater of the separate estimate values)							
Estimated Number of Firms	4	0	2	1	30	4	43
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.2%	0.3%	0.4%	0.1%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)							
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue							
Number exceeding 1.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
with Compliance Costs Unadjusted for Cost Pass-Through Effect							
Number exceeding 1.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Change in Business Value (valued on the basis of cash flow to total capital)							
Firms With Negative Net Worth Because of Regulation							
Number of Firms	6	0	3	1	18	2	30
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.1%	0.0%	0.1%	0.2%	0.2%	0.1%
Number of Employees in Firms with Negative Business Value	23	4	25	44	276	63	436

Table B-3: Option 2 Results by Firm Revenue Size Range and Estimated Total for All Firms in NAICS Sectors

	Firm Revenue Size Range, Based on SUSB/Economic Census Data ($000)								
	$100 - $1,000	$1,000 - $3,000	$3,000 - $5,000	$5,000 - $10,000	$10,000 - $50,000	$50,000 - $100,000	$100,000 - $1,000,000	All Firms	Small Firms
Total Firms in Revenue Ranges (from SUSB and Economic Census)									
Number of Firms	110,381	38,237	19,197	8,475	8,341	1,021	1,427	187,079	182,545
Total Revenue in Range (millions $2008)	$49,415	$67,110	$72,150	$69,532	$190,276	$71,202	$307,191	$826,875	$400,914
Estimated Employment	315,430	282,052	235,071	192,867	413,537	123,226	587,652	2,149,835	1,335,572
Total Firms in Revenue Ranges Estimated to Incur Costs									
Number of Firms	2,788	6,958	8,406	4,756	6,017	634	950	30,508	27,420
Total Annual Compliance Acreage and Cost									
Total Indicated Compliance Acreage	2,023	20,101	53,179	69,554	250,831	82,101	374,860	852,649	332,981
Total Indicated Cost (millions $2008)	$0.5	$9.3	$102.8	$240.0	$1,526.8	$504.1	$2,482.4	$4,865.9	$1,497.7
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures									
Composite Result (calculated as the greater of the separate estimate values)									
Estimated Number of Firms	1	7	34	788	259	37	55	1,181	1,024
Percentage of All Firms	0.0%	0.0%	0.2%	9.3%	3.1%	3.6%	3.8%	0.6%	0.6%
Percentage of Firms Incurring Costs	0.0%	0.1%	0.4%	16.6%	4.3%	5.9%	5.8%	3.9%	3.7%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)									
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue									
Number exceeding 1.0% of Revenue	0	15	11	107	613	35	91	873	593
Percentage of All Firms	0.0%	0.0%	0.1%	1.3%	7.4%	3.5%	6.4%	0.5%	0.3%
Percentage of Firms Incurring Costs	0.0%	0.2%	0.1%	2.2%	10.2%	5.6%	9.6%	2.9%	2.2%
Number exceeding 3.0% of Revenue	0	0	0	10	66	1	3	81	60
Percentage of All Firms	0.0%	0.0%	0.0%	0.1%	0.8%	0.1%	0.2%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.2%	1.1%	0.2%	0.4%	0.3%	0.2%
with Compliance Costs Unadjusted for Cost Pass-Through Effect									
Number exceeding 1.0% of Revenue	0	65	788	971	2,173	271	448	4,717	3,454
Percentage of All Firms	0.0%	0.2%	4.1%	11.5%	26.1%	26.6%	31.4%	2.5%	1.9%
Percentage of Firms Incurring Costs	0.0%	0.9%	9.4%	20.4%	36.1%	42.8%	47.2%	15.5%	12.6%
Number exceeding 3.0% of Revenue	0	56	349	512	1,234	75	172	2,399	1,843
Percentage of All Firms	0.0%	0.1%	1.8%	6.0%	14.8%	7.3%	12.1%	1.3%	1.0%
Percentage of Firms Incurring Costs	0.0%	0.8%	4.1%	10.8%	20.5%	11.8%	18.2%	7.9%	6.7%
Change in Business Value (valued on the basis of cash flow to total capital)									
Firms With Negative Net Worth Because of Regulation									
Number of Firms	0	5	53	45	264	25	37	430	301
Percentage of All Firms	0.0%	0.0%	0.3%	0.5%	3.2%	2.5%	2.6%	0.2%	0.2%
Percentage of Firms Incurring Costs	0.0%	0.1%	0.6%	0.9%	4.4%	4.0%	3.9%	1.4%	1.1%
Number of Employees in Firms with Negative Business Value	1	39	650	1,021	13,076	3,073	15,184	33,044	11,518

Table B-4: Option 2 Results by NAICS Sector Aggregated over Firm Revenue Size Ranges

	NAICS Sectors						All
	236115	236116	236117	236210	236220	237310	Sectors
Total Firms in Sectors (from SUSB and Economic Census)							
Number of Firms	69,288	6,005	30,347	4,159	67,235	10,044	187,079
Total Revenue in Sector (millions $2008)	$115,846	$28,356	$166,722	$56,447	$385,876	$73,628	$826,875
Estimated Employment	283,166	51,753	305,734	232,245	1,005,280	271,657	2,149,835
Total Firms in Sectors Estimated to Incur Costs							
Number of Firms	11,570	933	5,994	623	10,408	980	30,508
Total Annual Compliance Acreage and Cost, based on Adjusted Total Firms in Sectors							
Total Indicated Compliance Acreage	118,632	27,303	172,834	57,548	400,344	75,988	852,649
Total Indicated Cost (millions $2008)	$866.9	$216.2	$1,264.1	$233.5	$1,682.6	$602.7	$4,865.9
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures							
Composite Result (calculated as the greater of the separate estimate values)							
Estimated Number of Firms	84	5	38	18	228	78	451
Percentage of All Firms	0.1%	0.1%	0.1%	0.4%	0.3%	0.8%	0.2%
Percentage of Firms Incurring Costs	0.7%	0.6%	0.6%	2.9%	2.2%	7.9%	1.5%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)							
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue							
Number exceeding 1.0% of Revenue	86	7	56	37	448	239	873
Percentage of All Firms	0.1%	0.1%	0.2%	0.9%	0.7%	2.4%	0.5%
Percentage of Firms Incurring Costs	0.7%	0.8%	0.9%	6.0%	4.3%	24.4%	2.9%
Number exceeding 3.0% of Revenue	0	0	0	2	11	69	81
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.3%	0.1%	7.0%	0.3%
with Compliance Costs Unadjusted for Cost Pass-Through Effect							
Number exceeding 1.0% of Revenue	2,131	160	994	80	1,050	302	4,717
Percentage of All Firms	3.1%	2.7%	3.3%	1.9%	1.6%	3.0%	2.5%
Percentage of Firms Incurring Costs	18.4%	17.2%	16.6%	12.9%	10.1%	30.8%	15.5%
Number exceeding 3.0% of Revenue	1,015	72	480	44	534	254	2,399
Percentage of All Firms	1.5%	1.2%	1.6%	1.1%	0.8%	2.5%	1.3%
Percentage of Firms Incurring Costs	8.8%	7.7%	8.0%	7.0%	5.1%	25.9%	7.9%
Change in Business Value (valued on the basis of cash flow to total capital)							
Firms With Negative Net Worth Because of Regulation							
Number of Firms	89	7	42	11	229	53	430
Percentage of All Firms	0.1%	0.1%	0.1%	0.3%	0.3%	0.5%	0.2%
Percentage of Firms Incurring Costs	0.8%	0.8%	0.7%	1.7%	2.2%	5.4%	1.4%
Number of Employees in Firms with Negative Business Value	362	64	421	590	3,418	1,427	6,282

Table B-5: Option 3 Results by Firm Revenue Size Range and Estimated Total for All Firms in NAICS Sectors

	Firm Revenue Size Range, Based on SUSB/Economic Census Data ($000)								
	$100 - $1,000	$1,000 - $3,000	$3,000 - $5,000	$5,000 - $10,000	$10,000 - $50,000	$50,000 - $100,000	$100,000 - $1,000,000	All Firms	Small Firms
Total Firms in Revenue Ranges (from SUSB and Economic Census)									
Number of Firms	110,381	38,237	19,197	8,475	8,341	1,021	1,427	187,079	182,545
Total Revenue in Range (millions $2008)	$49,415	$67,110	$72,150	$69,532	$190,276	$71,202	$307,191	$826,875	$400,914
Estimated Employment	315,430	282,052	235,071	192,867	413,537	123,226	587,652	2,149,835	1,335,572
Total Firms in Revenue Ranges Estimated to Incur Costs									
Number of Firms	2,788	6,958	8,406	4,756	6,017	634	950	30,508	27,420
Total Annual Compliance Acreage and Cost									
Total Indicated Compliance Acreage	2,023	20,101	53,179	69,554	250,831	82,101	374,860	852,649	332,981
Total Indicated Cost (millions $2008)	$1.8	$135.7	$686.9	$801.9	$2,934.5	$813.5	$3,716.2	$9,090.4	$3,827.1
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures									
Composite Result (calculated as the greater of the separate estimate values)									
Estimated Number of Firms	4	97	317	4,297	531	65	88	5,398	5,112
Percentage of All Firms	0.0%	0.3%	1.7%	50.7%	6.4%	6.4%	6.2%	2.9%	2.8%
Percentage of Firms Incurring Costs	0.1%	1.4%	3.8%	90.3%	8.8%	10.3%	9.3%	17.7%	18.6%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)									
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue									
Number exceeding 1.0% of Revenue	40	462	703	781	1,362	67	158	3,573	3,008
Percentage of All Firms	0.0%	1.2%	3.7%	9.2%	16.3%	6.6%	11.1%	1.9%	1.6%
Percentage of Firms Incurring Costs	1.4%	6.6%	8.4%	16.4%	22.6%	10.6%	16.6%	11.7%	11.0%
Number exceeding 3.0% of Revenue	14	28	20	35	119	2	6	225	187
Percentage of All Firms	0.0%	0.1%	0.1%	0.4%	1.4%	0.2%	0.4%	0.1%	0.1%
Percentage of Firms Incurring Costs	0.5%	0.4%	0.2%	0.7%	2.0%	0.3%	0.7%	0.7%	0.7%
with Compliance Costs Unadjusted for Cost Pass-Through Effect									
Number exceeding 1.0% of Revenue	47	1,536	4,297	2,860	4,199	432	651	14,021	11,889
Percentage of All Firms	0.0%	4.0%	22.4%	33.7%	50.3%	42.3%	45.6%	7.5%	6.5%
Percentage of Firms Incurring Costs	1.7%	22.1%	51.1%	60.1%	69.8%	68.1%	68.5%	46.0%	43.4%
Number exceeding 3.0% of Revenue	47	1,331	2,916	1,971	2,455	132	275	9,126	8,106
Percentage of All Firms	0.0%	3.5%	15.2%	23.3%	29.4%	12.9%	19.3%	4.9%	4.4%
Percentage of Firms Incurring Costs	1.7%	19.1%	34.7%	41.5%	40.8%	20.7%	28.9%	29.9%	29.6%
Change in Business Value (valued on the basis of cash flow to total capital)									
Firms With Negative Net Worth Because of Regulation									
Number of Firms	1	68	263	248	570	45	59	1,254	1,007
Percentage of All Firms	0.0%	0.2%	1.4%	2.9%	6.8%	4.4%	4.2%	0.7%	0.6%
Percentage of Firms Incurring Costs	0.0%	1.0%	3.1%	5.2%	9.5%	7.1%	6.2%	4.1%	3.7%
Number of Employees in Firms with Negative Business Value	3	505	3,217	5,637	28,240	5,428	24,412	67,443	30,542

Table B-6: Option 3 Results by NAICS Sector Aggregated over Firm Revenue Size Ranges

	NAICS Sectors						All
	236115	236116	236117	236210	236220	237310	Sectors
Total Firms in Sectors (from SUSB and Economic Census)							
Number of Firms	69,288	6,005	30,347	4,159	67,235	10,044	187,079
Total Revenue in Sector (millions $2008)	$115,846	$28,356	$166,722	$56,447	$385,876	$73,628	$826,875
Estimated Employment	283,166	51,753	305,734	232,245	1,005,280	271,657	2,149,835
Total Firms in Sectors Estimated to Incur Costs							
Number of Firms	11,570	933	5,994	623	10,408	980	30,508
Total Annual Compliance Acreage and Cost, based on Adjusted Total Firms in Sectors							
Total Indicated Compliance Acreage	118,632	27,303	172,834	57,548	400,344	75,988	852,649
Total Indicated Cost (millions $2008)	$1,575.7	$400.5	$2,293.2	$479.2	$3,398.8	$943.0	$9,090.4
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures							
Composite Result (calculated as the greater of the separate estimate values)							
Estimated Number of Firms	280	20	189	45	651	150	1,336
Percentage of All Firms	0.4%	0.3%	0.6%	1.1%	1.0%	1.5%	0.7%
Percentage of Firms Incurring Costs	2.4%	2.1%	3.1%	7.3%	6.3%	15.3%	4.4%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)							
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue							
Number exceeding 1.0% of Revenue	718	46	425	126	1,766	491	3,573
Percentage of All Firms	1.0%	0.8%	1.4%	3.0%	2.6%	4.9%	1.9%
Percentage of Firms Incurring Costs	6.2%	5.0%	7.1%	20.2%	17.0%	50.1%	11.7%
Number exceeding 3.0% of Revenue	14	0	0	11	48	152	225
Percentage of All Firms	0.0%	0.0%	0.0%	0.3%	0.1%	1.5%	0.1%
Percentage of Firms Incurring Costs	0.1%	0.0%	0.0%	1.7%	0.5%	15.5%	0.7%
with Compliance Costs Unadjusted for Cost Pass-Through Effect							
Number exceeding 1.0% of Revenue	6,269	453	3,161	212	3,346	580	14,021
Percentage of All Firms	9.0%	7.5%	10.4%	5.1%	5.0%	5.8%	7.5%
Percentage of Firms Incurring Costs	54.2%	48.5%	52.7%	34.0%	32.1%	59.2%	46.0%
Number exceeding 3.0% of Revenue	3,923	259	2,218	142	2,071	513	9,126
Percentage of All Firms	5.7%	4.3%	7.3%	3.4%	3.1%	5.1%	4.9%
Percentage of Firms Incurring Costs	33.9%	27.8%	37.0%	22.7%	19.9%	52.3%	29.9%
Change in Business Value (valued on the basis of cash flow to total capital)							
Firms With Negative Net Worth Because of Regulation							
Number of Firms	290	25	88	26	730	96	1,254
Percentage of All Firms	0.4%	0.4%	0.3%	0.6%	1.1%	1.0%	0.7%
Percentage of Firms Incurring Costs	2.5%	2.7%	1.5%	4.1%	7.0%	9.8%	4.1%
Number of Employees in Firms with Negative Business Value	1,184	216	886	1,425	10,915	2,588	17,213

Table B-7: Option 4 Results by Firm Revenue Size Range and Estimated Total for All Firms in NAICS Sectors

	Firm Revenue Size Range, Based on SUSB/Economic Census Data ($000)								
	$100 - $1,000	$1,000 - $3,000	$3,000 - $5,000	$5,000 - $10,000	$10,000 - $50,000	$50,000 - $100,000	$100,000 - $1,000,000	All Firms	Small Firms
Total Firms in Revenue Ranges (from SUSB and Economic Census)									
Number of Firms	110,381	38,237	19,197	8,475	8,341	1,021	1,427	187,079	182,545
Total Revenue in Range (millions $2008)	$49,415	$67,110	$72,150	$69,532	$190,276	$71,202	$307,191	$826,875	$400,914
Estimated Employment	315,430	282,052	235,071	192,867	413,537	123,226	587,652	2,149,835	1,335,572
Total Firms in Revenue Ranges Estimated to Incur Costs									
Number of Firms	2,788	6,958	8,406	4,756	6,017	634	950	30,508	27,420
Total Annual Compliance Acreage and Cost									
Total Indicated Compliance Acreage	2,023	20,101	53,179	69,554	250,831	82,101	374,860	852,649	332,981
Total Indicated Cost (millions $2008)	$0.6	$14.5	$66.6	$85.8	$314.1	$86.1	$385.0	$952.7	$403.1
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures									
Composite Result (calculated as the greater of the separate estimate values)									
Estimated Number of Firms	1	10	27	25	95	5	6	169	135
Percentage of All Firms	0.0%	0.0%	0.1%	0.3%	1.1%	0.5%	0.4%	0.1%	0.1%
Percentage of Firms Incurring Costs	0.0%	0.1%	0.3%	0.5%	1.6%	0.7%	0.6%	0.6%	0.5%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)									
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue									
Number exceeding 1.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
with Compliance Costs Unadjusted for Cost Pass-Through Effect									
Number exceeding 1.0% of Revenue	28	29	25	41	144	2	8	276	230
Percentage of All Firms	0.0%	0.1%	0.1%	0.5%	1.7%	0.2%	0.5%	0.1%	0.1%
Percentage of Firms Incurring Costs	1.0%	0.4%	0.3%	0.9%	2.4%	0.3%	0.8%	0.9%	0.8%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Change in Business Value (valued on the basis of cash flow to total capital)									
Firms With Negative Net Worth Because of Regulation									
Number of Firms	0	8	33	36	59	5	6	147	122
Percentage of All Firms	0.0%	0.0%	0.2%	0.4%	0.7%	0.5%	0.4%	0.1%	0.1%
Percentage of Firms Incurring Costs	0.0%	0.1%	0.4%	0.8%	1.0%	0.7%	0.6%	0.5%	0.4%
Number of Employees in Firms with Negative Business Value	1	59	404	821	2,919	558	2,494	7,257	3,475

Table B-8: Option 4 Results by NAICS Sector Aggregated over Firm Revenue Size Ranges

	NAICS Sectors						All
	236115	236116	236117	236210	236220	237310	Sectors
Total Firms in Sectors (from SUSB and Economic Census)							
Number of Firms	69,288	6,005	30,347	4,159	67,235	10,044	187,079
Total Revenue in Sector (millions $2008)	$115,846	$28,356	$166,722	$56,447	$385,876	$73,628	$826,875
Estimated Employment	283,166	51,753	305,734	232,245	1,005,280	271,657	2,149,835
Total Firms in Sectors Estimated to Incur Costs							
Number of Firms	11,570	933	5,994	623	10,408	980	30,508
Total Annual Compliance Acreage and Cost, based on Adjusted Total Firms in Sectors							
Total Indicated Compliance Acreage	118,632	27,303	172,834	57,548	400,344	75,988	852,649
Total Indicated Cost (millions $2008)	$162.6	$40.4	$232.6	$50.6	$357.6	$108.9	$952.7
Percent and Number of Firms Falling Below NAICS Sector 1st Quartile Values for Financial Performance Measures							
Composite Result (calculated as the greater of the separate estimate values)							
Estimated Number of Firms	26	2	16	4	104	19	172
Percentage of All Firms	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.1%
Percentage of Firms Incurring Costs	0.2%	0.2%	0.3%	0.7%	1.0%	2.0%	0.6%
Cost-to-Revenue Comparisons (based on distribution of in-scope acreage of activity per $ million of in-scope revenue)							
with Compliance Costs Reduced by Cost Pass-Through Increase in Revenue							
Number exceeding 1.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
with Compliance Costs Unadjusted for Cost Pass-Through Effect							
Number exceeding 1.0% of Revenue	41	1	12	6	18	197	276
Percentage of All Firms	0.1%	0.0%	0.0%	0.1%	0.0%	2.0%	0.1%
Percentage of Firms Incurring Costs	0.4%	0.1%	0.2%	0.9%	0.2%	20.1%	0.9%
Number exceeding 3.0% of Revenue	0	0	0	0	0	0	0
Percentage of All Firms	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Firms Incurring Costs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Change in Business Value (valued on the basis of cash flow to total capital)							
Firms With Negative Net Worth Because of Regulation							
Number of Firms	38	3	17	3	73	13	147
Percentage of All Firms	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%
Percentage of Firms Incurring Costs	0.3%	0.3%	0.3%	0.5%	0.7%	1.3%	0.5%
Number of Employees in Firms with Negative Business Value	155	22	170	181	1,099	349	1,977

Appendix C: Sensitivity Analysis of Industry-Level Financial Impacts

This appendix presents the results of analyses EPA performed to test the sensitivity of firm- and industry-level impacts to alternate configurations of the in-scope firm criteria described in Section 6.2. The definition and configuration of in-scope firms affects the way that model projects are assigned to model firms, and therefore affects the incidence of firms incurring compliance costs.

Model Firm Project Performance Criteria

Recall that EPA's model project-to-firm allocation algorithm does not randomly assign model projects to firms, but instead, recognizes key constraints such as the capability of individual model firms to perform a given type of model project, and the relative performance capacity across model firms, accounting for the number of firms by sector and state. To summarize, the primary assignment of model projects (and associated compliance costs) to model firms involves the following steps (see Section 6.2 for full details):

1. Assess feasibility of model project performance by individual model firms, based on model firm in-scope revenue and operating model, and annual project value per model project acre;
2. Rank projects (defined by size and duration) according to *total* industry performance capacity for each type of project – from least capacity to most;
3. Successively assign projects to model firms in proportion to performance capacity of individual model firm categories; and,
4. As project assignments are made, adjust available performance capacity to account for the aggregate number of firms whose capacity is fully assigned, and also account for the quantity of model project demand that has already been assigned to firms.

This sensitivity analysis focuses on critieria set forth in Step 1, which is discussed in more detail below.

The first step in assigning model projects to model firms is to assess the feasibility of model firms to perform the individual model projects present for a given state and construction sector. *The test of performance feasibility is required because not all model firms are capable of performing the full slate of model projects present for a given state and construction activity sector.* The test of performance feasibility involves comparing:

- For a given model firm, the steady state maximum project acreage, on an annual performance basis, that the model firm is estimated capable of performing – assuming that the model firm performs only in-scope projects of a given duration

  with

- For a given model project, the annual effective performance requirement of the project.

If the model firm's steady state maximum annual project acreage exceeds the model project's annual performance requirement, then the model firm is assumed capable of performing the model project. These comparisons are performed for all possible combinations of model projects and model firms for a given state and construction activity sector. The feasibility determination is independent of the actual number of model projects that will need to be assigned to model firms, and likewise is independent of the actual number of model firms to which the model projects will be assigned.

The model firm's steady state annual project performance acreage is a function of:

- *The model firm's baseline in-scope revenue.* In-scope revenue, together with the other factors described below, is a key determinant of a model firm's project performance capacity. All else equal, the larger the model firm's revenue, the larger will be the size of project that the firm is capable of performing.
- *The acreage intensity of the model project category.* As described previously in *Chapter **4***, acreage intensity is the acreage quantity per dollar of construction project value (which is assumed to translate to business revenue) and was estimated by EPA for the principal construction activities – single-family housing construction, multifamily housing construction, commercial project construction, and industrial project construction – estimated to be within the scope of the C&D rule. Acreage intensity is used as the *translator* between a firm's in-scope revenue and the annual effective project acreage that the model firm is capable of performing.
- *The assumed steady state operating model of the firm,* in terms of the lag between annual project starts. This factor interacts with the duration of the model project under analysis to determine the total number of model projects that a firm will have ongoing in a single analysis year – accounting both for the model project (or bundle of model projects) started in that year and for the model projects (or single-year project bundles) that may have started in prior years but remain ongoing (and continuing to generate compliance costs) in the current analysis year.
- *Duration of the model project.* Model project duration interacts with the project start lag to determine the number of model projects ongoing in a given analysis year – including both the projects from the current year and projects continuing from prior years. For projects of greater than one year duration, EPA assumed that the model project, and its value, could be spread uniformly over the project's duration for determining the annual effective performance requirement of the model project. When the number of projects ongoing includes projects from prior years, the model firm's annual effective project acreage that is available for performing *new* model projects is reduced to account for the project performance capacity that is being used for those projects from prior years.

These in-scope firm feasibility critieria, together with the remaining steps in the overall allocation algorithm, are critical for determining which firms are assigned which projects, and therefore compliance cost. EPA judges that an allocation process governed by these assumptions is reasonable in that it enables the full set of project demands to be met by the industry without violating basic constraints implicit in the data with regard to firm capabilities.

Sensitivity Test of Model Firm Project Performance Criteria: Firm Specialization

EPA tested two alternative configurations of the basic model firm project performance criteria outlined above (and detailed in Chapter 6).

The first sensitivity test maintains the overall structure of the primary algorithm with respect to how a firm's capability to perform projects is evaluated, but then incorporates the Census' concept of firm specialization. The firm specialization fraction reports the average fraction of a firm's revenues in a sector that arise from the sector's primary business activity. This data allows EPA to exclude the fraction of firm revenue that, on average, is not associated with *new* construction (e.g., set aside the fraction of a firm's revenue associated with out-of-scope acitivity such as additions or maintenance work). *Table C-1* reports the specialization fraction, by sector. To implement this sensitivity test, EPA reduced the model firm revenue for firms in each sector by one minue the specialization fraction (e.g., model firm revenue in NAICS 236115 is reduced by 3%).

Table C-1: C&D Firm Specialization, by Sector

NAICS	C&D Sector Name	Firm Specialization, by Value
236115	New single-family housing construction	97%
236116	New multifamily housing construction	86%
236117	New housing operative builders	95%
236210	Industrial building construction	72%
236220	Commercial and institutional building construction	84%
237310	Highway, street, and bridge construction	88%

Source: 2002 Economic Census

By reducing the revenue in-scope for each model firm, each individual model firm is estimated to perform a lower quantity of *new* construction activity annually relative to the base case where all of the firm's revenue is assumed to be in-scope (i.e., associated with new construction activity). In turn, because the in-scope capacity of each individual firm is less, the allocation algorithm has to assign projects (and therefore cost) to a larger number of firms relative to the base case in order to clear the demand for each type of project. The results of this *Firm Specialization* case are reported in *Table 6-3*.

Table C-2: Summary of Cost and Economic Impact Analysis for Firm Specialization Test

Impact Analysis Concept		Option 4 with Specialization	Option 4 without Specialization
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)			
Total Costs ($millions)		$953	$953
Total Acreage Incurring Cost		852,649	852,649
Number of Firms	All Firms	187,100	187,100
	Firms In-Scope	81,665	81,665
	Firms Incurring Cost	35,706	30,508
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact			
Costs Unadjusted for Effect of Cost Pass-Through			
Costs Exceeding 1% of Revenue	Number Incurring Effect	219	276
	% of All Firms	0.1%	0.1%
	% of Firms In-Scope	0.3%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]			
Costs Exceeding 1% of Revenue	Number Incurring Effect	0	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance			
Firms Incurring Financial Stress	Number Incurring Effect	162	169
	% of All Firms	0.1%	0.1%
	% of Firms In-Scope	0.2%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)			
Firms with Negative Business Value (Potential Closures)	Number Incurring Effect	144	147
	% of All Firms	0.1%	0.1%
	% of Firms In-Scope	0.2%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.
EPA Estimates

As expected, the results show that if firm specialization is included, then a larger number of firms are assigned project activity (and therefore compliance cost) to offset the decrease in capacity of each individual firm. Under the primary analysis, about 30,500 firms incur costs, and under the specialization test, approximately 35,700 firms are estimated to incur costs. At the same time, because the same amount of activity (and cost) is now allocated across a slightly larger number of firms (and each firm's *total* revenue has not decreased), the economic impacts per firm have decreased slightly. Note, however, that it is not necessarily always the case the economic impacts will decrease as the cost of regulation is spread across a larger number of firms. For example, as shown in the next sensitivity case, if projects (and costs) are assigned to firms without regard for the basic constraints that govern expectations about which firms can perform which projects, then aggregate impacts can increase.

Because firm specialization is a reality, EPA recognizes that including specialization may be conceptually better than excluding specialization. However, EPA elected to exclude specialization from the primary analysis because that assumption is more conservative with respect to potential economic impacts per C&D firm.

Sensitivity Test of Model Firm Project Performance Criteria: All Firms In-Scope

EPA's second sensitivity test of the model firm project performance critieria effectively disregards the overall structure of the primary algorithm with respect to how a firm's capability to perform projects is evaluated. In this case EPA specifies that *all* model firms are capable of performing *all* of the model projects, and are therefore candidates to be assigned project acreage from any type of project. The key criteria that remain, and limit the quantity of a project (and cost) assigned to a firm, include the aggregate demand for each type of project and the relative quantity of capacity across model firms, accounting for the number of firms by sector and state.

The results of this *All-In* case are presented in *Table C-3.*

Table C-3: Summary of Cost and Economic Impact Analysis for the All-In Test

Impact Analysis Concept		Option 4, All Firms In-Scope for All Projects	Option 4, Primary Case
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)			
Total Costs ($millions)		$953	$953
Total Acreage Incurring Cost		852,649	852,649
Number of Firms	All Firms	187,100	187,100
	Firms In-Scope	187,100	81,665
	Firms Incurring Cost	134,978	30,508
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact			
Costs Unadjusted for Effect of Cost Pass-Through			
Costs Exceeding 1% of Revenue	Number Incurring Effect	12,013	276
	% of All Firms	6.4%	0.1%
	% of Firms In-Scope	6.4%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	69	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]			
Costs Exceeding 1% of Revenue	Number Incurring Effect	27	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance			
Firms Incurring Financial Stress	Number Incurring Effect	441	169
	% of All Firms	0.2%	0.1%
	% of Firms In-Scope	0.2%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)			
Firms with Negative Business Value (Potential Closures)	Number Incurring Effect	275	147
	% of All Firms	0.1%	0.1%
	% of Firms In-Scope	0.1%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

EPA Estimates

Key findings from this sensitivity test include:

- As expected, because the firm project performance critieria were removed, this case shows a very large increase in the number of firms incurring cost – rising to about 135,000 versus about 30,500 in the base case.
- EPA judges this case to be somewhat unrealistic and extreme with respect to the assignment of projects (and costs) to small firms, and therefore illustrative of the overall affordability of the rule for C&D firms:
  - The large increase in the number of firms incurring costs results in a large increase in the number of firms with costs exceeding 1% of revenues, but only a very small increase in the number of firms incurring costs in excess of 3% of revenues. This case, together with results from the primary analysis, therefore demonstrates that it is very unlikely that a significant number of firms will incur compliance costs in excess of 3% of revenue.
  - In addition, as seen in the small-firm impacts table for this case (*Table C-4*), even this extreme project assignment case does not result in economic impacts that would trigger a definitive SISNOSE finding.

Table C-4: Summary of Small-Firm Cost and Economic Impacts for the All-In Test

Impact Analysis Concept		Option 4, All Firms In-Scope for All Projects	Option 4, Primary Case
Resource Cost of Compliance and Affected Acreage and Firms (before market adjustments)			
Total Costs ($millions)		$561	$403
Total Acreage Incurring Cost		465,144	332,981
Number of Firms	All Firms	182,560	182,560
	Firms In-Scope	182,560	77,115
	Firms Incurring Cost	132,538	27,420
Firms with Compliance Cost Exceeding Percentages of Revenue Judged Potentially Indicative of Adverse Impact			
Costs Unadjusted for Effect of Cost Pass-Through			
Costs Exceeding 1% of Revenue	Number Incurring Effect	11,976	230
	% of All Firms	6.6%	0.1%
	% of Firms In-Scope	6.6%	0.3%
Costs Exceeding 3% of Revenue	Number Incurring Effect	69	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Costs Adjusted for Effect of Cost Pass-Through[a]			
Costs Exceeding 1% of Revenue	Number Incurring Effect	27	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Costs Exceeding 3% of Revenue	Number Incurring Effect	0	0
	% of All Firms	0.0%	0.0%
	% of Firms In-Scope	0.0%	0.0%
Firms Estimated to Incur Financial Stress From Deterioration in Measures of Financial Performance			
Firms Incurring Financial Stress	Number Incurring Effect	413	135
	% of All Firms	0.2%	0.1%
	% of Firms In-Scope	0.2%	0.2%
Firms whose Net Business Value Becomes Negative as a Result of Compliance (Potential Closures)			
Firms with Negative Business Value (Potential Closures)	Number Incurring Effect	255	122
	% of All Firms	0.1%	0.1%
	% of Firms In-Scope	0.1%	0.2%

a Assumes cost pass-through rate of 85% for residential sectors and 71% for non-residential and non-building sectors.

EPA Estimates

Appendix D: Detailed Results for the Housing Affordability Analysis

Table D-1: Price Change per Median Priced Home, by State (2008$)**

State	2008 Weighted-Average Median Home Price*	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
		Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change
Alaska	$341,709	$52	0.02%	$2,611	0.76%	$3,380	0.99%	$425	0.12%
Alabama	$201,888	$59	0.03%	$3,099	1.53%	$5,020	2.49%	$382	0.19%
Arkansas	$190,135	$59	0.03%	$2,801	1.47%	$4,562	2.40%	$378	0.20%
Arizona	$302,175	$46	0.02%	$1,259	0.42%	$1,916	0.63%	$290	0.10%
California	$638,616	$54	0.01%	$1,577	0.25%	$2,476	0.39%	$346	0.05%
Colorado	$351,615	$54	0.02%	$1,690	0.48%	$2,611	0.74%	$323	0.09%
Connecticut	$515,818	$66	0.01%	$2,087	0.40%	$4,859	0.94%	$514	0.10%
D.of Columbia	$600,875	$66	0.01%	$2,089	0.35%	$4,859	0.81%	$505	0.08%
Delaware	$368,663	$66	0.02%	$2,111	0.57%	$4,906	1.33%	$508	0.14%
Florida	$325,265	$59	0.02%	$3,529	1.09%	$5,789	1.78%	$419	0.13%
Georgia	$239,477	$59	0.02%	$2,753	1.15%	$4,506	1.88%	$388	0.16%
Hawaii	$680,778	$66	0.01%	$3,243	0.48%	$6,782	1.00%	$404	0.06%
Iowa	$231,239	$52	0.02%	$3,458	1.50%	$4,274	1.85%	$408	0.18%
Idaho	$266,955	$41	0.02%	$1,455	0.55%	$1,936	0.73%	$302	0.11%
Illinois	$324,385	$66	0.02%	$1,906	0.59%	$4,539	1.40%	$466	0.14%
Indiana	$222,184	$66	0.03%	$2,186	0.98%	$5,054	2.27%	$494	0.22%
Kansas	$215,404	$52	0.02%	$4,019	1.87%	$4,873	2.26%	$431	0.20%
Kentucky	$204,801	$59	0.03%	$1,872	0.91%	$3,354	1.64%	$371	0.18%
Louisiana	$210,672	$59	0.03%	$3,808	1.81%	$6,197	2.94%	$410	0.19%
Massachusetts	$427,051	$66	0.02%	$2,065	0.48%	$4,813	1.13%	$506	0.12%
Maryland	$521,237	$66	0.01%	$2,094	0.40%	$4,872	0.93%	$505	0.10%
Maine	$268,094	$66	0.02%	$1,993	0.74%	$4,716	1.76%	$503	0.19%
Michigan	$257,528	$66	0.03%	$1,490	0.58%	$3,818	1.48%	$455	0.18%
Minnesota	$303,302	$66	0.02%	$1,613	0.53%	$4,177	1.38%	$448	0.15%
Missouri	$235,786	$59	0.03%	$2,388	1.01%	$3,932	1.67%	$348	0.15%
Mississippi	$187,894	$59	0.03%	$3,069	1.63%	$4,914	2.62%	$392	0.21%
Montana	$266,952	$44	0.02%	$1,513	0.57%	$2,002	0.75%	$306	0.11%
North Carolina	$227,189	$59	0.03%	$2,178	0.96%	$3,822	1.68%	$366	0.16%
North Dakota	$197,495	$51	0.03%	$1,579	0.80%	$2,124	1.08%	$333	0.17%
Nebraska	$227,183	$52	0.02%	$2,982	1.31%	$3,786	1.67%	$392	0.17%
New Hampshire	$373,995	$66	0.02%	$1,712	0.46%	$4,368	1.17%	$497	0.13%
New Jersey	$529,581	$66	0.01%	$2,326	0.44%	$5,336	1.01%	$525	0.10%
New Mexico	$259,660	$50	0.02%	$1,397	0.54%	$2,216	0.85%	$328	0.13%
Nevada	$392,469	$43	0.01%	$1,137	0.29%	$1,737	0.44%	$268	0.07%
New York	$472,791	$66	0.01%	$1,954	0.41%	$4,637	0.98%	$483	0.10%
Ohio	$247,789	$66	0.03%	$1,851	0.75%	$4,645	1.87%	$486	0.20%
Oklahoma	$206,229	$59	0.03%	$2,434	1.18%	$3,999	1.94%	$337	0.16%
Oregon	$359,575	$54	0.02%	$2,583	0.72%	$3,702	1.03%	$446	0.12%
Pennsylvania	$316,294	$66	0.02%	$2,007	0.63%	$4,699	1.49%	$502	0.16%
Rhode Island	$402,183	$66	0.02%	$2,252	0.56%	$5,187	1.29%	$516	0.13%
South Carolina	$211,957	$59	0.03%	$2,472	1.17%	$4,069	1.92%	$372	0.18%
South Dakota	$187,729	$52	0.03%	$2,358	1.26%	$2,979	1.59%	$335	0.18%
Tennessee	$214,528	$59	0.03%	$2,159	1.01%	$3,717	1.73%	$374	0.17%
Texas	$182,931	$54	0.03%	$4,220	2.31%	$5,512	3.01%	$409	0.22%
Utah	$343,469	$46	0.01%	$1,380	0.40%	$2,138	0.62%	$321	0.09%
Virginia	$430,476	$59	0.01%	$1,856	0.43%	$3,326	0.77%	$358	0.08%
Vermont	$241,557	$66	0.03%	$1,739	0.72%	$4,425	1.83%	$470	0.19%
Washington	$400,953	$54	0.01%	$2,244	0.56%	$3,361	0.84%	$422	0.11%
Wisconsin	$293,041	$66	0.02%	$1,758	0.60%	$4,465	1.52%	$460	0.16%
West Virginia	$184,607	$59	0.03%	$1,517	0.82%	$2,905	1.57%	$365	0.20%
Wyoming	$251,810	$51	0.02%	$1,705	0.68%	$2,271	0.90%	$327	0.13%
U.S. Average	**$355,893**	**$59**	**0.02%**	**$2,231**	**0.63%**	**$4,093**	**1.15%**	**$415**	**0.12%**

** Weighted average based on the number of households and home prices across MSAs*
*** These are national avg price changes estimated from the national avg engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.*
EPA Estimates

Table D-2: Price Change per Lower Quartile Priced Home, by State (2008$)**

Using Median Lot Size (0.07 acres) for Attached New Single-Family Housing as Basis for Compliance Cost

State	2008 Weighted-Average Lower Quartile Home Price*	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
		Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change
Alaska	$251,621	$17	0.01%	$872	0.35%	$1,129	0.45%	$142	0.06%
Alabama	$123,641	$20	0.02%	$1,035	0.84%	$1,677	1.36%	$128	0.10%
Arkansas	$124,082	$20	0.02%	$936	0.75%	$1,524	1.23%	$126	0.10%
Arizona	$209,646	$16	0.01%	$420	0.20%	$640	0.31%	$97	0.05%
California	$471,255	$18	0.00%	$527	0.11%	$827	0.18%	$115	0.02%
Colorado	$264,185	$18	0.01%	$564	0.21%	$872	0.33%	$108	0.04%
Connecticut	$369,325	$22	0.01%	$697	0.19%	$1,623	0.44%	$172	0.05%
D. of Columbia	$435,225	$22	0.01%	$698	0.16%	$1,623	0.37%	$169	0.04%
Delaware	$246,148	$22	0.01%	$705	0.29%	$1,639	0.67%	$170	0.07%
Florida	$216,716	$20	0.01%	$1,179	0.54%	$1,933	0.89%	$140	0.06%
Georgia	$169,085	$20	0.01%	$920	0.54%	$1,505	0.89%	$129	0.08%
Hawaii	$449,590	$22	0.00%	$1,083	0.24%	$2,265	0.50%	$135	0.03%
Iowa	$165,740	$17	0.01%	$1,155	0.70%	$1,427	0.86%	$136	0.08%
Idaho	$194,131	$14	0.01%	$486	0.25%	$646	0.33%	$101	0.05%
Illinois	$222,637	$22	0.01%	$636	0.29%	$1,516	0.68%	$156	0.07%
Indiana	$155,438	$22	0.01%	$730	0.47%	$1,688	1.09%	$165	0.11%
Kansas	$146,130	$17	0.01%	$1,342	0.92%	$1,628	1.11%	$144	0.10%
Kentucky	$142,415	$20	0.01%	$625	0.44%	$1,120	0.79%	$124	0.09%
Louisiana	$132,604	$20	0.01%	$1,272	0.96%	$2,070	1.56%	$137	0.10%
Massachusetts	$327,820	$22	0.01%	$690	0.21%	$1,608	0.49%	$169	0.05%
Maryland	$357,278	$22	0.01%	$699	0.20%	$1,627	0.46%	$169	0.05%
Maine	$193,001	$22	0.01%	$666	0.34%	$1,575	0.82%	$168	0.09%
Michigan	$178,665	$22	0.01%	$498	0.28%	$1,275	0.71%	$152	0.09%
Minnesota	$236,113	$22	0.01%	$539	0.23%	$1,395	0.59%	$150	0.06%
Missouri	$157,531	$20	0.01%	$798	0.51%	$1,313	0.83%	$116	0.07%
Mississippi	$115,939	$20	0.02%	$1,025	0.88%	$1,641	1.42%	$131	0.11%
Montana	$187,766	$15	0.01%	$505	0.27%	$669	0.36%	$102	0.05%
North Carolina	$151,679	$20	0.01%	$727	0.48%	$1,277	0.84%	$122	0.08%
North Dakota	$140,567	$17	0.01%	$527	0.38%	$709	0.50%	$111	0.08%
Nebraska	$170,507	$17	0.01%	$996	0.58%	$1,265	0.74%	$131	0.08%
New Hampshire	$283,152	$22	0.01%	$572	0.20%	$1,459	0.52%	$166	0.06%
New Jersey	$373,406	$22	0.01%	$777	0.21%	$1,782	0.48%	$175	0.05%
New Mexico	$162,193	$17	0.01%	$467	0.29%	$740	0.46%	$110	0.07%
Nevada	$282,030	$14	0.01%	$380	0.13%	$580	0.21%	$90	0.03%
New York	$337,161	$22	0.01%	$653	0.19%	$1,549	0.46%	$161	0.05%
Ohio	$174,655	$22	0.01%	$618	0.35%	$1,551	0.89%	$162	0.09%
Oklahoma	$136,720	$20	0.01%	$813	0.59%	$1,336	0.98%	$112	0.08%
Oregon	$257,881	$18	0.01%	$863	0.33%	$1,236	0.48%	$149	0.06%
Pennsylvania	$211,005	$22	0.01%	$670	0.32%	$1,569	0.74%	$168	0.08%
Rhode Island	$306,197	$22	0.01%	$752	0.25%	$1,732	0.57%	$172	0.06%
South Carolina	$133,209	$20	0.01%	$826	0.62%	$1,359	1.02%	$124	0.09%
South Dakota	$133,026	$17	0.01%	$788	0.59%	$995	0.75%	$112	0.08%
Tennessee	$143,723	$20	0.01%	$721	0.50%	$1,241	0.86%	$125	0.09%
Texas	$122,806	$18	0.01%	$1,410	1.15%	$1,841	1.50%	$137	0.11%
Utah	$252,191	$16	0.01%	$461	0.18%	$714	0.28%	$107	0.04%
Virginia	$306,306	$20	0.01%	$620	0.20%	$1,111	0.36%	$120	0.04%
Vermont	$177,534	$22	0.01%	$581	0.33%	$1,478	0.83%	$157	0.09%
Washington	$285,372	$18	0.01%	$750	0.26%	$1,123	0.39%	$141	0.05%
Wisconsin	$218,675	$22	0.01%	$587	0.27%	$1,491	0.68%	$154	0.07%
West Virginia	$120,349	$20	0.02%	$507	0.42%	$970	0.81%	$122	0.10%
Wyoming	$186,541	$17	0.01%	$569	0.31%	$759	0.41%	$109	0.06%
U.S. Average	**$251,471**	**$20**	**0.01%**	**$745**	**0.30%**	**$1,367**	**0.54%**	**$139**	**0.06%**

** Weighted average based on the number of households and home prices across MSAs*
*** These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.*
EPA Estimates

Table D-3: Price Change per $100k Lowest Priced Home, by State (2008$)**

State	Lowest Home Price*	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
		Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change
Alaska	$100,000	$17	0.02%	$872	0.87%	$1,129	1.13%	$142	0.14%
Alabama	$100,000	$20	0.02%	$1,035	1.03%	$1,677	1.68%	$128	0.13%
Arkansas	$100,000	$20	0.02%	$936	0.94%	$1,524	1.52%	$126	0.13%
Arizona	$100,000	$16	0.02%	$420	0.42%	$640	0.64%	$97	0.10%
California	$100,000	$18	0.02%	$527	0.53%	$827	0.83%	$115	0.12%
Colorado	$100,000	$18	0.02%	$564	0.56%	$872	0.87%	$108	0.11%
Connecticut	$100,000	$22	0.02%	$697	0.70%	$1,623	1.62%	$172	0.17%
D.of Columbia	$100,000	$22	0.02%	$698	0.70%	$1,623	1.62%	$169	0.17%
Delaware	$100,000	$22	0.02%	$705	0.71%	$1,639	1.64%	$170	0.17%
Florida	$100,000	$20	0.02%	$1,179	1.18%	$1,933	1.93%	$140	0.14%
Georgia	$100,000	$20	0.02%	$920	0.92%	$1,505	1.51%	$129	0.13%
Hawaii	$100,000	$22	0.02%	$1,083	1.08%	$2,265	2.27%	$135	0.14%
Iowa	$100,000	$17	0.02%	$1,155	1.15%	$1,427	1.43%	$136	0.14%
Idaho	$100,000	$14	0.01%	$486	0.49%	$646	0.65%	$101	0.10%
Illinois	$100,000	$22	0.02%	$636	0.64%	$1,516	1.52%	$156	0.16%
Indiana	$100,000	$22	0.02%	$730	0.73%	$1,688	1.69%	$165	0.17%
Kansas	$100,000	$17	0.02%	$1,342	1.34%	$1,628	1.63%	$144	0.14%
Kentucky	$100,000	$20	0.02%	$625	0.63%	$1,120	1.12%	$124	0.12%
Louisiana	$100,000	$20	0.02%	$1,272	1.27%	$2,070	2.07%	$137	0.14%
Massachusetts	$100,000	$22	0.02%	$690	0.69%	$1,608	1.61%	$169	0.17%
Maryland	$100,000	$22	0.02%	$699	0.70%	$1,627	1.63%	$169	0.17%
Maine	$100,000	$22	0.02%	$666	0.67%	$1,575	1.58%	$168	0.17%
Michigan	$100,000	$22	0.02%	$498	0.50%	$1,275	1.28%	$152	0.15%
Minnesota	$100,000	$22	0.02%	$539	0.54%	$1,395	1.39%	$150	0.15%
Missouri	$100,000	$20	0.02%	$798	0.80%	$1,313	1.31%	$116	0.12%
Mississippi	$100,000	$20	0.02%	$1,025	1.03%	$1,641	1.64%	$131	0.13%
Montana	$100,000	$15	0.01%	$505	0.51%	$669	0.67%	$102	0.10%
North Carolina	$100,000	$20	0.02%	$727	0.73%	$1,277	1.28%	$122	0.12%
North Dakota	$100,000	$17	0.02%	$527	0.53%	$709	0.71%	$111	0.11%
Nebraska	$100,000	$17	0.02%	$996	1.00%	$1,265	1.26%	$131	0.13%
New Hampshire	$100,000	$22	0.02%	$572	0.57%	$1,459	1.46%	$166	0.17%
New Jersey	$100,000	$22	0.02%	$777	0.78%	$1,782	1.78%	$175	0.18%
New Mexico	$100,000	$17	0.02%	$467	0.47%	$740	0.74%	$110	0.11%
Nevada	$100,000	$14	0.01%	$380	0.38%	$580	0.58%	$90	0.09%
New York	$100,000	$22	0.02%	$653	0.65%	$1,549	1.55%	$161	0.16%
Ohio	$100,000	$22	0.02%	$618	0.62%	$1,551	1.55%	$162	0.16%
Oklahoma	$100,000	$20	0.02%	$813	0.81%	$1,336	1.34%	$112	0.11%
Oregon	$100,000	$18	0.02%	$863	0.86%	$1,236	1.24%	$149	0.15%
Pennsylvania	$100,000	$22	0.02%	$670	0.67%	$1,569	1.57%	$168	0.17%
Rhode Island	$100,000	$22	0.02%	$752	0.75%	$1,732	1.73%	$172	0.17%
South Carolina	$100,000	$20	0.02%	$826	0.83%	$1,359	1.36%	$124	0.12%
South Dakota	$100,000	$17	0.02%	$788	0.79%	$995	1.00%	$112	0.11%
Tennessee	$100,000	$20	0.02%	$721	0.72%	$1,241	1.24%	$125	0.12%
Texas	$100,000	$18	0.02%	$1,410	1.41%	$1,841	1.84%	$137	0.14%
Utah	$100,000	$16	0.02%	$461	0.46%	$714	0.71%	$107	0.11%
Virginia	$100,000	$20	0.02%	$620	0.62%	$1,111	1.11%	$120	0.12%
Vermont	$100,000	$22	0.02%	$581	0.58%	$1,478	1.48%	$157	0.16%
Washington	$100,000	$18	0.02%	$750	0.75%	$1,123	1.12%	$141	0.14%
Wisconsin	$100,000	$22	0.02%	$587	0.59%	$1,491	1.49%	$154	0.15%
West Virginia	$100,000	$20	0.02%	$507	0.51%	$970	0.97%	$122	0.12%
Wyoming	$100,000	$17	0.02%	$569	0.57%	$759	0.76%	$109	0.11%
U.S. Average	**$100,000**	**$20**	**0.02%**	**$745**	**0.75%**	**$1,367**	**1.37%**	**$139**	**0.14%**

*** These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.*
EPA Estimates

Table D-4: Price Change per $50k Lowest Priced Home, by State (2008$)**

State	Lowest Home Price*	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
		Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change	Price Change**	Percent Change
Alaska	$50,000	$17	0.03%	$872	1.74%	$1,129	2.26%	$142	0.28%
Alabama	$50,000	$20	0.04%	$1,035	2.07%	$1,677	3.35%	$128	0.26%
Arkansas	$50,000	$20	0.04%	$936	1.87%	$1,524	3.05%	$126	0.25%
Arizona	$50,000	$16	0.03%	$420	0.84%	$640	1.28%	$97	0.19%
California	$50,000	$18	0.04%	$527	1.05%	$827	1.65%	$115	0.23%
Colorado	$50,000	$18	0.04%	$564	1.13%	$872	1.74%	$108	0.22%
Connecticut	$50,000	$22	0.04%	$697	1.39%	$1,623	3.25%	$172	0.34%
D.of Columbia	$50,000	$22	0.04%	$698	1.40%	$1,623	3.25%	$169	0.34%
Delaware	$50,000	$22	0.04%	$705	1.41%	$1,639	3.28%	$170	0.34%
Florida	$50,000	$20	0.04%	$1,179	2.36%	$1,933	3.87%	$140	0.28%
Georgia	$50,000	$20	0.04%	$920	1.84%	$1,505	3.01%	$129	0.26%
Hawaii	$50,000	$22	0.04%	$1,083	2.17%	$2,265	4.53%	$135	0.27%
Iowa	$50,000	$17	0.03%	$1,155	2.31%	$1,427	2.85%	$136	0.27%
Idaho	$50,000	$14	0.03%	$486	0.97%	$646	1.29%	$101	0.20%
Illinois	$50,000	$22	0.04%	$636	1.27%	$1,516	3.03%	$156	0.31%
Indiana	$50,000	$22	0.04%	$730	1.46%	$1,688	3.38%	$165	0.33%
Kansas	$50,000	$17	0.03%	$1,342	2.68%	$1,628	3.26%	$144	0.29%
Kentucky	$50,000	$20	0.04%	$625	1.25%	$1,120	2.24%	$124	0.25%
Louisiana	$50,000	$20	0.04%	$1,272	2.54%	$2,070	4.14%	$137	0.27%
Massachusetts	$50,000	$22	0.04%	$690	1.38%	$1,608	3.22%	$169	0.34%
Maryland	$50,000	$22	0.04%	$699	1.40%	$1,627	3.25%	$169	0.34%
Maine	$50,000	$22	0.04%	$666	1.33%	$1,575	3.15%	$168	0.34%
Michigan	$50,000	$22	0.04%	$498	1.00%	$1,275	2.55%	$152	0.30%
Minnesota	$50,000	$22	0.04%	$539	1.08%	$1,395	2.79%	$150	0.30%
Missouri	$50,000	$20	0.04%	$798	1.60%	$1,313	2.63%	$116	0.23%
Mississippi	$50,000	$20	0.04%	$1,025	2.05%	$1,641	3.28%	$131	0.26%
Montana	$50,000	$15	0.03%	$505	1.01%	$669	1.34%	$102	0.20%
North Carolina	$50,000	$20	0.04%	$727	1.45%	$1,277	2.55%	$122	0.24%
North Dakota	$50,000	$17	0.03%	$527	1.05%	$709	1.42%	$111	0.22%
Nebraska	$50,000	$17	0.03%	$996	1.99%	$1,265	2.53%	$131	0.26%
New Hampshire	$50,000	$22	0.04%	$572	1.14%	$1,459	2.92%	$166	0.33%
New Jersey	$50,000	$22	0.04%	$777	1.55%	$1,782	3.56%	$175	0.35%
New Mexico	$50,000	$17	0.03%	$467	0.93%	$740	1.48%	$110	0.22%
Nevada	$50,000	$14	0.03%	$380	0.76%	$580	1.16%	$90	0.18%
New York	$50,000	$22	0.04%	$653	1.31%	$1,549	3.10%	$161	0.32%
Ohio	$50,000	$22	0.04%	$618	1.24%	$1,551	3.10%	$162	0.32%
Oklahoma	$50,000	$20	0.04%	$813	1.63%	$1,336	2.67%	$112	0.22%
Oregon	$50,000	$18	0.04%	$863	1.73%	$1,236	2.47%	$149	0.30%
Pennsylvania	$50,000	$22	0.04%	$670	1.34%	$1,569	3.14%	$168	0.34%
Rhode Island	$50,000	$22	0.04%	$752	1.50%	$1,732	3.46%	$172	0.34%
South Carolina	$50,000	$20	0.04%	$826	1.65%	$1,359	2.72%	$124	0.25%
South Dakota	$50,000	$17	0.03%	$788	1.58%	$995	1.99%	$112	0.22%
Tennessee	$50,000	$20	0.04%	$721	1.44%	$1,241	2.48%	$125	0.25%
Texas	$50,000	$18	0.04%	$1,410	2.82%	$1,841	3.68%	$137	0.27%
Utah	$50,000	$16	0.03%	$461	0.92%	$714	1.43%	$107	0.21%
Virginia	$50,000	$20	0.04%	$620	1.24%	$1,111	2.22%	$120	0.24%
Vermont	$50,000	$22	0.04%	$581	1.16%	$1,478	2.96%	$157	0.31%
Washington	$50,000	$18	0.04%	$750	1.50%	$1,123	2.25%	$141	0.28%
Wisconsin	$50,000	$22	0.04%	$587	1.17%	$1,491	2.98%	$154	0.31%
West Virginia	$50,000	$20	0.04%	$507	1.01%	$970	1.94%	$122	0.24%
Wyoming	$50,000	$17	0.03%	$569	1.14%	$759	1.52%	$109	0.22%
U.S. Average	**$50,000**	**$20**	**0.04%**	**$745**	**1.49%**	**$1,367**	**2.73%**	**$139**	**0.28%**

** Weighted average based on the number of households and home prices across MSAs*
*** These are national average price changes estimated from the national average engineering estimate of per acre compliance cost converted to the equivalent of compliance costs per housing unit. Price changes for MSAs are estimated individually using engineering estimates of state-level compliance costs.*
EPA Estimates

Table D-5: Number of Households Whose Purchasing Decision for a New Single-Family Median Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices, by State - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home

State	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home
Alaska	1	0.03%	35	1.50%	46	1.94%	6	0.24%
Alabama	5	0.02%	248	1.20%	401	1.94%	31	0.15%
Arkansas	3	0.03%	147	1.20%	242	1.97%	20	0.16%
Arizona	4	0.02%	116	0.54%	175	0.82%	27	0.12%
California	9	0.02%	268	0.64%	420	1.00%	59	0.14%
Colorado	4	0.02%	124	0.77%	192	1.19%	24	0.15%
Connecticut	2	0.03%	68	1.03%	164	2.49%	17	0.25%
D.of Columbia	0	0.02%	8	0.58%	19	1.34%	2	0.14%
Delaware	1	0.03%	21	0.83%	49	1.93%	5	0.20%
Florida	15	0.03%	899	1.61%	1,467	2.64%	107	0.19%
Georgia	9	0.02%	425	1.04%	694	1.70%	60	0.15%
Hawaii	0	0.02%	15	1.14%	31	2.38%	2	0.14%
Iowa	3	0.02%	199	1.62%	246	2.01%	23	0.19%
Idaho	1	0.02%	36	0.69%	47	0.92%	7	0.14%
Illinois	9	0.03%	271	0.73%	645	1.74%	66	0.18%
Indiana	7	0.03%	240	0.88%	555	2.03%	54	0.20%
Kansas	3	0.02%	206	1.74%	249	2.11%	22	0.19%
Kentucky	4	0.02%	139	0.74%	249	1.32%	28	0.15%
Louisiana	4	0.02%	249	1.42%	404	2.32%	27	0.15%
Massachusetts	4	0.03%	139	0.80%	324	1.85%	34	0.19%
Maryland	3	0.02%	100	0.79%	230	1.82%	24	0.19%
Maine	2	0.03%	56	1.03%	131	2.42%	14	0.26%
Michigan	12	0.03%	266	0.71%	681	1.82%	81	0.22%
Minnesota	6	0.03%	154	0.73%	399	1.90%	43	0.20%
Missouri	7	0.03%	262	1.06%	431	1.74%	38	0.16%
Mississippi	3	0.02%	149	1.28%	238	2.05%	19	0.16%
Montana	1	0.02%	25	0.78%	34	1.04%	5	0.16%
North Carolina	10	0.02%	349	0.90%	612	1.58%	59	0.15%
North Dakota	1	0.03%	23	0.79%	31	1.06%	5	0.17%
Nebraska	2	0.03%	104	1.48%	131	1.88%	14	0.19%
New Hampshire	1	0.03%	32	0.75%	82	1.91%	9	0.22%
New Jersey	3	0.02%	110	0.78%	252	1.78%	25	0.18%
New Mexico	1	0.02%	42	0.59%	66	0.93%	10	0.14%
Nevada	1	0.02%	39	0.58%	60	0.88%	9	0.14%
New York	10	0.03%	298	0.82%	706	1.94%	74	0.20%
Ohio	13	0.03%	371	0.89%	931	2.24%	98	0.23%
Oklahoma	4	0.03%	160	1.10%	262	1.80%	22	0.15%
Oregon	3	0.03%	131	1.43%	188	2.05%	23	0.25%
Pennsylvania	12	0.03%	354	1.00%	826	2.34%	89	0.25%
Rhode Island	1	0.02%	20	0.82%	46	1.90%	5	0.19%
South Carolina	4	0.02%	186	0.95%	306	1.56%	28	0.14%
South Dakota	1	0.02%	36	1.01%	46	1.27%	5	0.14%
Tennessee	6	0.03%	237	0.94%	407	1.62%	41	0.16%
Texas	23	0.02%	1,795	1.89%	2,344	2.47%	174	0.18%
Utah	2	0.02%	46	0.67%	72	1.04%	11	0.16%
Virginia	5	0.02%	146	0.73%	261	1.30%	28	0.14%
Vermont	1	0.03%	24	0.80%	62	2.03%	7	0.22%
Washington	4	0.02%	168	1.01%	252	1.52%	32	0.19%
Wisconsin	6	0.03%	158	0.88%	401	2.23%	42	0.23%
West Virginia	2	0.02%	49	0.57%	93	1.09%	12	0.14%
Wyoming	0	0.02%	15	0.68%	20	0.91%	3	0.13%
U.S. Total	**239**	**0.03%**	**9,757**	**1.05%**	**17,222**	**1.86%**	**1,667**	**0.18%**

EPA Estimates

Table D-6: Number of Households Whose Purchasing Decision for a New Single-Family Lower Quartile Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices, by State - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home

Using Median Lot Size (0.07 acres) for Attached New Single-Family Housing as Basis for Compliance Cost

State	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home
Alaska	0	0.01%	10	0.30%	14	0.38%	2	0.05%
Alabama	2	0.01%	88	0.32%	142	0.52%	11	0.04%
Arkansas	1	0.01%	50	0.31%	81	0.51%	7	0.04%
Arizona	2	0.01%	42	0.14%	65	0.21%	10	0.03%
California	5	0.01%	159	0.20%	250	0.32%	35	0.04%
Colorado	1	0.01%	44	0.20%	68	0.30%	8	0.04%
Connecticut	1	0.01%	34	0.29%	79	0.68%	8	0.07%
D.of Columbia	0	0.01%	5	0.20%	13	0.46%	1	0.05%
Delaware	0	0.01%	10	0.25%	24	0.58%	3	0.06%
Florida	7	0.01%	401	0.46%	658	0.75%	48	0.05%
Georgia	3	0.01%	154	0.30%	251	0.48%	22	0.04%
Hawaii	0	0.01%	13	0.37%	26	0.77%	2	0.05%
Iowa	1	0.01%	66	0.41%	82	0.51%	8	0.05%
Idaho	0	0.01%	13	0.19%	18	0.25%	3	0.04%
Illinois	5	0.01%	135	0.23%	322	0.55%	33	0.06%
Indiana	3	0.01%	88	0.25%	202	0.58%	20	0.06%
Kansas	1	0.01%	78	0.50%	95	0.60%	8	0.05%
Kentucky	2	0.01%	51	0.21%	92	0.38%	10	0.04%
Louisiana	2	0.01%	97	0.42%	158	0.69%	10	0.05%
Massachusetts	2	0.01%	71	0.28%	164	0.64%	17	0.07%
Maryland	2	0.01%	53	0.23%	124	0.53%	13	0.06%
Maine	1	0.01%	21	0.27%	50	0.64%	5	0.07%
Michigan	4	0.01%	97	0.19%	248	0.48%	30	0.06%
Minnesota	2	0.01%	51	0.19%	131	0.48%	14	0.05%
Missouri	2	0.01%	91	0.27%	150	0.45%	13	0.04%
Mississippi	1	0.01%	55	0.36%	88	0.57%	7	0.05%
Montana	0	0.01%	10	0.21%	13	0.28%	2	0.04%
North Carolina	3	0.01%	124	0.24%	218	0.43%	21	0.04%
North Dakota	0	0.01%	8	0.20%	10	0.27%	2	0.04%
Nebraska	1	0.01%	36	0.40%	46	0.51%	5	0.05%
New Hampshire	1	0.01%	15	0.23%	38	0.60%	4	0.07%
New Jersey	2	0.01%	72	0.27%	165	0.61%	16	0.06%
New Mexico	1	0.01%	16	0.16%	25	0.25%	4	0.04%
Nevada	1	0.01%	16	0.15%	25	0.23%	4	0.04%
New York	5	0.01%	154	0.25%	365	0.58%	38	0.06%
Ohio	5	0.01%	136	0.24%	342	0.60%	36	0.06%
Oklahoma	2	0.01%	63	0.32%	103	0.53%	9	0.04%
Oregon	1	0.01%	55	0.37%	79	0.54%	10	0.06%
Pennsylvania	5	0.01%	157	0.28%	368	0.64%	39	0.07%
Rhode Island	0	0.01%	13	0.33%	29	0.76%	3	0.08%
South Carolina	2	0.01%	73	0.28%	121	0.46%	11	0.04%
South Dakota	0	0.01%	16	0.34%	20	0.43%	2	0.05%
Tennessee	2	0.01%	86	0.26%	149	0.45%	15	0.05%
Texas	9	0.01%	674	0.55%	880	0.72%	65	0.05%
Utah	1	0.01%	18	0.18%	28	0.27%	4	0.04%
Virginia	2	0.01%	73	0.22%	130	0.40%	14	0.04%
Vermont	0	0.01%	8	0.21%	21	0.53%	2	0.06%
Washington	2	0.01%	81	0.30%	121	0.45%	15	0.06%
Wisconsin	2	0.01%	67	0.26%	169	0.65%	17	0.07%
West Virginia	1	0.01%	14	0.13%	26	0.25%	3	0.03%
Wyoming	0	0.01%	5	0.19%	7	0.26%	1	0.04%
U.S. Total	**98**	**0.01%**	**3,969**	**0.30%**	**7,095**	**0.53%**	**690**	**0.05%**

EPA Estimates

Table D-7: Number of Households Whose Purchasing Decision for a New Single-Family $100k Lowest Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices, by State - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home

State	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home
Alaska	0	0.00%	8	0.15%	10	0.19%	1	0.02%
Alabama	2	0.01%	93	0.32%	151	0.52%	12	0.04%
Arkansas	1	0.01%	56	0.32%	91	0.52%	8	0.04%
Arizona	2	0.00%	44	0.11%	68	0.16%	10	0.02%
California	4	0.00%	129	0.06%	207	0.09%	28	0.01%
Colorado	1	0.00%	40	0.11%	62	0.18%	8	0.02%
Connecticut	1	0.00%	31	0.12%	71	0.28%	8	0.03%
D. of Columbia	0	0.00%	4	0.07%	10	0.17%	1	0.02%
Delaware	0	0.00%	7	0.11%	17	0.27%	2	0.03%
Florida	7	0.01%	444	0.34%	728	0.56%	53	0.04%
Georgia	3	0.00%	138	0.22%	225	0.36%	19	0.03%
Hawaii	0	0.00%	4	0.04%	8	0.09%	0	0.01%
Iowa	1	0.01%	70	0.35%	87	0.44%	8	0.04%
Idaho	0	0.00%	14	0.15%	19	0.20%	3	0.03%
Illinois	4	0.01%	126	0.15%	299	0.36%	31	0.04%
Indiana	3	0.01%	89	0.21%	207	0.50%	20	0.05%
Kansas	1	0.01%	75	0.41%	91	0.50%	8	0.04%
Kentucky	2	0.01%	51	0.19%	92	0.34%	10	0.04%
Louisiana	2	0.01%	99	0.39%	161	0.63%	11	0.04%
Massachusetts	2	0.00%	56	0.12%	132	0.28%	14	0.03%
Maryland	1	0.00%	44	0.10%	101	0.24%	11	0.02%
Maine	1	0.01%	18	0.18%	43	0.42%	5	0.04%
Michigan	4	0.01%	99	0.15%	253	0.38%	30	0.04%
Minnesota	2	0.00%	42	0.11%	108	0.27%	12	0.03%
Missouri	2	0.01%	87	0.22%	143	0.36%	13	0.03%
Mississippi	1	0.01%	60	0.37%	96	0.59%	8	0.05%
Montana	0	0.00%	8	0.13%	11	0.18%	2	0.03%
North Carolina	3	0.01%	127	0.21%	222	0.37%	21	0.04%
North Dakota	0	0.01%	7	0.16%	9	0.22%	1	0.03%
Nebraska	1	0.01%	38	0.33%	48	0.41%	5	0.04%
New Hampshire	0	0.00%	11	0.11%	29	0.28%	3	0.03%
New Jersey	2	0.00%	86	0.15%	198	0.34%	19	0.03%
New Mexico	1	0.01%	17	0.14%	27	0.22%	4	0.03%
Nevada	1	0.00%	14	0.08%	22	0.12%	3	0.02%
New York	6	0.00%	186	0.15%	442	0.35%	46	0.04%
Ohio	5	0.01%	137	0.19%	344	0.47%	36	0.05%
Oklahoma	2	0.01%	62	0.28%	103	0.46%	9	0.04%
Oregon	1	0.00%	53	0.22%	76	0.31%	9	0.04%
Pennsylvania	5	0.01%	155	0.19%	364	0.44%	39	0.05%
Rhode Island	0	0.00%	12	0.17%	27	0.38%	3	0.04%
South Carolina	2	0.01%	74	0.26%	123	0.42%	11	0.04%
South Dakota	0	0.01%	14	0.27%	18	0.34%	2	0.04%
Tennessee	2	0.01%	86	0.23%	149	0.39%	15	0.04%
Texas	9	0.01%	684	0.52%	893	0.67%	66	0.05%
Utah	0	0.00%	14	0.09%	23	0.14%	3	0.02%
Virginia	2	0.00%	65	0.12%	118	0.21%	12	0.02%
Vermont	0	0.01%	7	0.14%	18	0.35%	2	0.04%
Washington	2	0.00%	72	0.16%	108	0.24%	14	0.03%
Wisconsin	2	0.01%	66	0.17%	167	0.42%	17	0.04%
West Virginia	1	0.01%	20	0.17%	38	0.33%	5	0.04%
Wyoming	0	0.01%	7	0.18%	9	0.23%	1	0.03%
U.S. Total	**97**	**0.00%**	**3,953**	**0.20%**	**7,064**	**0.36%**	**680**	**0.03%**

EPA Estimates

Table D-8: Number of Households Whose Purchasing Decision for a New Single-Family $50k Lowest Priced Home Would Be Affected by a Regulation-Induced Increase in Housing Prices, by State - based on Owner Occupied Households that Recently Purchased a New, Option In-Scope, Home

State	EPA Option 1		EPA Option 2		EPA Option 3		EPA Option 4	
	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home	Number	As % of SF home buyers qualifying for the new, option-in-scope, home
Alaska	0	0.00%	1	0.03%	2	0.03%	0	0.00%
Alabama	0	0.00%	23	0.07%	38	0.12%	3	0.01%
Arkansas	0	0.00%	13	0.07%	20	0.11%	2	0.01%
Arizona	0	0.00%	8	0.02%	12	0.03%	2	0.00%
California	2	0.00%	46	0.02%	73	0.03%	10	0.00%
Colorado	0	0.00%	8	0.02%	12	0.03%	1	0.00%
Connecticut	0	0.00%	6	0.02%	14	0.06%	2	0.01%
D. of Columbia	0	0.00%	1	0.01%	2	0.03%	0	0.00%
Delaware	0	0.00%	2	0.03%	5	0.07%	0	0.01%
Florida	1	0.00%	83	0.06%	137	0.10%	10	0.01%
Georgia	1	0.00%	25	0.04%	40	0.06%	3	0.01%
Hawaii	0	0.00%	2	0.03%	5	0.05%	0	0.00%
Iowa	0	0.00%	14	0.07%	18	0.08%	2	0.01%
Idaho	0	0.00%	2	0.02%	3	0.03%	0	0.00%
Illinois	1	0.00%	28	0.03%	67	0.08%	7	0.01%
Indiana	0	0.00%	16	0.04%	39	0.09%	4	0.01%
Kansas	0	0.00%	15	0.08%	19	0.10%	1	0.01%
Kentucky	0	0.00%	10	0.04%	19	0.06%	2	0.01%
Louisiana	0	0.00%	25	0.09%	41	0.15%	3	0.01%
Massachusetts	0	0.00%	13	0.03%	31	0.06%	3	0.01%
Maryland	0	0.00%	8	0.02%	19	0.04%	2	0.00%
Maine	0	0.00%	4	0.03%	9	0.08%	1	0.01%
Michigan	1	0.00%	20	0.03%	57	0.08%	6	0.01%
Minnesota	0	0.00%	7	0.02%	20	0.05%	2	0.01%
Missouri	0	0.00%	18	0.04%	29	0.07%	3	0.01%
Mississippi	0	0.00%	15	0.08%	24	0.13%	2	0.01%
Montana	0	0.00%	2	0.03%	2	0.04%	0	0.01%
North Carolina	1	0.00%	27	0.04%	48	0.08%	5	0.01%
North Dakota	0	0.00%	3	0.06%	4	0.09%	1	0.01%
Nebraska	0	0.00%	11	0.08%	13	0.11%	1	0.01%
New Hampshire	0	0.00%	2	0.02%	6	0.06%	1	0.01%
New Jersey	1	0.00%	20	0.03%	46	0.08%	4	0.01%
New Mexico	0	0.00%	4	0.03%	6	0.05%	1	0.01%
Nevada	0	0.00%	2	0.01%	3	0.02%	1	0.00%
New York	2	0.00%	50	0.04%	119	0.09%	12	0.01%
Ohio	1	0.00%	29	0.04%	74	0.09%	7	0.01%
Oklahoma	0	0.00%	13	0.05%	22	0.09%	2	0.01%
Oregon	0	0.00%	10	0.04%	14	0.06%	2	0.01%
Pennsylvania	1	0.00%	38	0.04%	92	0.10%	10	0.01%
Rhode Island	0	0.00%	3	0.04%	7	0.09%	1	0.01%
South Carolina	0	0.00%	15	0.05%	24	0.08%	2	0.01%
South Dakota	0	0.00%	2	0.04%	3	0.05%	0	0.00%
Tennessee	0	0.00%	18	0.04%	31	0.08%	3	0.01%
Texas	3	0.00%	217	0.15%	284	0.19%	21	0.01%
Utah	0	0.00%	2	0.01%	3	0.02%	1	0.00%
Virginia	0	0.00%	12	0.02%	22	0.04%	2	0.00%
Vermont	0	0.00%	1	0.03%	4	0.07%	0	0.01%
Washington	0	0.00%	13	0.03%	19	0.04%	2	0.01%
Wisconsin	0	0.00%	14	0.03%	41	0.10%	3	0.01%
West Virginia	0	0.00%	5	0.04%	10	0.08%	1	0.01%
Wyoming	0	0.00%	1	0.02%	1	0.02%	0	0.00%
U.S. Total	**22**	**0.00%**	**928**	**0.04%**	**1,652**	**0.08%**	**155**	**0.01%**

EPA Estimates

Appendix E: Distribution of Single-Family Home Price Increases

This appendix presents EPA's estimate of the distribution of single-family home price increases due to the final regulation, accounting for a wide range of single-family home prices and lot sizes.

To develop the home price impact distribution, EPA began by developing a national-level distribution of the cost per acre incurred by project size and duration. The national-level cost per acre for any given project size and duration is simply the sum of the total cost (i.e., cost per project times the number of projects) for the model project across all states and sectors, divided by the total quantity of acres for the model project across all states and sectors. Using this set of cost-per-acre values, EPA developed the distribution of cost-per-acre reflecting the probability of each value's occurrence based the fraction of total acreage assigned to each cost value.

Independent of the cost-per-acre distribution, EPA secondly used data from the Census of Construction to develop a probability distribution describing the fraction of single-family housing units constructed across a range of home price and lot size ranges. *Table E-1* presents this distribution, showing the fraction of homes within each of Census' nine home-price and five lot-size ranges.

Table E-1: Distribution of Homes by Price Range and Lot Size

Home Price Range			Lot Size Mid-Point (acres)					
Lower-Bound	**Upper-Bound**	**Mid-Point**	**0.16**	**0.18**	**0.23**	**0.38**	**0.51**	**Total**
$125,000	$125,000	**$125,000**	4.31%	1.91%	1.39%	1.31%	0.96%	9.89%
$125,000	$149,999	**$137,500**	4.52%	2.26%	1.69%	1.64%	0.92%	11.03%
$150,000	$199,999	**$175,000**	7.66%	4.08%	3.65%	4.06%	1.90%	21.35%
$200,000	$249,999	**$225,000**	4.90%	3.00%	2.53%	3.33%	1.50%	15.26%
$250,000	$299,999	**$275,000**	3.74%	2.24%	1.90%	2.70%	1.28%	11.87%
$300,000	$399,999	**$350,000**	4.66%	2.35%	2.07%	3.40%	1.91%	14.39%
$400,000	$499,999	**$450,000**	2.07%	1.04%	0.96%	1.74%	1.26%	7.08%
$500,000	$749,999	**$625,000**	1.72%	0.85%	0.77%	1.56%	1.34%	6.26%
$750,000	$750,000	**$750,000**	0.55%	0.33%	0.33%	0.74%	0.92%	2.88%
		Total	34.14%	18.08%	15.29%	20.49%	11.99%	100.00%

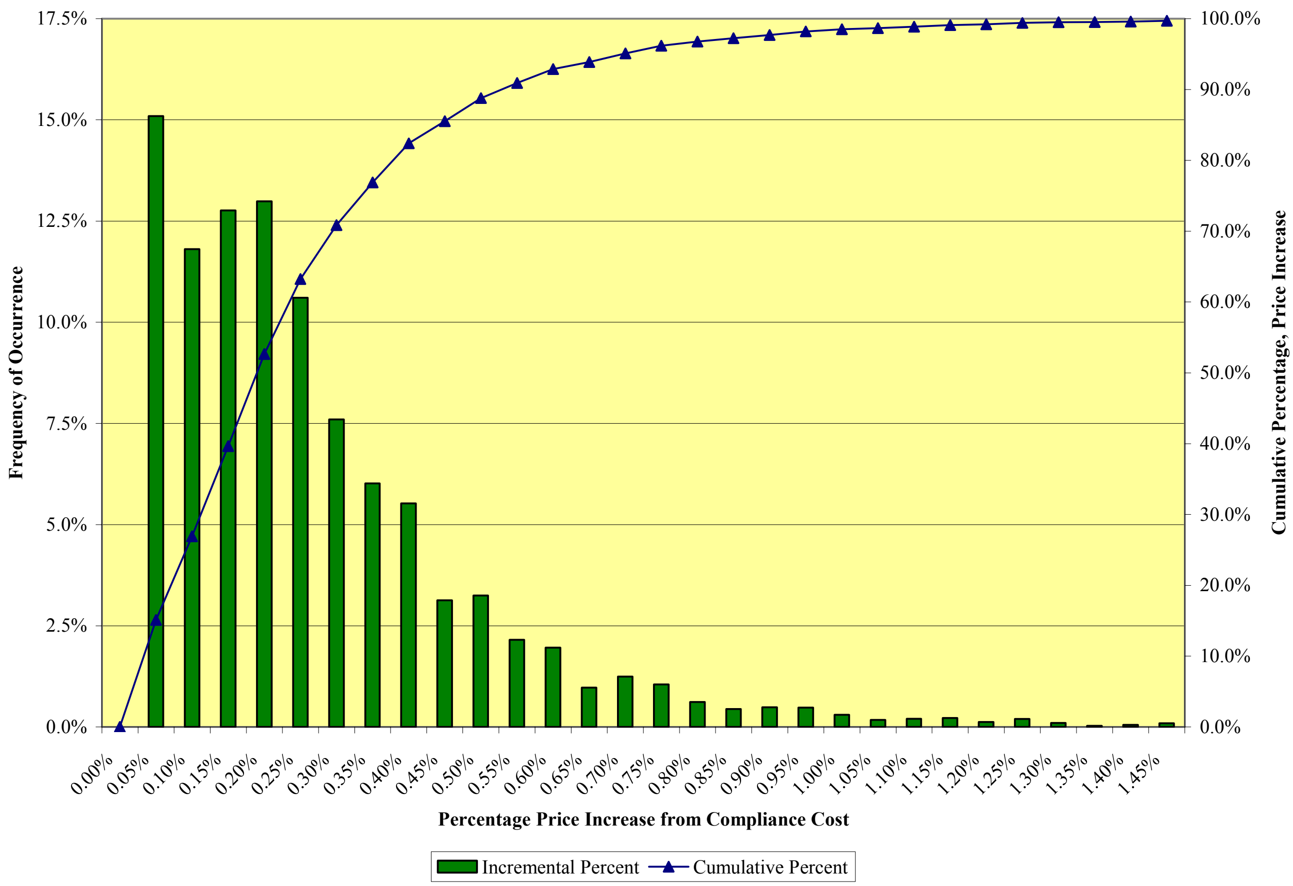
Source: U.S. Census

Next, EPA mapped these distributions together to arrive at the final home price impact distribution. First, EPA estimated the expected percentage increase in the home price within each cell of the 45-cell housing distribution for each of the 90 unique cost-per-acre values from the cost distribution. For each combination of the housing distribution and the cost-per-acre distribution (4,050 total combinations), the percentage increase in the home price is estimated by:

- Multiplying the cost-per-acre time the project cost multiplier and then lot-size (in acres). This produces an estimate of the home price increase in dollars. Multiplying the cost by the previously estimated cost multiplier accounts for the possibility that cost increases at a single-family residential housing project can translate into an increase in the asking price of a new home by more than the direct compliance cost increase (see Appendix G). Also note that, following the same methodology present in Chapter 7, EPA applied a 13% multiplier to scale-up each lot-size value to account for the typical road development associated with each lot. EPA derived this multiplier from information in the Center for Watershed Protection's *Impervious Cover and Land Use in the Chesapeake Bay Watershed* (Capiella, 2001).
- Then the price change in dollars is simply divided by the mid-point of the home price range for the given cell being analyzed to estimate the price change on a percentage basis.

To create the final distribution of price effects (in percentage terms), EPA lastly estimated the joint probability of occurrence of each unique price effect value based on the product of the probability of occurrence from the respective cells of the cost-per-acre and housing distribution that comprise each price impact value. The final joint distribution is presented in *Figure 3-1*. *Figure 3-1* shows a skewed distribution with about 90% of new single-family homes expected to experience a price increase of 0.5% or less. Approximately, 50% of homes experience a price increase of 0.2% or less, and approximately 75% of homes show increase in price of 0.35% or less.

Figure E-1: Distribution of Potential Percentage Increases in New Single-Family Housing Prices (Option 4)



Source: EPA Analysis

Appendix F: C&D Industry Definition Crosswalks

Table F-1: Crosswalk between 2002 NAICS and 1997 NAICS Structures

2002 NAICS	Description	Relevant 1997 NAICS codes
236	**Construction of buildings**	
2361	Residential building construction	
236115	New single-family general contractors	233210 Single-family housing construction (general contractors)
236116	New multifamily general contractors	233220 Multifamily housing construction (general contractors)
236117	New housing operative builders	233210 Single-family housing construction (operative builders) 233220 Multifamily housing construction (operative builders)
236118	Residential remodelers	233210 Single-family housing construction (remodeling contractors) 233220 Multifamily housing construction (remodeling contractors)
2362	Nonresidential building construction	
236210	Industrial building construction	233310 Manufacturing and industrial building construction (Other manufacturing and industrial building construction) 234930 Industrial nonbuilding structure construction (Other industrial nonbuilding construction) 234990 All other heavy construction (waste disposal plant)
236220	Commercial and institutional building construction	233220 Multifamily housing construction (barrack and dormitory) 233310 Manufacturing and industrial building construction (grain elevators, dry cleaning plants, and manufacturing and industrial warehouses construction) 233320 Commercial and institutional building construction 235990 All other special trade contractors (indoor swimming pool)
237	**Heavy and civil engineering construction**	
2371	Utility system construction	
237110	Water and sewer line and related structures construction	234910 Water, sewer, and pipeline construction (water and sewer line, mains, and related structures (including pumping stations, etc.) construction 234990 All other heavy construction (sewage and water treatment plants and irrigation systems construction 235810 Water well drilling contractors
237120	Oil and gas pipeline and related structures construction	213112 Support activities for oil and gas operations (partial) 234910 Water, sewer, and pipeline construction (Oil and gas pipelines, mains, and related structures (including oil storage)) 234930 Industrial nonbuilding structure construction
237130	Power and communication line and related structures construction	234920 Power and communication transmission line construction 234930 Industrial nonbuilding structure construction (power generation plants and transformer stations, except hydroelectric)
2372	Land subdivision	233110 Land subdivision
2373	Highway, street, and bridge construction	234110 Highway and street construction 234120 Bridge and tunnel construction (bridge construction) 235210 Painting and wall covering contractors (highway and traffic line painting contractors)
2379	Other heavy and civil engineering Construction	234120 Bridge and tunnel construction (tunnel construction) 234990 All other heavy construction (all other heavy and civil engineering construction 235990 All other special trade contractors (anchored earth retention)
238	**Specialty trade contractors**	
2381	Foundation, structure, and building exterior contractors	
238110	Poured concrete foundation and structure contractors	235710 Concrete contractors (concrete contractors, except paving)
238120	Structural steel and precast concrete contractors	235910 Other structural steel erection contractors (partial)
238130	Framing contractors	235510 Carpentry contractors (framing carpentry)
238140	Masonry contractors	235410 Masonry and stone contractors 235420 Drywall, plastering, acoustical and insulation contractors (Stucco contractors)
238150	Glass and glazing contractors	235920 Glass and glazing contractors

Table F-1: Crosswalk between 2002 NAICS and 1997 NAICS Structures

2002 NAICS	Description	Relevant 1997 NAICS codes
238160	Roofing contractors	235610 Roofing, siding and sheet metal contractors (roofing)
238170	Siding contractors	235610 Roofing, siding and sheet metal contractors (siding)
238190	Other foundation, structure, and building exterior contractors	235910 Structural steel erection contractors (metal curtain walls and metal furring installation contractors) 235990 All other special trade contractors (forming, ornamental metal work installation, and other foundation, structure, and building exterior contractors)
2382	Building Equipment Contractors	
238210	Electrical Contractors	235110 Plumbing, heating, and air-conditioning contractors (environmental controls installation contractors) 235310 Electrical Contractors
238220	Plumbing and HVAC contractors	235110 Plumbing, heating and air-conditioning contractors (other plumbing, heating, and air-conditioning contractors) 235950 Building equipment and other machinery installation contractors (scrubber, dust collection, and other industrial ventilation installation contractors)
238290	Other building equipment contractors	235950 Building equipment and other machinery installation contractors (partial) 235990 All other special trade contractors (boiler, duct, and pipe insulation and service station equipment, lightning rod, bowling alley, church bell, and tower clock installation contractors)
2383	Building finishing contractors	
238310	Drywall and insulation contractors	235420 Drywall, plastering, acoustical, and insulation contactors (partial)
238320	Painting and wall covering contractors	235210 Painting and wall covering contractors (partial)
238330	Flooring contractors	235520 Flooring contractors
238340	Tile and terrazzo contractors	235430 Tile and terrazzo contractors
238350	Finish carpentry contractors	235510 Carpentry contractors (Finish carpentry contractors)
238390	Other building finishing contractors	235610 Roofing, siding, and sheet metal contractors (sheet metal contractors, except roofing and siding) 235990 All other special trade contractors (trade show exhibits installation and dismantling, spectator seating, modular furniture, window covering fix installation, other building finishing contractors)
2389	Other specialty trade contractors	
238910	Site preparation contractors	213112 Support activities for oil and gas operations 213113 Support activities for coal mining 213114 Support activities for metal mining 213115 Support activities for nonmetallic minerals (except fuels) 234990 All other heavy construction (right-of-way cleaning and line slashing, blasting, trenching, and equipment rental (except cranes) with operator) 235110 Plumbing, heating, and air-conditioning contractors (septic tank, cesspool, and dry well construction contractors) 235930 Excavation contractors 235940 Wrecking and demolition contractors 235990 All other special trade contractors (dewatering contractors, core drilling for construction, and test drilling for construction)
238990	All other specialty trade contractors	234990 All other heavy construction (crane rental with operator) 235710 Concrete contractors (residential and commercial asphalt, brick, and concrete paving contractors) 235990 All other special trade contractors (partial)

Source: U.S. Census Bureau (2007)

Table F-2: Crosswalk between 1997 NAICS and 1992 SIC Structures

1997 NAICS	Description	Relevant 1992 SIC codes
233	**Building, developing, and general contracting**	
2331	Land subdivision and development	
233110	Land subdivision and development	6552 Land subdividers and developers, except cemeteries
2332	Residential building construction	
233210	Single-family housing construction	1521 General contractors–single-family houses 1531 Operative builders (partial) 8741 Management services (partial)
233220	Multifamily housing construction	1522 General contractors–residential buildings other than single-family (partial) 1531 Operative builders (partial) 8741 Management services (partial)
2333	Nonresidential building construction	
233310	Manufacturing and industrial building Construction	1531 Operative builders (partial) 1541 General contractors–industrial buildings and warehouses (partial) 8741 Management services (partial)
233320	Commercial and institutional building Construction	1522 General contractors–residential buildings, other than single-family (partial) 1531 Operative builders (partial) 1541 General contractors–industrial buildings and warehouses (partial) 1542 General contractors–nonresidential buildings except industrial buildings and warehouses 8741 Management services (partial)
234	**Heavy Construction**	
2341	Highway, street, bridge, and tunnel Construction	
234110	Highway and street construction	1611 Highway and street construction contractors, except elevated highways 8741 Management services (partial)
234120	Bridge and tunnel construction	1622 Bridge, tunnel, and elevated highway construction 8741 Management services (partial)
2349	Other heavy construction	
234910	Water, sewer, and pipeline construction	1623 Water, sewer, pipeline, and communications and power line construction (partial) 8741 Management services (partial)
234920	Power and communication transmission line construction	1623 Water, sewer, pipeline, and communications and power line construction (partial) 8741 Management services (partial)
234930	Industrial nonbuilding structure construction	1629 Heavy construction, n.e.c. (partial) 8741 Management services (partial)
235	**Special trade contractors**	
2351	Plumbing, heating, & air-conditioning contractors	
235110	Plumbing, heating, & air-conditioning contractors	1711 Plumbing, heating, & air-conditioning contractors
2352	Painting and wall covering contractors	
235210	Painting and wall covering contractors	1721 Painting and paper hanging special trade contractors 1799 Special trade contractors (partial)
2353	Electrical contractors	
235310	Electrical contractors	1731 Electrical work special trade contractors
2354	Masonry, drywall, insulation and tile contractors	
235410	Masonry and stone contractors	1741 Masonry, stone setting, and other stone work, special trade contractors
235420	Drywall, plastering, acoustical, and insulation contractors	1742 Plastering, drywall, acoustical, and insulation work, special trade contractors 1743 Terrazzo, tile, marble, and mosaic work, special trade contractors (partial) 1771 Concrete work, special trade contractors (partial)
235430	Tile, marble, terrazzo, and mosaic contractors	1743 Terrazzo, tile, marble, and mosaic work, special trade contractors (partial)

Table F-2: Crosswalk between 1997 NAICS and 1992 SIC Structures

1997 NAICS	Description	Relevant 1992 SIC codes
2355	Carpentry and floor contractors	
235510	Carpentry contractors	1751 Carpentry work special trade contractors
235520	Floor laying and other floor contractors	1752 Floor laying and other floor work, special trade contractors
2356	Roofing, siding, and sheet metal contractors	
235610	Roofing, siding, and sheet metal contractors	1761 Roofing, siding, and sheet metal work special trade contractors
2357	Concrete contractors	
235710	Concrete contractors	1771 Concrete work special trade contractors
2358	Water well drilling contractors	
235810	Water well drilling contractors	1781 Water well drilling special trade contractors
2359	Other special trade contractors	
235910	Structural steel erection contractors	1791 Structural steel erection special trade contractors
235920	Glass and glazing contractors	1793 Glass and glazing special trade contractors 1799 Special trade contractors (partial)
235930	Excavation contractors	1794 Excavation work special trade contractors
235940	Wrecking and demolition contractors	1795 Wrecking and demolition work special trade contractors
235950	Building equipment and other machinery installation contractors	1796 Install or erection of building equipment, special trade contractors
235990	All other special trade contractors	1799 Special trade contractors (partial)

Source: U.S. Census Bureau (2000)

Appendix G: Estimating the Compliance Cost Financing Multiplier

EPA analyzed a model construction project to estimate a cost multiplier, per dollar of compliance cost, which captures debt and equity carrying-cost considerations that firms will incur in performing compliance activities. These financing cost considerations are not captured in the engineering estimate of compliance cost per acre, And EPA therefore estimated this multiplier to apply as a mark-up to the incremental compliance costs. The incremental compliance cost multiplier effect is used in the Affordability Analysis (*Chapter 7*) and the Social Cost (*Chapter 8*) analysis, however is not needed to support the firm- and industry-level economic analysis as financing costs are explicitly captured in that framework (see *Chapter 6*).

The hypothetical model project developed to support this analysis is based on EPA's best available data and assumptions to generalize construction project characteristics.

Description of the Project Model Structure

EPA based the cost multiplier estimate on an economic model of a single-family residential construction project that corresponds to a typical 1-acre size project. The model project analysis framework accounts for the timing of outlays and financing for land purchase, development, construction, compliance cost outlays, and the ultimate sale of the model construction project. EPA then calculated the discounted present value of project outlays; effectively collapsing the time-explicit framework into a single-period equivalent analysis.

The model project analysis framework account for the financing costs associated with project-level outlays using pre-tax costs of debt and equity capital parameters of 7.0% and 13.54%, respectively. These cost of debt and equity parameters were developed using the methodology described in *Chapter 4*.

The location of the model project is unspecified and, for this reason, EPA used national-level data wherever possible. Also, EPA assumes that model project site is 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 stormwater controls and construction and marketing of completed unit(s).

EPA assumes that the model project follows a development process consisting of three phases:

- **Land acquisition –** The developer-builder puts together the necessary financing to purchase the parcel. When lenders are involved, they may require 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 so-called "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 during this phase. A substantial portion of this work could be subcontracted to specialty subcontractors (e.g., foundation, framing, roofing, plumbing, electrical, and painting subcontractors).

Inputs to Model C&D Project

The model project is characterized by physical and technical parameters (e.g., project total acreage, size and number of construction products associated with the project, acreage disturbed) as well as financial parameters (e.g., types, timing, and magnitude of costs incurred during various phases of the project, and the sources for these funds in terms of the amounts borrowed versus the amounts provided from the developer-builder's equity).

The general cost categories included during the various stages of each model project – independent of compliance outlays – are summarized in *Table G-1*.

Table G-1: Costs Elements for Model Project Phases

Project Phase	Project Cost Elements
Land Acquisition (Year 1)	Raw land purchase
	Debt cost of land acquisition loan
	Equity cost of capital outlays for land acquisition
Land Development (Year 2)	Land development (e.g., site preparation, site improvement - paving, water and sewer, erosion and sediment - water and electric hook-up)
	Impact fees and analysis
	Other fees (e.g., cost of processing approvals, land dedication or fee in lieu, bonding/escrow fee)
	Land preservation and planting (e.g., tree and wetland preservation and planting; value of land left as green space or park)
	Other costs
	Overhead
	Debt cost of land development loan
	Equity cost of capital outlays for land development
Building Construction (Years 3-4)	Construction cost
	Overhead
	Debt cost of construction loan
	Equity cost of capital outlays for construction
	Real estate and marketing fees

Phase 1 – Land Acquisition

The first phase of the model project is land acquisition, which includes the purchase of raw land for the project.

The model single-family residential project is assumed to be an undeveloped parcel zoned for single-family residential housing. The cost of raw land per acre for single- and multi-family development is estimated from the National Association of Home Builder's (NAHB) *2007 National Results - Construction Costs for a Single-Family Unit*. NAHB's annual report includes "average" costs for the development and construction of a single-family housing unit using information compiled from builders in approximately 50 metropolitan markets.

NAHB's 2007 single-family unit cost report indicates a raw lot cost of $45,507, and the median lot size for a new single-family lot as defined by the Census is 8,854 square feet in size.

EPA assumed that the land acquisition cost is financed over a time period equal to the total length of the project – from land acquisition through development, construction, and sale. EPA conservatively assumes the model project takes four years – that is, revenue from the sale of the housing unit(s) occurs four years after initiation of the land acquisition loan. Part of the land acquisition loan is financed through debt (with debt cost of 7.0%) and part is financed using developer equity (with a 13.54% equity cost) assuming a land acquisition loan-to-value ratio of 65%, which is based on FDIC's Real Estate Lending Rules for land acquisition.

Phase 2 – Land Development

NAHB's *2007 National Results - Construction Costs for a Single-Family Unit* is the data source used by EPA to establish the baseline land development costs for the model project. NAHB reports specific line item costs for land development, which EPA grouped into five categories:

1. Land development (e.g., site preparation, site improvement – paving, water and sewer, erosion and sediment – water and electric hook-up);
2. Impact fees and analysis;
3. Other fees (e.g., cost of processing approvals, land dedication or fee in lieu, bonding/escrow fee);
4. Land preservation and planting costs (e.g., tree and wetland preservation and planting; value of land left as green space or park); and,
5. Other costs.

NAHB reports each cost element on a per-single-family-lot basis. EPA converted these per-lot costs to a per-acre based on the implicit number of lots per acre (4.93). EPA assumed, based on the NAHB data, that overhead costs are 10% of total baseline land development costs. EPA assumed the loan to finance the land development costs is initiated one year following the initiation of the land acquisition loan and continues until the project is completed. Therefore, the land development loan has a duration of three years. Part of the land development loan is assumed to be financed through debt and part is financed using developer equity assuming a land development loan-to-value ratio of 75%, based on FDIC's Real Estate Lending Rules for land development.

Phase 3 – Building Construction

The third phase of the project is construction, which includes the physical structures as well as costs for other site infrastructure such as paving and sidewalk construction, which is primarily a function of the cost of construction per square foot, the number of square feet per unit, and the number of housing units per acre.

NAHB's *2007 National Results - Construction Costs for a Single-Family Unit* and the U.S. Census *Characteristics of New Housing* are the data sources used by EPA to establish the construction cost for the model project. The U.S. Census *Characteristics of New Housing* data indicates the 2008 national median lot size for a single-family home is approximately 0.2 acres, and that the typical size of a single-family home built on that lot is 2,209 square feet. This implies 4.93 single-family units per acre. NAHB reports the total construction cost for a single-family unit is $65.57/square foot.

EPA has also estimated the total project square footage of roads, driveway, and sidewalk construction area based on ratios of such impervious surfaces to total the total project size as reported in a 2001 study of impervious cover and land use in the Chesapeake Bay watershed (Capiella, 2001). R.S. Means provides values for the average cost of residential paving (e.g., roads, driveway) and sidewalk construction of $1.31 and $4.15 per square foot, respectively.

EPA assumed that overhead costs are 10% of total construction costs. EPA assumed that the loan to finance the total construction cost is initiated one year following the initiation of the land development loan and continues until the project is completed. The construction loan is therefore two years in duration. Part of the construction loan is assumed to be financed through debt and part is financed using developer equity assuming a construction loan-to-value ratio of 80%, which is based on FDIC's Real Estate Lending Rules.

Lastly, EPA developed marketing fee and real estate sales commission values as a percentage of the sale price of each housing unit based on NAHB's single-family housing unit construction cost data. EPA assumed that marketing fees are 2.7% of the cost of each unit constructed in a given project, and the sales commission is 4.6% of the cost of each unit constructed in the project. The marketing fees and sales commission are *not* assumed to carry a financing cost that will affect project price as they are assumed to be incurred late in the construction phase of the project – and hence, relatively close to the period when revenue from sale is realized.

Summary of Key Model Project Inputs

Table G-2 presents the key assumptions and data sources used to develop the model single-family construction project described above.

Table G-2: Key Input Parameters for the Single-Family Construction Model Project

Parameter Description	Value	Source
Project-size variables		
Site-size (acres)	1	*EPA assumption**
Average single-family home size (square feet)	2,209	*U.S. Census Bureau Characteristics of New Housing*
Average lot size (acres)	0.2	*U.S. Census Bureau Characteristics of New Housing*
Lot density (number of lots per acre)	4.93	*Calculated value*
Land acquisition and development variables		
Cost of raw land (per acre)	$224,172	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Land development costs (per lot)	$39,167	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Impact analysis (per lot)	$5,160	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Land preservation and planting (per lot)	$3,115	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Other Fees (per lot)	$5,350	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Other Costs (per lot)	$3,996	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Overhead costs	10%	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Construction cost variables		
Construction cost (per square foot)	$65.57	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Overhead costs	10.0%	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Real estate cost variables		
Marketing fees (% of home sales price)	2.7%	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Real estate sales commission (% of sales price)	4.6%	*NAHB 2007 - Construction Costs for a Single-Family Unit*
Financing terms variables		
Debt cost	7.0%	*Calculated value*
Equity cost	13.54%	*Calculated value*
Loan-to-value ratio for land acquisition	65%	*FDIC Real Estate Lending Rules*
Loan-to-value ratio for land development	75%	*FDIC Real Estate Lending Rules*
Loan-to-value ratio for construction	80%	*FDIC Real Estate Lending Rules*
Term of land acquisition loan (years)	4	*EPA assumption*
Term of land development loan (years)	3	*EPA assumption*
Term of construction loan (years)	2	*EPA assumption*

* The model project definition of 1-acre is not intended to imply that all projects subject to regulation are 1-acre in size. This is simply the assumed size of the model project for purposes of estimating the compliance cost unit multiplier value.

Estimating Project-Level Effects and Associated Cost Multiplier

The model project framework incorporates the entire set of costs associated with acquiring, developing, and completing construction of housing units or buildings on a given site. The example 1-acre single-family model project is presented in *Table G-3* below to show the specification of the model project framework and the resulting incremental changes in costs due to compliance outlays.

The assumed compliance outlay value is incurred at the beginning of the land development phase of the project (i.e., beginning of year 2). The compliance outlay is therefore incorporated into the debt and equity financing for land development – financing which has a 3-year duration. As a result, notice in *Table G-3* that the costs for land acquisition and construction do not change from baseline to post-compliance conditions, but costs for land development do change. In the example below, the *land development loan* and the *capital outlay for land* *development* both increase because part of the illustrative $3,500 per acre compliance outlay is financed through debt and part is financed through equity. The sum of the changes in debt and equity outlays equals the total per-acre compliance outlay value. These outlays then incur a multiplier effect due, respectively, to the 3-year costs of debt and equity financing.

Table G-3: Example Single-Family Construction Model Project Framework (1-Acre Site)

Project Cost Element	Baseline Value	Hypothetical Option	Change Due to Compliance
Land Acquisition			
Raw land cost	$224,172	$224,172	$0
Debt Cost for Land Acquisition			
Land acquisition loan value	$145,712	$145,712	$0
End-of-project acquisition loan balance	$190,999	$190,999	$0
Equity Cost for Land Acquisition			
Capital outlay for land acquisition	$78,460	$78,460	$0
End-of-project capital balance	$130,395	$130,395	$0
Total Land Acquisition Cost	**$321,394**	**$321,394**	**$0**
Land Development			
Development Costs			
Land development	$192,941	$192,941	$0
Impact analysis	$25,419	$25,419	$0
Land preservation and planting	$15,345	$15,345	$0
Other fees	$26,355	$26,355	$0
Other costs	$19,685	$19,685	$0
Overhead costs	$27,974	$27,974	$0
Regulatory Option Compliance Outlay	$0	$ 3,500	$ 3,500
Debt Cost for Land Development			
Land development loan value	$230,789	$233,414	$2,625
End-of-project development loan balance	$282,726	$285,942	$3,216
Equity Cost for Land Development			
Capital outlay for land development	$76,930	$77,805	$875
End-of-project capital balance	$112,603	$113,884	$1,281
Total Land Development Cost	**$395,329**	**$399,826**	**$4,496**
Construction			
Construction Costs			
Project construction	$713,555	$713,555	$0
Overhead	$71,355	$71,355	$0
Debt Cost for Construction			
Construction loan value	$627,928	$627,928	$0
End-of-project construction loan balance	$718,915	$718,915	$0
Equity Cost for Construction			
Capital outlay for construction	$156,982	$156,982	$0
End-of-project capital balance	$202,374	$202,374	$0
Total Construction Cost	**$921,289**	**$921,289**	**$0**
Estimate Sales Price to Consumer			
Total project cost before real estate fees	**$1,638,013**	**$1,642,509**	**$4,496**
Price per unit before real estate fees	**$332,517**	**$333,429**	**$913**
Marketing fees	$ 8,825	$8,849	**$24**
Sales commission	$15,286	$15,328	**$42**
Final project cost	**$ 1,756,785**	**$1,761,607**	**$4,823**
Final sales price per unit	**$ 356,627**	**$357,606**	**$979**

Once incremental compliance costs are incorporated into the model project framework, it produces – assuming 100% cost pass-through – a price differential relative to the baseline price. This price differential is higher than the incremental compliance costs assigned to the project by this implicit cost "multiplier" factor. The multiplier is calculated by dividing the total change in the *final project cost* from the baseline by the incremental cost of compliance assigned to the project. Referring back to the example in *Table G-3*, the multiplier is estimated by dividing $4,823 / $3,500.

It is important to emphasize that neither the absolute dollar value of incremental compliance associated with a given project nor the baseline cost of the project determines the value of the cost multiplier. The multiplier represents a mark-up, per dollar of compliance, and is determined by the financing terms specified for the model projects. These include the debt cost, equity cost, loan to value ratios, and the durations of the loans for each phase of development. The multiplier value is therefore option-independent. EPA estimated a compliance cost multiplier of 1.38, which means each dollar of incremental compliance cost becomes $1.38 of incremental price change for the construction unit due to debt and equity cost considerations.

Appendix H: References

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