INTENTION AND ACTION: PLAN AND POLICY IMPLEMENTATION FOR WATER RESOURCE PROTECTION

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of City and Regional Planning

Chapel Hill
2015

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ABSTRACT

Danielle Laura Spurlock: Intention and Action: Plan and Policy Implementation for Water Resource Protection
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Urban land development is one of the principal means through which human activities alter water resources. An extensive body of research links land use to water quality outcomes, but these studies often do not account for how human behavior and institutional action shape urban land development. This gap in the planning scholarship offers an opportunity to examine the land development process and the policies aimed at protecting water quality.

Comprehensive plans, development management ordinances, and approved development applications help organize the land use development process. The translation of a plan and ordinances into action to protect water resources, however, cannot be assumed. This dissertation examines 1) the quality of policy inputs (i.e., comprehensive plans and ordinances); 2) the influence of mandates on the quality of policy inputs; and 3) the implementation of one key best management practice to protect water quality—riparian buffers.

The study focused on two watersheds in Maryland and North Carolina, which have differing mandates for comprehensive planning and the protection of environmentally sensitive areas. Established plan quality content analysis methods were adapted for water resource protection and extended to an ordinance quality analysis of riparian buffer policies. These riparian buffer policies were compared to development applications, which, in turn, were compared to high-resolution land cover classification maps to investigate policy slippage and implementation.

The findings suggest comprehensive planning mandates without substantive guidance or geographically-limited mandates that only encourage extension to other sensitive areas are insufficient conditions for higher quality policy inputs. Low overall plan and ordinance quality scores highlight the gap between scientific knowledge accumulated about water resource protection and the planning inputs created and utilized by the planning profession. Finally, the three logistics regressions used to investigate the relationships among the quality of policy inputs, local context, and riparian buffer outcomes found statistically significant relationships. Conceptual groupings of both plan and ordinance quality principles as well as project-specific characteristics were associated with more tree cover and less impervious surface within the buffer. Additional research opportunities and immediate recommendations for planning monitoring and enforcement programs are provided.

For Shanda, big sister extraordinaire.

ACKNOWLEDGEMENTS

This dissertation is the product of love, labor, and faith. I would like to thank my committee for their guidance in the conception and execution of this research project. From my proposal defense to my dissertation defense, each of you suggested revisions, additions, and insights that enhanced the final project immeasurable. Thank you to Dr. Lawrence Band, Dr. Todd BenDor, Dr. Gary Henry, Dr. Nikhil Kaza (unofficial member) and Dr. Yan Song for your expertise, your time, and your kindness.

To Dr. Phil Berke. There is not enough space to express my gratitude to you for all of your support and care over these long years. You are the reason I returned to graduate school and your tutelage is the reason why I finished. You were the wind at my back during this entire process. Pushing me forward. Catching me when I fell. And finally lifting me up as I finished. I know I have the best mentor the planning world has to offer.

I would like to thank the following organizations and programs that helped fund this research: the Royster Society of Fellows, the UNC Institute for the Environment (Carolina Environmental Synthesis Program and Triangle ULTRA); the F. Stuart Chapin Jr. Fund; and the Lincoln Institute of Land Policy (C. Lowell Harriss Dissertation Fellowship). The financial support of these organizations allowed me to devote myself fully to research, gave me access to data, and allowed me to hire the help I needed to complete this undertaking.

A small army of undergraduate and graduate research assistants made this research project possible. To Casey Bradfield, Sierra Woodruff, Katherine Dydak, Meg Aminto, Avery Livengood, Carl Kolosna, Morgan Bettcher, Adam Carr, and Lillian Wu. Thank you for your dedication to the project demonstrated by your willingness to read thousands of pages of plans, ordinances, and development applications, your interest in the project's goals, and your diligence in bending GIS to your will.

Thank you to my friends and colleagues in the doctoral program who took me in when I didn't have a cohort, showed me how to navigate the program, read countless drafts and covered them in tracked changes, and provided invaluable and incisive critiques of papers and presentations with humor. To Tab Combs, Mary Donegan, Marc Howlett, and Ward Lyles. I am a better scholar because of each of you.

I would like to thank my friends who tolerating my incessant need to talk about all aspects of the project, forced me to leave it on the shelf and engage in frivolity, and celebrated with me when it was complete. To Tasseli McKay, Summer Alston, Fayola Jacobs, Adrienne Heller, Jessica Barron, Adina Black, Jackie Malik, Sarah Mayorga-Gallo, Candis Smith, and Rose Buckelew.

This dissertation is an inter-generational project. For the Grants, Taylors, Manns, and Spurlocks who valued education above all else and sacrificed so graduate study would be an expectation of me, not just a dream. I thank the woman who blazed the way for me, Dr. Laura Hines. As the reigning Laura, I am forever in your debt because of the mountains you scaled and your belief that I could achieve anything. Thank you Mom (Barbie) and Dad (George III) for letting me follow my dreams and lurking around the corner with food when I came to your house to write for hours. To my brothers, George IV and Nicholas, who made it seem as though finishing this dissertation was inevitable. And thank you to my older sister who would tell me to, "Get it done". Shanda. It's Done.

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1.1 Research Problem

Only an estimated 2.5% of all water on Earth is freshwater. Of that 2.5%, 68.6% is sequestered in glaciers and permanent icecaps while about 30.1% is groundwater. Of the remaining 1.3% freshwater, approximately 73% resides as ice and snow while 21% takes the form of surface freshwater resources such as lakes and rivers (Hornberger, Raffensperger, Wiberg, & Eshleman, 1998)[1]. It is from this limited amount of available freshwater that human populations fulfill critical biological, economic, and social needs.

The average person requires about 20-50 liters of water to meet their daily basic drinking, hygiene, and cooking needs (World Water Assessment Programme, 2009). Globally, diarrhea remains the leading cause of illness and death, but worldwide mortality from diseases such as cholera has been significantly reduced through the provision of clean water and sanitation facilities (UNICEF and World Health Organization, 2012). During the early twentieth century in the United States, the efforts of the nascent field of planning contributed to the reduction of infant, child, and total mortality through the provision of potable water and sanitation infrastructure (Cutler & Miller, 2005; Perdue, Gostin, & Stone, 2003). Sanitation engineers guided key alterations to the urban built environment such as the construction of citywide sewer infrastructure that worked in conjunction with natural drainage contours (Peterson, 1979). Additionally, they were early advocates for the

[1] The remaining 6% of freshwater is held within swamps and marshes, soil moisture, the atmosphere, and living things.

systematic removal of refuse and animal waste from streets and the provision of potable water sources. These early engineering interventions to protect public health and safety were joined by regulatory uses of the state's police power (i.e., the advent of zoning in the U.S.). Regulatory authority based on police power is an essential component of present day efforts to safeguard human and environmental health by the field of planning, and is the focus of this dissertation.

The "reserved powers" of states granted under the 10th amendment of the United States Constitution provide the legal foundation for planning's use of police power ("The Constitution of the United States of America," 1791). Using its police power, a state may create, enact, and enforce regulations to protect "the health, safety, morals, and general welfare" of its citizenry (Burke, 2002). In order for local jurisdictions to have this authority, a state must delegate that power to jurisdictions, an action known as Dillon's rule.[2] For example, the Department of Commerce streamlined the delegation of zoning authority from states to local jurisdictions by composing the 1926 Standard State Zoning Enabling Act (Department of Commerce, 1926). This Act preceded the 1928 Standard City Planning Enabling Act, which recommended the establishment of a permanent planning branch within local government and outlined the contents of a master plan (Department of Commerce, 1928). The language[3] within the Standard State Zoning Enabling Act is imprecise with respect to the linkage between zoning and plans and the judicial record on this relationship is unclear (Mandelker, 1976). Thus, the ambitious original purpose of the master plan (or

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[2] Dillon's rule is the rule of delegation of authority named for the 19th century judge who first used the formulation (Burke, 2002).

[3] The key phrase declares that zoning "shall be in accordance with a comprehensive plan" (Department of Commerce, 1926).

comprehensive plan)[4]— a statement of 'willful intention' to quote Kent—is separated from action, forever complicating the relationship between the comprehensive plan and the regulatory tools necessary to implement it (1991). This dissertation explores the creation of comprehensive plans and development management ordinances with respect to the protection of water resources and how local governments utilize these policy inputs within the land use decision-making process.

1.1.1 Urbanization and Water Quality

Historically, surface water resources heavily influenced the location of human settlements with the "25 largest cities, the 25 largest production locations, the 25 most prosperous areas and the 25 most densely populated areas in the world" all found near water bodies (World Water Assessment Programme, 2009, p. 120). Proximity to these water bodies was critical for the development and prosperity of human settlements, but a host of environmental costs can accompany the utilization of these resources. For example, the damming of a river to provide a more permanent, drought-resistant water supply alters the depth, temperature, and light available to aquatic habitats. The dam may also serve as a source of hydroelectric power while reducing the amount of sediment downstream, which can contribute to the erosion of aquatic environments like deltas. In another example, urban and suburban developments often exist on former wetlands that were drained to enable construction and result in the impingement of sprawling development on environmentally-

[4] "The plan shall be made with the general purpose of guiding and accomplishing a coordinated, adjusted and harmonious development of the municipality and its environs which will, in accordance with present and future needs, best promote health, safety, morals, order, conveniences, prosperity, and general welfare, as well as efficiency and economy in the process of development, including, among other things, adequate provision for traffic, the promotion of safety from fire and other dangers, adequate provision for light and air, the promotion of good civic design and arrangement, wise and efficient expenditure of public funds, and the adequate provision of utilities and other public requirements" (Department of Commerce, 1928).

sensitive areas. This type of construction and other land use patterns associated with urbanization are particularly concerning as the loss of natural areas alters the absorption and natural filtration of stormwater.

Stormwater runoff, rainwater that fails to be absorbed, affects water quality through two pathways: natural and anthropogenic. The natural pathway involve factors such as topography (e.g., steep slopes), the hydraulic conductivity of different soil types, geology, the amount and density of vegetation cover, precipitation intensity and amount, and river discharge (Baker, 2003; Hornberger et al., 1998). The anthropogenic pathway consists of human activities that change the built environment, increase the amount of stormwater runoff generated, introduce pollutants into stormwater runoff, and alter its progression through the environment.

Urban land development is one of the principal means through which human activities alter the amount and progression of stormwater runoff. The construction of residential, governmental, institutional, commercial, and industrial buildings as well as the creation of an extensive paved road system increases the amount of impervious surface, which, in turn, impedes the absorption of rainwater by blocking direct contact with permeable surfaces. Haphazard urban development within the United States converted vast expanses of undeveloped greenfield areas into unprecedented amounts of impervious surface (i.e., paved roads, rooftops, and parking lots). Arnold and Gibbons argue impervious surface is a "quantifiable land use indicator correlated with water quality" (1996, p. 245)[5]. In many urban areas, the drainage system developed to manage the stormwater generated from

[5] Though Brabec and colleagues argue for a less simplistic conception of the impact of impervious surfaces on water quality, their work does not exclude impervious surface as a proxy for water quality degradation (Brabec, Schulte, & Richards, 2002).

impervious surfaces focused on “minimiz[ing] storage and maximiz[ing] conveyance” (Hey, 2001, p. 3). As a result, stormwater runoff is rapidly directed away from development to limit flooding. Unfortunately, the swift, unencumbered return to surface water resources reduces the amount of time natural processes can filtered out pollutants (i.e., heavy metals, synthetic chemicals, nutrients, sediment, and microbes). Focusing on urban development offers an opportunity to investigate the processes that govern the creation of the built environment while examining policies aimed at protecting water quality.

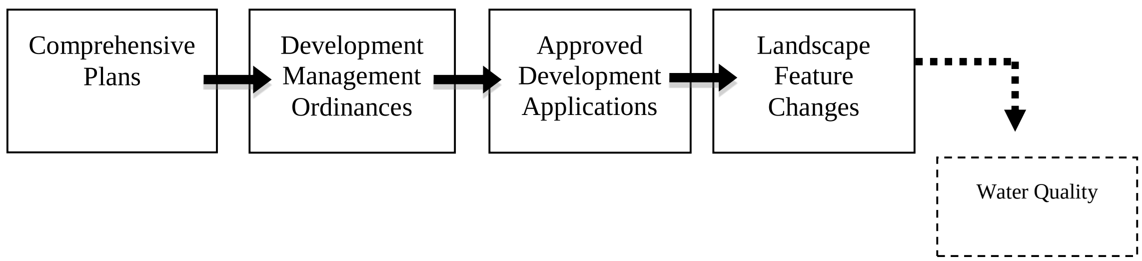
Within the 50 U.S. states and the District of Columbia, the Environmental Protection Agency lists over 40,000 water bodies as “impaired”, which is a classification for water resources with recurring, monitored violations of water quality criteria (United States Environmental Protection Agency, 2013). A substantial body of research in hydrology, ecology, and geology focuses on the production of stormwater runoff within the urban built environment and the introduction of pollutants into water bodies. This body of research examines the impact of the amount, location, and connectivity of impervious surface on pollutant production, the export of nutrients from urbanized land uses, and the effect of various spatial scales on water quality (Allan, 2004; Dougherty et al., 2006; P. Lee, Smyth, & Boutin, 2004; Shuster, Bonta, Thurston, Warnemuended, & Smith, 2005; Wickham et al., 2002). A complementary body of literature examines the relationship between water quality and urban form including the impact of exurban development, development density, and neighborhood design types (Goonetilleke, Thomas, Ginn, & Gilbert, 2005; Greenberg, Mayer, Miller, Hordon, & Knee, 2003; Hansen et al., 2005; Nassauer, Allan, Johengen, Kosek, & Infante, 2004; Richards, Anderson, Santore, & United States Environmental Protection Agency, 2006). Less research emphasis, however, has been placed on the institutions and policies that help shape the observed urban form and if land use policies are implemented in accordance to plans and ordinances. The next two sections of this chapter provide an overview of the land use development process and explore the barriers to collective action for water resource protection.

1.2 Land Use Development Process

Planning can be divided into a number of sub-disciplines (e.g., land use, transportation, housing and community development, real estate development, economic development) with direct influence on the urbanized built environment. Land use planning shapes the utilization of land within and adjacent to human settlements by directing the allocations of various land uses (e.g., agricultural, residential, commercial, institutional, and industrial) and the spatial arrangement of these uses (Berke, Godschalk, Kaiser, & Rodriguez, 2006). This broad definition of land use planning encompasses the policies that help direct the type, use, density, and spatial arrangement of structures within the built and natural environments and the sociopolitical institutions that develop and enforce these policies. Although urban land development is a clear contributor to declining water quality, few research projects evaluate the implementation of the land use policies aimed at protecting water quality.

Comprehensive plans, development management ordinances, and approved development applications help organize the land use development process and shape the landscape features that directly impact the protection of water resources. Figure 1.1 traces the land use policy process from comprehensive plans to changes in landscape features and their potential impact on water quality. This figure outlines the key inputs of the land development process introduced in subsequent sections and is examined in depth in Chapter 2 as part of the project's conceptual model.

Figure 1.1: Land Use Policy Process



1.2.1 Comprehensive Plans

Comprehensive plans are key policy documents that should provide the overarching framework of goals, objectives, and policies that guide future development. Local comprehensive plans are critical tools as they offer an opportunity to 1) assemble information about the current state of the community, 2) create projections and estimates for the future, 3) evaluate alternative courses of action, and 4) reconcile competing objectives (Berke, Godschalk, et al., 2006). For example, the creation of a comprehensive plan offers an opportunity to assemble information about future water use projections and current threats to water quality such as nonpoint source pollution. Further, the planning process can help reconcile competing objectives like increasing a jurisdiction's economic tax base while maintaining low-density development in environmentally sensitive portions of watersheds.

A subset of planning research links better quality comprehensive plans with better implementation and outcomes (Berke, Backhurst, et al., 2006; Brody & Highfield, 2005; Burby et al., 1997; Nelson & French, 2002). A high quality comprehensive or land use plan is one that incorporates the "highest quality of thought and practice" in the plan's goals, fact base and policy framework, which should help a community adapt to changing conditions while providing a structured vision of how a community wants to develop in the future (Berke & Godschalk, 2009, p. 228). Additionally, a high quality plan should include information and policies to facilitate the implementation and monitoring of plan goals.

A number of planning scholars contributed to the creation of a set of principles aimed at differentiating plans based on their quality (Baer, 1997; Berke, Godschalk, et al., 2006; Berke & Godschalk, 2009; Kaiser & Davies, 1999; Kaiser, Godschalk, & Chapin, 1995). Despite the central role water resources play in the functioning of urbanized areas, there is paucity of evaluations that examine the incorporation of water resource protection into comprehensive plans. Currently, only two studies adapt these principles to measure the quality of plans with respect to watershed and ecosystem protection (Berke, Spurlock, Hess, & Band, 2013; Brody, Highfield, & Carrasco, 2004). An assessment of ecosystem management efforts within comprehensive plans in southern Florida found low plan quality scores even with a federal program aimed at restoring the Everglades, a state watershed management program, and a mandate for local comprehensive planning (Brody et al., 2004). Berke, Spurlock, and colleagues evaluated comprehensive plans in a portion of the Jordan Lake watershed in North Carolina and found few water quality protection goals, less detailed information about local water resources, and a limited number of policies aimed at protecting water resources (2013). This study builds on these prior research efforts by 1) assessing the quality of comprehensive plans with respect to the protection of water resources and integrating those findings with 2) an evaluation of development management ordinances.

1.2.2 Development Management Ordinances

Development management ordinances contain the specific standards that govern the location and design of development and describe the review procedures necessary to gain approval. They can take the form of legislative, regulatory, incentive, and investment tools; offer specificity about acceptable actions during the development review process; and outline the requirements for the type, design, and location of constructed development. In short, ordinances represent a link between the goals, information, and policies contained within plans and approved development.

A few studies explore the role of ordinances in implementation (Hill, Dorfman, & Kramer, 2010; McPherson, 2001; Norton, 2008). These studies suggest compliance with ordinances is not consistent, the content of codes can differ based on spatial characteristics, and content can be associated with different implementation outcomes. There is also a limited body of work focusing on water quality and ordinances. A group of law professors proposed a Model Water Code in the early 1970s, which was followed by a Model Stormwater Control Ordinance in the 1980s and a follow-up study of the ordinance's adoption in Florida (Ausness, 1987; Maloney, Ausness, & Morris, 1972; Maloney, Hamann, & Canter, 1980). In 2004, the American Society of Civil Engineers (ASCE) released a Regulated Riparian Model Water Code (American Society of Civil Engineers & Engineers, 2004). There are, however, no studies that examine the quality of development management ordinances.

A review of practitioner resources suggested that a high quality ordinance should delineate the information required for the development application and include clear explanations of the policies and their applicability (Kelly, 1988; Lerable, 1995). Although the research literature does not include references to ordinance quality principles similar to the principles developed for plan quality, there are two recent studies that investigate ordinances using content analysis. Norton's examination of zoning codes for 32 jurisdictions within a Michigan county measured the amount of policy focus within ordinances on neo-traditional landscapes (2008). Stevens and Hanschka investigated whether recently adopted flood bylaws are consistent with government guidelines and the best practices in flood risk management (2014). This study builds on these previous studies by creating a set of principles for ordinance quality that draw on the plan quality research literature, the theory of street-level bureaucracy, and practitioner resources. Similarly to both studies, I use content analysis to investigate the consistency of jurisdictional regulations with best practices around water resource protection. Development management ordinances are an understudied portion of the land development process and this study investigates the important connection between comprehensive plans and land use outcomes.

1.2.3 Approved Development Applications

During the development review process, planning staff utilize ordinances in the deliberations surrounding a particular development at a specific site. Approved development applications are the product of this review stage prior to construction and, collectively, provide insight into a community's development over time. As the final policy interface between development management ordinances and alterations to the natural and built environments, development applications represent a potential slippage point between ordinance provisions and approved development. Thus, the study of development applications is an important step in the land use policy process with implications for the implementation of comprehensive plans and development management ordinances.

There is a growing body of research that utilizes approved development applications to study plan implementation. Higher quality plans have been linked with the implementation of plan policies using development applications and studies suggest the monitoring and enforcement style articulated in development ordinances can affect compliance (Brody & Highfield, 2005; Burby, May, & Paterson, 1998; Burby, 2003; Laurian, Day, Backhurst, et al., 2004). A number of studies of development applications found elements of the development review process such as flexibility, complexity, and resources are key components affecting compliance with plans and ordinances (Alterman & Hill, 1978; Burby et al., 1998; Laurian, Day, Backhurst, et al., 2004). While there are conflicting conclusions about the influence of developer characteristics and agency capacity on the implementation of approved development applications, market influences and the scale of the development are consistent factors affecting implementation (Alterman & Hill, 1978; Berke, Backhurst, et al., 2006; Burby et al., 1998).

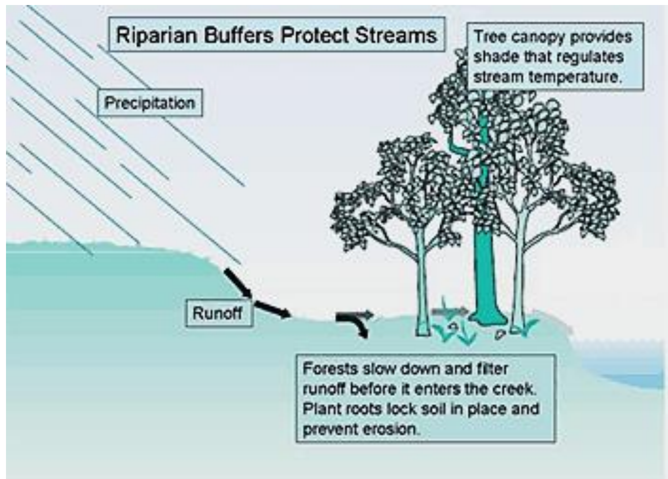
These studies highlight the important role played by development applications in the investigation of plan implementation. A community may have a high quality plan, may convert that plan successfully into high quality ordinances, but development may still negatively impact water quality if, for example, the staff involved in the review process ignore, or incorrectly interpret ordinances, or regularly grant variances. This study examines approved development applications as a key step linking policies to protect water quality to development decisions and land use outcomes. The study's emphasis is on slippage between the policies contained in development management ordinances and the development actually approved by the planning staff.

1.2.4 Landscape Features

The term landscape features refers to the land, water, vegetation, structures, and infrastructure that compose a landscape. Riparian buffers are “vegetated zones adjacent to streams and wetlands that represent a best management practice (BMP)” to help address issues around the quantity and quality of stormwater runoff (Mayer, Reynolds, Canfield, & McCutchen, 2005, p. iv). Figure 1.2 illustrates the role of riparian buffers in the filtration of pollutants, stream temperature regulation, and the reduction of runoff velocity; all of which have implications for erosion and runoff absorption. Buffers also offer benefits associated with flood control, stream bank stabilization, and can protect aquatic and terrestrial habitats.

Riparian buffers were selected as the focus of this research because of 1) the well-defined linkage between riparian buffers and water quality, 2) the extensive scientific literature on design characteristics to optimize riparian buffer functioning, and 3) the widespread adoption of riparian buffer policies by jurisdictions (Booth & Keinfelt, 1993; Griffin, 1980; Klein, 1979; Lowrance et al., 1997; Mayer et al., 2005; Phillips, 1989; Schueler, 1994; Todd, 1989; Vidon & Hill, 2004). The focus on riparian buffers allows for an examination of a diverse set of regulatory, incentive, and acquisition policies within ordinances and development applications. These policies include, but are not limited to, the preservation of native vegetation, fee-simple land acquisition, conservation easements, sedimentation and erosion control, structural stormwater best management practices (BMPs), and/or low impact design (i.e., infill, conservation development, green building, green site and street design).

Figure 1.2: Illustration of a Riparian Buffer



Source: Chesterfield County, VA
Riparian Stewardship Program, 2010

A number of studies explore the connection between planning inputs and changes to landscape features. Talen's 1996 study investigates whether park facilities in a 1966 plan were actually developed and located according to the plan using spatial analysis (1996a). Loh used Geographic Information Systems (GIS) to investigate whether instances of nonconformity with plans were artifacts of the land development process or decisions made in direct contradiction to the plan (2011). Chapin and colleagues also used GIS to conduct a parcel level assessment of land use changes, which allowed for the examination of the relationship between comprehensive plan approval and land use changes (Chapin et al., 2008). Ozawa and Yeakley investigated the loss of riparian vegetation under three different development policies using high-resolution land cover classification maps (2007). Each of these studies investigated alterations to landscape features and offer an essential refinement to implementation studies—the comparison of planning inputs to on-the-ground conditions. This study utilizes GIS and high-resolution land cover classification maps to examine the implementation of riparian buffers (i.e., width, vegetation, and impervious surface encroachment) for approved developments.

1.2.5 Land Use Policy Process, Policy Slippage, and Implementation

The translation of a plan into action cannot be assumed. The failure to implement plans is a long-standing critique of the planning process and many plans languish on a shelf despite the considerable expenditure of time and resources necessary for their creation. In a scathing criticism of planning in general (and comprehensive planning in particular), Altshuler questioned the utility of a 'comprehensive' plan and its ability to guide decision-making given the limitations on planners' power within the political arena (1965a, 1965b). Clawson's criticisms of planning focus on the disjointed implementation of plans although he acknowledges the complexity introduced by the dense network of stakeholders with disparate motivations involved in plan implementation (1971). Wheaton (1969), Hall (1980), and Alexander and Faludi (1989) point out the uncertainty and fallibility of planner judgments, which necessitates the review and verification of their actions.

Recent empirical research identify contextual factors that complicate implementation efforts such as the complexity of the planning decision-making process, the political influence of the developer, market influences, and the lack of "publics" (Alterman & Hill, 1978; Berke, Backhurst, et al., 2006; Brody & Highfield, 2005; Burby, 2003; Laurian, Day, Backhurst, et al., 2004). In her work on implementation, Loh identifies four points in the land use policy process where potential breaks may occur between the plan's objectives and land use outcomes: 1) plan conception, 2) plan writing, 3) conversion from plan to ordinances, and 4) ordinance enforcement (2012). Loh refers to these points as "disconnects", but this research will use the term "slippage" as used in the implementation literature (Berman, 1978; Farber, 1999; Pressman & Wildavsky, 1973). Slippage refers to deviations or differences between a stated policy or objective and the actual actions taken and/or outcomes. This dissertation focuses on two potential slippage points during ordinance enforcement: application approval and constructed development.

Farber divides policy slippage into two categories: negative and affirmative slippage (1999). Negative slippage refers to the failure to implement without prior authorization. Affirmative slippage is associated with deviations from policy that are openly renegotiated. These two conceptualizations of policy slippage parallel two common approaches to plan evaluation: conformance and performance approaches. Conformance-based evaluation uses a definition of success based on the agreement between the intentions expressed in plan and what is actually implemented. It is analogous to negative policy slippage where any deviation from planning inputs is considered noncompliance. The main strengths of this approach are the clear-cut linkages between planning and action and straightforward metrics for measurement. However, scholars such as Baer raise concerns about determining success or failure based solely on departures from an intended plan because departures are inevitable as plans alone are not sufficient for implementation (i.e., factors like politics matter) and the circumstances surrounding decisions shift (1997).

Alexander and Faludi[6] define a performance-based approach to evaluation as the examination "of the policy or plan as a frame of reference for operational decisions" (1989,

[6] Alexander and Faludi include a third conceptualization, subjective evaluation that will not be address here.

p. 134). For example, a plan might be considered implemented if it were simply consulted during the development process. Though this definition accounts for uncertainty by allowing flexibility in the use of a plan, successful implementation of the plan is difficult to measure.

This project combines conformance- and performance-based approaches. The conformance-based element includes the creation of scoring protocols to reduce the subjectivity of measures while determining the agreement among plan policies, ordinances, and applications (i.e., negative policy slippage) (Alexander & Faludi, 1989; Berke, Godschalk, et al., 2006; Brody, Carrasco, & Highfield, 2006; Laurian, Day, Berke, et al., 2004). The performance-based approach focuses on the operational decisions of planners and development applicants to capture the rationales provided to explain departures from ordinance provisions (i.e., affirmative policy slippage) using content analysis of approved development applications (Forester, 1993; Talen, 1997).

This project is the first single study to investigate the entire land use policy process from comprehensive plans through development management ordinances to approved and constructed development. It contributes to the research literature by applying plan quality principles to the protection of water resources and creating ordinance quality principles to examine an essential but understudied portion of the land development process. The use of GIS and high resolution land cover classification maps places this project among a small number of projects linking policy inputs to actual alterations to landscape features. Finally, the review of the full land use policy process allows for the identification of multiple policy slippage points throughout the development process.

This section outlined the key policy inputs into the land use development process and described the challenges of measuring implementation success. In addition to the policy slippage points highlighted by past implementation studies, there are three factors that make organizing collective action to protect water resources particularly difficult: growth pressures on individual local governments, the spatial mismatch between watershed and jurisdictional boundaries, and the nature of nonpoint pollution. The following sections review the obstacles faced by local governments seeking to take action to protect water resources and explores one common policy intervention used to address these barriers: mandates.

1.3 The Obstacles to Collective Action for Watershed Protection

Land use decisions by individual local governments can have clear economic benefits as jurisdictions can increase their tax base through development (Berke, Godschalk, et al., 2006; Hopkins, 2001). Beyond the possible economic benefits associated with individual land use decisions, Molotch's work on the urban growth machine suggests that growth (and the accompanying land use development) serves as a motivation for a variety of stakeholders within urban areas and contributes to fierce competition for growth[7] at the regional scale (Molotch, 1976).

> Each locality, in striving to make these gains, is in competition with other localities because the degree of growth, at least at any given moment, is finite. The scarcity of developmental resources means that government becomes the arena in which land-use interest groups compete for public money and attempt to mold those decisions which will determine the land-use outcomes. Localities thus compete with one another to gain the preconditions of growth (ibid, p. 312).

[7] The 1987 refinement of the urban growth machine concept by Logan and Molotch distinguishes between the exchange value championed by the pro-growth advocates and the use value supported by challengers of indiscriminate growth. They still maintain that growth is a "mixed blessing at best" (Logan & Molotch, 1987, p. 85).

Although the actual benefits of growth remain disputed, its perceived benefits factor into the development pressures placed on local jurisdictions and the motivations underlying land use decisions. Individual jurisdictions benefit not only from actual constructed development, but also from the creation of a favorable business climate that enables a jurisdiction to compete with neighboring jurisdictions for growth (ibid, p. 312). Thus, there are short-term economic benefits of growth as well as longer term reputational benefits, and these benefits do not necessarily account for growth-related problems such as traffic congestion, air pollution, and water pollution (Feagin, 1988). Using the concept of the tragedy of the commons as a reference point, water resources represent a commons[8] degraded in favor of the benefits of growth and its associated land use development. The individual benefits from producing pollution outstrip the individual's share of the collective costs of polluting (Hardin, 1968). Developers profit from land use decisions with minimum delays while local governments are often competing with other jurisdictions to attract development and expand their tax base (Logan & Molotch, 1987; Molotch, 1976). Development in an environmental protective manner is a longer term goal with a more diffuse set of positive consequences that must compete with a jurisdiction's more immediate financial interest and benefits.

Nonpoint source water pollution provides an even more complicated illustration of the complexities surrounding common pool resources by adding two issues of scale that

[8] Elinor Ostrom draws attention to the lack of a shared language while discussing "the commons", but she does not continue the use of this term as she states that Hardin confuses open access commons with joint property commons in his work (Ostrom, 2008). Future references in the text use the term common pool resources. Common pool resources are "a natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use" (Ostrom, 1990, p. 30). Common pool resources can suffer from overcrowding or overuse in a way that differentiates them from public goods.

affect the collective sharing of costs: the spatial mismatch between jurisdictional and watershed boundaries and the definition of nonpoint source pollution. Water pollution is a clear cost. As described above, the continued functioning of human settlements is dependent upon water resources and the degradation of water resources negatively affects their use for drinking water, recreation, and sustenance. Local jurisdictional boundaries rarely, however, correspond with watershed boundaries (Dunne & Leopold, 1978). While watershed boundaries are determined by hydrological principles, the administrative boundaries of jurisdictions reflect historical, social, political, and economic forces in addition to the influences of the physical environment (United States Geographic Survey, 2013). This spatial mismatch results in a further attenuation of individual costs as the number of stakeholders responsible for a single body of water increases[9]. Not only do the benefits to an individual polluter outweigh their share of the collective costs of degrading a resource, but there is the possibility that costs are borne by a completely different set of jurisdictions.

Sources of nonpoint pollution are, by definition, difficult to identify and pinpoint in space, which impedes individual jurisdictions from assuming the true cost of degradation. Local jurisdictions must weigh the benefits associated with land use development patterns consistent with the urban growth machine against a shared portion of collective costs that may or may not directly impact their water resources. For example, it may be in the 'rational' self-interest of an individual jurisdiction not to require more expensive construction practices around tree preservation or grading because the cost of sedimentation in a local waterway is borne by multiple jurisdictions (Hardin, 1968).

[9] The difference in boundaries is accompanied by a difference in scale. Though there will likely be a number of smaller watersheds within a local jurisdiction, the aggregation of these smaller watersheds into larger watersheds (e.g., Gunpowder-Patapsco into the Chesapeake Bay) multiplies the number of stakeholders and potential polluters.

Federal legislation is one mechanism to overcome barriers to collective action. Section 303(e) of the Clean Water Act requires states to establish and maintain a continuing planning process to monitor, maintain, and improve the water quality. States, in turn, must work with local jurisdictions using both regulatory and non-regulatory means to maintain water quality and restore impaired water bodies. There is, however, no comparable national legislative framework for land use although the federal government does intervene on a number of issues that directly and indirectly impact land management, (Burby & May, 1998). States are tasked with the protection of water quality, but many decisions governing a key contributing factor to water quality—land use—occur at the local level. As a result, local jurisdictions must work in partnership with state and federal governments to help remediate water quality issues, which fits the description of a "shared governance dilemma".

Shared governance refers to occasions where "common or overlapping responsibilities are apportioned among layers of government" (May & Williams, 1986). A shared governance dilemma can result from this particular governance structure when these layers of government must work in concert to achieve a particular goal, but the commitment and capacity of local governments to take actions that are in line with state goals and objectives is variable at best (Berke, 1998; Burby & May, 1998; May & Williams, 1986). Local commitment refers to the willingness of a jurisdiction to take action to reach a shared goal and is reflective of political will, individual and agency opinions about prescriptive requirements, and issue prioritization by staff and community members (Burby & May, 1998; Dalton & Burby, 1994; May & Williams, 1986). Again, short-term economic interests can heavily influence land use decisions and may lower commitment (Berke, Godschalk, et al., 2006; Hopkins, 2001). Even when there is a well-defined incentive for the protection of water resources, there may still be limited local commitment (Burby & May, 1998). Jurisdictions can, in effect, free-ride on the efforts of other jurisdictions without taking comparable action. In a recent study of comprehensive plans, Berke, Spurlock and colleagues found that local governments utilizing a lake for drinking water included less water resource protection information and fewer policies in their comprehensive plans than jurisdictions within the same watershed that were not using the lake as a drinking water source (Berke et al., 2013). This type of free-riding in the management of a common pool resource is a widespread problem. Further, while isolated efforts by jurisdictions can positively impact water quality, a regional approach is necessary to make substantial progress in the protection of water resources (Dunne & Leopold, 1978; Ostrom, 1990). Using sedimentation as example, policies enacted to limit erosion by one jurisdiction can reduce the overall amount of sediment in a water body, but a sedimentation problem can persist if other jurisdictions within the same watershed fail to take action.

Local capacity refers to the ability of a jurisdiction to take action to reach a shared goal and includes factors such as staff expertise, budget, and decision-making authority (Burby & May, 1998; May & Williams, 1986; Winter & May, 2001). Even for a jurisdiction with high levels of local commitment, capacity can be a limiting factor. The development process can be a complex and resource-intensive process where multiple departments within a single local government must coordinate their efforts. Departmental budgets help dictate the number of staff available to provide technical assistance during the application process; the type and extensiveness of monitoring and enforcement activities; and can impose limits on staff expertise through salary ranges and fewer continuing education opportunities.

Capacity also affects a jurisdiction's ability to coordinate the efforts of multiple agencies within a local government with neighboring jurisdictions.

In short, a number of land use policy interventions with the potential to help remediate water quality issues must take place at the local level. Local jurisdictions, however, often lack the commitment to take protective action due to the economic benefits of the land use development process and spatial realities of water resource protection. Additionally, the lack of capacity complicates water resource protection even if a jurisdiction is committed to implementation. In an attempt to address the barriers to collective action inherent in water resource protection, some states adopt planning mandates to address the shared governance dilemma described above. The following section introduces the research on mandates, planning policy inputs, and outcomes.

1.4 Planning Mandates

This study explores the use of a regulatory, full partnership approach[10] to shared governance, most readily identifiable with mandates (Berke, 1998). Many states choose to use mandates to address the shared governance dilemma that results from the requirements of the Clean Water Act. For mandates to have their intended effect on local decisions, these legislative directives must influence action (i.e., alter plans, modify ordinances, and/or influence decision making). A considerable body of planning literature exists on the positive influence of state mandates on outcomes such as the quality of plans, the strength of development management regulations, and planning outcomes like diverting development

[10] In a regulatory, full partnership approach, states delineate requirements while allowing local governments latitude in the fulfillment of the requirements. A variant of the regulatory, full partnership approach occurs when states combine broad directives with legislature requiring specific measures. In this approach, the jurisdiction retains less autonomy in its satisfaction of certain measures.

from hazardous areas (Berke, Dixon, & Ericksen, 1997; Berke, Roenigk, Kaiser, & Burby, 1996; Berke & French, 1994; Berke, 1998; Brody, Highfield, & Thorton, 2006; Burby & May, 1998; Burby & Paterson, 1993; Burby, 2005; Burby et al., 1993, 1998; Dalton & Burby, 1994; Hoch, 2007a; May & Burby, 1996; May & Williams, 1986). Jurisdictions in states with mandates are more likely to have higher quality plans than jurisdictions in states without mandates (Berke & French, 1994; Berke et al., 1996; Burby, 2005; Burby et al., 1997; Dalton & Burby, 1994). Higher quality plans are, in turn, associated with stronger development regulations (Burby et al., 1997). Additionally, a limited number of studies found an association between mandates and better planning outcomes such as less development in hazardous areas and lower hazard losses (Burby, 2005; Dalton & Burby, 1994). This is the first study to investigate the impact of planning mandates on water resource protection by examining the quality of comprehensive plans and the quality of riparian buffer policies.

Mandates alone, however, are not a panacea for implementing land use planning goals. Although jurisdictions subject to planning mandates are more likely to adopt plans, these plans often only adhere to the minimum requirements of the law and fail to implement mandate provisions fully (Berke & Beatley, 1992; May & Birkland, 1994). Further, the improvement in the quality of plans, development regulations, and implementation is dependent of the design and enforcement of mandates (Berke, Crawford, Dixon, & Ericksen, 1999; Berke et al., 1997, 1996; Burby & Paterson, 1993; Burby et al., 1993; Dalton & Burby, 1994; Kusler, 1980; Popper, 1988). This study examines the differential impact of two types of planning mandates on water resource protection by including two watersheds in two states with different planning contexts. One watershed is subject to a state mandate for comprehensive planning (Gunpowder-Patapsco watershed in Maryland) and one watershed is not (Jordan Lake watershed in North Carolina). These two watersheds are also subject to two different mandates aimed at protecting environmentally sensitive areas. The results of this research will help clarify the role of mandates in the protection of water resources through their influence on planning inputs.

1.5 Purpose of Research

Land use planning represents a societal investment that can help balance environmental protection with economic development (Campbell, 1996; Hopkins, 2001). Comprehensive plans, development management ordinances, and approved development applications are at the nexus of land use development and water resource protection as they are the policy documents that govern landscape features (i.e., the land, water, vegetation, and structures that compose a landscape). This project seeks to contribute to the growing body of plan implementation literature by combining an examination of these policy inputs with observations from high-resolution land cover classification maps in order to evaluate the incorporation of water resource protection.

1.6 Research Questions

Comprehensive plans and development management ordinances are important policy inputs that reflect a community's commitment to water resource protection and shape the development process. As key policy documents, comprehensive plans provide the overarching framework of goals, objectives, and policies that should guide future development. Ordinances are legislative tools with legal implications used to implement the policies set out in plans. The first objective of this research is to explore the quality of comprehensive plans and development management ordinances with respect to the protection of water resources while investigating the impact of mandates on these planning inputs. Two research questions guide the research into this objective.

RQ1: Do jurisdictions in a state with a mandate for comprehensive planning have **higher quality comprehensive plans** with respect to water resource protection than jurisdictions in a state without a mandate?

RQ2: Does the design of a single purpose state mandate (i.e., complexity, inclusion of capacity and commitment-building elements, and implementation style) adopted to protect environmentally sensitive areas affect the **quality of buffer protection provisions** within development management ordinances?

The second objective of this research is to investigate the implementation of a key land use policy aimed at protecting water resources—riparian buffer policies. Implementation studies remain an underdeveloped area of research in planning. This research project investigates the implementation of ordinance policies by examining approved development applications and constructed development. Slippage, the discrepancy between a stated policy and its actual implementation, can undermine effective strategies to protect water quality. This study measures slippage at two difference points: policy slippage and implementation. To measure policy slippage, the study compares the riparian buffer policies outlined in ordinances to the buffer provisions within approved development applications. To measure implementation, the study compares riparian buffer provisions within approved development applications to the buffers characteristics measured from high-resolution land cover classification maps. Three research questions guide this portion of the research project.

RQ3: How frequently does **policy slippage** occur between the riparian buffer policies outlined within development management ordinances and the provisions of approved development applications?

RQ4: Does the quality of policy inputs, the presence of mandates, and local context **explain variation in policy slippage**?

RQ5: Does the quality of policy inputs, the presence of mandates, and local context **explain variation in implementation**?

1.7 Conclusion

The indispensable roles played by water resources in human health and the establishment of human settlements should help to prioritize watershed protection. The multitude of stakeholders with differing valuations of environmental protection, however, can lead to conflicting problem definitions and goals for protection. Additionally, the economic motivations and spatial barriers associated with land use development complicate collective action to protect common pool resources.

Natural science researchers including hydrologists, ecologists, and conservation biologists have focused intense study on the linkages between water quality and land use. The research agenda on water quality from a social science perspective (i.e., behavioral and policy factors) is less well-developed. As a result, although there is a significant body of research linking land use and water quality, few current evaluations examine how this information is utilized by the planning profession (i.e., the quality of planning inputs with respect to water resource protection and the role of planning inputs in explaining the variation in implementation). Further, while there are many single case studies on plan implementation, single cases lack comparative analyses and can only focus on a few factors per case, which constrains knowledge accumulation. This study addresses these limitations by offering a comparative analysis of a cross-section of planning inputs and approved and constructed development in two watersheds. Both the methodology developed to evaluate implementation and the accumulation of empirical evidence will enable planning scholars and practitioners to synthesize new theories about the conditions that support and hinder plan implementation and inform practice and policy formulation at the local level.

1.8 Study Overview

Chapter 1 began by linking urbanization and water quality and identifying land use planning as a possible point of intervention to protect water resources. It introduced the key inputs in the land use policy process and the need to connect these inputs to implementation. Chapter 1 included a discussion of the spatial and economic barriers associated with the implementation of water resource protection policies along with the role of mandates can play in the development of higher quality planning inputs and implementation. The chapter concluded with the purpose of this study and the questions that guide the research.

Chapter 2 explores the concepts of intention, action, and outcomes within definitions of planning and how different definitions influence plan evaluation efforts. These concepts informed the adaption of an evaluation logic model as the basis of the project's conceptual model. This model unites these concepts with the planning process for local land use decisions first outlined in Figure 1.1. The chapter reviews each policy inputs associated with land use planning (i.e., comprehensive plans, development management ordinances, and approved development applications) with an emphasis on past research efforts. Additionally, it explores the influence of state policy, local social-economic factors, and site conditions on land use outcomes. The chapter concludes with the hypotheses tested in this study.

Chapter 3 describes the research design, methods, and variables used in this study. The project consists of four broad tasks: 1) the content analysis of comprehensive plans and development management ordinances; 2) the content analysis of a sample of approved development applications; 3) measurements of riparian buffer composition from high-resolution land cover classification maps; and 4) the creation of regression models to test a series of hypotheses about the variables contributing to variation in policy implementation. The chapter concludes with a discussion of a potential threats to validity associated with the study.

Chapter 4 provides an assessment of the three mandates under study for this project: Maryland's comprehensive planning mandate and single purpose mandates of both Maryland and North Carolina that seek to protect environmentally sensitive areas. The design features (i.e., complexity, capacity and commitment-building elements, and implementation style) of each mandate is characterized in order to allow a more nuanced examination of the influence of mandates on planning inputs and implementation in subsequent chapters.

Chapter 5 presents the results for the content analysis of the comprehensive plans. The plan quality protocol detailed in Chapter 3 is applied to comprehensive plans to determine their quality with respect to water resource protection. This chapter examines whether jurisdictions in a state with a comprehensive planning mandate have higher quality plans, on average, than jurisdictions in a state without a comprehensive planning mandate.

Chapter 6 examines the results from the content analysis of the development management ordinances. This chapter differentiates between riparian buffer policies based on their quality using the ordinance quality protocol detailed in Chapter 3 and investigates whether the design of two different single-purpose mandates influence the quality of riparian buffer provisions within development management ordinances.

Chapter 7 begins with the analysis of policy slippage between stages within the land use policy process. The chapter investigates both sanctioned and unsanctioned deviations between the riparian buffer policies outlined within development management ordinances and the provisions of approved development applications. The second portion of the chapter reports on a series of regression models created to test the implementation of riparian buffer policies. These models examine the factors that explain variation in the vegetative content and impervious surface encroachment of riparian buffers as observed from high resolution land cover classification maps.

Chapter 8 revisits the study hypotheses in order to integrate the various analyses completed for this dissertation. The chapter discusses both scholarly and practical applications of this research. The dissertation concludes with recommendations for future research to clarify and build upon the results of this study.

CHAPTER 2: EVALUATING PLAN IMPLEMENTATION

2.1 Introduction

Growth patterns over the past 50 years introduced unprecedented amounts of impervious surface into the built environment with direct consequences for water quality. As communities face the continued deterioration of water resources, land use planning offers an essential point of intervention to protect watersheds. This chapter presents a theoretical framework for the evaluation of local land use planning efforts. I focus on two core tasks: 1) establishing the planning process for local land use decisions and 2) examining how state policy, local social-economic factors, and site conditions influence land use outcomes. This framework identifies factors affecting local governments' efforts to protect water resources and slippage points in the implementation process.

The first section reviews several definitions of "planning" that emphasize the importance of outcomes and the role of evaluation in planning. These definitions inform an evaluation logic model—the basis of the project's conceptual model. This section also discusses how differing definitions of planning success complicate the theoretical connections between planning inputs and outcomes. The second section introduces the conceptual model and the key conceptual dimensions associated with the measurement of planning inputs (i.e., plan and ordinance quality), the translation of policy into development applications (i.e., policy slippage), and the enactment of policy in constructed development (i.e., implementation). The third section delves deeper into an approach for overcoming the barriers to collective action to protect common pool resources introduced in Chapter 1—the adoption of planning mandates. This section covers the research literature connecting planning mandates, the creation and quality of plans and policies, and implementation. The chapter concludes with the hypotheses that guide this research.

2.2 What is Planning?

Political scientist, Aaron Wildavsky asserts planning is “the attempt to control the consequences of our actions. The more consequences we control, the more we have succeeded in planning. To use somewhat different language, planning is the ability to control the future by current acts" (Wildavsky, 1973, p. 128). In short, successful planning cannot just be an attempt to influence the future. There must be a discernible impact on the intended objective. Wildavsky is one of the first scholars to highlight the complexity that arises from defining planning as the extent of actual control rather than just an attempt to control the future (1973, p. 130). His incorporation of impact on outcomes into his definition led him to question the value of planning due to the constrained role of the planner in plan or policy implementation and difficulties arising from sociopolitical conditions.

Planning scholar Ernest Alexander acknowledges the complexity resulting from the emphasis on the “promise” of planning opposed to its “performance” (Alexander, 1981, p. 129). He does not, however, concede that achievement of success is dictated by outcomes only.

> Planning is the deliberate social or organisational activity of developing an optimal strategy of future action to achieve a desired set of goals, for solving novel problems in complex contexts, and attended by the power and intention to commit resources and to act as necessary to implement the chosen strategy (1981, p. 131).

Alexander stresses planning is a deliberate activity focused on the future with an <u>intention</u> to implement a strategy to reach a particular outcome. Thus, planning is not just about a measureable impact on the stated goal (outcomes), or the strategies and policies (action), but is also about the intention that guides the decision-making process. Planning theorist Charles Hoch echoes the emphasis on intention in his definition of planning by stating "Planning implies forethought and intention…. If we imagine planning as a kind of forethought, then the regular act of monitoring achievement means remembering the earlier intention as a framework for assessment" (Hoch, 2002). This planning definition is a crucial contribution to planning practice. By aligning the justification for planning with its monitoring, Hoch suggests planning practice must include evaluation[11]. Further, Hoch identifies planning documents as key planning inputs:

> When we produce plan documents we expect people to read them and use the advice to inform and influence their own judgments about the allocation of public resources, the use of property and so forth. Implicit in such sincere and often urgent effort is the belief that planning will improve the quality of the judgments and that these improvements will produce more effective consequences on the use of resources, property or whatever. If we did not expect plans to make a useful difference, why would we make them? (Hoch, 2002).

The justification for planning is its potential to influence action and outcomes. Taken together, the work of Wildavsky, Alexander, and Hoch informs the conceptual framework introduced in the next section by identifying four key concepts: intention, action, outcomes,

[11] In his work, Hoch defines two different approaches to plan evaluation: rationality and pragmatic reasoning. While the rational approach has the benefits of "objectivity and precision", this approach "sacrifices context and continuity" (Hoch, 2002). Hoch advocates for a pragmatic reasoning approach which incorporates context and continuity and does not artificially isolate action from analysis. While I wholeheartedly agree with his call to avoid the pitfalls of over-reliance on rationality and its veneer of objectivity, the rational approach utilized in this study allows for regional-level evaluation, which is an essential strategy for watershed protection.

and impact. Further, Hoch's statements intertwining intention and plan documents help identify a starting point for the evaluation of intention in planning practice.

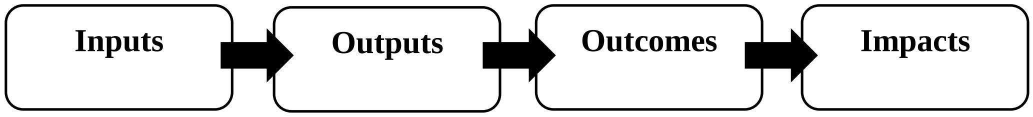
2.3 Evaluating the Public Planning Process

If planning implies intention, then the documents prepared as part of a planning process should reflect some measure of intention in written form (Hoch, 2002). Figure 1.1 in Chapter 1 illustrates the key documents of the land development process and their hypothesized connection with landscape features and water quality outcomes. Although these documents do not capture or express the totality of intentions from the multitude of public and private stakeholders affected by a planning process, they do typify the public planning process (Hopkins, 2001).

2.3.1 An Evaluation Logic Model for Land Use Development

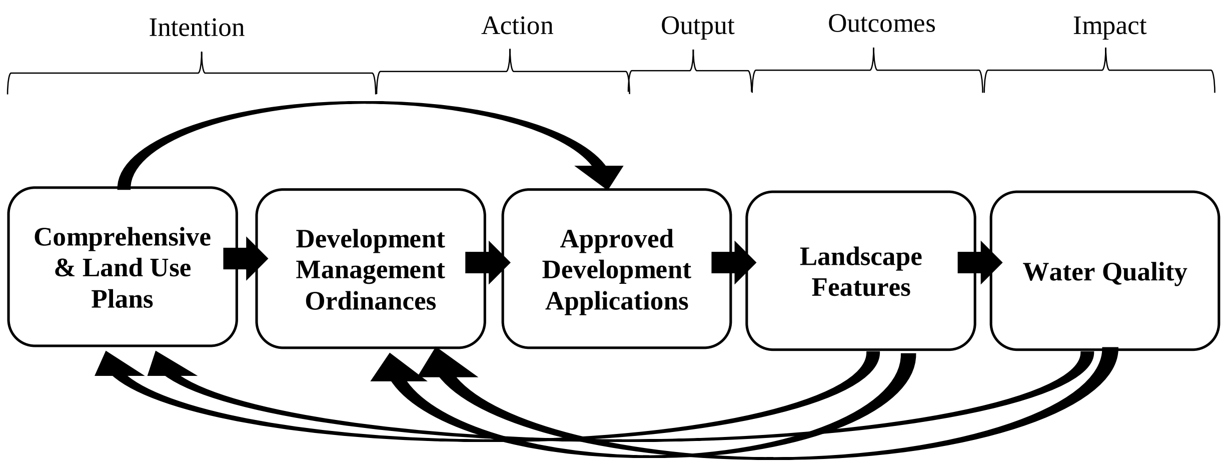
The evaluation logic model is a framework associated with program design, management, and assessment. In its simplified form, it depicts key program concepts and relationships to illustrate the underlying rationale for a program (W. Chen, Cato, & Rainford, 1999; Renger & Titcomb, 2002). *Evaluation: Promise and Performance* by Joseph Wholey is usually cited as the first publication to use the term "logic model" (1979). This model has since been informed by practitioners and evaluation scholars notably the Bennett hierarchy of evidence and the USAID Log Frame (Bennett, 1976; Solem, 1987; United States Agency for International Development, 2000).

Figure 2.1: Traditional Evaluation Logic Model



The traditional model depicted in Figure 2.1 consists of four components: inputs, outputs, outcomes, and impact. Inputs refer to what is invested, the ingredients necessary for the system to do its work. Outputs are what is done, that is, the activities undertaken. Outcomes and Impacts are short and long-term changes and/or benefits that result from the program or policy. Figure 2.2 appends the policy inputs of the land use development introduced in Chapter 1 to the concepts of intention and action from the planning definitions forwarded by Wildavsky, Alexander, and Hoch (Alexander, 1981; Hoch, 2002; Wildavsky, 1973). Although an evaluation logic model is often depicted in a linear form as in the figure above, Figure 2.2 includes a number of feedback loops to better capture the cyclic nature of policy implementation.

Figure 2.2: Adapted Evaluation Logic Model for Land Use Development



Comprehensive plans and ordinances are two key inputs that help govern the development process by spanning the transition from how a jurisdiction plans to develop (intention) to the detailed policies that will govern development (action). Comprehensive plans should provide the overarching framework to guide development. Thus, a comprehensive plan is a suitable place to begin the measurement of a community's intention.

Ordinances can be seen as the documents that operationalize the intention laid out in plans—a bridge between intention and action. Ordinances expound upon the intention articulated in plans and create the boundaries for acceptable action within the development process. The intention contained in comprehensive plans becomes more specific and actionable within ordinances making ordinances another opportunity to evaluate what we intend to do and how we plan to act. For example, a jurisdiction's comprehensive plan may provide an overview of a stormwater best management practices (BMPs) policy to reduce the amount of runoff from new developments. The jurisdiction's ordinance should add specificity to that intention by outlining requirements for the placement, performance, and maintenance of stormwater BMPs.

Approved development applications are at the intersection between these planning inputs and action. Through the development review process, the intention contained in the written regulations, provisions, and incentives of ordinances is transformed into approved changes to the built environment. Approved development applications are the outputs of the development process that shape landscape features (i.e., the land, water, vegetation, structures, and infrastructure that compose a landscape). Landscape features, in turn, affect the ultimate impact of interest for this research—water quality. As discussed in Chapter 1, the linkage between land use and water resources is well documented in the research literature (Alberti, 1999, 2005; Allan, 2004; Center for Watershed Protection, 1998; Dougherty et al., 2006; Girling & Kellett, 2002; Goonetilleke et al., 2005; Greenberg et al., 2003; Hansen et al., 2005; J. Lee & Heaney, 2003; Nassauer et al., 2004; Richards et al., 2006; Shuster et al., 2005; Wear, Turner, & Naiman, 1998; Wickham et al., 2002).

2.3.2 Barriers to Plan Implementation

The previous section described the idealized pathway between key planning inputs and land use outcomes. There are, however, a number of barriers to plan and policy implementation. Shifting sociopolitical circumstances within a community often necessitate modifications to plans and policies, and can diminish the connection between everyday decision-making and the proposed future conditions outlined in plans (Mazmanian & Sabatier, 1983; Wildavsky, 1973). The lack of identifiable stakeholders (or publics) who are interested in particular policy can contribute to ineffective plan implementation as planners end up advocating for proposals that lack local support, trigger opposition, or are irrelevant to local conditions (Burby, 2003; Cobb & Elder, 1972). Finally, a fundamental barrier to implementation is the heterogeneity of definitions of planning, which contributes to difficulty in defining what planning intends to do and what metrics should be used to determine successful implementation. Talen states that defining planning as a process (i.e., "planning implementation") calls for a different conception of success than a definition that incorporates outcomes (i.e., "plan implementation") (1996b). In response to this dilemma, this study opts for the outcome-focused definitions on planning covered in Section 2.2 and explores two approaches to evaluation to help define planning success.

2.3.3 Performance and Conformance-Based Definitions of Planning Success

Oliveira and Pinho produced an excellent review of evaluation in urban planning, which divided the literature into the two dominant evaluation traditions: performance- and conformance-based evaluation (2010). These two approaches for measuring successful implementation differ on the strength of the linkage between planning documents and observed outcomes and impacts. Alexander and Faludi[12] describe the performance-based approach as the examination "of the policy or plan as a frame of reference for operational decisions" such that a plan might be considered successfully implemented if it helped guide the development process (1989, p. 134). Conformance-based evaluation focuses on compliance or consistency with stated policies where implementation is successful if development outcomes closely match the plan.

In performance-based evaluative schemes, the plan is not seen as a blueprint, but as an advising tool where success may be signified by consultation of the plan in the decision-making process (Mastop & Faludi, 1997). The plan may influence action directly through following the plan or indirectly by influencing those who make the final decisions. This position is consistent with Innes' discussion of the multiple ways that information can influence action with more substantial action coming through indirect means (1998). Further, this method recognized uncertainty and makes provisions for departures from the plan if a valid rationale exists (Alexander & Faludi, 1989). The measurement of performance-based evaluation, however, is difficult and often reduced to consultation alone, which means success can be claimed any time the plan is referenced.

Dutch scholars produced the vast majority of the existing research literature on performance-based approaches to plan evaluation with the majority of the papers appearing in a single issue of Environment and Planning B (de Lange, Mastop, & Spit, 1997; Driessen, 1997; Mastop & Faludi, 1997; Mastop & Needham, 1997; Needham, Zwanikken, & Faludi, 1997; van Damme, Galle, Pen-Soetermeer, & Verdaas, 1997). A number of these studies establish the theoretical background of performance-based evaluation approaches and outline

[12] Alexander and Faludi include a third conceptualization: Subjective evaluation that will not be address here.

future areas of research (Mastop & Faludi, 1997; Mastop & Needham, 1997). One study examined if the stakeholders charged with making plans were aware of discrepancies between plans and their implementation (Needham et al., 1997). The remaining papers undertake a performance-based evaluation of some aspect of the planning process. Driessen identifies a set of "policy games" used by a network of stakeholders to influence the implementation of policies contained in spatial plans (Driessen, 1997). He suggested situational rationality and the interdependency between levels of stakeholders precludes a conformance approach (ibid). Another Dutch research team also argue against a conformance-based approach in their study of national planning policies because they believe policies created at this level of government are usually strategic and less likely to have a direct influence on spatial organization (de Lange et al., 1997).

More recent additions to the performance-based evaluation literature continue to clarify how performance evaluation *could* take place (Faludi, 2000, 2006). While the existing literature on performance-based evaluation rightly focuses attention on uncertainty and the necessity of allowing flexibility in the use of a plan, successful implementation is difficult to measure using this definition and "no fully fledged performance study has been completed" (Mastop & Faludi, 1997).

A conformance-based approach to evaluation determines success by the extent of conformity between the intentions expressed in the plan and what is actually implemented. This strong linkage between plan content and action (and the associated straightforward measurement) are the main benefits of this approach. A number of scholars support the use of conformance-based approaches to evaluation because the approach reinforces the linkage between planning and control over future outcomes and is consistent with how planners articulate their role (Alterman & Hill, 1978; Baer, 1997; Calkins, 1979; Laurian, Day, Berke, et al., 2004; Talen, 1996b, 1997). Talen argues that although the level of control attributed to planners by a conformance-based approach is greatly disputed in theory and practice, the profession must retain some desire for direct influence on planning outcomes (1997). The main drawbacks of this approach are its inflexibility, which conflicts with the uncertainty inherent in planning for future conditions. Baer argues a departure from the plan should not, in and of itself, be deemed a failure (1997). Departures are inevitable because plans alone are not sufficient for implementation and the circumstances surrounding decisions shift.

This project combines elements from conformance- and performance-based approaches to evaluation in an effort to address Baer's concerns about inevitable departures from a plan and the justification for those departures. The conformance-based element includes the creation of scoring protocols to reduce the subjectivity of measures while determining the agreement between development management ordinances and approved development applications. The methodology also uses a performance-based approach to focus on the operational decisions of planning staff and development applicants. This approach captures the rationales provided to explain departures from a plan or ordinance through the content analysis of development applications (Forester, 1993; Talen, 1997). The following section adapts the evaluation logic model presented in Figure 2.2 to create the conceptual model that guides this examination of implementation. This model incorporates the comprehensive plans, development management ordinances, and approved development applications associated with land use planning and connects these key policy inputs and outputs to land use outcomes.

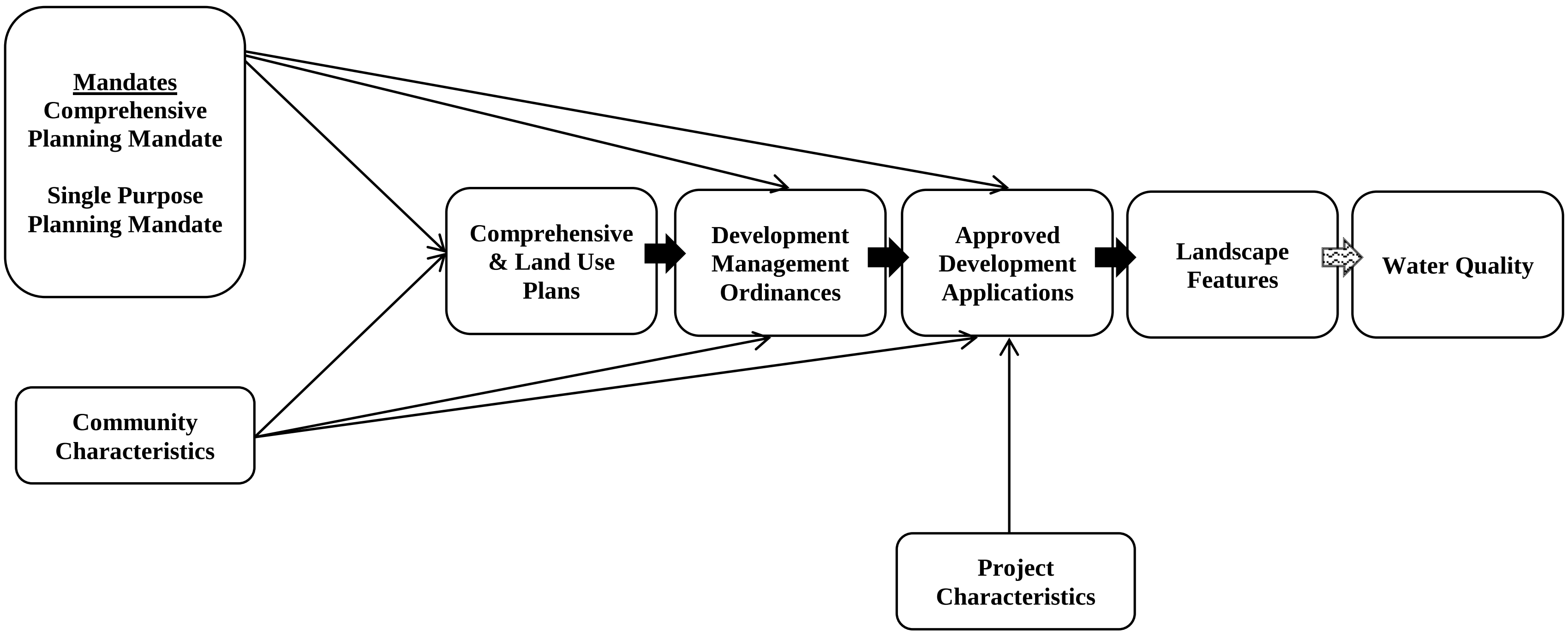
2.4 Conceptual Model

A conceptual model is "a diagram of proposed causal linkages among a set of concepts believed to be related" (Earp & Ennett, 1991). Using boxes and arrows to represent concepts and processes, a conceptual model can use theory and/or empirical evidence to depict the existence and directionality of relationships between concepts (Earp & Ennett, 1991; Glanz, Lewis, & Rimer, 1997). Conceptual models are particularly useful because they focus attention on an endpoint of interest, and, unlike a theory, do not seek to examine an entire causal process (Earp & Ennett, 1991). This project's conceptual model adapts an evaluation logic model for the land use development process. The planning inputs are comprehensive plans and development management ordinances and the planning output of interest is approved development applications. The outcome of interest is modifications to landscape features by one policy in particular—riparian buffers.

A comprehensive plan that incorporates policies to protect water resources should help a community adapt to changing conditions while providing a vision of how a community wants to develop in the future. In turn, comprehensive plans should guide the adoption of ordinances. As a result, a community with a comprehensive plan that integrates water quality protection goals, detailed information on drinking water, waste water, and stormwater, and specific policies aimed at protecting water resources should be more likely to have ordinances that reflect that commitment to water resource protection. Additionally, a community's riparian buffer policy should guide the approval of development applications that are consistent with the ordinances and observed riparian buffers should be consistent with approved development applications.

Figure 2.3 depicts the relationships among comprehensive plans, development management ordinances, approved development applications, landscape features, and water quality. The unshaded arrow between landscape features and water quality delineated a relationship that is beyond the scope of this research. Additionally, the model includes three sets of variables (mandates, community characteristics, project characteristics) that past research suggest may influence implementation.

Figure 2.3: Conceptual Model



2.4.1 Comprehensive and Plan Quality

For water resource protection, the process of creating a comprehensive plan offers an opportunity to set goals for environmental protection and assemble information about future water use projections and current threats to water quality such as nonpoint source pollution. The planning process can help reconcile competing objectives such as increasing the economic tax base while maintaining low-density development in environmentally sensitive portions of watersheds. A plan that pays careful attention to the use and protection of water resources can guide development and help a community adapt to shifting conditions.

A number of planning scholars contributed to the creation of a set of principles to differentiate between plans based on their quality (Baer, 1997; Berke, Godschalk, et al., 2006; Kaiser & Davies, 1999; Kaiser et al., 1995). Theoretically, these principles ensure the inclusion of goals, information, policy solutions, clear strategies for implementation and monitoring, and the representation of a diverse set of stakeholders in the plan-making process. In 2009, Berke and Godschalk published a meta-analysis of existing plan quality studies and identified a widely used set of plan quality principles: issue identification, goals, fact base, policy framework, implementation, monitoring and evaluation, and internal consistency[13] (Berke & Godschalk, 2009). Other studies incorporated participation as a key principle to measure plan quality and the principle appears in key land use planning textbooks (Berke, Ericksen, Crawford, & Dixon, 2002; Berke et al., 2013; Berke, Godschalk, et al., 2006; Burby, 2003). In particular, the addition of participation is supported by an analysis of 60 plans in Florida and Washington that found plan-making processes with

[13] The term *internal consistency* was used in this context to denote how well the six plan quality principles (i.e., goals, fact base, policy framework, implementation, monitoring and evaluation) are integrated within a single plan.

greater stakeholder involvement were associated with higher quality comprehensive plans and that the proposals made in these plans were more likely to be implemented (Burby, 2003).

Various combinations of these principles have been used to evaluate plan quality with respect to ecosystems, natural hazards, and smart growth (Berke et al., 1999; Berke & French, 1994; Dalton & Burby, 1994). A subset of the research links the quality of plans with implementation and outcomes. Work by Nelson and French found an association between higher quality plans and a reduction in damage from the 1994 Northridge earthquake (2002). Brody and Highfield measured plan implementation by comparing the original land use design in plans to actual development over a 10 year period and found mixed results relating plan quality and protection of wetlands in Florida (2005). A selection of policies, sanctions, and monitoring were associated with conformity with plan content aimed at protecting wetlands (ibid). Berke and colleagues found when implementation is conceptualized as conformance with stated policies, higher quality of plans improved implementation (Berke, Backhurst, et al., 2006).

Drawing on the growing body of plan quality research, this study identified seven plan quality principles for inclusion: Goals, Fact Base, Policy Framework, Implementation, Monitoring, Inter-Jurisdictional Coordination, and Participation. Berke and colleagues recently organized these seven plan quality principles into direction-setting principles (Goals, Fact Base, Policy Framework) and action-oriented principles (Implementation, Monitoring, Inter-jurisdictional Coordination, Participation) (Berke, Smith, & Lyles, 2012; Berke et al., 2013). This conceptual reorganization emphasizes the dual purposes of a plan: to set a course of action and to facilitate the implementation of the plan (Lyles et al., 2014). Although the creation of a plan is a laudable goal unto itself, failure to execute the plan diminishes its utility.

<u>Direction–setting plan quality principles</u>

1) **Goals** should be the result of a consensus-building process about future conditions where competing interests about how the community should look and function are reconciled by a diverse group of stakeholders.

2) A **fact base** assembles information about the current state of the community and provides future projections with the purpose of creating a realistic pathway to the community's goals.

3) **Policy framework** outlines the strategies necessary to realize the community's goals using the information gathered in the fact base.

<u>Action-oriented plan quality principles</u>

4) **Implementation** includes steps like the assignment of responsibility and the allocation of the time and resources necessary to move a plan from a document into action.

5) **Monitoring** involves the on-going review of implementation and achievement of community goals. Through monitoring, a plan can incorporate new information and adapt to changing conditions.

6) **Inter-jurisdictional coordination** acknowledges the interconnectedness of space, particularly of land use and environmental resources. The decisions made by one community inevitably influence its neighbors, and jurisdictions should strive to create collaborative systems to communicate and coordinate planning activities.

7) **Participation** emphasizes the unique strengths and challenges faced by stakeholders and interest groups within a community, and details the efforts made to involve and respect the input from all sectors of society.

2.4.2 Development Management Ordinances and Ordinance Quality

Ordinances are the legislative tools used to implement the policies set out in plans. They contain the specific standards governing the location and design of development and describe the review processes necessary to gain approval. Jurisdictions can require the individual or group seeking approval to provide detailed information about the existing conditions of the site, proposed construction, how the development will adhere to development standards, and the possible impact on the surrounding area.

Similar to plan quality, the hypothesized link between ordinance quality and development is that better quality ordinances will be associated with better quality development. Unfortunately, few studies explore the role of ordinances in implementation. This linkage, however, is a key intervening step between comprehensive plans and development applications.

A study of 15 Sacramento parking lots for compliance with a parking lot shading ordinance found average shading levels of 22%, which is below the 50% level stipulated in the ordinance (McPherson, 2001). Content analysis of zoning codes for a census of cities, towns, and townships in a single Michigan county found a division between urban and rural jurisdictions with urban areas focusing more on land use and form, infrastructure, housing, community character/environment than rural jurisdictions (Norton, 2008). Hill, Dorfman, and Kramer investigated the impact of land use policies (including a tree ordinance) on tree canopy coverage in the Atlanta MSA using a survey of key informants (2010). The existence of a tree ordinance did not have a statistical significance effect on tree canopy at the 0.05 level, but each additional ordinance clause resulted in a 1.03% increase in county land area covered with tree canopy at the end of the ten-year period. Stevens and Hanschka's recent study found that despite government guidelines encouraging the adoption of flood bylaws, roughly 66% of the jurisdictions failed to adopt a flood bylaw or include flood risk management provisions within their zoning bylaws (Stevens & Hanschka, 2014). These studies suggest government guidance does not necessarily result in local ordinance adoption;

compliance with ordinances is not consistent; the content of codes can differ based on spatial characteristics; and content can be associated with different implementation outcomes. These findings support my investigation of compliance with ordinance provisions in different geographic locations with a focus on implementation and the influences of mandates.

This study uses a set of eight principles developed from the planning research literature, the concept of street-level bureaucracy, and planning practitioner resources (Alterman & Hill, 1978; Kelly, 1988; Lerable, 1995; Lipsky, 1980; Stevens & Berke, 2008). The ordinance quality principles are Goals, Fact Base, Policy Description, Policy Restrictions, Policy Flexibility, Monitoring and Enforcement, Complexity, and Discretion. The first three principles are corollaries to the direction-setting plan quality principles. The ordinance Goals principle runs parallel to the plan quality goal principle as it reaffirms the goals set out by the comprehensive plan. The Fact Base principle focuses on the type and specificity of the information required of the development applicant and differentiates between different levels of information using the research literature and model ordinances. The Policy Description principle outlines the ordinance policies and under what circumstances policies are applicable. The fourth principle, Policy Restrictions, draws on professional reports aimed at improving ordinances and their enforcement. It incorporates the necessity of clear communication of the constraints placed on policy actions (Kelly, 1988; Lerable, 1995). These four principles make up the Policy Content conceptual framework.

Policy Content ordinance quality principles

1) **Goals** reaffirm the comprehensive plan's goals to capture the important linkage the plan and the ordinance and includes objectives for key administrative actions necessary for implementation.

2) **Fact Base** identifies the informational inputs required by the policy including acceptable sources of data and processes to resolve disputes over data interpretation.

3) **Policy Description** explains the provisions and regulations of a policy including the specific circumstances under which particular parameters are applicable.

4) **Policy Restrictions** described the conditions under which there are constraints or specific limitations placed on the policy.

The next four ordinance quality principles focus on the review process: Policy Flexibility, Complexity, Monitoring and Enforcement, and Discretion. These four ordinance quality principles make up the Administrative Framework. In an early contribution to the plan implementation literature, Alterman and Hill included the degree of flexibility and the rationale, if any, provided for changes in the permits prior to final approval. They found deviations from the land use plan were affected by the complexity of the development review process, the degree of flexibility, the political influence of the developer, and market influences (1978).

Policy Flexibility covers how ordinances account for circumstances leading to departures from ordinance provisions and/or allow for unique solutions. This principle reflects the necessary inclusion of flexibility advocated for by a number of planning scholars (Alexander & Faludi, 1989; Baer, 1997; Mastop & Faludi, 1997). The Complexity principle focuses on the intricacies of policy administration that arise from the provisions included under Fact Base, Policy Description, and Policy Restrictions and is a concept explored by Brotherton in his study of permit quality (1992). The Monitoring and Enforcement principle outlines the ongoing process to oversee and manage the actions and practices stipulated by the ordinance and is a concept at the core of plan implementation and evaluation literature (Baer, 1997; Calkins, 1979).

Administration ordinance quality principles

5) **Policy Flexibility** refers to deviations from policy provisions that allow for adaptation to different circumstances including variances or incentive policies.

6) **Complexity** is a measure of the difficulty of administering a particular policy by gauging the effort necessary to navigate overlapping provisions and intensive data demands.

7) **Monitoring and Enforcement** includes the on-going process to oversee and manage the actions and practices stipulated by a policy.

The remaining Administration principle is based on the theory of street-level bureaucracy, a framework examining the actions of the public agencies and employees charged with the implementation of policy (Lipsky, 1980). Street-level bureaucrats are public agency employees who often possess specialized knowledge, interpret imprecise provisions, and actually perform the actions that implement laws. As a result, street-level bureaucrats have discretion in how policies are implemented. This framework informed the inclusion of the ordinance quality principle Discretion, which refers to the level of control staff members retain in interpreting and altering ordinance provisions.

8) **Discretion** refers to instances where staff charged with policy implementation can make an interpretation or judgment.

2.4.3 Approved Development Applications and Policy Slippage

Approved development applications link the prevailing policies of a community to the development that is actually approved by planning staff, and represent a potential slippage point between ordinance provisions and approved development. A community may have a high quality plan, may convert that plan successfully into high quality ordinances, but development may still negatively impact water quality if, for example, approved applications regularly grant variances or ignore or incorrectly interpret ordinance provisions.

Alterman and Hill examined development applications and found that 66% of the approved applications were in accordance with the land use plan, which demonstrates an interesting mixture of both adherence and deviation (1978). A number of studies in New Zealand also investigated development applications (Backhurst et al., 2002; Berke, Backhurst, et al., 2006; Laurian, Day, Backhurst, et al., 2004). Backhurst and colleagues investigated plan quality with respect to sustainable development using development applications (known as resource consents in New Zealand) from 6 districts to examine whether the quality of a plan affected implementation as measured by the inclusion of stormwater techniques and the project's effect on urban amenities (2002). The authors found a high level of variability in the quality of information required for applications, minimal public involvement in the development review process, little evidence of monitoring, and a bias towards more conservative techniques versus best practices. Within the same study, Berke and colleagues examined development review processes and found the conception of plan success (conformance or performance) influenced the impact of plan quality (2006). When plan conformance was measured by the percentage of low impact design policies specified in the plan that also appear in an approved application, higher quality plans improved implementation. Research by Laurian and colleagues used implementation breadth (the percentage of total policies mentioned at least once in a sample of approved applications) and depth (the percentage of total policies mentioned in each individual approved application) to measure implementation and found moderate to high scores (54-100%) for implementation breadth and low scores for implementation depth (<18%) (2004).

Within the United States, development applications have also been the focus of conformance-based evaluations. Brody, Highfield, and Thornton studied all available state and federal permits altering wetlands in Florida between 1993 and 2002 and found an average conformance scores of 0.21 (on a scale of 0 to 1) for wetland development and the spatial intent of plans (2006).

The focus on a single policy (riparian buffers) for this research precluded the use of breadth or depth to measure implementation. Instead, this project uses a measurement of policy slippage that combines negative and affirmative slippage as described by Farber (1999). Negative slippage refers to unsanctioned deviations from a policy while affirmative slippage is associated with deviations from policy that are openly renegotiated. The following eight topic areas organize the comparison between ordinance policies and approved development applications to enable the examination of policy slippage.

1) **Policy Description** denotes the essential provisions of the ordinance with respect to a particular policy.
2) **Allowable Uses/Restricted Uses** captures both the allowable uses on a particular development site in addition to restricted uses.
3) **Exemptions/Exceptions** contains references to exemptions or exceptions applicable to this particular development.
4) **Site Design** includes descriptions of the approved site design in addition to process elements such as construction sequencing, scheduling, and other project management tasks.
5) **Maps/Plans** covers the depiction of policy elements on physical maps or plans associated with the development site.
6) **Variances** include any requested departures from regulations contained in the ordinance with respect to a particular policy.
7) **Monitoring and Enforcement** refers to inspections or monitoring associated with a development in addition to any details about enforcement activities.

8) **Rationale** provides the justification, if any, provided for differences between applicable ordinance policies and the provisions approved in development. This indicator acts as a modifier code, which means it concurs with other topic areas.

2.4.4 Landscape Features and Implementation

Although this project does not directly link particular land use developments to pollutant loading or the amount of stormwater runoff generated, it does seek to link comprehensive plans, ordinances, and development applications to changes in landscape features (i.e., the land, water, vegetation, and structures that compose a landscape). There are a number of studies that utilized aerial photography, land cover classification maps, and geographic information systems (GIS) to investigate the relationship between land use development policies and observed patterns of development. Talen's 1996 study investigated whether park facilities were actually developed and located according to the 1966 plan (Talen, 1996a). This study utilized a flexible definition of implementation where conformance was not defined as an exact match to the location within the 1966 plan. Instead, successful plan implementation was defined as a park location that met the same accessibility and socioeconomic characteristics of the proposed 1966 park locations. Unfortunately, park access and equity of park placement in 1990 was not consistent with the 1966 plan. Ozawa and Yeakley investigated the loss of riparian vegetation under three different development policies using high-resolution land cover maps (2007). Although they could not ultimately determine the effectiveness of the different policy regimes, they did find that 1) the different regulatory strategies made a difference in vegetation loss, 2) vegetation loss increased with distances from streams, and 3) large, discrete projects accounted for a high percentage of the vegetation loss.

Two studies used GIS to investigate the conformity of observed land use patterns with maps (Chapin et al., 2008; Loh, 2011). Loh's study used GIS and case study research to create a typology of nonconformity—Type A (nonconformity due to succession), Type B (nonconformity due to succession and grandfathered uses), Type C (nonconformity due to directly contradictory land use decisions) (2011). Chapin and colleagues also used GIS to conduct a parcel level assessment of land use changes, which allowed for an examination of the relationship between comprehensive plan approval and land use changes (Chapin et al., 2008). They found substantial new development in coastal hazard zones in Okalossa County, Florida despite the existence of a state mandate aimed at limiting such development.

The landscape features of interest for this study are riparian buffers, the vegetated zones adjacent to streams and wetlands. The research on optimal design and functioning for riparian buffers informed the use of this three parameters in this study: buffer width, vegetative target, and impervious surface encroachment. There are numerous research studies to support buffer width as an important factor affecting a buffer's potential role in pollutant removal, water temperature moderation, bank stabilization, and habitat provision (Mayer et al., 2005; Phillips, 1989; Vidon & Hill, 2004). There are also many studies examining how the type and amount of vegetation determines the filtering capacity of buffers (Center for Watershed Protection & Schueler, 1995; Pickett et al., 2001; Sweeney, 1992). For this study, implementation is investigated by identifying differences between the buffer provisions contained in approved development applications and observations made of landscape features using high resolution land cover classification maps.

1) **Buffer width** is the width described in an approved development application and is used to delineate an area for observation.

2) **Vegetative Target** indicates percentages of various vegetative covers including coarse vegetation such as tree cover, fine vegetation such as grass, or the absence of vegetation (i.e., bare earth) observed within the approved buffer width.

3) **Impervious Surface Encroachment** signals the presence (and percentage) of impervious surface within the buffer excluding any surfaces explicitly approved in development application.

2.5 Linking State Mandates to Better Land Use Outcomes

Many states choose to use mandates to address the barriers to collective action discussed in Chapter 1 (Berke et al., 1996; Berke, 1998; Brody, Highfield, et al., 2006; Burby & Dalton, 1994; Burby, 2005; Burby et al., 1993; Dalton & Burby, 1994; Hoch, 2007a; May & Burby, 1996; May & Williams, 1986). A well-designed mandate can affect the level of priority afforded a particular issue; substitute for local factors that induce local planners and politicians to take action; address strong opposition to planning efforts; and help close the gap between awareness and priorities (Berke et al., 1996; Berke, 1998; Burby et al., 1997; May, 1991). In addition to the potential effect of mandates on the sociopolitical factors embedded within the policy making process, there is a growing body of research exploring the relationships among planning mandates, better planning inputs, and land use outcomes. A number of studies conclude that jurisdictions in states with mandates were more likely to have higher quality plans than jurisdictions in states without mandates (Berke & French, 1994; Berke et al., 1996; Burby, 2005; Burby et al., 1997; Dalton & Burby, 1994). Both the presence of plans and higher quality plans are, in turn, associated with more stringent risk reduction provisions in development regulations and lower losses from disasters (Burby, 2005; Burby et al., 1997).

Despite the linkage with positive planning outcomes, local governments remain hesitant to adhere to state mandates without some form of coercive action. In one study, the mandated elements were ignored in their entirety (Wyner & Mann, 1986). In other cases, mandates result in plan adoption, but were not associated with more effective policies or better implementation as governments fulfilled only the bare minimum required by the law (Berke & Beatley, 1992; May & Birkland, 1994). Dalton and Burby found that although land use plans effectively limited development in hazardous areas, local governments were unlikely to adopt plans unless mandates were actively monitored and enforced (1994). Berke and colleagues found mandates improved the quality of plans (i.e., stronger fact base, goals and policies), but that plan quality varied by mandate design (1996). In short, the adoption of a state mandate is not sufficient condition to compel better local planning outcomes. Instead, a growing body of research highlights the important relationship between the scope and design of mandates and their effectiveness.

2.5.1 State Mandate Scope: Single Purpose versus Comprehensive Approaches

Scope refers to the breadth of topics covered by a mandate. For example, a comprehensive mandate may encompass a variety of topics included housing, transportation, and environmental protection while a single purpose mandate may focus on a specific element such as hazard mitigation. Popper (1988) and Kusler (1980) considered single purpose mandates to be more politically feasible and as effective as comprehensive mandates, which are more general in their purpose and, perhaps, more difficult to enforce. Others argue comprehensive planning mandates can incorporate “bottom-up” approaches that “inject statewide interests…while recognizing the legitimacy of local concerns” (Berke, 1998, p. 82). Engagement of local governments can help overcome barriers to the implementation of mandates by foregoing overly prescriptive mandates and avoiding intergovernmental conflict (Innes, 1992; Lowry, 1985).

In 1993, Burby and colleagues concluded that comprehensive mandates are more effective than single purpose mandates (1993). This finding, however, was refined by Dalton and Burby's study of 176 communities, which found comprehensive planning mandates improved coordination and strongly influenced plan quality while single purpose mandates were associated with stronger development management programs (Dalton & Burby, 1994). The authors argue there is a role for both types of mandates in improving the achievement of planning objectives. This study investigates both the impact of comprehensive planning mandates on plan quality and the influence of single-purpose mandates on development management ordinances.

1) **Comprehensive Planning Mandate** refers to the presence of a state mandate to adopt a comprehensive plan. The comprehensive planning mandate is characterized by its complexity, implementation style, and the inclusion of capacity and commitment building provisions.

2) **Single Purpose Mandate** also uses mandate complexity, implementation style, and the inclusion of capacity and commitment building provisions to differentiate between two different single purpose mandates aimed at protecting environmentally sensitive areas.

2.5.2 State Mandate Design: Impact on Implementation

Past research on mandate design identified a number of features that communicate the importance of the legislation and support its implementation by signaling intent, shaping agency actions, and providing incentives for action (Burby et al., 1997, p. 80). In particular, mandate complexity, the capacity- and commitment- building features authorized by the legislation, and implementation style (specifically the use of persuasive means) are the key elements influencing implementation.

Mandate complexity refers to the range of policy objectives included within a mandate, the clarity of mandate goals, and the consistency between the mandate intent and the implementation elements. Berke and colleagues found the clarity of mandate provisions had direct and indirect impacts on the quality of plans as the understanding of the mandates was associated with 1) the uptake of those intentions in plans and 2) the assignment of more staff for plan preparation (Berke et al., 1999). Burby and colleagues found the complexity of mandates, long considered to be a barrier to implementation, could be overcome with provisions to build local commitment and capacity (Burby et al., 1993). The authors concluded simplicity in mandate construction should be less of a concern than providing financial and technical assistance, which communicated the state's commitment to and expectations for implementation.

Local commitment refers to the willingness of a jurisdiction to take action to reach a shared goal while local capacity refers to the ability of a jurisdiction to take action (Burby & May, 1998; Dalton & Burby, 1994; May & Williams, 1986). Mandates including commitment-building provisions such as public and local government awareness elements, financial resources, authority for citizen suits to force compliance, evaluation and monitoring elements, and authority for preemptive state action were associated with higher quality plans. Provisions that build local capacity such as technical assistance, education and training opportunities, funding for personnel and equipment, and authorization for local fees and taxes tended to promote compliance with mandates and are associated with higher quality plans.

Implementation style is the approach state agencies take in working with local governments and can be defined as a continuum ranging from informal, cooperative styles to more formal, legalistic styles. It also includes the authorization or requirement to use persuasive tools to ensure compliance including coercive approaches (i.e., monitoring and the application of sanctions) or incentive-based tools such as financial and technical assistance. Berke, Dixon, and Erikson explored how different implementation styles influence plan quality by comparing environmental plans from New Zealand (a cooperative approach with greater flexibility and discretion) to Florida (a more coercive approach emphasizing both technical capacity building and financial support) (1997). The New Zealand plans included stronger goals and reflected more political will behind implementation while the Florida plans included a better fact base, stronger regulatory policy framework, and implementation efforts that focused on deterrence compliance (i.e., adherence to the law) versus normative compliance (i.e., adherence because it is consistent with internalized values) (Berke et al., 1997; Burby et al., 1993).

1) **Mandate Complexity** refers to the clarity of mandate goals, the clarity of policy objectives guiding particular actions, and the complexity of implementing the mandate.

2) **Capacity-Building Features** focus on increasing the ability of a jurisdiction to take action to implement a mandate and may include the provision of technical and financial assistance.

3) **Commitment-Building Features** center on the willingness of a jurisdiction to take action and may include the provision of incentive funding, deadlines, state oversight, and sanctions.

4) **Implementation Style** refers to the enforcement approach state agencies take in working with local governments and ranges from formal, legalistic enforcement styles to flexible, accommodating approaches.

Based on this body of research, jurisdictions subject to mandates are more likely to have plans with a stronger fact bases, goals, and policies. With mandates in place, local governments adopt stronger development management programs and, within hazard mitigation, experience better planning outcomes (e.g., reduction in hazard losses). The adoption of a mandate, however, is not universally associated with better planning outcomes. Instead, the scope of the mandate (comprehensive versus single purpose) and mandate design features such as complexity, implementation style, and the inclusion of capacity- and commitment-building provisions are important considerations.

Currently, there are no studies comparing the effect of comprehensive or single purpose mandates on water resource protection. This study includes an investigation of 1) the presence of a comprehensive planning mandate on plan quality and 2) the influence of single-purpose mandates on ordinance quality. Both investigations focus on how the design of mandates affects the quality of planning inputs.

2.5.3 Community and Project Variables

Planning inputs are a necessary but insufficient component of an evaluation of the development process because the implementation of policies occurs within a complex sociopolitcal environment. It is important to investigate the contextual factors that may help explain variation in the quality of these inputs and in implementation. The study includes population size, population density, growth rates, and median housing values, which other studies have identified as variables with an impact on planning inputs (Alterman & Hill, 1978; Berke et al., 1999, 1996; Berke, Backhurst, et al., 2006; Brody et al., 2004; Brody, 2003a; Burby, 2003). Socioeconomic factors such larger population size and greater community wealth (measured by median housing value) have each been associated with higher quality comprehensive plans although this relationship is not consistent across all studies (Berke et al., 1999, 1996; Berke, Backhurst, et al., 2006; Brody, 2003a; Dalton & Burby, 1994). Both population size and community wealth are hypothesized to work through planning capacity (i.e., staff, financial resources, and expertise). Thus, though an inadequate measure of capacity, this study also includes the number of planning staff per 1000 residents. Population density and growth rates are used as proxies for land availability and development pressure. Although there is some evidence that higher population density and higher growth rates are associated with lower quality plans and more deviation from the plan during implementation, the findings are inconsistent across studies (Alterman & Hill, 1978; Berke et al., 1996; Brody, 2003a; Burby, 2003; Dalton & Burby, 1994).

The study also explores the possible effects of six project characteristics on implementation. Three variables focus on the configuration and use of the parcel: parcel size, land use type, and the percentage of the parcel covered by the buffer. Two variables center on whether the parcel is a part of a larger development: 1) a dummy variable about whether or not the development was part of a multiple lot development and 2) if so, the overall size (in acres) of the development. Finally, there is also an image lag variable to determine the time between when the first structure in a development was built and the year of the base image used to create the land cover classification map.

1) **Community Characteristics** includes population size, growth rates, population density, median housing value, and number of planning staff.

2) **Project Characteristics** includes parcel size, land use type, the percentage of the parcel covered by the buffer, subdivision/PUD, development size, and image age.

2.6 Hypotheses

The conceptual model depicted in Figure 2.3 describes the relationships of interest for this study. The following numbered statements outline the research questions (RQ) and the associated hypotheses (H) under these research questions.

RQ1: Do jurisdictions in a state with a mandate for comprehensive planning have higher quality comprehensive plans with respect to water resource protection than jurisdictions in a state without a mandate?

> H1: Jurisdictions in a state with a mandate for comprehensive planning have higher quality comprehensive plans with respect to water resource protection than jurisdictions in a state without a mandate.

RQ2: Does the design of a single purpose state mandate (i.e., complexity, inclusion of capacity- and commitment-building elements, and implementation style) adopted to protect environmentally sensitive areas affect the quality of buffer protection provisions within development management ordinances?

> H2: Jurisdictions in a state with a mandate with design features that support implementation have higher quality buffer protection provisions within their development management ordinances than jurisdictions in a state with a mandate with fewer supportive design features.

RQ3: How frequently does policy slippage occur between the riparian buffer policies outlined within development management ordinances and the provisions of approved development applications?

H3a: Policy slippage between riparian buffer policies found in development management ordinances and the buffer provisions approved in development applications occurs more frequently in jurisdictions with lower plan quality scores.

H3b: Policy slippage between riparian buffer policies found in development management ordinances and the buffer provisions approved in development applications occurs more frequently in jurisdictions with lower ordinance quality scores.

H3c: Policy slippage between riparian buffer policies found in development management ordinances and the buffer provisions approved in development applications occurs more frequently in jurisdictions in a state without a mandate for comprehensive planning compared to jurisdictions in a state with a mandate.

H3d: Policy slippage between riparian buffer policies found in development management ordinances and the buffer provisions approved in development applications occurs more frequently in jurisdictions in a state with a mandate that includes fewer supportive design features than jurisdictions in a state with a mandate with more design features supportive of implementation.

RQ4: Does the quality of policy inputs, the presence of mandates, and local context explain variation in policy slippage?

H4: Higher quality policy inputs (i.e., comprehensive plans and development management ordinances) are associated with less frequent policy slippage controlling for local contextual factors and the presence and design of mandates.

RQ5: Does the quality of policy inputs, the presence of mandates, and local context explain variation in implementation?

H5: Higher quality policy inputs (i.e., comprehensive plans and development management ordinances) are associated with better implementation outcomes controlling for local contextual factors and the presence and design of mandates.

2.8 Conclusion

The objective of this research is to investigate the implementation of policies that can influence water quality. First, this chapter established the key planning inputs and outputs of the local land use planning process: comprehensive plans, development management ordinances, and approved development applications. These planning inputs and outputs form the backbone of the conceptual model. Next, the chapter examined how state policy, local socioeconomic factors, and project conditions influence the land use decision-making process. Mandates are a common intervention meant to alter local policy development and implementation. Community and project variables help establish the context in which many planning decisions take place. Together, this conceptual framework identifies possible factors affecting local governments' protection of water resources and slippage points in the implementation process. Using the conceptual model as the foundation for inquiry, Chapter 3 describes the research design and methods used to test the hypotheses stated in section 2.6 of this chapter.

CHAPTER 3: RESEARCH DESIGN & METHODS

3.1 Introduction

The chapter begins with a discussion of the study's research design and its connection to the emerging field of theory-driven evaluation. It then introduces the site selection process and the research methods used for this study. The section on research methods is divided into two parts that cover the investigation of 1) the quality of policy inputs—comprehensive plans and development management ordinances and 2) the implementation of riparian buffer policies. These sections detail the data collection process for the key policy inputs and covers the content analyses, map-based measurements, and statistical techniques used in this project. The final section of this chapter discusses the possible threats to validity for this particular research project.

3.2 Research Design

In order to investigate the relationships illustrated in the conceptual model, this study utilizes a cross-sectional, two group, post-test only evaluation research design (Shadish, Cook, & Campbell, 2002; Singleton & Straits, 1999). This quasi-experimental design compares a cross-section of the policy inputs and implementation efforts of two nonequivalent groups. The post-test utilizes a normative implementation environment-impact evaluation, which is a composite of a normative implementation environment evaluation and an impact evaluation (H.-T. Chen, 1990). By attaching theory-driven evaluation strategies to a traditional input-output model of evaluation, this project seeks to address criticisms that evaluation studies lack a firm grounding in theory.

A normative implementation environment evaluation is built upon implementation environment theory, which examines “the nature of the contextual environment within which the program should be implemented” (H.-T. Chen, 1990, p. 51). For this study, the implementation environment is each jurisdiction’s land use development process. The investigation of plan quality, ordinance quality, and the inclusion of community and project variables help to delineate the environment in which policy implementation takes place. An impact evaluation focuses on the effectiveness of a program or strategy—the relationship between the treatment and the outcome. In this study, the treatments are comprehensive planning mandates and single purpose mandates for environmentally sensitive areas. The outcome is observed alterations to the landscape features associated with riparian buffers. The next section details the selection process for the two groups (i.e., watersheds) included in the study.

3.3 Site Selection

A two stage site selection process identified the two nonequivalent groups compared in this study. First, mandates are an important variable of interest so two states with differing state policy regimes around land use planning and water resource protection were selected. Then, I selected two watersheds within these states with similar impairment histories and demographic profiles.

As described in Chapters 1 and 2, a number of factors affect the planning process as defined by comprehensive plans, development management ordinances, and approved development applications. Mandates are one strategy utilized to overcome barriers to the protection of common pool resources. The selection of Maryland and North Carolina provided an opportunity to compare two different state policy regimes around land use planning and water resource protection. While both states enable local jurisdiction to create comprehensive plans, only Maryland has a comprehensive planning mandate (e.g., Articles 66B, 25A, and 28 of the Maryland Annotated Code and the Economic Growth, Resource Protection, and Planning Act of 1992). Additionally, although both states have legislative mandates with provisions for riparian buffer policies (Maryland—Chesapeake Bay Critical Area Protection Act and the Maryland Nontidal Wetlands Protection Act of 1989; North Carolina—Water Supply Protection Act of 1989), the mandates differ with respect to their design. In order to characterize state mandates based on their design, this study adapted measurements used by Burby, May and colleagues for four key design features—complexity, implementation style, and the inclusion of commitment- and capacity-building provisions of mandates (1997). The following sections introduce each concept and the methods used to measure them. Table 3.1 operationalizes the four concepts based solely on the coding[14] of the legislative provisions (Burby et al., 1997).

[14] The original study included interviews with state agency personnel.

Table 3.1: Mandate Design Features

Design Features	Indicators
Mandate Complexity	
Mandate goal clarity	• Number of goals • Vagueness • Complexity • Directness • Specificity
Policy objective clarity	• Number of policy objectives • Vagueness • Complexity • Directness • Specificity
Implementation complexity	• State organizational arrangements • Intergovernmental arrangements • Number of state agencies involved • Frequency of mandated local actions • Deadlines for local action
Capacity-building	• State-provided technical assistance • State-funded mapping/other information • State-provided education or training • State funding for personnel or equipment • Authorization for new local fees or taxing authority
Commitment-building	• Incentive funding for local governments • Matching funding for local participation • Authorization for citizen suits • Review or evaluation of local regulations • Deadlines for local government action • Sanctions for failure to meet deadlines • Sanctions for failure to comply • State pre-emption of local authority
Implementation Style	• Presence of sanctions • Approved enforcement methods • Form of compliance monitoring • Discretion in interpretation of administrative rules

Adapted from (Burby et al., 1997, pp. 162–164)

Mandate Complexity. For this study, mandate complexity refers to the clarity of mandate goals, the clarity of policy objectives guiding particular actions, and the complexity of implementing the mandate. Both Goal Clarity and Policy Objective Clarity were measured using similar approaches. Six variables were rated on a three-point scale[15]. The ends of the scales were defined using the same scale as the 1997 study: number of goals (many to few), vagueness (vague to specific), complexity (complex to simple), directness (undirected to directed), and specificity (broad to narrow). The scales are organized such that higher scores indicate mandates with clearer goals or clearer policy objectives. Five indicators measured on a three-point scale were used to operationalize the variable of implementation complexity. These indicators include the number of state agencies involved in implementation; state and intergovernmental arrangements necessary to implement the mandate; the frequency of mandates actions; and presence of deadlines for local action. Higher scores on these indicators denote greater complexity for implementation.

Capacity-Building and Commitment-Building Features. Capacity-building features focus on increasing the ability of a jurisdiction to take action and commitment-building features build the willingness of a jurisdiction to take action. Five indicators were used to operationalize the capacity-building variable while eight indicators were used to operationalize the commitment-building variable. All capacity- and commitment-building indicators listed in Table 3.1 were measured on a three-point scale such that a higher score corresponds to stronger mandate provisions to develop the capacity and commitment of local jurisdictions.

[15] The goal rating in the 1997 study used a seven-point scale (Burby et al., 1997, pp. 162–164). This study opted for a three point scale to remain consistent with scales used for other categories.

Implementation Style. Implementation style refers to the approach state agencies take in working with local governments. Ideally, this variable would be measured using interviews with state personnel and local jurisdictions, but that approach outstripped the resources of this study. Instead, the indicators described by Burby, May and colleagues were adapted for the coding of legislative mandates. The 1997 study measured 1) the use of sanctions, 2) enforcement, 3) mode of communication, 4) interpretation of administrative rules, and 5) form of compliance monitoring. This study reviewed legislative mandates for 1) the presence of sanctions, 2) approved enforcement methods, 3) discretion within the administration rules (flexible vs. strict adherence), and 4) the form of compliance monitoring (goals/outcomes vs. process/deadline). Again, a three-point scale was utilized to rate these indicators such that higher scores correspond to more formal, legalistic implementation styles.

3.4 Watershed Profiles

The spatial mismatch between the natural boundaries of watersheds and the boundaries of local jurisdictions (i.e., the scale at which land use planning and decision-making around development is traditionally carried out) underscore why a study of implementation at the watershed level is an important contribution to the research literature. Within Maryland and North Carolina, two watersheds were selected based on their history of impairment and demographic similarities—the Gunpowder-Patapsco watershed in Maryland and Jordan Lake watershed in North Carolina. Watersheds with a history of impairment were selected based on the assumption that areas experiencing water quality issues would be more likely to take planning action to address degraded water bodies. Unfortunately, project resources precluded data collection for all jurisdictions in both watersheds so proximity to the impaired water body was used as a selection factor. Proximity to an impaired water body has implications for nutrient loading and political motivation to take steps to protect a particular water body (Ostrom, 1990). Although development throughout a watershed has an impact on the water quality, modeling of nitrogen and phosphorus loads often find lower loads from jurisdictions located farther from the body of water under study. For example, 43% of the nitrogen load from a wastewater treatment plant in the City of Greensboro (~50 miles away) reaches Jordan Lake compared to 96% of the nitrogen load from a wastewater treatment plant in Durham (~20 miles away) (North Carolina Division of Water Quality, 2009b, p. 321). This study used a 20 mile radius to identify jurisdictions for inclusion in the study. The following section profiles each watershed, identifies the jurisdictions included within the study, and details the reasons for exclusions.

3.4.1 Gunpowder-Patapsco Watershed in Maryland

The Gunpowder-Patapsco watershed is a part of the Chesapeake Bay drainage basin and was selected based on its impairment history. The Chesapeake Bay was first targeted for protection and restoration in 1983 after the recognition of a historic decline in the health of the estuary ("The Chesapeake Bay Agreement of 1983," 1983). EPA's most current assessment data reported 54 out of 79 water bodies within the Gunpowder-Patapsco watershed were impaired, which is an indication of recurring, monitored violations of water quality criteria (United States Environmental Protection Agency, 2002).

The Gunpowder-Patapsco watershed contains portions of six Maryland counties (Anne Arundel, Baltimore, Carroll, Frederick, Harford, Howard) and 9 jurisdictions including the city of Baltimore[16]. In total, there were 15 Maryland jurisdictions within the Gunpowder-Patapsco watershed. Two jurisdictions (Aberdeen and Frederick County) were not included at any level of the analysis. Frederick County was not included due to the relatively small area of the county (~0.024 square miles) located in the Gunpowder-Patapsco watershed. Data were not collected for Aberdeen after multiple unsuccessful attempts to gain access to data files via mail, email, and telephone correspondence as well as unsuccessful attempts to locate a copy of the plan through the local library system. In total, 13 jurisdictions within the Gunpowder-Patapsco watershed were included in this study.

3.4.2 Jordan Lake watershed in North Carolina

Upon its completion in 1983, the B. Everett Jordan Reservoir (hence Jordan Lake) received a Nutrient Sensitive Water designation and has since consistently tested eutrophic or hyper-eutrophic (North Carolina Department of Environment and Natural Resources, 2009; North Carolina Division of Water Quality, 2009a). The Jordan Lake watershed encompasses portions of 10 counties and 13 jurisdictions including some or all of the urban areas of Durham, Chapel Hill, Cary, Burlington, and Greensboro. Twelve jurisdictions were eliminated based on distances greater than 20 miles from Jordan Lake. One jurisdiction (Town of Carrboro) did not have a land use or comprehensive plan and was eliminated from the study. The City of Durham and Durham County currently engage in a joint planning effort, which includes the production of a single comprehensive plan and development

[16] York County in Pennsylvania is also part of the Gunpowder-Patapsco watershed but is not included in this study.

management ordinance and joint development review. In total, nine jurisdictions within the Jordan Lake watershed were included in this study.

3.5 Demographic Comparisons

To substantiate the comparability of the two watersheds, the following section includes data from the 2000 and 2010 U.S. Census, the 2006-2010 American Community Survey (ACS), and municipal and county budgets. Six community level variables were used to help determine if there were similarities or differences between the watersheds that might influence the key variables of interest. Two demographic variables from the U.S. Census and ACS were collected: population size and median home value. Population density was calculated using population size and land area from the ACS data. Growth rate was calculated using population size from the 2000 U.S. Census and the 2006-2010 ACS data. Planning capacity per 1000 residents was calculated using the number of staff in planning departments with ‘planner’ in their job title based on 2010 municipal and county budgets and from the websites of jurisdictions and 2010 population size. Table 3.2 contains the demographic variables for each jurisdiction within the two study watersheds.

Table 3.2: Watershed Demographic Characteristics

	Pop. Size (2000)	Pop. Size (2010)	Growth Rate 2000-2010 (%)	Pop. Density (2010)	Median housing value ($) (2010)	Planners (#/ planners per 1000)
Gunpowder-Patapsco	2,569,584	2,729,208	6.2	1209.8	306,054	0.088
Anne Arundel Co.	489,656	537,656	9.8	1295.9	370,100	0.087
Baltimore City	651,154	620,961	-4.6	7671.9	160,400	0.021
Baltimore Co.	754,292	805,029	6.7	1345.5	269,900	0.063
Bel Air	10,080	10,120	0.4	3453.9	243,500	0.296
Carroll Co.	150,897	167,134	10.8	373.4	350,900	0.120
Hampstead	5,060	6,323	25.0	1982.1	243,200	0.0
Harford Co.	218,590	244,826	12.0	560.1	298,800	0.118
Havre de Grace	11,331	12,952	14.3	2354.9	260,300	0.232
Howard Co.	247,842	287,085	15.8	1145.0	456,200	0.244
Manchester	3,329	4,808	44.4	2054.7	300,800	0.0
Mount Airy	6,425	9,288	44.6	2254.4	408,500	0.215
Sykesville	4,197	4,436	5.7	2807.6	366,500	0.0
Westminster	16,731	18,590	11.1	2803.9	249,600	0.163
Jordan Lake	1,189,613	1,846,478	36.0	765.6	246,278	0.072
Apex	20,212	37,476	85.4	2438.3	246,700	0.294
Cary	94,536	135,234	43.1	2488.2	289,000	0.170
Chapel Hill	48,715	57,233	17.5	2709.9	356,400	0.280
Chatham Co.	49,329	63,505	28.7	93.1	193,900	0.094
Durham City/Co.	223,314	267,587	19.8	935.7	176,100	0.012
Morrisville	5,208	18,576	256.7	2248.9	266,400	0.323
Orange Co.	118,227	133,801	13.2	336.2	258,800	0.067
Pittsboro	2,226	3,743	68.1	904.1	206,900	0.267
Wake Co.	627,846	900,993	43.5	1078.7	222,300	0.012

Past plan quality studies found positive associations between larger population size and greater community wealth (as measured by median housing value) and higher quality comprehensive plans although not all studies have consistently found this relationship (Berke et al., 1999, 1996; Berke, Backhurst, et al., 2006; Brody, 2003a; Dalton & Burby, 1994). There is some evidence that higher population density and higher growth rates (proxies for land availability and development pressure) are associated with lower quality plans, but the findings are inconsistent across studies with some studies finding no effect and others finding an association between higher growth rates and high plan quality scores (Alterman & Hill, 1978; Berke et al., 1996; Brody, 2003a; Burby, 2003; Dalton & Burby, 1994). Population size and community wealth are hypothesized to work through planning capacity (i.e., staff, financial resources, and expertise) and are associated with higher quality plans. Table 3.3 provides the mean and standard deviation for each demographic characteristics by watershed and the p-values from the comparison of means tests.

Table 3.3: Demographic Characteristics by Watershed

	Gunpowder-Patapsco		Jordan Lake		
	Mean	*SD*	*Mean*	*SD*	p value
Pop. Size (2000)	197,660.3	267,301.1	132,179.2	198,424.9	0.973
Pop. Size (2010)	209,939.1	277,014.9	179,794.2	282,338.6	0.764
Growth Rate 2000-2010 (%)	0.151	0.149	0.640	0.761	0.006**
Pop. Density 2010	2,316.2	1,845.2	1,470.5	1,003.6	0.217
Median housing value ($)	306,054	80,907.52	246,278	55,122.45	0.066*
Planning Capacity (#/ planners per 1000)	0.019	0.024	0.013	0.009	0.663

Both watersheds have a demographic characteristics associated with higher and lower plan quality. The wealth and population sizes of jurisdictions within the Gunpowder-Patapsco watershed may support higher plan quality scores, but the uneven distribution of planning capacity may not. A higher percentage of the Gunpowder-Patapsco watershed consists of jurisdictions with greater than 250,000 residents compared to the Jordan Lake watershed (38.4% vs. 22%) even though there is not a statistically significant difference for overall population size at the watershed level. The median home value for jurisdictions within the Gunpowder-Patapsco watershed was $306,054 compared to $246,278 in the Jordan Lake watershed, which was statistically significantly different at the 0.1 level (p=0.066). Although lower in wealth and population size when compared to the Gunpowder-Patapsco watershed, the Jordan Lake watershed contains jurisdictions with larger population size and considerable wealth, which may support higher plan quality. Additionally, jurisdictions within the Jordan Lake watershed have more consistent planning capacity. While there is not a statistically significant difference between the watersheds for planning capacity, three jurisdictions in the Gunpowder-Patapsco watershed have no planning capacity despite the higher average score, which suggests uneven distribution of planning capacity within the watershed.

Finally, there was not a statistically significant difference between the watersheds with respect to population density although jurisdictions in the Gunpowder-Patapsco had, on average, higher population density. There was a statistical difference for growth rate with jurisdictions in the Jordan Lake watershed growing faster, on average, than jurisdictions in the Gunpowder-Patapsco. Jurisdictions within the Gunpowder-Patapsco watershed exhibit a wide range of growth rates with declining growth (Baltimore City, -4.6%), moderate growth (Carroll County 10.8%), and rapid growth (Mount Airy, 44.6%) while the Jordan Lake watershed exhibits moderate to very rapid growth with rates ranging from 13.2% to 256.7%. Given the inconsistent findings within the literature, it is unclear how the statistically significant difference in growth rate will influence the quality of planning inputs like comprehensive plans.

3.6 Data Collection and Analysis

This section introduces the research methods used for this study and is divided into two parts: 1) the analysis of comprehensive plans and development management ordinances and 2) the implementation of riparian buffer policies. Section 3.5.1 details the data collection process for the comprehensive plans and development management ordinances and describes the content analyses and statistical analyses used for the portion of the study focused on the quality of planning inputs. Section 3.5.2 discusses the sampling of approved development applications and the collection of high-resolution land cover classification data. It also presents the content analysis used for the applications, the map-based measurements, and statistical techniques used in this analysis.

3.6.1 Quality of Policy Input Analysis

The concepts of plan quality and ordinance quality guided the analysis of water resource protection in comprehensive plans and the quality of riparian buffer policies within development management ordinances. The following section describes the data collection, protocol creation, content analysis, and statistical analysis associated with these analyses.

3.6.1.1 Data Collection: Policy Inputs

Comprehensive plans were collected for the 22 jurisdictions within the study population (13 jurisdictions in Maryland and 9 jurisdictions in North Carolina). Plans were downloaded from county and municipal websites, provided by planning staff, or scanned at local libraries. The plan quality analysis of water resource protection centered on the comprehensive plans in effect in 2008. The implementation analysis described in Section

3.5.2 also utilizes plan quality data, but this analysis examined development during the period from 2000-2008. Additional plans were coded to ensure that approved development applications were matched to the comprehensive plan in effect during their review process.

Development management ordinances were collected for the 22 jurisdictions. Ordinances were downloaded from county and municipal websites or provided by planning staff. The development management ordinances in effect in 2008 were coded for the ordinance quality analysis. Similar to the use of plan quality data in the implementation analysis, development management ordinances were matched to development applications based on their approval date. Amendments to riparian buffer policies were tracked through annotations within ordinances and, in some cases, all versions of the ordinance during the study period were provided by a jurisdiction.

3.6.1.2 Protocol Creation: Policy Inputs

Two protocols were created to guide the content analysis of plan quality and ordinance quality. These concepts are first defined by principles and then operationalized with indicators. These protocols were developed through multiple iterations of three steps: 1) integration of research literature, 2) expert review, and 3) practice application. The first step in protocol creation utilized an approach to evaluation known as backmapping to guide the creation of the protocols (Elmore, 1980; Hopkins, 2001). In this approach, the evaluation begins with the desired outcome (e.g., a high quality plan or a high quality riparian buffer policy), and then works backward through the actions necessary to achieve that outcome. The actions and factors essential for a high quality plan or ordinance were then operationalized with a set of indicators under each principle. The next step involved several iterations of expert review of the protocol. During these reviews, experts in the fields of hydrology, land use, and local water resource management made notes on the protocol and highlighted areas for clarification and further exploration. Their suggestions were researched, incorporated into the protocol, and submitted again for expert review. The third step included several rounds of testing of the protocols. Comprehensive plans and ordinances from jurisdictions not within the study population were used to test the protocols. These jurisdictions were selected based on similar demographics and/or were identified by experts as jurisdictions with either strong or weaker planning traditions.

Plan Quality Protocol. A high quality plan is one where the plan represents community goals from a diverse group of stakeholders; provides data to inform decision-making; outlines policy solutions that incorporate local values; and includes clear strategies for implementation. This study utilizes the following seven principles to differentiate amongst plans based on their quality: Goals, Fact Base, Policy Framework, Implementation, Monitoring, Participation, and Inter-Jurisdictional Coordination. Berke and colleagues recently reorganized these seven plan quality principles into direction-setting principles (goals, fact base, and policy framework) and action-oriented principles (implementation, monitoring, inter-jurisdictional coordination, and participation) (Berke et al., 2012, 2013). These conceptual groupings were investigated in addition to the analysis of individual plan quality principles.

Direction-Setting Plan Quality principles

1) **Goals** should be the result of a consensus building process about future community conditions where a community reconciles competing interests and integrates the input of a diverse group of stakeholders about how their community should look and function;

2) A **fact base** assembles information about the current state of the community, and provides future projections with the purpose of creating a realistic pathway to the community's goals;

3) **Policy framework** outlines the action steps necessary to realize the goals based on the information gathered in the fact base.

Action-Oriented plan quality principles

4) **Implementation** helps move a plan from a document into action by assigning responsibility and allocating time and resources;

5) **Monitoring** involves the on-going review of plan implementation and the achievement of community goals. Though monitoring, a plan can incorporate new information and adapt to changing conditions;

6) **Inter-jurisdictional Coordination** recognizes the interconnectedness of space. The decisions made by one community inevitable influence its neighbors, and processes must be in place for communication and to coordinate action;

7) **Participation** emphasizes the unique strengths and challenges faces by individuals within a jurisdiction, and the efforts needed to involve and respect all sectors of society.

These seven plan quality principles were operationalized to evaluate the incorporation of water resource protection in comprehensive plans. Based on the published watershed protection literature, specific items were created for drinking water supply and quality; the amount, rate, and quality of waste water; and mitigation of stormwater (Brody, 2003b; Burby, Moreau, Miller, & Moreau, 1983; Center for Watershed Protection, 1998). Table 3.3 summarized the indicators and their scoring by principle. The final protocol consists of 110 items under the seven plan quality principles and can be found in Appendix A.

Table 3.3: Plan Quality Indicators and Scoring by Principle

Principle	Indicator		Scoring
Goals (10)	Environment (6) Economy (1) Vulnerability (1)	Equity (1) Awareness (1)	Score (0-1): 0 = not mentioned in plan 1 = mentioned
Fact Base (34)	Water Supply (21) Stormwater (5) Waste Water (8)		Score (0-2): 0 = not mentioned in plan 1 = mentioned not detailed 2= mentioned & detailed
Policy Framework (41)	Awareness (3) Low impact design (7) BMPs (21)	Land acquisition (4) Regulatory (6)	Score (0-2): 0 = not mentioned in plan 1 = mentioned not detailed 2= mentioned & detailed
Implementation (6)	Actions specified (1) Responsibility (1) Funding Sources (1)	Timeline (1) Prioritization (1) Sanctions (1)	Score (0-2): 0 = not mentioned in plan 1 = mentioned not detailed 2= mentioned & detailed
Monitoring (5)	Outcomes for goals (1) Evaluation/ feedback (1) Indicators (1)	Org. Agreement (1) Updating (1)	Score (0-2): 0 = not mentioned in plan 1 = mentioned not detailed 2= mentioned & detailed
Inter-jurisdictional Coordination (7)	Horizontal linkages (1) Vertical linkages (1) Intergovt Agreement (1) Conflict management (1)	Coordination Procedures (1) Funding sources (1) Info sharing (1)	Score (0-2): 0 = not mentioned in plan 1 = mentioned not detailed 2= mentioned & detailed
Participation (7)	Plan involvement (1) Techniques (1) Public Agency Support (1) Representativeness (1)	Prior engagement (1) Recruitment (1) Plan Evolution (1)	Score (0-2): 0 = not mentioned in plan 1 = mentioned not detailed 2= mentioned & detailed

Ordinance Quality Protocol. A high quality ordinance describes the intended effect of the policy, outlines the regulations and provisions of the policy, and provides an implementation structure to govern the approval and monitoring process. This study uses a set of eight principles based on the plan quality research literature, the concept of street-level bureaucracy, and planning practitioner resources: Goals, Fact Base, Policy Description, Policy Flexibility, Policy Restrictions, Complexity, Monitoring and Enforcement, and Discretion (Alterman & Hill, 1978; Kelly, 1988; Lerable, 1995; Lipsky, 1980; Stevens & Berke, 2008). Mirroring the conceptual groups used for plan quality, the ordinance quality principles are divided into Policy Content (the substantive policy components) and Administration (the factors that influence policy implementation). The principles under Policy Content are *Goals*, *Fact Base*, *Policy Description*, and *Policy Restrictions* while the Administration principles are *Policy Flexibility*, *Monitoring and Enforcement*, *Complexity*, and *Discretion*. These conceptual groupings were investigated in addition to the analysis of individual ordinance quality principles.

Policy Content ordinance quality principles

1) **Goals** captures the important linkage between the comprehensive plan and the ordinance, and covers stated objectives for the overarching administrative actions that are essential for ordinance implementation.

2) **Fact Base** identifies the informational inputs required by the policy including acceptable sources and processes to resolve disputes over data interpretation.

3) **Policy Description** explains the provisions and regulations of a policy including the specific circumstances under which particular parameters are applicable.

4) **Policy Restrictions** described the conditions under which there are constraints or specific limitations contained within the policy.

Administration ordinance quality principles

5) **Monitoring and Enforcement** includes the on-going process to manage the actions and practices stipulated by a policy.

6) **Policy Flexibility** refers to deviations from policy provisions that allow for adaptation to different circumstances including variances or incentive policies.

7) **Complexity** is a measure of the difficulty of administering a particular policy by gauging the effort necessary to navigate intensive data demands and highly detailed provisions.

8) **Discretion** refers to instances where staff charged with policy implementation have the authority to make an interpretation or judgment with respect to particular policy provisions.

The 92 indicators that operationalize these eight ordinance quality principles for riparian buffers were informed by the research literature and model ordinances identified by the Environmental Protection Agency (Center for Watershed Protection & Schueler, 1995; Lowrance et al., 1997; Mayer et al., 2005; Phillips, 1989; Pickett et al., 2001; Schueler & Governments, 1987; Sweeney, 1992; United States Environmental Protection Agency, 2006; Vidon & Hill, 2004; Wenger, 1999). Table 3.4 summarizes the indicators and their scoring by principle and the full protocol appears in Appendix B.

Table 3.4: Ordinance Quality Indicators and Scoring by Principle

Principle	Indicator		Scoring
Goals (5)	Environment (2) General Welfare (1)	Conformance (1) Continuity (1)	Score (0-1): 0 = not mentioned 1 = mentioned
Fact Base (7)	Stream ID (1) Vegetation (1) Floodplain (1) Wetlands (1)	Soil (1) Drainage (1) Topography (1)	Score (0-3): 0 = not mentioned 1 = basic level of information 2= standard level of information 3= enhanced level of information
Policy Description (30)	Width (11) Vegetation (4) Habitat (2) Site Design (3) Allowable Uses (4)	Owner Activities (2) Exceptions (3) Other Critical Areas (1)	Score (0-3): 0 = no policy 1 = basic policy 2= standard policy 3= enhanced policy
Policy Restrictions (10)	Hazardous Uses (2) Impervious Surface (1) Agriculture (2)	Mining (1) Waste Disposal (4)	Score (0-3): 0 = no policy 1 = basic policy 2= standard policy 3= enhanced policy
Monitoring (13)	BMPs (2) Inspection (3) Notification (2) Fees (1)	Complaint (1) Monitoring (1) Coordination (1) Violation (2)	Score (0-3): 0 = no policy 1 = basic policy 2= standard policy 3= enhanced policy
Policy Flexibility (13)	Buffer Averaging (1) Protection Policy (4)	Variance (4) Incentives (4)	Score (0-3): 0 = no policy 1 = basic policy 2= standard policy 3= enhanced policy
Complexity (36)	Fact Base (7) Policy Description (29) Policy Restrictions (10)		Cumulative Score : Indicators scored at 3= enhanced level
Discretion	**Basic**: The reviewer of the application is granted authority in the interpretation or implementation of an ordinance provision. **Standard:** The reviewer of the application is granted authority in the interpretation or implementation of an ordinance provisions AND an additional administrator, agency, or department are involved in the review process (i.e., may request additional information, set standards, or approve the application). **Enhanced**: The reviewer of the application is granted authority in the interpretation or implementation of an ordinance provision AND an additional administrator, agency, or department are involved in review process AND there are clear limitations placed on the extent of the alterations that can be made by these parties.		

3.6.1.3 Content Analysis: Policy Inputs

The content analysis of the comprehensive plans and development management ordinances was conducted using Atlas.ti software, a qualitative data analysis software that allows for 1) the creation of a code tree for all protocol indicators, 2) the selection of segments of text for code assignment, 3) the assignment of multiple codes to any selected segment, and 4) search and visualization functions to aid in data organization. Each document was imported into Atlas.ti in portable document format (.pdf). All of the documents were available in this format and the use of .pdf files allowed for the documents to be coded with the same formatting and graphics as in printed form.

A coding tree was created in Atlas.ti for each of the protocols. The coding tree is organized by principle with instructions and detailed definitions for each indicator based on the protocol. Entire documents were coded including appendices, sidebars, maps, and tables. Each indicator in the coding protocols was measured on either a binary or ordinal scale. For the plan protocol, each indicator was measured on either a binary scale (0 = the indicator was not mentioned and 1 = the indicator was mentioned) or an ordinal scale (0 = the indicator was not mentioned, 1 = the indicator was mentioned but not detailed, and 2 = the indicator included a clear and detailed narrative description). Within the ordinance protocol, each indicator was measured on either a binary scale (0 = the indicator was not mentioned and 1 = the indicator was mentioned) or an ordinal scale (0 = the indicator was not mentioned, 1 = the indicator reached basic level of information/policy requirement; 2 = the indicator reached standard level of information/policy requirement, and 3 = the indicator reached an enhanced information/policy requirement). Table 3.5 is an example of an indicator description from the fact base section of the plan quality protocol, which utilized ordinal scoring.

Table 3.5: Plan Quality- Fact Base Indicator Description

Indicator	Indicator Description	Scoring Description
Drinking water sources	Drinking water supply sources and safe yields of each source	**Detailed:** Description of water supply sources and safe yield in mgd (millions of gallons/day) **Mentioned not detailed:** Incomplete or vague description of water supply sources; missing safe yield values

Coders were selected from master's level students with either at least one year of coursework in land use and environmental planning or substantial professional experience in land use or water resource planning. Each comprehensive plan was double coded with each coder applying the protocol to the plan independently with a period of reconciliation to limit the possibility of measurement error. The project resources precluded double coding development management ordinances so additional training to improve reliability were conducted. Approximately 50% of the ordinances were double coded. Three content analysis methods were used to increase reliability: 1) understandable coding instructions, 2) clear criteria for selecting coders, and 3) independent coding (Krippendorff, 2004).

Inter-coder reliability scores are an indication of the agreement between two coders coding the same material. These scores are important indicators of the protocol's reliability—its ability to be a consistent measure. Inter-coder reliability scores for the independent, pre-reconciled plan quality data were calculated to assess the reliability of data derived from plan coding. This study calculated two indices or reliability: percentage agreement and Krippendorff's alpha (Krippendorff, 2004).

A period of reconciliation to limit the possibility of measurement error was completed for the plan and ordinance coding. The process included three steps: 1) merger of projects, 2) independent review, and 3) reconciliation. The two independently coded projects were merged in Atlas.ti to show each coder's application of the coding tree. Each coder then reviewed all coding discrepancies and assigned one of four memos (Use Coder 1 coding, Use Coder 2 coding, Unsure, and Ambivalent). The projects were merged again with a reconciliation period where segments that continue to be in dispute were reconciled. This methodology allowed for both coders to review all coding without scheduling long one-on-one sessions, limited the pressure to defend one's coding without preparation, and limited potential power dynamics between coders. After reconciliation, the final scores were calculated for each principle by summing the scores across all indicators under a principle, dividing by the total possible score, and then multiplying by 10 to normalize each score to a scale of 0 to 10.

3.6.1.4 Statistical Analysis: Policy Inputs

Bivariate statistics were central to the investigation of the hypotheses around plan quality and ordinance quality due to the small number of cases (n=22 jurisdictions). This study uses frequencies, t-tests, and correlations to gain a better understanding of the relationships among variables. Data was imported into STATA 13.0, and each variable was tested for normality and unequal variance using both graphic plots and numeric tests (i.e., Shapiro-Wilk and Shapiro-Francia tests for normality, tests for skewness and kurtosis, two-sample variance comparison tests, and the Kolmogorov–Smirnov equality-of-distributions). Three comparison of means tests (t-tests, Welch's t-test, and Mann-Whitney U test) were utilized based on the results of the normality and variance tests to determine if differences between mean principles scores achieved traditional levels of statistical significance (p=0.05) when compared at the watershed level.

3.6.2 Implementation of Riparian Buffer Policies

The analysis of implementation introduced two additional sets of variables: policy slippage and implementation. Policy slippage refers to differences between the riparian buffer policies outlined in ordinances and the buffer provisions within approved development applications. Implementation refers to the deviations from approved development applications and observations of constructed development taken from high-resolution land cover classification maps. To investigate these two concepts, this study used two types of data: approved development applications and high resolution land cover classification maps. The following section details the data collection process, protocol creation, and content analysis. This section then covers with the study's statistical analysis and the community and project variables used to rule out alternative causal explanations. The section concludes with a table of all of the variables used in this study.

3.6.2.1 Data Collection: Implementation of Riparian Buffer Policies

Approved Development Applications. The sampling frame of approved development applications was constructed using three types of data: parcel data, watershed and stream data, and tax records. Geographic Information Systems (GIS) parcel data consisted of shapefiles that delineate the boundaries of a particular parcel. These shapefiles are often joined to databases with information about street addresses, parcel owners, development description, land use, and the year a structure was built. United States Geological Study (USGS) data was used to create a shapefile of watershed boundaries, and USGS stream data was used to identify all perennial and intermittent streams within the watersheds under study.[17] Tax data was used when parcel data for a particular jurisdiction did not include the year a structure was built or a description of the development.

First, the parcel data and stream data were overlaid for each jurisdiction and clipped to the study's watershed boundaries. Then, using the buffer tool within ArcGIS 10.0, perennial and intermittent streams were buffered to 100 linear feet from the streamline. All parcels within this buffer were included in a list and ordered by the year built. Parcels with a year built date between 2000 and 2008 were included in the sampling frame. For parcels without a year built date, tax records provided a description of the development along with information about when it was built. A review of tax records were also completed for parcels when the year built was recorded as 0. This step ensured developments within the study period with areas near streams designated as open space were included within the sampling frame. The list was further refined by using the description data obtained from either the parcel data or tax data. The description data allowed parcels to be collapsed into subdivisions or other named developments prior to sampling. Using this sampling frame, a simple random sample of 20 developments per jurisdiction was selected.

Jurisdictions with less than three eligible developments (i.e., built during the study period and within 100ft of a perennial or intermittent stream) were not included in the project. Three eligible developments were set as the threshold for inclusion because this number of data points allows for the creation of a trend line. Five jurisdictions (Hampstead [1], Manchester [1], Mt. Airy [1], Sykesville [2], and Westminster [0]) had less than three eligible developments. All of these jurisdictions are located within Carroll County, MD.

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[17] Many jurisdictions have their own stream data that may be more accurate than USGS data (especially for intermittent streams). USGS data was used during the creation of the sampling frame to maintain consistency across sites. Stream data from local sources was utilized for the map-based measurements.

According to personal communications and website research, three of these five jurisdictions (Hampstead, Manchester, and Sykesville) depend on Carroll County planning staff for permitting, inspections, and development review. Although aggregation to Carroll County was a possibility, the three different scores on plan quality and ordinance quality as well as differing community characteristics would likely confound any conclusions. One jurisdiction within Harford County, MD refused to provide access to approved development applications (Havre de Grace).

For jurisdictions with more than 3 eligible developments but fewer than 20 eligible developments, all eligible developments were included. Table 3.6 includes the 15 jurisdictions (9 jurisdictions in Jordan Lake and 6 jurisdictions in Gunpowder-Patapsco) included in the implementation study and the number of development applications collected for each jurisdiction. In total, 205 development applications were collected across the two watersheds.

Table 3.6: Number of Development Applications by Jurisdiction

Jurisdiction	Number of development applications
Jordan Lake watershed	
Apex	16
Cary	20
Chapel Hill	12
Chatham County	20
Durham City/County	14
Morrisville	5
Orange County	20
Pittsboro	9
Wake County	3
TOTAL	119
Gunpowder-Patapsco watershed	
Baltimore City	7
Baltimore County	16
Bel Air	3
Carroll County	20
Harford County	20
Howard County	20
TOTAL	86
STUDY TOTAL	205

High-Resolution Land Cover Classification Maps. High-resolution (1 meter) land cover classification maps were obtained for each watershed using a combination of existing resources and the completion of a supervised classification for study areas not adequately covered by existing resources.

1) High-resolution land cover classification maps for portions of Anne Arundel, Baltimore City, Baltimore County, Harford County, and Howard County were obtained from the University of Vermont Spatial Analysis Laboratory. These resources are high-resolution datasets for 2006 that included seven land cover classes: (1) Tree Canopy, (2) Grass/Shrub, (3) Bare Earth, (4) Water, (5) Buildings, (6) Roads, and (7) Other Paved Surfaces.

2) High-resolution land cover classification maps for portions of Orange County, Durham County, and Wake County were obtained from Dr. Drew Pilant, a Remote Sensing Research Scientist for the United States Environmental Protection Agency. This resource is a high-resolution dataset for 2006 that included seven land cover classes: (0) Unclassified, (1) Water (2) Dark Impervious (3) Light Impervious (4) Soil-Barren (5) Trees-Forest, and (6) Grass-Herbaceous.

3) High-resolution land cover classification maps for portions of Orange County and Durham County were obtained from the Department of Forestry and Environmental Resources at the North Carolina State University. These resources are high resolution datasets for 2006 that included six land cover classes: (1) Tree Canopy, (2) Water (3) Road (4) Building, (5) Grass, and (6) Bare Earth.

4) High-resolution land classification maps for the entirety of both study watersheds were created using high-resolution aerial imagery downloaded from United States Department of Agriculture. This dataset was created to help account for coverage and timing gaps in the other land classification resources (e.g., the lag between development approval and construction). For example, a development approved in 2006 may not be built until 2008 and would not be covered by the previous resources. The high-resolution images were collected for 2011 (Gunpowder-Patapsco) and 2012 (Jordan Lake) from the National Agriculture Imagery Program. These images were subjected to a supervised classification

with post-processing with available planimetric data to check the image for accuracy[18]. The accuracy assessments performed on the classification were within generally acceptable ranges (Maryland: 89.2% overall accuracy and 86.5% KAPPA accuracy; North Carolina 83.2% overall accuracy and 79% KAPPA accuracy) (Congalton, 1991). The final high-resolution maps include five land cover classes: (1) Trees, (2) Water, (3) Impervious Surfaces, (4) Grass, and (5) Bare Earth.

Given the disparate data sources, five land cover classes were identified for use in the final analysis: (1) Trees, (2) Water, (3) Impervious surfaces, (4) Grass, and (5) Bare Earth. Table 3.7 lists the categories.

Table 3.7: Land Cover Class

Land Cover Class	Collapsed categories
Tree Cover	Tree Canopy, Trees-Forest, Trees
Water	Water
Impervious Surfaces	Buildings, Roads, Other Paved Surfaces, Dark Impervious, Light Impervious, Impervious Surfaces
Grass	Grass, Grass/Shrubs, Grass-Herbaceous
Bare Earth	Bare Earth, Soil-Barren

[18] Unlike the previously described land classification resources, this resource did not utilize LiDAR elevation or surface models which can help extract surface features and refine an image. The limitations of these data sources should not pose substantial barriers as the map-based measurements for this analysis do not require elevation data.

3.6.2.2 Protocol Creation & Content Analysis: Approved Development Applications

Eight policy slippage principles were used to code riparian buffer policies within development applications: Policy Description, Allowable Uses/Restricted Uses, Exemptions/Exceptions, Site Design, Maps/Plans, Variances, Monitoring & Enforcement, and Rationale. These policy slippage principles are drawn from the Ordinance Quality principles of Policy Description, Policy Restrictions, Policy Flexibility, Monitoring and Enforcement, and Discretion in order to facilitate the comparison between ordinance policies and approved development applications. The policy slippage protocol includes 64 indicators across eight principles.

1) **Policy Description** denotes the essential provisions of the ordinance with respect to a particular policy.

2) **Allowable Uses/Restricted Uses** captures both the allowable uses on a particular development site in addition to restricted uses.

3) **Exemptions/Exceptions** contains references to exemptions or exceptions applicable for this particular development.

4) **Site Design** includes descriptions of the approved site design in additional to process elements such as construction sequencing, scheduling, and other project management tasks.

5) **Maps/Plans** covers the depiction of policy elements on physical maps or plans associated with the development site.

6) **Variances** includes any requested deviations from regulations contained in the ordinance with respect to a particular policy.

7) **Monitoring and Enforcement** refers to inspections or monitoring associated with a development in addition to any details about enforcement activities.

8) **Rationale** provides a justification for any deviations for policy provisions and acts as a modifier code to other indicators.

The approach to coding the approved development applications using the policy slippage protocol was slightly different than the approach used for plan and ordinance quality. Unlike the other coding protocols, there is not an accompanying scoring protocol. Instead, the goal of the coding was to identify applicable sections within development applications for comparison with ordinance provisions. Three different coders reviewed the approved development applications in their entirety and assigned segments of texts and images to particular indicators. A single coder reviewed all coded segments and summarized each code for comparison with ordinance provisions. Table 3.8 summarizes the indicators for policy slippage by principle.

Table 3.8: Policy Slippage Indicators by Principle

Principle	**Indicator**	
Policy Description (20)	BMPs (4) Vegetation (7)	Buffer Width (9)
Allowable Uses-Restricted Uses (16)	Agriculture (2) Allowable Uses (1) Buffer Crossings (1) Extractive Industry (2) Hazardous Uses (2)	Impervious Surface (1) Stormwater BMPs (1) Waste Treatment (4) Other Allowable Uses (1) Other Restricted Uses (1)
Exemptions-Exceptions (3)	Exemptions (1) Recreation Exemption (1)	Other Except_Exemp (1)
Site Design (5)	Grading (1) Infrastructure (1) Setbacks (1)	Site Design Flexibility (1) Other Site Design (1)
Maps (5)	Floodplain depiction (1) Floodplain intrusion (1)	Buffer Depiction (3)
Variances (5)	Allowable Uses (1) Maintenance (1) Vegetation (1)	Width (1) Other Variances (1)
Monitoring and Enforcement (10)	Buffer Notification (1) Fees (1) Inspections (3) Ownership (1)	Recorded Buffers (1) Violations (1) Water Quality (1) Other Monitoring
Rationale	Modifier used with other codes	

There are two formulation of the policy slippage dependent variable. For the conformance approach to evaluating policy slippage, the dependent variable is a binary (0=

no policy slippage or 1=presence of policy slippage). For the performance-based approach to evaluating policy slippage, the dependent variable is ordinal (0= no policy slippage, 1=policy slippage with a rationale, and 2=presence of policy slippage without a rationale).

3.6.2.3 Map-Based Measurements: Implementation

The examination of implementation integrates the content analysis of development applications with measurements from land cover classification maps at the parcel level. The analysis involved two steps: 1) a summary of buffer width, vegetative target, and impervious surface encroachment for each development application in the sample and 2) an assessment of the buffer width, vegetative composition, and impervious surface encroachment as observed from the land cover classification maps. First, using a rasterized land cover classification map, the land cover classification data was summarized for the entire development. Then, local stream data was buffered to the width delineated in the approved development permit. These buffers were used to extract the land cover classification data for the riparian buffer. Finally, using the number of pixels for each land cover classification type within the approved buffer and the overall number of pixels for the buffer, three variables were created (% tree cover, % bare earth, and % impervious surface). Appendix C provides a step-by-step description of this process illustrated with images. Thresholds were created for each of variable in order to create three binary variables (0 or 1) for implementation. Table 3.9 summarizes the three variables used for implementation.

Table 3.9: Implementation Variables

Buffer width	The buffer width described in an approved development application. This width is used to delineate the area for land cover classification observations.
Vegetative Target	The percentage of vegetative target (i.e., tree cover and bare earth) observed within approved buffer width.
Impervious Surface Encroachment	The percentage of impervious surface observed within the approved buffer width not explicitly approved in the development application.

3.6.2.4 Statistical Analysis: Implementation of Riparian Buffer Policies

As described in Chapter 2, this project seeks to integrate conformance- and performance-based approaches to evaluation. To accomplish this goal statistically, three separate sets of regression analyses are outlined to explore the factors contributing to policy slippage and implementation.

For the conformance-based evaluation of policy slippage, the dependent variable is binary (0= no policy slippage or 1=presence of policy slippage). A logistic regression was selected for this analysis because it allows for the modeling of dichotomous dependent variables. The log odds of the dependent variable are modeled as a linear combination of the independent variables. Equation 3.1 contains the model specified for this analysis.

The regression equation for the performance-based evaluation of policy slippage (Equation 3.2) is nearly identical to Equation 3.1, except the dichotomous policy slippage dependent variable is replaced an ordinal or rank ordered policy slippage variable (0= no policy slippage, 1=policy slippage with a rationale, and 2=presence of policy slippage without a rationale). An ordered logistic regression analysis—a hybrid cumulative logit model using robust standard errors—was specified (Allison, 2009).

The implementation analysis used a logistic regression model with *implementation* as the dependent variable (0= below threshold for vegetative target or impervious surface and 1= above threshold for vegetative target or impervious surface). In this case, I used a logit model for ordinal independent variables to allow for the inclusion of the ordinal variables from the performance-based approach (O'Connell, 2006). Appropriate model diagnostics including assessment of fit, residuals, and influential points were completed for each regression.

Logistic regression for policy slippage using a conformance approach

(Equation 3.1)

$$y_i = \alpha + \beta_1(\text{PlanQ})_1 + \beta_2(\text{OrdQ})_2 + \beta_3(\text{PlanMandate})_3 + \beta_j(\text{Community})_i + \beta_k(\text{Project})_j + \varepsilon_i$$

where y_i is the logged odds of an approved development application *i* containing policy slippage. The variables *PlanQ and OrdQ* are the plan quality and ordinance quality scores associated with approved development application *i*. The variable *PlanMandate* is a dummy variable that takes on the value of '1' for observations in a watershed with a comprehensive planning mandate[19]. *Community* is a vector of the community socio-demographic variables including population size, population density, growth rate, median home value, and number of planning staff. *Project* is a vector of the project characteristics including land use type (i.e., residential, commercial, industrial, institutional, etc.), parcel size, location within a subdivision or planned unit development, overall development size if within a subdivision or

[19] This regression was also completed with variable BufferDesign replacing the PlanMandate variable. The BufferDesign variable incorporated findings on the design of the buffer mandate, but is eliminated in this equation due to multicollinearity with the PlanMandate Variable.

PUD, percentage of the parcel covered by the buffer, and time between year built and year of the base image used to create the land cover classification map.

Ordered logistic regression for policy slippage using a performance approach

(Equation 3.2)

$$y_i > K\text{-}1 = \alpha + \beta_1(\text{PlanQ})_1 + \beta_2(\text{OrdQ})_2 + \beta_3(\text{PlanMandate})_3 + \beta_j(\text{Community})_i + \beta_k(\text{Project})_j + \varepsilon_i$$

where y_i is the logged odds that an approved development application *i* is within a particular ordered response category of policy slippage. The variables *PlanQ and OrdQ* are the plan quality and ordinance quality scores and variable *PlanMandate* is a dummy variable for the presence of a comprehensive planning mandate[20]. *Community* is a vector of the community socio-demographic variables and *Project* is a vector of the project characteristics.

Logistic regression for implementation

(Equation 3.3)

$$y_i = \alpha + \beta_1(\text{PlanQ})_1 + \beta_2(\text{OrdQ})_2 + \beta_3(\text{PlanMandate})_3 + \beta_4(\text{PolicySlippage})_5 + \beta_j(\text{Community})_i + \beta_k(\text{Project})_j + \varepsilon_i$$

where y_i is the logged odds of an approved development application *i* is implemented. The variables *PlanQ and OrdQ* are the plan quality and ordinance quality scores and the variable *PlanMandate* is a dummy variable denoting the presence of a comprehensive planning

[20] This regression was also completed with variable BufferDesign replacing the PlanMandate variable. The BufferDesign variable incorporated findings on the design of the buffer mandate, but is eliminated in this equation due to multicollinearity with the PlanMandate Variable.

mandate[21]. *PolicySlippage* is a variable of policy slippage between approved development application *i* and ordinance *i. Community* is a vector of the community socio-demographic variables and *Project* is a vector of the project characteristics. Table 3.10 includes the variables used in this study along with their definitions and sources.

[21] This regression was also completed with variable BufferDesign replacing the PlanMandate variable. The BufferDesign variable incorporated findings on the design of the buffer mandate, but is eliminated in this equation due to multicollinearity with the PlanMandate Variable.

Table 3.10: Summary of Study Variables

Variable	Definition	Source
Planning Process		
Plan Quality	Incorporation of water resource protection in comprehensive plans	Plan Content Analysis
Ordinance Quality	Optimal design and functioning for riparian buffers policies	Ordinance Content Analysis
Policy Slippage	Differences between ordinance provisions and policies within development applications	Application Content Analysis
Implementation	Measurements of vegetative target and impervious surface encroachment	High Resolution Land Cover Classification maps
State Planning Context		
Comprehensive Planning Mandate	Presence and design of comprehensive planning mandate	State Statutes and Administrative Codes
Riparian Buffer Mandate Design	Design of mandate to protect environmentally sensitive areas	State Statutes and Administrative Codes
Local Community Characteristics		
Population Growth	Population change from 2000 to 2010	U.S. Census (2000); ACS (2010)
Population Density	Number of persons per square mile of land area	U.S. Census (2000); ACS (2010)
Median Home Value	Median value of owner-occupied homes (in dollars)	U.S. Census (2000); ACS (2010)
Planning capacity per 1000 residents	Number of planning staff in planning departments per 1000 residents	2010 municipal and county budgets; websites
Project Characteristics		
Land Use Type	Type of development	Application Content Analysis
Parcel Size	Size of parcel (in acres)	Application Content Analysis
Subdivision or PUD	Development of a multiple lots	Application Content Analysis
Development Size	Size of development (in acres)	Application Content Analysis
Buffer-Percentage	Percentage of the parcel covered by the buffer	ArcGIS Calculation
Image Lag	Time between year built and year of the base image	Calculated

3.7 Threats to Validity

There are four possible threats to the internal validity of this study: statistical conclusion, construct validity, ambiguous temporal precedence, and history (Shadish, Cook, & Campbell, 2002). A threat of statistical conclusion validity is possible because project resource constraints limited the study population and sample size, which, in turn, limit statistical power. Ideally, the sample size would be increased along with the employment of methods such as matching or stratification to increase power. Project resources, however, limited the study to two watersheds with a total of 22 jurisdictions precluding these statistical and sampling techniques. I ran cross-tabulations to identify instances of small cell sizes and used statistical tests robust to smaller cell sizes when appropriate.

Construct validity is a concern because the project depends on the creation of protocols, which are subject to measurement error and, therefore, may not accurately measure the construct under study. I used three content analysis methods to increase reliability: 1) understandable coding instructions, 2) clear criteria for selecting coders and 3) independent work by coders (Krippendorff, 2004). The coding protocols include instructions and definitions for each indicator. Several rounds of protocol testing were completed using documents from jurisdictions not within the study population to improve the accuracy of coders.

Ambiguous temporal precedence, or the lack of clarity about which variable occurred first, is a possible threat because the dates of plan adoption, ordinance adoption, and development application approvals may not occur in a linear, temporal pattern. The possibility of this threat was minimized by the legal structure of plan and ordinance adoption, which allowed for identification of the dates associated with these documents. For the investigation of policy slippage and implementation where this particular threat is most likely, the development review period was carefully delineated so the correct plan and ordinance could be matched with the approved development applications. In some cases, this matching necessitated the coding of additional plans and ordinances.

Finally, history is potential threat to internal validity. For example, there are a number of other events (e.g., the additional watershed planning activities in Maryland and the basin-wide planning in North Carolina) occurring concurrently with the adoption of comprehensive plans and development management ordinances or the approval of development applications. The effect of these alternative development activities on the dependent variables of interest cannot be controlled for and may be in the direction of the hypothesized effect. Thus, this threat precludes causal statements about the relationship between the study variables.

External validity refers to the extent to which study findings can be generalized to other jurisdictions and sociopolitical contexts. Given that this study does not utilize a national, randomized sample, inferences about study findings to a larger population would be inappropriate. However, study findings on the impact on mandates on plan quality and ordinance quality, the frequency of policy slippage, and the factors influencing implementation should be able to guide subsequent studies based on a more representative population that could, in turn, lead to more generalizable conclusions.

3.8 Conclusion

In this chapter, I introduced the research design, methods, and variables for this study. This study utilized an evaluative, cross-sectional, post-test only design to examine five research questions focused on 1) the impact of mandates on plan quality and ordinance quality, 2) the frequency of policy slippage, and the 3) factors that help explain implementation. There was a two stage process for site selection. First, Maryland and North Carolina were selected due to their differing policy regimes for state level involvement in land use planning and watershed protection. Then, two watersheds were identified within these states based on levels of impairment and similar demographic profiles: the Gunpowder-Patapsco watershed in Maryland and the Jordan Lake watershed in North Carolina.

Content analysis is the central research methodology used in this study, and Section 3.4 detailed the processes of data collection, protocol creation, testing, and coding used to construct three key project variables: plan quality, ordinance quality, and policy slippage. Measurements from high-resolution land cover classification maps were used in concert with the policy slippage data to construct the implementation variables. Methods for bivariate statistics, logistic regression, and ordered logistic regression to test the hypotheses derived from the conceptual framework presented in Figure 2.3 were detailed. To help rule out alternative causal explanations and to isolate the influence of planning inputs on implementation, community and project variables used by previous plan quality and implementation studies were measured and included in the study's statistical models. The chapter concluded with a discussion of threats to internal and external validity possible for the study.

CHAPTER 4: MANDATE DESIGN ASSESSMENT

4.1 Introduction

This study seeks to respond to Burby and colleagues' two decades-old call for more research into both the procedural outcomes and "on the ground" impact of mandates (Burby et al., 1993, n. 4). This chapter examines of the design of mandates in order to inform later investigations into the quality of planning inputs and the implementation of local land use decisions. The selection of two states (Maryland and North Carolina) allows for a comparative study of the two types of mandates depicted in the conceptual model (Figure 2.3): comprehensive planning mandates and single-purpose mandates. Maryland has a comprehensive planning mandate and North Carolina does not[22], allowing for an examination of the impact of a comprehensive planning mandate on plan quality. Both states have geographically-limited mandates affecting riparian buffer policies, which enabled a comparison of the influence of two different single-purpose mandates on ordinance quality. The following sections describe the design of the three mandates—Maryland's comprehensive planning mandate and both states' legislative mandates with provisions for the protection of environmentally sensitive areas. This chapter provides the foundation for subsequent examinations of the impact of mandates on policy inputs (plan quality and ordinance quality), policy slippage, and implementation.

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[22] The North Carolina 1974 Coastal Area Management Act, which mandates comprehensive planning, does not affect the watershed and jurisdictions selected for this study.

4.2 State Policy Regime Profile

4.2.1 Maryland

With the adoption of the Smart Growth and Neighborhood Conservation Initiative in 1997, Maryland became the first state to enact a growth management strategy with targeted state funding in areas designated by local jurisdictions (the Priority Funding Areas Act). Although the legislation's success at containing urban growth has been uneven, it has been hailed for its use of incentives opposed to a reliance on regulation (Cohen, 2002; Lewis, Knaap, & Sohn, 2009).

Maryland had consistently adopted legislation to promote land conservation and environmental protection with explicit references to the relationship between land use and water quality (Knaap & Schmidt-Perkins, 2006; Maryland State Archives, 2013)[23]. Maryland's long history of state involvement in land use and infrastructure planning begins with the establishment of the nation's first state planning commission in 1933 (Clawson, 1981; Howland & Sohn, 2007; Lewis et al., 2009; Maryland State Archives, 2013; Sohn & Knaap, 2005). Today, state-level planning is the responsibility of the Maryland Department of Planning, which undertakes a wide range of activities including data analysis to support local planning initiatives, technical assistance, and the review of local plans and programs to "ensure that all the State's natural resources, built environment and public assets are

[23] In addition to this legislation, there are a number of planning initiatives around watershed protection within the state. Maryland is part of a regional Chesapeake Bay Tributary Strategy created in 1992 to support the restoration and protection of the Bay. In 2004, Maryland instituted changes to its Tributary Strategy (Maryland Department of the Environment, 2008b). The Department of the Environment now guides the implementation of stormwater management and soil and erosion policies contained in ten basin-specific plans through requirements for state-approved local ordinances (Maryland Department of the Environment, 2008a).

preserved and protected as smart and sustainable growth goals are attained" (Maryland Department of Planning, 2014).

Two key pieces of legislation mandate action and help shape current state and local land use planning efforts with respect to water resource protection: the Chesapeake Bay Critical Area Protection Act of 1984 and the Economic Growth, Resource Protection, and Planning Act of 1992. Maryland jurisdictions are delegated planning and land use regulatory authority by Articles 66B, 25A, and 28[24] of the Maryland Annotated Code, which stipulates that jurisdictions exercising these powers must adhere to the provisions of state statutes including the adoption of a comprehensive plan. This legislation, as amended by the Economic Growth, Resource Protection, and Planning Act of 1992, requires local jurisdictions to address eight vision statements in their comprehensive plans including the first five statements that have implications for water resource protection.

> 1. Development is concentrated in suitable areas.
> 2. Sensitive areas are protected.
> 3. In rural areas, growth is directed to existing population centers and resource areas are protected.
> 4. Stewardship of the Chesapeake Bay and the land is a universal ethic.
> 5. Conservation of resources, including a reduction in resource consumption, is practiced.
> 6. To assure the achievement of items (1) through (5) of this section, economic growth is encouraged and regulatory mechanisms are streamlined.
> 7. Adequate public facilities and infrastructure under the control of the county or municipal corporation are available or planned in areas where growth is to occur.
> 8. Funding mechanisms are addressed to achieve these Visions.
>
> Md. State Finance and Procurement Code Ann. § 5-7A-01

[24] In 2012, the Maryland General Assembly repealed Article 66B and Article 28 and replaced it with the Land Use Article.

In addition to addressing these visions, mandated comprehensive plans must include elements on land use, transportation, mineral resources, sensitive areas, and community facilities[25]. Jurisdictions that fail to comply with this mandate cannot rezone land.

In 1984, the Maryland General Assembly enacted the Chesapeake Bay Critical Area Protection Act (hence Critical Area Act), which included broad directives for local jurisdictions to create programs to protect water resources and fish, plant, and wildlife habitat while accommodating growth in an environmentally protective manner (Chesapeake Stormwater Network, 2011). Areas located 1,000 feet from the all tidal waters and tidal wetlands were designated as critical areas. In 1986, the Critical Area Act added a requirement for a minimum 100ft buffer of natural vegetation from the mean high water line of tidal water, wetlands, and tributary streams along with other buffer provisions. This mandate is geographically-limited and does not cover all riparian areas in the state although the legislation encourages jurisdictions to extend these protections to other areas. As a result, this study investigates how the presence and design of mandates aimed a geographically narrow area (i.e., the Critical Area) influence the quality of riparian buffer policies throughout a watershed.

4.2.2 North Carolina

In contrast to the high level of state involvement in land use and planning observed in Maryland, North Carolina does not have a state office or department devoted to planning or similar state-level legislation on smart growth although there are programs aimed at basin-

[25] Two additional elements (Municipal Growth and the Water Resources) were added to the comprehensive plan requirements in the 2006 with a deadline for incorporation of October 1, 2009.

level planning for water quality[26]. There is no statewide legislative mandates requiring jurisdictions to create a comprehensive plan in order to exercise land regulatory powers with the exception of the 1974 Coastal Area Management Act. This legislation, however, is only applicable to coastal counties and municipalities[27]. There are a number of growth management strategies legally available to North Carolina jurisdictions (i.e., moratoria, adequate public facility ordinances, impact fees, urban service areas), but the adoption of these provisions remains at the discretion of local jurisdictions (Owens, 2006).

In 1989, the North Carolina General Assembly passed the Water Supply Protection Act, which required riparian buffers and placed restrictions on development density based on the classification of neighboring water bodies. Expansion of and revisions to this Act required local jurisdictions to adopt ordinances that meet minimum state standards to protect water supply sources. These ordinances are approved by the Environmental Management Commission, a 19-member commission responsible for adopting rules for the protection, preservation, and enhancement of water resources (North Carolina Department of Environment and Natural Resources, 2009). Each local government must administer and enforce the minimum requirement (which vary based on the classification of the adjacent water body) of a 30 foot vegetated stream buffer for low density development or a 100 foot vegetated stream buffer for high density development[28] (North Carolina § 143.214.5, 15A

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[26] In 1991, North Carolina began a basin-wide initiative with the planning division of North Carolina Department of Water Quality responsible for the development of plans. These plans are either adopted, disproved, or modified by the Environmental Management Commission. North Carolina General Statutes require the demonstration of incremental progress to the goals set forth in the basin-wide plans.

[27] The watershed selected for this study is not subject to the 1974 CAMA act.

[28] The low density development option ranges from 1 dwelling unit/2 acre or 6% built upon area to 1 dwelling unit/ 0.5 acre or 24% built on area depending on the classification of the water supply body. The high density development option ranges from 6-70% built upon depending on the classification of the water supply body.

NCAC 02B .0214-.0216). Similar to the mandate in Maryland, the Water Supply Protection Act is geographically-limited meaning it is only applicable to a limited portion of a jurisdiction's land area. Local jurisdictions can adopt ordinances that contain more stringent requirements than the state minimum with exceptions for agriculture and silviculture. Again, this study investigates how the presence and design of mandates aimed at a geographically narrow area (i.e., water supply watersheds) influence ordinance quality throughout a watershed.

4.3 Mandate Design

4.3.1 Comprehensive Planning Mandate

While both states enable local jurisdictions to create comprehensive plans, only Maryland has a comprehensive planning mandate. Articles 66B and 28 (now replaced by the Land Use Article) delegate land use planning and regulatory powers to local jurisdictions. In order to exercise these powers, jurisdictions must adhere to the amendments made by the Economic Growth, Resource Protection, and Planning Act of 1992, which requires a comprehensive plan. Table 4.2 summarizes the design features of the comprehensive planning mandate in Maryland using the methodology adapted from Burby, May and colleagues introduced in Chapter 3 (Burby et al., 1997).

Table 4.1: Design Feature Scores for Maryland Comprehensive Planning Mandate

Mandate Design Feature (Max. Possible Score)	**Score (%)**
Complexity	
Goal Clarity (15)	7 (47%)
Policy Objectives Clarity (15)	8 (53%)
Implementation Complexity (15)	10 (67%)
Capacity-Building (15)	5 (29%)
Commitment-Building (24)	17 (71%)
Implementation Style (12)	8 (67%)

Complexity. Mandate complexity includes an assessment of the clarity of mandate goals, the clarity of policy objectives guiding particular actions, and the implementation complexity (i.e., number of agencies involved and the process to gain approval). Mandates with higher scores on goal and policy objective clarity and lower scores on implementation complexity are more supportive of implementation. Beginning with goal clarity, the 1992 Economic Growth, Resource Protection, and Planning Act requires comprehensive plans to address the eight visions introduced in Section 4.2.1. The eight visions tend to be stated in vague terms (e.g., Development is concentrated in suitable areas) with less directed action (e.g., Sensitive areas are protected) while the achievement of these visions requires complex action. In a few instances like Visions 3 and 7[29], the goals are more specifically focused on geographic areas or the provision of infrastructure, but, overall, the vision statements remain broad and vague while providing little direction, but requiring complex action for goal achievement.

[29] Vision 3—In rural areas, growth is directed to existing population centers and resource areas are protected.
Vision 7—Adequate public facilities and infrastructure under the control of the county or municipal corporation are available or planned in areas where growth is to occur.

For the mandate in effect during the study period, there were ten required elements for comprehensive plans in Maryland (land use, transportation, community facilities, mineral resources (if applicable), sensitive areas, fisheries (if applicable), development capacity analysis, development regulations, implementation, and areas of Critical State Concern). There are between two to four policy objectives for each element and these objectives tend toward similar levels of vagueness, specificity, and directness. For example, the sensitive areas element, an area closely associated with water resource protection, includes only two policy objectives: 1) the element contains "goals, objectives, principles, policies, and standards designed to protect sensitive areas from the adverse effects of development" and 2) the element is reviewed by the Department of the Environment and the Department of Natural Resources for consistency with departmental programs and goals (Article 66B §3.05(a)(4)(ix)). Similar to the goals, the policy objectives tend toward broad, vague statements aimed at a complex outcome (e.g., protecting sensitive areas).

The implementation of Maryland's comprehensive planning mandate requires actions by at least three state agencies (Department of Planning, Department of Environment, and the Department of Natural Resources) and requires consultation with neighboring jurisdictions. These adjoining jurisdictions can comment on the plan with the possibility of mediation if a conflict arises. The coordination with state agencies and other local jurisdictions is streamlined by the State Clearinghouse, which distributes the plan to appropriate agencies and jurisdictions and consolidates review comments[30]. When additional elements are added to the mandate, a clear deadline for inclusion in comprehensive plans is established with

[30] Even with the State Clearinghouse streamlining the review process, the number of agencies and the review by adjoining jurisdictions resulted in a higher implementation complexity score.

possible extensions at the discretion of the Department of Planning. The mandate also requires the review and possible revision of the plan on a six year cycle with parallel review and revisions to development management ordinances.

Capacity- and Commitment-Building Elements. Capacity-building elements focuses on increasing a jurisdiction's ability to take action while commitment-building elements cultivate the willingness of a jurisdiction to take action. There was a large differential between the relatively low scoring capacity-building elements contained in the mandate and the substantially higher scoring commitment-building elements. While the mandate provides for technical assistance and state-funded mapping and information resources, there are no state funded 1) education and training opportunities, 2) personnel and equipment, or 3) any mention of authorization for new local fees or taxing authority. In contrast, the mandate scores high on commitment-building by including authorization of citizen lawsuits, the review of plans, and the inclusion of deadlines as well as sanctions for failure to comply.

Implementation Style. There is language suggestive of flexible interpretation of the mandate (i.e. various state agencies had discretion deciding whether or not plans were consistent with other programs and departmental goals); however, the implementation style of the Maryland mandate tends toward formalistic, legalized implementation. The mandate includes clear sanctions (revocation of the ability to rezone land if a jurisdiction fails to comply) and the compliance monitoring leans heavily on adherence to process and deadlines opposed to the achievement of particular outcomes. There was no written guidance on enforcement procedures prior to the imposition of sanctions.

4.3.2 Environmental Sensitive Area Mandates

Both the Chesapeake Bay Critical Area Protection Act in Maryland and North Carolina's Water Supply Protection Act of 1989 are geographically-limited mandates that require the protection of certain environmentally sensitive areas and may influence the quality of riparian buffer policies throughout the watershed. Both mandates allow for local jurisdictions to exceed the minimum requirements of the mandate. In the regulations adopted to enact the Critical Area Act, Maryland jurisdictions are explicitly encouraged to extend water resource protection policies to other areas.

> Local jurisdictions are encouraged to apply protection measures similar to those contained in their Critical Area program to land disturbances beyond the Critical Area boundary in an effort to protect or enhance water quality and to conserve plant and animal habitats of the Critical Area (MD. COMAR, 27.01.10.01(K)).

In North Carolina, jurisdictions may exceed minimum requirements, but the text emphasizes compliance with procedural regulations.

> In adopting a local ordinance that imposes water supply watershed management requirements that are more stringent than those adopted by the Commission, a county must comply with the notice provisions of G.S. 153A-343 and a municipality must comply with the notice provisions of G.S. 160A-384 (§143-214.5(d)).

Thus, from its conception, there is more legislative encouragement for the geographically-limited mandate in Maryland to influence ordinance quality at a watershed level when compared to the mandate in North Carolina. Table 4.3 summarizes the design features scores for the mandates in Maryland and North Carolina and the following section summarizes the assessment for both Maryland and North Carolina's mandates.

Table 4.2: Design Feature Scores for Environmental Sensitive Area Mandates

Mandate Design Feature (Max. Possible Score)	**Maryland** Score (%)	**North Carolina** Score (%)
Complexity		
Goal Clarity (15)	10 (67%)	5 (33%)
Policy Objectives Clarity (15)	11 (73%)	13 (87%)
Implementation Complexity (15)	9 (60%)	7 (47%)
Capacity-Building (15)	11 (73%)	6 (40%)
Commitment-Building (24)	18 (75%)	15 (63%)
Implementation Style (12)	9 (75%)	10 (83%)

Complexity. As stated above, higher scores on goal and policy clarity and lower scores on mandate complexity are more supportive of mandate implementation. The first element, goal clarity, assesses the vagueness, complexity, directness, specificity, and the number of goals. Maryland's Critical Areas Protection Act charges each jurisdiction with the development of a Critical Areas Program to fulfill three goals:

1) Minimize adverse impacts on water quality that result from pollutants that are discharged from structures or conveyances or that have runoff from surrounding lands;

2) Conserve fish, wildlife, and plant habitat; and

3) Establish land use policies from development in the Chesapeake and Atlantic Coastal Bays Critical Area which accommodate growth and also address the fact that, even if pollution is controlled, the number, movement, and activities of persons in that area can create adverse environmental impacts.

(MD. COMAR, 27.01.10.01(O))

While these goals include words and phrases with broad interpretations such as "conserve" or "minimize adverse impacts", the overall statements offer a more specific and narrow focus compared to vision statements from the comprehensive planning mandate like 'sensitive areas are protected'. The actions necessary to accomplish these goals remain complex and only the final goal more clearly directs action.

The most prominent passage of North Carolina's Water Supply Protection Act utilizing goal language states that required water standards shall 1) to protect human health, 2) prevent injury to plant and animal life, 3) prevent damage to public and private property, 4) insure the continued enjoyment of the natural attractions of the State, 5) encourage the expansion of employment opportunities, and 6) provide a permanent foundation for healthy industrial development and to secure for the people of North Carolina, now and in the future, the beneficial uses of these great natural resources (§143-211(c)). There are more goals than the Maryland mandate and the goals tend to be vague such as 'protect human health', which could encompasses a broad range of activities. The North Carolina mandate does not provide directed actions to accomplish its goals, and the actions necessary to achieve these goals are quite complex. Additionally, a number of these goals may be in conflict (i.e., Goals 1-4 with Goals 5-6) in some development scenarios. In sum, the Maryland mandate scores higher on goal clarity than the North Carolina mandate because of the limited number of goals, its use of specificity, and the inclusion of some directed action.

Policy Objective Clarity. The Maryland mandate includes numerous policy objectives to guide the creation of the programs and to serve the State's interest in having uniform and consistent protection of sensitive areas. The scope and specificity of these policy objectives depends on the topics areas, but, overall, these objectives are directed, specificity, and narrow in focus. For example, the division of the Critical Area in Intensely Developed Areas, Limited Development Areas, and Resource Conservation Areas is accompanied by guidelines for allowable and restricted uses, stormwater requirements, infrastructure placement, and site design.

There are a few policy objectives associated with the North Carolina mandate and they also tend to be very narrow in scope. Depending on the classification of water supply watersheds, local governments must develop watershed protection programs that limit both allowable uses and development density and provide for stormwater drainage and buffers. The potential ranges of development density, buffers widths, and restricted uses are clearly delineate for each classification and, as a result, the mandate scores quite high on the clarity of policy objectives. The North Carolina mandate scores slightly better than the Maryland on policy objective clarity because of the mandate contains fewer objectives and the objectives tend to be simpler than the objectives contained in the Maryland mandate.

Implementation Complexity. For this element, a higher score corresponds to more complexity in mandate implementation. In Maryland, jurisdictions must submit their program to Critical Area Commission for approval and local jurisdictions are encouraged (but not required) to establish cooperative arrangements with jurisdictions and other state agencies with lands within or adjacent to the critical area. There are deadlines associated with submission of the program to the Commission as well as annual reports on development within the critical area.

In North Carolina, the mandate scores relatively low for implementation complexity. Jurisdictions must submit their program to the Environmental Management Commission for approval and to three other state agencies for their files (i.e., no review or action is required). The mandate encourages intergovernmental arrangements, but local jurisdictions are not required to coordinate with neighboring jurisdictions. Beyond the initial deadline to submit an ordinance, there do not appear to any on-going mandated local actions. The added layers of state approval in Maryland increases the implementation complexity score above that of North Carolina.

Capacity and Commitment-Building Elements. The Maryland mandate contains capacity-building elements such as technical assistance upon request, state assistance in mapping and funding for the initial program development as well as on-going funding opportunities for implementation. Additionally, jurisdictions can collect fees in lieu of on-site mitigation under certain circumstances. The North Carolina mandates scores lower than Maryland due to the inclusion of fewer capacity-building elements. While there are provisions for technical assistance, a model ordinance, and workshops to aid jurisdictions in the preparation of their ordinance, the mandate does not include the same level of funding opportunities as the Maryland mandate.

The scores for commitment-building elements were more comparable for the two states. The Maryland mandate included deadlines for initial local government action, sanctions for failure to meet deadlines, financial penalties for failure to comply with the mandate, and provisions for state preemption of local authority if a program is either not created or not enforced. However, the state pre-emption extends only to the creation of the program. Local jurisdictions are then responsible for implementation. In the North Carolina mandate, commitment-building elements including planning grants, deadlines for initial local government action, sanctions for failure to meet deadlines, financial penalties for failure to comply with the mandate (civil penalty not to exceed $25,000), and provisions for state preemption of local authority if an ordinance is either not created or not enforced.

Implementation Style. The mandates from both states tend towards formalistic, legalized implementation as there are sanctions (i.e., civil penalties and/or preemption of local authority). In Maryland, the enforcement approach utilizes deadlines for the submission of the program and semi-annual reports on development in the critical area while North Carolina approach to enforcement begins with submission of the plan with a cover letter by the local jurisdiction's legal counsel attesting its adherence to state requirements. The North Carolina enforcement approach leans heavily on deadlines even with provisions for less formalized enforcement (i.e., local authority cannot be preempted before recommendations for improvement are provided to a local government). In contrast, the extensive guidance provided on violations and variances in the Maryland mandate does suggest a more goals and outcome focused approach to the protection and restoration of the critical area.

In summary, the clarity of the goals and policy objectives of the Maryland mandate coupled with commitment and capacity-building elements should support the implementation of the mandate. The mandate does require some coordination with state or other governmental entities, but there are mechanisms in place to help facilitate the coordination. Additionally, there is a structure in place to monitor development over time although the semi-annual timeline for monitoring may contribute to less than consistent implementation of the program. However, the mandate includes provisions to nullify approvals and repair environmental damage.

For the North Carolina mandate, the goals are less clearly stated, but the clarity of the mandate's policy objectives and the relatively low implementation complexity may support its implementation. The heavily formalistic and legalistic implementation style is consistent with the higher scoring clarity of policy objectives and lower level of capacity-building elements (Burby et al., 1997, pp. 90–91). However, it is unclear how implementation of the mandate will be monitored over time. There are clear sanctions in addition to other commitment-building elements, but there do not appear to be institutional structures in place to monitor compliance with the mandate beyond the initial approval by the Commission and applications for 401 wetlands permits.

4.4 Conclusion

Mandates are one strategy to overcome the barriers to water resource protection described in Chapter 2. The Maryland comprehensive planning mandate described in this chapter requires jurisdictions to take action on a set of broad goals while providing little direction on how to accomplish policy objectives and fewer resources to build local capacity. The presence of more commitment-building features and a more legalistic implementation style places the emphasis on procedural compliance instead of outcomes. The next chapter (Chapter 5: Plan Quality) examines how the design of this mandate influences plan quality by comparing one watershed subject to the Maryland comprehensive planning mandate (Gunpowder-Patapsco watershed in Maryland) to one watershed (Jordan Lake watershed in North Carolina) without a comprehensive planning mandate.

Although the environmental sensitive area mandates score similarly on design features, there are subtle distinctions within categories. The Maryland mandate provides very specific guidance for the substantive content of a wide range of local policies associated with this mandate. The North Carolina mandate also provides clear guidance but is limited to a few policy objectives. Both mandates contain capacity-building and commitment-building elements, but Maryland makes more resources available and has more sanctions in place.

Finally, jurisdictions in Maryland and North Carolina have the legal latitude to exceed the minimum requirements of the single-purpose mandates aimed at protecting environmentally sensitive areas. Maryland encourages (but does not require) the extension of Critical Area protections while North Carolina allows for more stringent requirements, but emphasizes the legal requirements associated with that action. In short, Maryland's mandate provides an extensive list of substantive requirements, a range of incentives and on-going support, but is limited to a smaller geographic area. The North Carolina mandate covers a larger geographic area, but requires fewer substantive elements and provides a lower level of support. Chapter 6 examines how the design of these geographically-limited mandates influences ordinance quality by comparing the quality of buffer protection provisions within development management ordinances of the Gunpowder-Patapsco watershed in Maryland to the Jordan Lake watershed in North Carolina.

CHAPTER 5: PLAN QUALITY RESULTS

5.1 Introduction

Many states use mandates to compel jurisdictions to take action to control growth, manage risk from natural hazards, or protect environmental resources (Berke et al., 1996; Berke, 1998; Burby & Dalton, 1994; Burby & May, 1998; Burby, 2005; Burby et al., 1993, 1997; Dalton & Burby, 1994; May & Burby, 1996; May & Williams, 1986). The majority of these studies conclude that jurisdictions in states with mandates were more likely to have higher quality plans than jurisdictions in states without mandates, but most of these studies were conducted on the topic of hazard mitigation. This study is the first to investigate the influence of a comprehensive planning mandate on plan quality with respect to water resource protection.

This chapter reports the results of a series of bivariate statistical analyses used to test the first research question posed in Chapter 1: Do jurisdictions in a state with a mandate for comprehensive planning have higher quality comprehensive plans with respect to water resource protection than jurisdictions in a state without a mandate? I expect jurisdictions in the Gunpowder-Patapsco watershed that are subject to Maryland's comprehensive planning mandate to have, on average, higher quality comprehensive plans than jurisdictions in the Jordan Lake watershed in North Carolina where there is no comprehensive planning mandate.

This study utilized seven principles from the plan quality literature to investigate the incorporation of water resource protection in the comprehensive plans of jurisdictions. These seven principles were operationalized using 110 indicators[31] based on the water resource protection research literature (Burby et al., 1983; Center for Watershed Protection, 1998; Dunne & Leopold, 1978; Schueler & Holland, 2000; Schueler, 1994). The complete protocol can be found in Appendix A.

The total scores for each principle were separately normalized to a scale of 0 to 10 to enable comparisons amongst principles. For individual indicators, the percentage of plans that include a particular indictor was used to examine differences between the two watersheds[32]. Each variable was tested for normality and unequal variance using both graphic and numeric methods. Three comparison of means tests (t-test, Welch's t-test, Mann-Whitney U test) were utilized based on results of the normality and unequal variance tests to determine if differences between scores achieved traditional levels of statistical significance (p=0.05) when compared at the watershed level.

The following sections provide detailed results on the two conceptual groupings of plan quality principles (i.e., direction-setting and action-oriented frameworks) as well as results for each principle. The direction-setting framework includes the principles that should guide a community's current and future development: *Goals*, *Fact Base*, and *Policy Framework*. The principles within the action-oriented framework (i.e., *Implementation*, *Monitoring*, *Inter-Jurisdictional Coordination*, and *Participation*) outline the steps and actions necessary to implement and monitor the plan as well as efforts to engage and maintain relationships with key stakeholders.

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[31] The indicators for *Goals* were coded on a binary scale (0- not mentioned, 1- mentioned). The indicators for the remaining principles were coded on an ordinal scale (0- not mentioned, 1- mentioned but not detailed, and 2- mentioned and detailed).
[32] The Mann-Whitney U test was used when the normality assumption was violated.

5.2 Direction-Setting Framework

Planning, at its core, unites intention and action by articulating objectives and policies to shape current actions that will, in turn, help produce future outcomes. In order to fulfill this function, a comprehensive plan should include: 1) goals that establish community's objectives, 2) information outlining the current conditions and future projections, and 3) a policy framework that details strategies to guide future programs, policies, and projects. A total of 85 indicators were used to operationalize the direction-setting framework: *Goals* (10); *Fact Base* (34), and *Policy Framework* (41). Table 5.1 includes the mean score and standard deviation for each direction-setting principle by watershed and the p-values from the comparison of means tests.

Table 5.1: Direction-Setting Principle Scores by Watershed[33]

	Gunpowder-Patapsco		Jordan Lake		
	Mean	*SD*	*Mean*	*SD*	p value
Goals	3.31	1.84	3.11	2.37	0.428
Fact Base	2.90	1.48	2.78	1.37	0.852
Policy Framework	2.53	1.32	2.53	1.91	0.999
Overall Direction-Setting mean	*2.86*	*1.23*	*2.81*	*1.79*	*0.934*

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

Neither watershed scored half of the available points for any of the individual principles of the direction-setting framework. Although *Goals* is the highest scoring principle, the majority of the goals identified by the research literature as key contributors to water resource protection were not included in the comprehensive plans of either the

[33] Tests for normality indicated the *Goals* variable was not normally distributed, and the Mann-Whitney U test, a nonparametric test against the null hypothesis that two populations are the same, was performed. Both numerical tests and graphic indicated that the *Direction-Setting, Fact Base* and *Policy Framework* variables did not violate the normality assumption, and t-tests were used to compare the means.

Gunpowder-Patapsco or the Jordan Lake watersheds. There was not a statistically significant difference between the overall mean *Goals* score for the two watersheds *(p=0.428).*

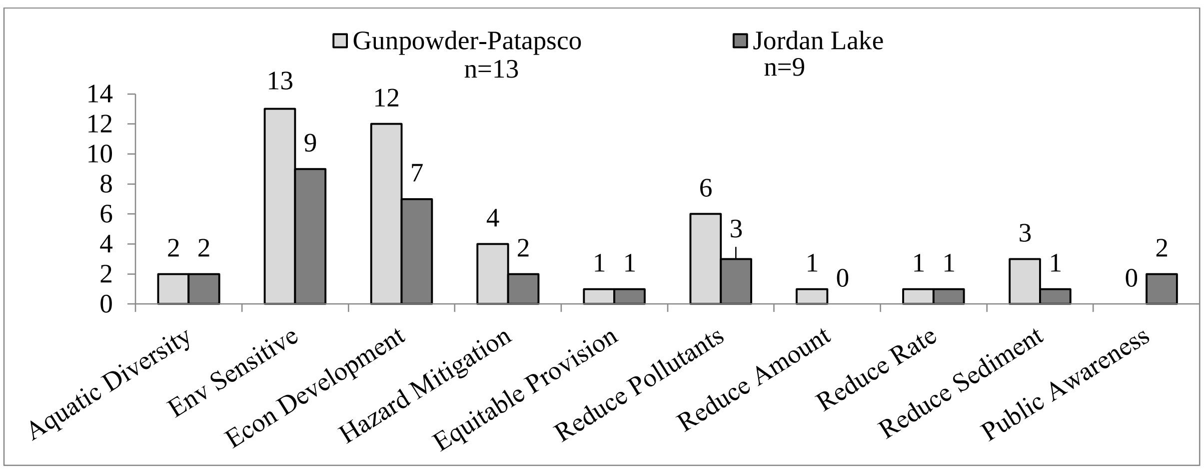
The low mean scores for the *Fact Base* and *Policy Framework* principles for both study watersheds suggest there is an opportunity for all the jurisdictions to formulate 1) stronger information bases with respect to the protection of water resources and 2) more extensive policy frameworks that provide a range of policy options. There was not a statistically significant difference between the overall *Fact Base* mean scores *(p=0.852)* or the overall *Policy Framework* mean scores *(p=0.999).* The following sections examine these three direction-setting principles in more depth.

5.2.1 Goals

The formulation of goals is an essential component in the articulation of intention (Berke, Godschalk, et al., 2006; Hoch, 2007b). This study used the number of goals as a proxy for intention to take action to protect water quality. The inclusion of more water quality-related goals within a plan reflects more comprehensive coverage of the topics identified by the research literature as key factors for the protection of water quality. Figure 5.1 is a bar chart of the number of jurisdictions including a particular goal within their comprehensive plan for each study watershed.

Only one goal appeared in all 22 plans: the protection of environmentally sensitive natural areas. For five jurisdictions (three in the Gunpowder-Patapsco and two in the Jordan Lake watershed), this is the only water resource protection goal included in their comprehensive plan. The majority of plans in both the Gunpowder-Patapsco watershed (12 or 92%) and the Jordan Lake watershed (7 or 77%) included goals about balancing economic development with the protection of water resources. Nine plans had goals about reducing the pollutant load in stormwater runoff (Gunpowder-Patapsco [6 or 46%] and Jordan Lake [3 or 33%]). Four plans in the Gunpowder-Patapsco watershed (31%) and two plans in the Jordan Lake watershed (22%) included a goal about hazard mitigation. Less than 25% of the plans in either watershed included goals for aquatic diversity of plant and animal life, equitable provision of services, reduction in the quantity or rate of stormwater runoff, or public awareness/involvement in watershed protection.

Figure 5.1: Number of Jurisdictions by Goal and by Watershed



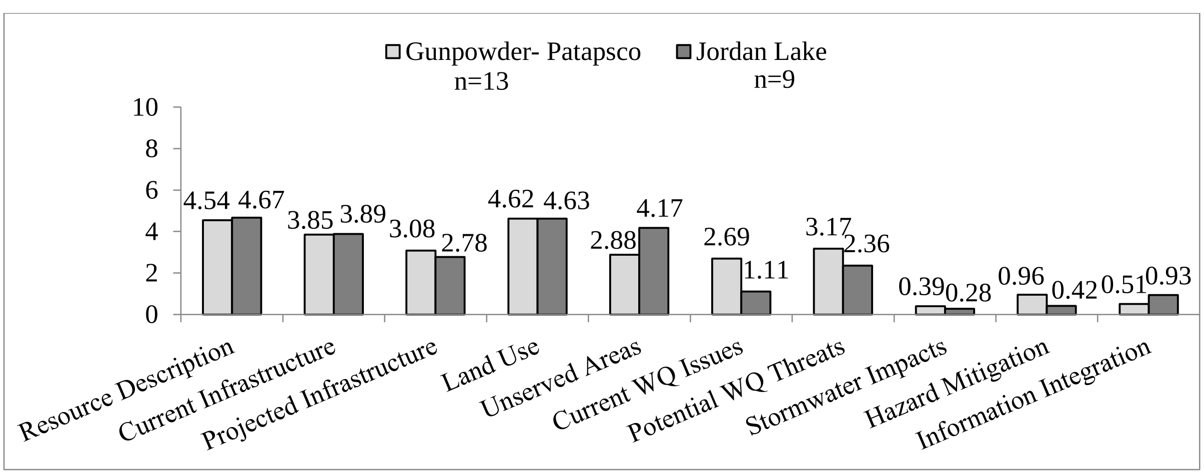
While the absence of a goal does not preclude the inclusion of information or policies associated with a particular topic, goal formation is, perhaps, the most visible declaration of intention. This intention (or forethought towards an preferred outcome) is key to differentiating plan-based action from other types of action (Hoch, 2007b; Hopkins, 2001). A deficiency of goals can undermine the direction-setting function of the plan because, without a robust set of goals, it becomes unclear how a jurisdiction intends to act to protect water resources.

5.2.2 Fact Base

The fact base of a comprehensive plan helps a community's chart a pathway to its goals by establishing current conditions and then linking those conditions to the future through estimates and projections. It also provides guidance and justification for the selection of proposed policies. The thirty-four indicators of the *Fact Base* principle covered ten topic areas: 1) a description of water resources and drinking water supply, 2) current infrastructure, 3) projected infrastructure, 4) current and projected land use, 5) unserved areas, 6) current water quality issues, 7) potential threats to water quality, 8) stormwater impacts, 9) hazard mitigation, and 10) information integration. Figure 5.2 is a bar chart of the mean scores by each fact base topic area for each watershed.

Comparison of means tests for the individual topics areas did not find statistically significant differences between the watersheds. Current and Projected Land Use was the only topic area coded within all 22 plans. Given the central and historical role land use has played in comprehensive planning, the universal inclusion of this subject is not surprising (Kaiser & Godschalk, 1995). It helps explain why, along with Resource Description, Land Use was one of the highest scoring fact base topic areas for both watersheds.

Figure 5.2: Mean Score by Fact Base Topic Area by Watershed

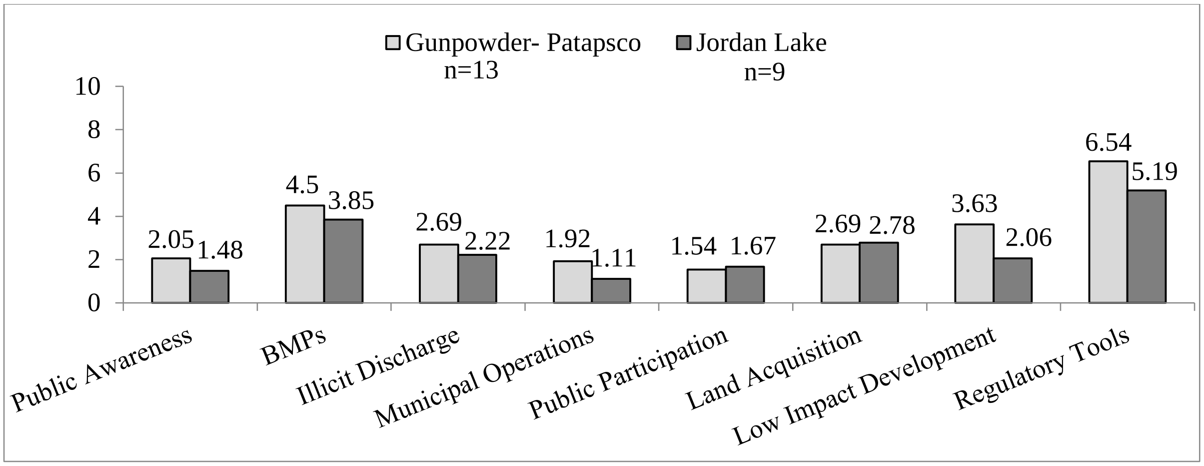


Only two jurisdictions scored over 50% of the total possible *Fact Base* score (Orange County, NC [5.4] and Manchester, MD [5.3]). This finding, however, should not be construed as an absence of information in the comprehensive plans of the two study watersheds. Thirty of the thirty-four *Fact Base* indicators were coded in at least one plan. Nineteen indicators were mentioned in 50% or more of the plans in either the Jordan Lake or Gunpowder-Patapsco watersheds. Eleven indicators were mentioned in 50% or more of the comprehensive plans in both watersheds. These findings highlight the inconsistent inclusion of *Fact Base* indicators at the watershed level, which is a major barrier to water resource protection at a regional level.

5.2.3 Policy Framework

The policy framework of a comprehensive plan establishes the set of strategies that a community might use to reach its goals and objectives. These policies should be directed at achieving a particular goal and may justify their selection through references to their fact base and/or best practices in the field (Berke, Godschalk, et al., 2006; Kaiser & Davies, 1999). This study used 41 indicators to operationalize this principle recognizing that a diverse policy framework helps facilitate the protection of water resources by providing options within the complex sociopolitical context of land use management. Figure 5.3 is a bar chart of the Policy Framework mean scores by the eight topic areas for each study watershed.

Figure 5.3: Mean Score by Policy Framework Topic Area by Watershed



A number of topic areas scored low including Public Awareness, Illicit Discharge, Municipal Operations, Public Participation, and Land Acquisition. Neither watershed consistently included policies to educate and engage the public in water resource protection. Nor did either watershed consistently incorporate preventative monitoring and programming activities like altering municipal operations to protect water quality or supporting illicit discharge programming. Finally, although slightly higher scoring than other topic areas, few jurisdictions included Land Acquisition policies to protect water resources.

The topic area mean scores for Best Management Practices and Low Impact Development[34] were higher, but neither watershed scored over 50% of the available points in these areas. Only the mean score for Regulatory Tools exceeded the 50% mark in both watersheds. This topic area covered zoning, buffer requirements, overlays and districts, growth and service boundaries, and municipal oversight activities such as development

[34] It is important to note for the Low Impact Development policies and the Regulatory Tools policies to be coded, the plans needed to make a connection between the policies and water quality. This coding decision stems from the possible negative consequences some policies can have on water resources. For example, a community may have a plan for infrastructure extensions that can negatively impacts water quality if it allows the extension of infrastructure into sensitive areas.

review. The relatively high scores for *Regulatory Tools* suggests both watersheds may rely more heavily on regulatory policies while neglecting programing and monitoring policies to complement these more prescriptive structures. Finally, although the Gunpowder-Patapsco watershed scored higher than the Jordan Lake watershed in all categories except public participation and land acquisition, there were no statistically significant differences between the watersheds for any of the Policy Framework topic areas.

5.3 Action-Oriented Framework

Comprehensive plans should clearly outline the steps and actions necessary to implement the policies contained in the plan as well as the mechanisms to monitor and evaluate its implementation. Additionally, plans should provide a description of the actions taken to 1) incorporate community input into the plan and 2) coordinate efforts to create and maintain relationships among key stakeholders (Berke, Godschalk, et al., 2006; Burby, 2003; McClendon, 2003). A total of 25 indicators were used to operationalize the action-oriented framework: *Implementation* (6); *Monitoring* (5), *Inter-jurisdictional Coordination* (7), and *Participation* (7). Table 5.2 includes the mean score and standard deviation for each action-oriented principle by watershed and the p-values from the comparison of means tests.

Table 5.2: Action-Oriented Principle Scores by Watershed[35]

	Gunpowder-Patapsco		Jordan Lake		
	Mean	*SD*	*Mean*	*SD*	p value
Implementation	2.24	1.78	1.94	1.82	0.705
Monitoring	2.15	2.12	3.22	2.91	0.329
Inter-jurisdictional Coordination	4.01	2.53	2.38	1.34	0.065*
Participation	4.40	1.51	3.57	1.29	0.198
Overall Action-Oriented mean	*3.20*	*1.23*	*2.78*	*1.39*	*0.462*

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

Neither watershed scored half of the available points for any one individual principle of the action-oriented framework. The low mean scores for the *Implementation* and *Monitoring* principles for both of the study watersheds result from few jurisdictions assigning responsibility for implementation tasks, allocating the time and resources necessary to implement the plan, or establishing a process to monitor progress towards achieving plan goals. There was not a statistically significant difference between the overall *Implementation* mean scores *(p=0.705)* or the overall *Monitoring* mean scores *(p=0.329).*

Inter-jurisdictional Coordination is the only principle where there was a statistically significant difference between the two watersheds at the 0.1 level (*p=0.065*). The mean *Inter-Jurisdictional Coordination* score was the second-highest scoring action-oriented principle for the Gunpowder-Patapsco watershed (4.01), but the second lowest scoring principle for the Jordan Lake watershed (2.38). The *Participation* mean score was the highest scoring action-oriented principle for both watersheds (Gunpowder-Patapsco—4.40; Jordan

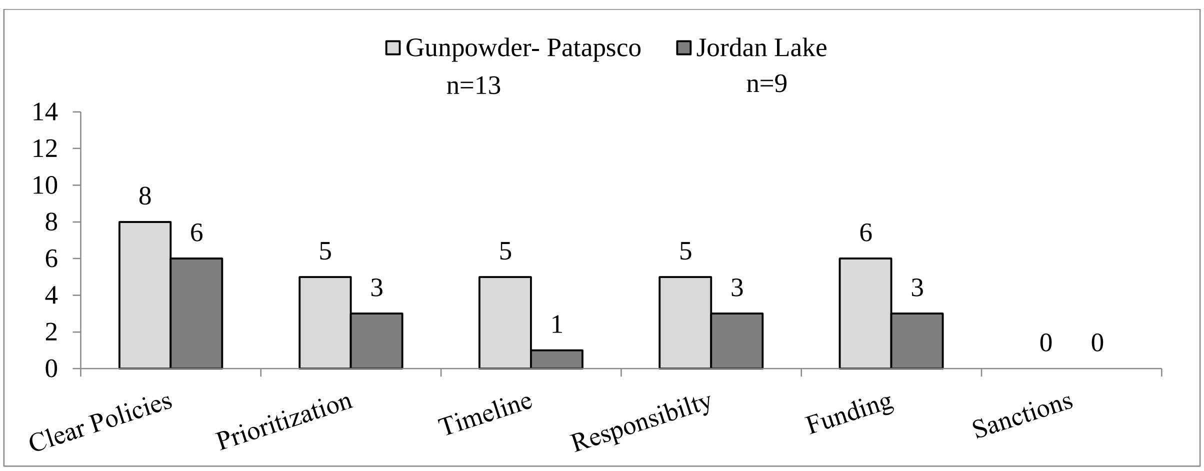
[35] Numerical tests for normality and graphic plots suggested the *Implementation* and *Monitoring* variables were right-skewed and may violate assumptions for normality. Both a t-test and a Mann-Whitney U test were performed and neither test found a statistically significant difference. In both cases, the more conservative p-value is reported. Both numerical tests and graphic plots indicated that the *Action-Oriented*, *Inter-Jurisdictional Coordination* and *Participation* variables did not violate the assumption of normality.

Lake—3.57), but there was not a statistically significant difference between the watersheds ($p=0.198$). The following sections examine these four action-oriented principles in more depth.

5.3.1 Implementation

Implementation begins to bridge intention and action by stating and prioritizing policies, assigning responsibility, providing timelines, and identifying potential funding sources (Berke, Godschalk, et al., 2006). This principle should unite the intention articulated in the direction-setting framework with the administrative actions necessary to bring the plan goals and policies to fruition. Figure 5.4 is a bar chart of the number of jurisdictions including each of the six implementation indicators within their comprehensive plans by watershed.

Figure 5.4: Number of Jurisdictions by Implementation Indicator and by Watershed



No one single *Implementation* indicator was coded in all 22 plans and there were no statistically significant differences between the two watersheds on any indicator. A majority of both watersheds (62% of Gunpowder-Patapsco plans and 67% of Jordan Lake plans) included clearly identified actions to implement policies. Approximately 38% of the plans in the Gunpowder-Patapsco watershed 1) prioritized actions, 2) included a timeline, and 3) assigned responsibility for implementing policies. Comparably, about 33% plans in the Jordan Lake watershed assigned priority to specific implementation actions or designated responsible organizations. Only one plan in the Jordan Lake watershed (11%) including a timeline. Forty-six percent of the Gunpowder-Patapsco plans and 33% of the Jordan Lake plans included sources of funding to support plan implementation. No jurisdictions included sanctions or ramifications for the failure to implement the plan's policies or programs.

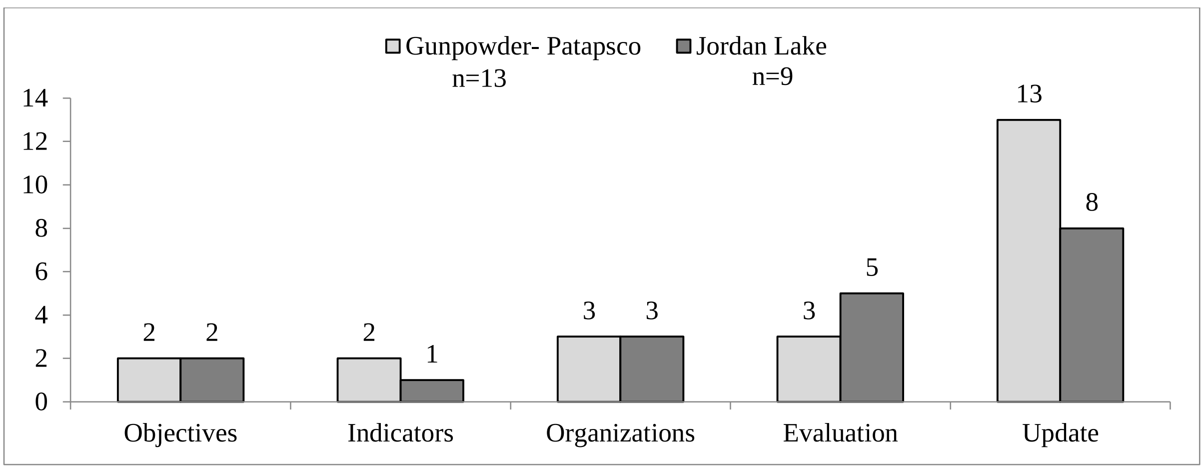
While the majority of both watersheds included clearly stated policies, a key step in implementation, fewer jurisdictions in either watersheds prioritized policies, included a timeline or funding, or assigned responsibility. Further, there were no consequences for failing to implement the plan. Overall, the clearly stated policies included in the plans were not accompanied by key factors supportive of their implementation.

5.3.2 Monitoring

Monitoring supports plan implementation by providing the feedback necessary to maintain the alignment between the intention articulated by a plan and shifting community conditions (Berke, Godschalk, et al., 2006). The indicators under this principle assess the inclusion of measurable objectives, the identification of the data sources needed to track progress, the assignment of monitoring responsibilities to organizations, the articulation of an evaluation process, and a timeline for updating the plan. Figure 5.5 is a bar chart of the number of jurisdictions by the five monitoring indicators for each watershed.

Monitoring was the only individual plan quality principle where the overall score for the Jordan Lake watershed exceeded the score for the Gunpowder-Patapsco watershed, but there were no statistically significant differences between the two watersheds on individual *Monitoring* indicators. All but one plan (Chatham County, NC) included the indicator for updating the plan. Less than a third of the plans in either watershed included 1) measureable objectives, 2) indicators to monitor progress, or 3) organizations responsible for monitoring plan implementation. A majority of the jurisdictions in the Jordan Lake watershed (56% or 5 plans) at least mentioned a process to evaluate progress towards plan objectives compared to 23% of the Gunpowder-Patapsco plans.

Figure 5.5: Number of Jurisdictions by Monitoring Indicator and by Watershed

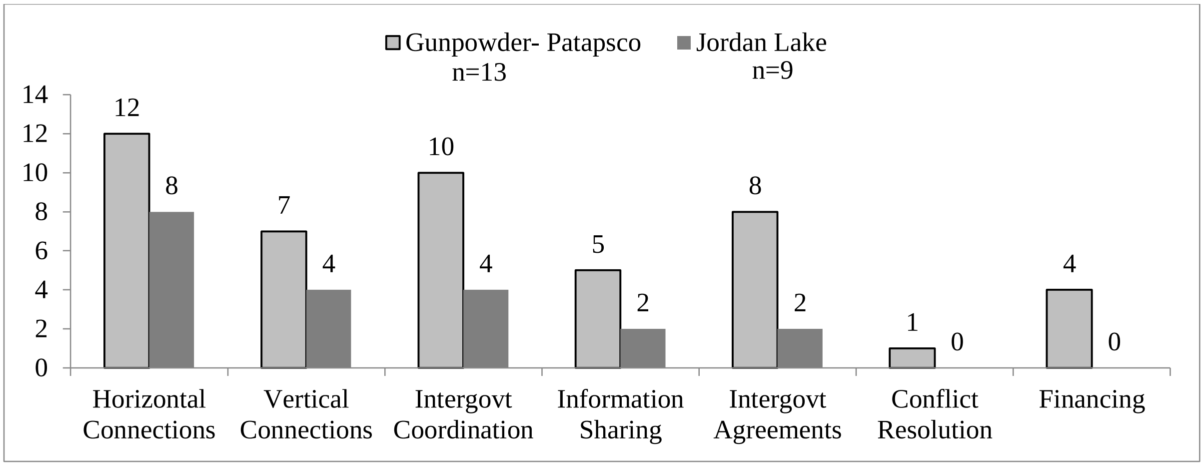


Similar to the results of the *Implementation* principle, only one indicator is mentioned in the majority of plans in both watersheds—Update. While the inclusion of a timeline for updating the plan is an important step in maintaining plan relevancy amidst changing conditions, it is only one component to monitoring progress. The majority of plans lack measureable objectives, identified data sources, monitoring organizations, and a clearly articulated evaluation process. In short, the majority of plans fail to describe the who, what, and how of their monitoring process.

5.3.3 Inter-jurisdictional Coordination

The spatial mismatch and barriers to collective action inherent in water resource protection detailed in Chapter 2 highlight the importance of the *Inter-Jurisdictional Coordination* principle. Comprehensive plans provide an opportunity to describe existing connections among local, regional, and state stakeholders and the processes utilized to coordinate and maintain collaborative activities. The indicators under this principle describe the horizontal and vertical connections between stakeholders, policies in place for information sharing, intergovernmental coordination and agreements, the provision of conflict resolution procedures, and financing for intergovernmental activities. Figure 5.6 is a bar chart of the number of jurisdictions mentioning the seven inter-jurisdictional coordination indicators by watershed.

Figure 5.6: Number of Jurisdictions by Coordination Indicator and by Watershed



Although no one indicator was mentioned in all of the plans, the vast majority of the Gunpowder-Patapsco plans (12 or 92%) and the Jordan Lake plans (8 or 89%) included descriptions about horizontal connections between stakeholders (e.g., relationships within a watershed or region). Fewer plans in either watershed mentioned vertical connections with state agencies and programs concerning water resources (54% of Gunpowder-Patapsco plans [7] and 44% of Jordan Lake plans [4]).

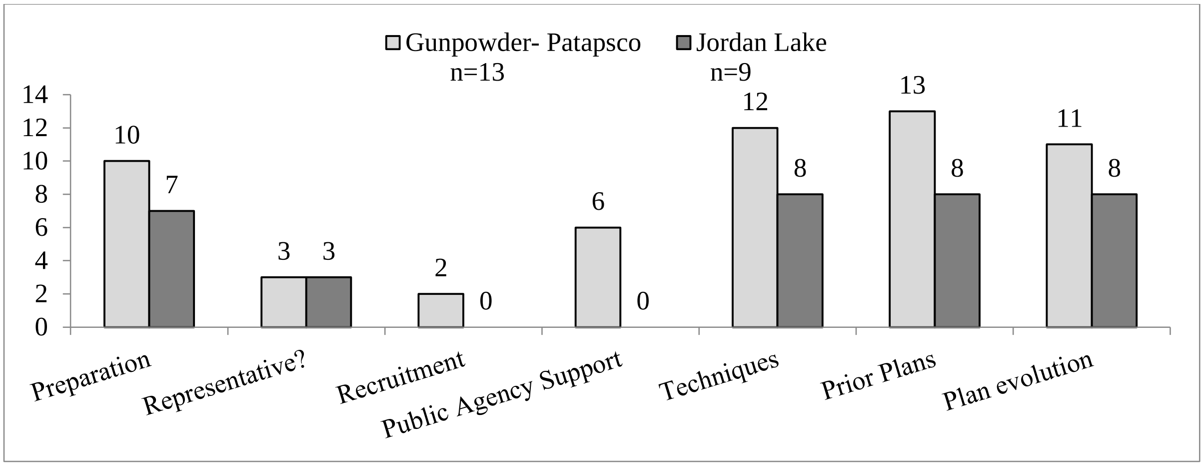
Inter-jurisdictional Coordination is the only plan quality principle where there was a statistically significant difference between the mean scores for the Jordan Lake and Gunpowder-Patapsco watersheds. The difference was likely due to scores on three indicators: 1) description of processes for intergovernmental coordination, 2) policies governing the creation and maintenance of inter- governmental agreements or other cooperative agreements, and 3) policies governing the commitment of financial resources from multiple jurisdictions. A much higher percentage of plans in the Gunpowder-Patapsco watershed mention intergovernmental coordination (77% vs. 44%), inter-governmental agreements (62% vs. 22%), and financial resources (31% vs. 0%).

The statistically significant difference between the watersheds on the *Inter-Jurisdictional Coordination* principle may reflect requirements of Maryland's comprehensive planning mandate. Jurisdictions must submit their plans to adjoining jurisdictions for comment. This plan review requirement establishes at least some inter-jurisdictional exchange that may help account for the higher score observed in the Gunpowder-Patapsco watershed. Further investigation is necessary to determine if the scores are evidence that jurisdictions in Maryland are managing the spatial mismatch inherent in water resource protection and if there are positive impacts on the coordination of development around the boundaries between jurisdictions.

5.3.4 Participation

Purposeful and substantive engagement of stakeholders throughout the plan making process can help ensure a plan reflects and integrates the goals and objectives of a wide cross-section of stakeholders (Berke, Godschalk, et al., 2006). Participation injects information from stakeholders into the planning process, provides information to community stakeholders, and can increase ownership of the final plan and support for its implementation (Brody, Godschalk, & Burby, 2003; Burby, 2003). The indicators for the *Participation* principle focused on 1) a description of the participants involved in plan creation, 2) how representative those participants were of the larger community, 3) participant recruitment, 4) the involvement of public agencies outside of the planning department, 5) techniques used to facilitate participation, 6) the influence of prior planning activities, and 7) an explanation of how input from participants influenced the plan. Figure 5.7 is a bar chart of the number of jurisdictions by the seven participation indicators for each watershed.

Figure 5.7: Number of Jurisdictions by Participation Indicator and by Watershed



Over 75% of the plans in both watersheds at least mentioned 1) the organizations and individuals involved in plan preparation; 2) the participation techniques used during the planning process; 3) how prior planning activities influenced the current planning process; and 4) how the plan evolved based on participant input. Three plans from either watershed (23% in Gunpowder-Patapsco and 33% in Jordan Lake) described how participants within the planning process were representative of all the stakeholders affected by the proposed plan. An even smaller percentage of plans (15% in Gunpowder-Patapsco and 0% in Jordan Lake) included an explanation of the recruitment of particular organizations or individuals.

There was a statistically significant difference at the 0.05 level for a single indicator (Public Agency Support, $p=0.015$). This indicator refers to the involvement of key public agencies other than the planning department in the planning process. Forty-six percent of the plans in the Gunpowder-Patapsco watershed mentioned this indicator while no plans in the Jordan Lake watershed included it.

While many plans from both watersheds included descriptions of participants, participation techniques, and the influence of prior plans and participant input, the plans may not be representative of all the groups affected by proposed policies. Few plans describe how participants are recruited into the planning processes and whether those involved in plan preparation were representative of the community, which limits an assessment of efforts to include populations often marginalized in planning processes. Additionally, the limited discussion of other public agencies in plan creation may result in less buy-in and involvement from agencies that play key roles in plan implementation.

5.4 Conclusion

The plan quality scores were relatively low with few individual jurisdictions scoring over half of the available points for any single principle, and neither watershed scored over half of the available points on any single principle. A weak direction-setting framework can hinder a community's ability to propose and take actions to protect water resources. There is an opportunity for all the jurisdictions to articulate more specific goals around the protection of water resources and to link those goals to a more diverse set of policies using a stronger fact base.

A weak action-oriented framework may indicate there are barriers to plan implementation. While specific goals, a detailed fact base, and a diverse policy framework are essential components of a comprehensive plan (as they represent the intention to protect water resources), the action-oriented framework is necessary to translate this intention into action (Berke et al., 2013). The low mean scores for implementation for both watersheds are of particular concern because they may indicate limited capacity to assemble the people and resources necessary to put the plan into action. In summary, there are substantial opportunities to improve the incorporation of water resource protection into comprehensive plans of both study watersheds.

This chapter investigated how plan quality differed in two watersheds in two states with and without a comprehensive planning mandate. Based on the research literature, jurisdictions in a state with a mandate for comprehensive planning were expected to have, on average, higher quality comprehensive plans with respect to the protection of water resources than jurisdictions in a state without a mandate. Thus, the Gunpowder-Patapsco watershed in Maryland was expected to have higher scores on individual plan quality principles when compared to the scores from the Jordan Lake watershed in North Carolina. Contrary to this hypothesis, the two study watersheds were only statistically significantly different on one principle (*Inter-Jurisdictional Coordination, p=0.065*) and the difference was at the 0.1 level opposed to the 0.05 level. There are a few design features of the comprehensive planning mandate that might help explain why the mandate was not a sufficient condition to promote water resource protection above the levels observed in jurisdictions acting without a mandate.

The characterization of the comprehensive planning mandate in Chapter 4 highlighted mid-level goal and objective clarity and the more extensive inclusion of commitment-building elements compared to capacity-building elements. The result is vague and undirected goals and policy objectives focused on sensitive areas with fewer capacity-building elements to improve the substantive focus on the protection of water resources. Further, with a formal and legalistic implementation style that is more process-focused, the mandate may emphasize adherence to plan submission deadlines and incorporation of required elements versus content necessary to meet specific goal or outcomes around water quality.

In 2006, Maryland amended their comprehensive plan mandate to require the inclusion of a water resource element in plans by 2009. A follow-up study should include this next generation of plans in both watersheds to determine if the increased specificity of mandate parameters improves plan quality. Additionally, other watersheds operating under other types of comprehensive planning mandates should be included to clarify the role of mandates in improving plan quality. Finally, while the state mandate did not make a difference on plan quality, statistical conclusion validity is a threat to the study's internal validity due to the small sample size and other factors that influence plan quality at the local level could be more important predictors of plan quality. A study with a larger sample of jurisdictions should investigate how community variables influence plan quality with respect to water resource protection.

CHAPTER 6: ORDINANCE QUALITY RESULTS

6.1 Introduction

Local governments are not the only stakeholders involved in land use development[36], but they do play a key role in the development process through the creation and enforcement of ordinances. Development management ordinances should establish policies consistent with a community's priorities and shape land use through the development review process. Yet, ordinances remain an under-studied portion of the land use development process. This study is the first to 1) create a set of ordinance quality principles to examine the content and administration of development management ordinances and 2) investigate the influence of single purpose mandates on ordinance quality with respect to water resource protection.

This chapter reports the results of a series of bivariate statistical analyses used to test the second research question posed in Chapter 1: Does the design of a single purpose state mandate adopted to protect environmentally sensitive areas affect the quality of buffer protection provisions within development management ordinances? To help answer this question, the design of mandates protecting environmental sensitive areas in Maryland and North Carolina were characterized in Chapter 4 based on their complexity, the inclusion of capacity and commitment-building elements, and their implementation style.

[36] Though land management is often discusses as completely within the purview of state and local governments, Burby points out that the federal government often intervenes on social issues that directly and indirectly impact land management (i.e., air and water pollution, groundwater contamination, traffic congestion, exposure to airport noise, and coastal hazard mitigation) (1998).

The mandate in Maryland included clearer goals and more capacity- and commitment-building elements. The slightly higher rating for North Carolina mandate on policy objectives clarity is due to the inclusion of fewer objectives compared to the numerous policy objectives in the Maryland mandate. Both mandates tend towards a more formalistic and legalistic implementation style. Overall, the mandate from Maryland includes more features supportive of implementation.

Although both mandates are geographically limited, the mandate from Maryland encourages (but does not require) local jurisdictions to "apply protection measures similar to those contained in their Critical Area program to land disturbances beyond the Critical Area boundary" (MD. COMAR, Title 27, Chapter 10 (K)) while the North Carolina mandate emphasize procedural compliance if a jurisdictions "imposes" more stringent regulations (160A-384. §143-214.5(d)). For these reasons, the Gunpowder-Patapsco watershed in Maryland was expected to have higher scores on individual ordinance quality principles when compared to the scores from the Jordan Lake watershed in North Carolina.

This study created eight principles of ordinance quality: Goals, Fact Base, Policy Description, Policy Restrictions, Policy Flexibility, Monitoring and Enforcement, Complexity, and Discretion. These eight principles were operationalized using 92 indicators[37] based on research studies investigating the optimal design and functioning of riparian buffers, model riparian buffer ordinances, planning practitioner resources, and the

[37] The indicators for *Goals* principle were coded on a binary scale (0- not mentioned, 1- mentioned) while indicators for the other seven principles were coded on an ordinal scale (i.e., 0= not mentioned, 1= standard information requirement, 2= enhanced information requirement or 0= no policy, 1= basic policy, 2= standard policy, 3=enhanced policy requirement). The levels of information or policy requirements were designated based on the research literature and model ordinances for riparian buffers, and are tied to levels of protection such that higher information and policy requirements suggest a higher level of protection. *Policy Flexibility* contains the only exception to this approach where eight of the fourteen indicators were coded on a binary scale to indicate the presence of environmentally protective and incentive policies.

concept of street-level bureaucracy (Center for Watershed Protection & Schueler, 1995; Kelly, 1988; Lerable, 1995; Lipsky, 1980; Mayer et al., 2005; Schueler & Holland, 2000; Stevens & Berke, 2008; United States Environmental Protection Agency, 2006; Wenger, 1999). The complete protocol can be found in Appendix B.

The total scores for each principle were separately normalized to a scale of 0 to 10 to enable comparisons amongst principles by watershed. For individual indicators, the percentages of plans that <u>include</u> a particular indictor were used to examine differences between the two watersheds[38]. Each variable was tested for normality and unequal variance using both graphic and numeric methods. Three comparison of means tests (t-tests, Welch's t-test, Mann-Whitney U test) were utilized based on results of the normality and unequal variance tests to determine if differences between scores achieved traditional levels of statistical significance (p=0.05) when compared at the watershed level.

The following sections present detailed results for each of the eight ordinance quality principles by dividing them into two conceptual frameworks: Policy Content and Administration. The policy content framework includes the principles that define the substantive components of a particular policy (i.e., *Goals, Fact Base, Policy Description, and Policy Restrictions*). The principles within the administration framework (i.e., *Flexibility, Monitoring and Enforcement, Complexity, and Discretion*) focus on the factors that influence the implementation of the policy.

[38] The Mann-Whitney U test was used when the normality assumption was violated.

6.2 Policy Content Framework

Development management ordinances span the transition from how a jurisdiction plans to develop (intention) to the detailed policies that will govern development (action). The transition begins with the content of policies, which were examined through 1) the goals established for the policy, 2) the information required to apply the policy, 3) the requirements and provisions of the policy, and 4) the restrictions placed upon the policy. A total of 51 indicators were used to operationalize the policy content framework: *Goals* (5); *Fact Base* (7), *Policy Description* (29), and *Policy Restrictions* (10). Table 6.1 includes the mean score and standard deviation for each of the policy content principles by watershed and the p-values from the comparison of means tests.

Table 6.1: Policy Content Principle Scores by Watershed[39]

	Gunpowder-Patapsco		Jordan Lake		
	Mean	*SD*	*Mean*	*SD*	p value
Goals	4.62	2.50	5.11	1.45	0.600
Fact Base	3.08	2.61	2.31	1.43	0.477
Policy Description	2.84	1.82	3.72	1.38	0.237
Policy Restrictions	1.62	1.43	2.26	1.43	0.373
Overall Policy Content mean	*3.04*	*1.81*	*3.37*	*1.13*	*0.634*

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

The *Goals* principle was the highest scoring principle for both watersheds, but only the overall mean score for the Jordan Lake watershed exceeded 50% of the available points. *Fact Base* is the only principle where the overall mean score for the Gunpowder-Patapsco watershed exceeded the score for the Jordan Lake watershed, but the difference was not

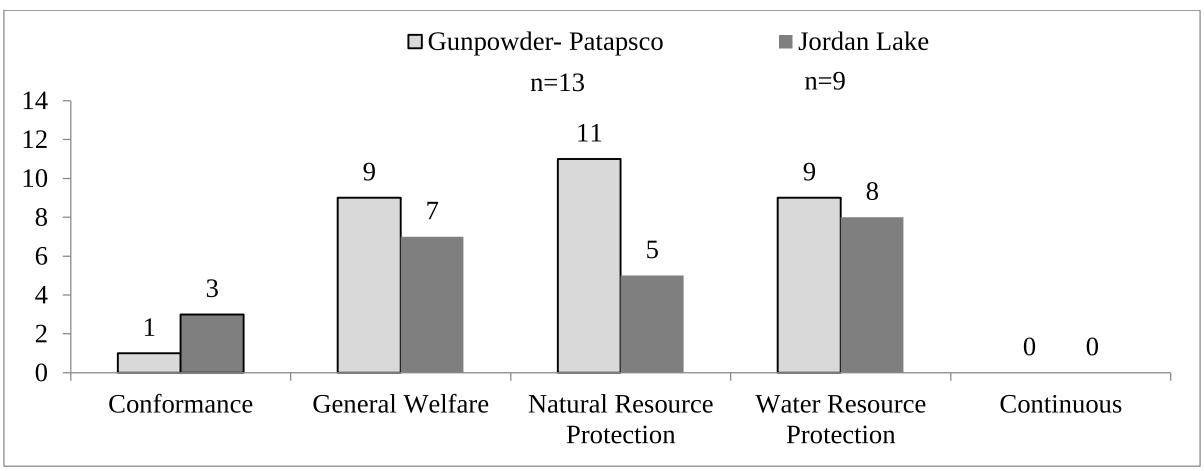
[39] Numerical tests and graphic plots indicated the *Goals*, *Fact Base, and Policy Description* principles did not violate the normality assumption, and t-tests were used to compare the means. *Policy Restrictions* principle violated assumptions for normality so a Mann-Whitney U test, a non-parametric comparison of means test, was performed to compare the two watersheds.

statistically significant *(p = 0.477)*. Nor were there statistically significant differences between the watersheds for the *Policy Description (p=0.237)* or *Policy Restrictions (p= 0.373)* principles. The following sections examine these four Policy Content principles in more depth.

6.2.1 Goals

Goals, objectives, and purpose statements within development management ordinances serve multiple functions. First, they can set the broad intention for the ordinance's provisions and requirements and can reaffirm the connection between the ordinance and the comprehensive plan (DeGrove & Stroud, 1988; Lincoln, 1996). Five indicators (Conformance, General Welfare, Natural Resource Protection, Water Resource Protection, and Continuous) operationalize this principle. Figure 6.1 is a bar chart of the number of jurisdictions within each study watershed that included particular ordinance goals.

Figure 6.1: Number of Jurisdictions by Goal and by Watershed



The first of these five goals (Conformance) seeks to capture the linkage between the larger vision defined by the comprehensive plan and the ordinance. In a number of states, ordinances acquire their validity through agreement with the comprehensive plan (Carruthers & Ulfarsson, 2002). For this study, Maryland (Gunpowder-Patapsco) requires conformance while North Carolina (Jordan Lake) does not (Md. Code Ann. Art. 66B, n.d.; Owens, 2006). Only one jurisdiction in the Gunpowder-Patapsco watershed (8%) and three jurisdictions in the Jordan Lake watershed (33%) included a statement about conformance. The legal requirement in Maryland may render an explicit statement of this goal redundant for the Gunpowder-Patapsco jurisdictions while the lack of a requirement in North Carolina may act as a disincentive for jurisdictions within the Jordan Lake watershed.

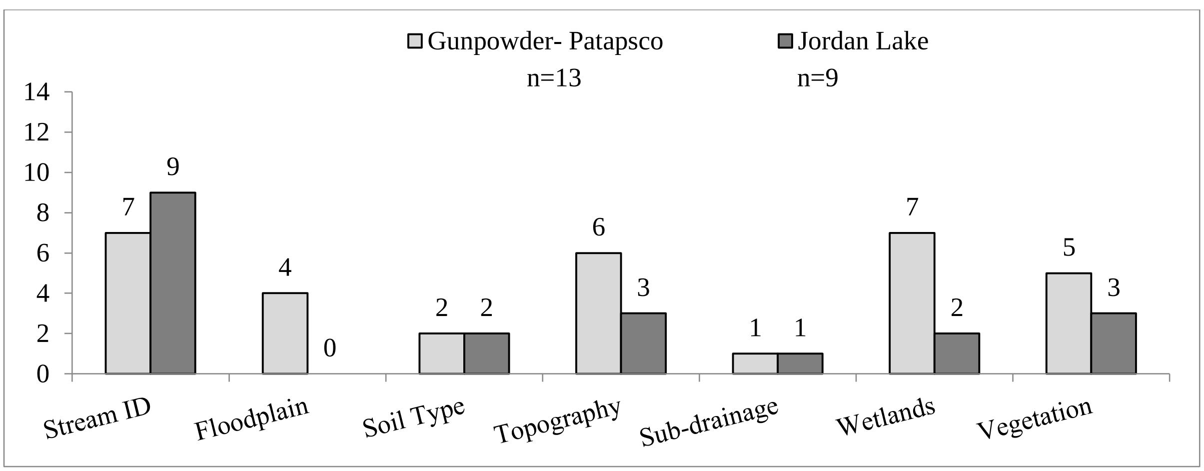
The next four *Goals* indicators increase in their level of specificity. General Welfare—with its historical roots tying planning to police power—is the least specific goal while goals for protecting natural resources and water resources are more specific (Department of Commerce, 1928). The establishment of a continuous buffer system was the most specific goal. At least seventy percent of the Gunpowder-Patapsco jurisdictions included each of the first three goals—General Welfare (9 ordinances or 70%), Natural Resource Protection (11 ordinances or 85%), and Water Resource Protection (9 ordinances or 70%). Moreover, eight jurisdictions (or 62%) included all three goals while two jurisdictions did not include any goals. Within the Jordan Lake watershed, a majority of the jurisdictions included these three goals—General Welfare (7 ordinances or 78%), Natural Resource Protection (5 ordinances or 56%), and Water Resource Protection (8 ordinances or 89%). Each jurisdiction included at least one goal and tended to combine the General Welfare goal with either the Natural Resource or the Water Resource Protection goal. The most specific goal (Continuous) was not included by any jurisdiction in either watershed.

The *Goals* principle was the highest scoring principle for both watersheds. Although the most specific goal suggested by research literature was not included by any jurisdictions, the majority of both watersheds establish a set of goals related to water resource protection.

6.2.2 Fact Base

Within the ordinance protocol, the fact base indicators differentiate among ordinances using the specificity of required information. Seven indicators were used to operationalize the *Fact Base* principle with respect to riparian buffer policies (Stream ID, Floodplain, Soil Type, Topography, Sub-drainage, Wetlands, and Vegetation). Each of these indicators represent elements that contribute to the optimal design and functioning of a riparian buffer (Center for Watershed Protection & Schueler, 1995; Lowrance et al., 1997; Mayer et al., 2005; Phillips, 1989; Schueler & Governments, 1987; Sweeney, 1992; United States Environmental Protection Agency, 2006; Vidon & Hill, 2004; Wenger, 1999). Figure 6.2 is a bar chart of the mean scores by indicator for the two study watersheds.

Figure 6.2: Number of Jurisdictions by Fact Base Indicator and by Watershed



Given that the characterization of a stream as ephemeral, intermittent, or perennial (Stream ID) tends to have implications for buffer width, the inclusion of this indicator (which identifies acceptable sources for stream identification) by the majority of jurisdictions in both watersheds (54% of the Gunpowder-Patapsco watershed and 100% of the Jordan Lake watershed) is not unexpected. This indicator, however, is the only individual fact base indicator where a comparison of means test found a statistically significant difference between the study watersheds at the 0.05 level (*p=0.0195*).

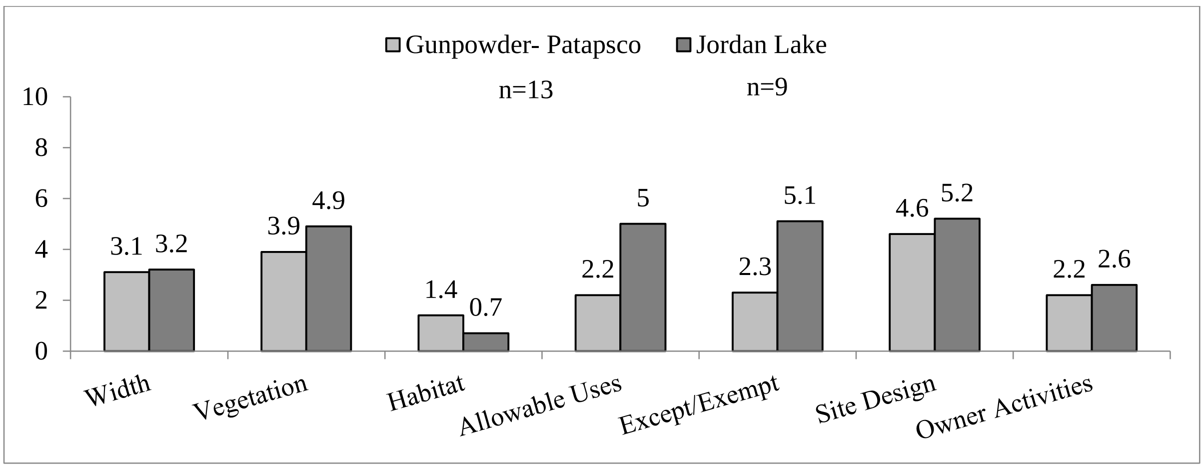
The next six indicators (Floodplain, Soil Type, Topography, Sub-drainage, Wetlands, and Vegetation) are key informational inputs for an effective riparian buffer policy. Comparison of means tests for these indicators did not find statistically significant differences at the 0.05 level between the watersheds. Wetlands, which refers to the delineation of wetlands as part of the riparian buffer policy, was the only indicator other than Stream ID mentioned in 50% of the ordinances within at least one of the watershed (Gunpowder-Patapsco, 54%). The identification of the 100-year floodplain, erodible soils, topographic information, and the classification of pre-development vegetation were not included in the majority of ordinances within either watershed. Further, only two jurisdictions explicitly retained the authority to require a sub-drainage assessment (Baltimore County, MD and Chatham County, NC).

Ordinances for the majority of the jurisdictions in these two watersheds do not require the site-specific information recommended by the research literature to help determine the width or vegetative target for riparian buffers. While stream characterization provides important information for a riparian buffer policy, the failure to require baseline information on other factors such as floodplain extent, topography, the presence of erodible soils, the location of wetlands, and pre-development vegetation represent a missed opportunity to utilize information that might support a wider buffer or restorative actions that can improve the design and functioning of a particular stretch of buffer and its associated water quality.

6.2.3 Policy Description

The *Policy Description* principle outlines the core provisions of a policy including the specific circumstances under which particular provisions are applicable. For this study, twenty-nine indicators operationalize key provisions of riparian buffer policies and were grouped into seven topic areas (Width, Vegetation, Habitat, Site Design, Allowable Uses, Exemptions and Exceptions, and Owner Activities). Figure 6.3 is a bar chart of the Policy Description mean scores by the seven topic areas for each study watershed.

Figure 6.3: Mean Score by Policy Description Topic Area by Watershed



The Width topic area builds most directly on the information collected as part of the *Fact Base* principle. Given the relatively low mean scores for the *Fact Base* principle, the relatively low scores on Width for both watersheds was not surprising. There was not a statistically significant difference between the two watersheds for this topic area ($p = 0.835$).

Vegetation included indicators about the vegetative target, management strategy, and restoration efforts for vegetation within the buffer. The mid-level overall mean scores of Vegetation suggest more jurisdictions are accounting for these factors in their buffer policies. Habitat focuses on efforts to protect important aquatic and wildlife species. Few jurisdictions in either watershed include a habitat protection plan or any references to habitat fragmentation. Comparison of means tests for these two individual topics areas did not find any statistically significant differences (Vegetation, *p= 0.407*; Habitat, *p= 0.495*).

Allowable Uses and Exemptions/Exceptions focus on the permissive uses within the buffer (i.e., buffer crossings) as well as the uses of areas adjacent to the buffer (i.e., agriculture and recreation). There was a statistically significant difference between the two study watersheds for both of these topic areas (Allowable Uses, *p=0.0013*; Exemption/Exceptions, *p=0.0321*). Jurisdictions within the Jordan Lake watershed more frequently included provisions regulating 1) the extraction of timber within the buffer, 2) stream-dependent uses within the buffer, 3) buffer crossings, and 4) use and location of stormwater best management practices with respect to the riparian buffer. Jurisdictions within the Gunpowder-Patapsco watershed included policies governing agriculture exceptions slightly more frequently than Jordan Lake jurisdictions (38% vs 33%) while the ordinances within the Jordan Lake watershed more frequently mentioned provisions governing recreation exceptions (67% vs 31%) and general exemption policies (78% vs 23%).

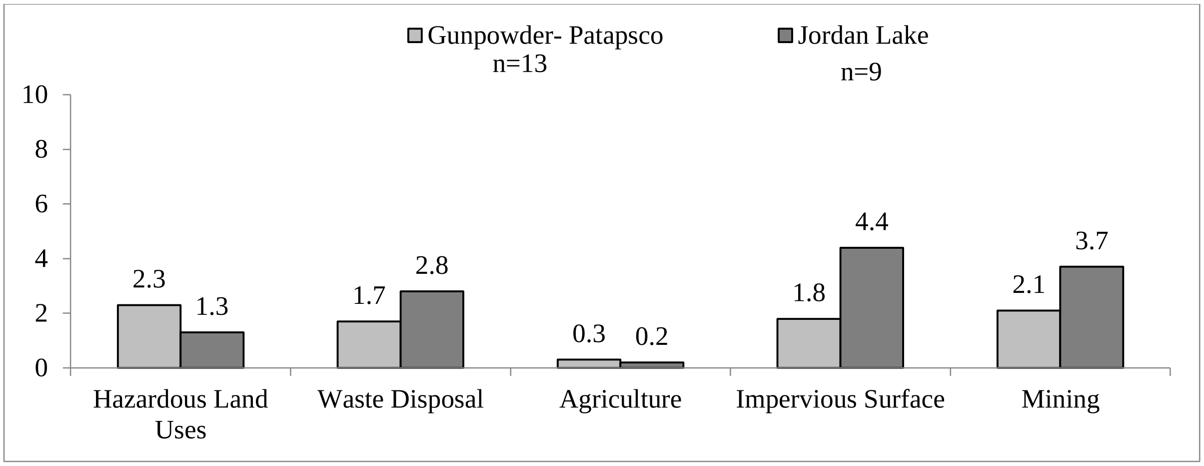
The remaining topic areas concentrate on the site design features of the development that have a possible impact on the buffer (i.e., grading, clearing, and setbacks from the buffer's outer boundary), policies governing property ownership of the buffer, and owner actions around vegetation management. Site Design was the highest scoring topic area for both watersheds although there was not a statistically significant difference between the scores (*p=0.680*). The mean scores for Owner Activities for both watersheds were low and the watersheds were not statistically significantly different from each other (*p=0.428*).

Numerous research studies identify buffer width, allowable uses, and the type, amount, and management of vegetation as important considerations (Center for Watershed Protection & Schueler, 1995; Lowrance et al., 1997; Mayer et al., 2005; Phillips, 1989; Pickett et al., 2001; Schueler & Governments, 1987; Sweeney, 1992; Vidon & Hill, 2004; Wenger, 1999). The low scores on Width and Vegetation for both watersheds indicate that the policies governing these riparian buffer features include some, but not all of the key provisions identified by the research literature. Further, the very low scores on the Habitat and Owner Activities may indicate missed opportunities to 1) integrate a wide range of ecological functions into buffer policies and 2) delineate policies to protect buffers from damaging owner activities. The three remaining topic areas (Allowable Uses, Exceptions/Exemptions, and Site Design) each scored at or over 50% of the available points for the Jordan Lake watershed, but the scores for Gunpowder-Patapsco were relatively low. While the regulation of the uses in and adjacent to the buffer as well the construction practices near buffer boundaries scored higher than other topic areas, these scores still fall short of the optimal provisions laid out by the research literature and model ordinances.

6.2.4 Policy Restrictions

The Policy Restriction principle describes the constraints or specific limitations contained within the policy. There are ten indicators that operationalize the principle, which were grouped into five topic areas (Hazardous Land Uses, Waste Disposal, Agriculture, Impervious Surface, and Mining). Figure 6.4 is a bar chart of the mean scores by the five topic areas for each watershed.

Figure 6.4: Mean Score by Policy Restriction Topic Areas by Watershed



Few ordinances in either watershed included the indicators of the *Policy Restrictions* principle. None of the five topic areas scored more than 50% of the available points. Agriculture (i.e., provisions limiting the use of fertilizers and livestock activity within or near the riparian buffer) scored very low. The scores for Waste Disposal (i.e., the location of waste disposal facilities, sewer lines, and septic fields) and Hazardous Land Uses (e.g. confined animal feeding operations and facilities storing hazardous materials) were also relatively low. There was not a statistically significant difference between the two watersheds for any of these topic areas (Hazardous Land Uses, $p=0.272$; Waste Disposal, $p=0.242$; Agriculture, $p=0.804$). Although the higher overall scores for Impervious and Mining signify that more ordinances in both watersheds included provisions limiting impervious surface and regulating mining activities within the buffer, these scores were still low. The two study watersheds were statistically significantly different at the 0.1 level for the Impervious topic area, but not for Mining (Impervious, $p=0.0904$; Mining, $p= 0.328$). The low scores for this principle suggest that ordinances in both watersheds do not include explicit restrictions for uses and activities that may reduce the effectiveness of the riparian buffer.

6.3 Administration Framework

The inclusion of research-based evidence in a policy may be a necessary condition for more effective and efficient policymaking, but it is not sufficient to ensure better outcomes. Policies must be implemented to have any effect on an issue. The administration framework includes the principles that either facilitate or complicate the implementation of policies. This principle was examined through 1) the monitoring and enforcement structure established for the policy, 2) the flexibility built into the policy, 3) the complexity of administering the policy, and 4) the discretion contained within the policy. There are a total of 62 indicators used to operationalize the administration framework: *Monitoring and Enforcement* (13); *Policy Flexibility* (13), *Complexity* (36), and *Discretion*. Individual indicators were not used to operationalize Discretion. Instead, this principle examines the frequency that the Discretion code co-occurred with other indicators and the limitations (if any) placed on the use of discretion in administering the policy. Table 6.2 includes the mean score and standard deviation for the first three administration principles by watershed and the p-values from the comparison of means tests.

Table 6.2: Ordinance Quality Principle Scores by Watershed[40]

	Gunpowder-Patapsco		Jordan Lake		
	Mean	*SD*	*Mean*	*SD*	p value
Monitoring and Enforcement	3.43	2.74	3.73	1.63	0.772
Policy Flexibility	3.31	2.27	4.88	2.75	0.159
Complexity	2.01	1.85	2.16	1.09	0.837
Overall Administration mean	*2.92*	*2.07*	*3.59*	*1.96*	*0.441*

**p-values* $\leq$ 0.1, ** *p-values* $\leq$ 0.05, *** p-values$\leq$0.001

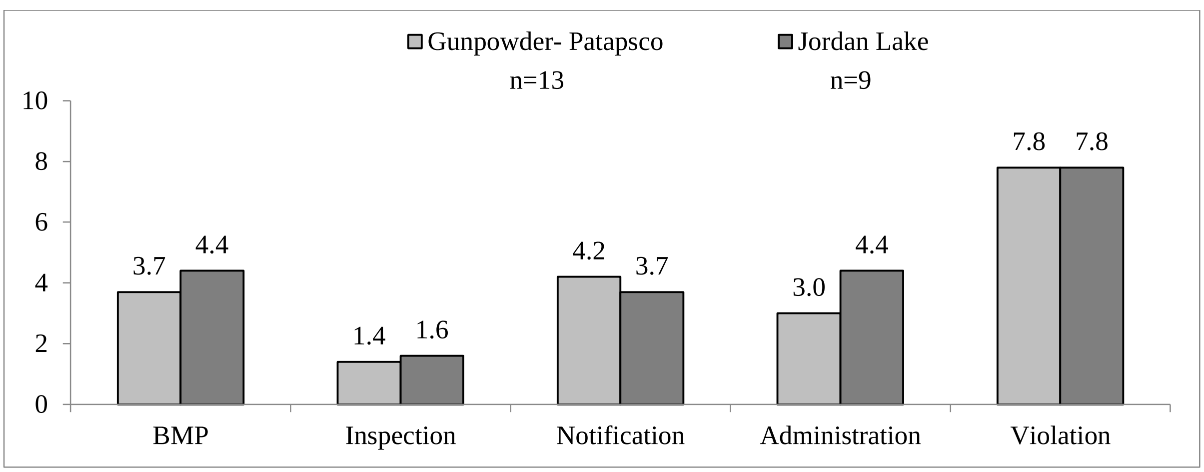
[40] Numerical tests and graphic plots indicated the *Monitoring and Enforcement*, *Policy Flexibility*, and *Complexity* principles did not violate the normality assumption, and t-tests were used to compare the means.

None of the mean scores for the first three administration principles exceeded 50% of the available points. The mean scores for the ordinances in Jordan Lake watershed were higher than the scores for the Gunpowder-Patapsco watershed, but the differences were not statistically significant *(*Monitoring and Enforcement, *p=0.772;* Policy Flexibility, *p=0.159;* Complexity, *p=0.837)*. The following sections examine the four administration principles in more depth.

6.3.2 Monitoring and Enforcement

The Monitoring and Enforcement principle refers to the on-going oversight and management practices stipulated by a policy. Thirteen indicators operationalize the principle, and Figure 6.5 is a bar chart of the mean scores by the five topic areas (BMP, Inspection, Notification, Administration, and Violation).

Figure 6.5: Mean Score by Monitoring and Enforcement Topic Area by Watershed



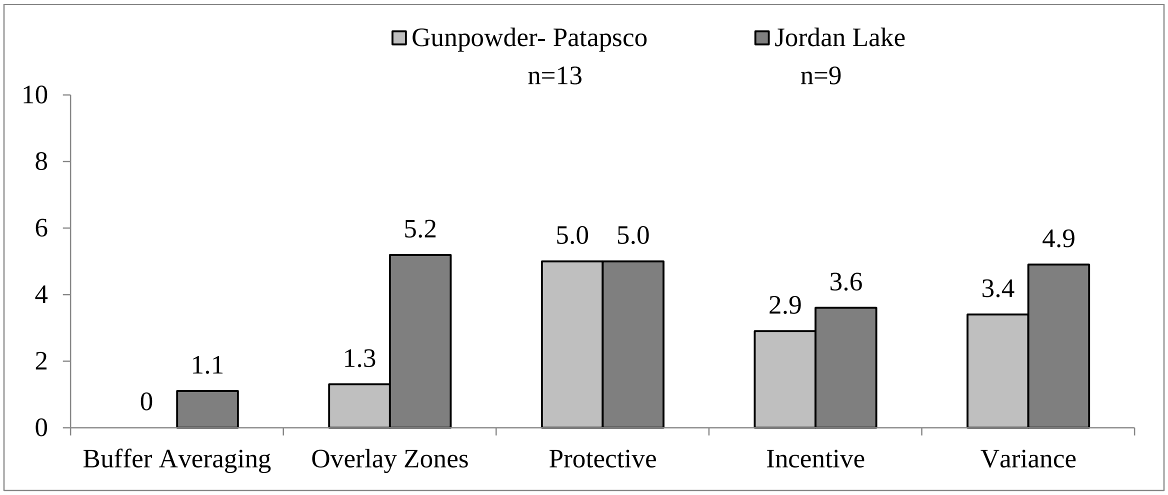
The topic areas of BMP and Inspection center on the monitoring and maintenance of structural best management practices and the specific conditions surrounding buffer inspection (i.e., the timeline of inspection, the initiating factors for an inspection, on-going water quality monitoring). Few ordinances in the study watersheds included detailed provisions for buffer inspections. More ordinances included specific policies around the monitoring and maintenance of stormwater best management practices. Although the Jordan Lake watershed scored higher on these topic areas than the Gunpowder-Patapsco watershed, the differences were not statistically significant (BMP, $p=0.886$; Inspection, $p=0.693$).

The next three topic areas focus on notification about the boundaries of the buffer, the administration structure for monitoring the buffer, and how violations are managed. The scores for both Notification and Administration are moderate, but do not exceed 50% of the available points and were not statistically significantly different at the 0.05 level although Administration is statistically significant at the 0.1 level with Jordan Lake scoring higher (Notification, $p=0.972$; Administration, $p=0.101$). Violation is the highest scoring topic area of all of the ordinance quality principles. The high scores for both watersheds are due, in part, to the enhanced level of general sanctions specified in the ordinances of both study watersheds (89% of Jordan Lake and 85% of Gunpowder-Patapsco). Fewer ordinances included a violation description specific to riparian buffers (4 ordinances or 44% of Jordan Lake watershed and 6 ordinances or 46% of Gunpowder-Patapsco watershed). The difference between the watersheds on this topic area was not statistically significant ($p=0.885$). With the exceptions of Violation, the scores for this principle are relatively low, which suggests there are opportunities for the incorporation of better monitoring and enforcement practices.

6.3.2 Policy Flexibility

The *Policy Flexibility* principle includes policy provisions that allow for adaptation to different circumstances including variances or incentive policies. Fourteen indicators operationalize the principle. Six indicators use a 0 to 2 ordinal scale and eight indicators use a binary scale to measure the presence of environmentally protective or incentive policies that provide flexibility such as restoration incentives and off-site mitigation. Figure 6.6 is a bar chart of the mean scores by the six topic areas (Buffer Averaging, Overlay Zones, Protective Policies, Incentives, and Variances).

Figure 6.6: Mean Score by Policy Flexibility Topic Area by Watershed



Buffer Averaging allows for flexibility in the width of portions of a buffer as long as the overall buffer width averages to the width required by the ordinance. Only one jurisdiction in the Jordan Lake watershed and no jurisdictions in the Gunpowder-Patapsco watershed included buffer averaging provisions and there was not a statistically significant difference between the watersheds (*p=0.238*). Overlay Zone allows for regulations to be tailored to particular properties or districts. There was a statistically significant difference between the two study watersheds on this topic area as 5 ordinances or 56% of the Jordan Lake watershed included overlay zones as a tool to implement their riparian buffer policies compared to 15% (two ordinances) of the Gunpowder-Patapsco watershed (*p=0.0417*).

Protective policies such as conservation easements or fee simple acquisition was one of the highest scoring topic areas with both watersheds scoring half of the available points. Incentives included counting buffers against open space requirements or providing restoration incentives. There was not a statistically significant difference between the watersheds for either topic area (Protection, $p=1.00$; Incentive, $p=0.730$). The final topic area, Variance, included provisions around the administration of variance and limitations on variances. The difference between the study watersheds on this topic area was statistically significant at the 0.1 level with Jordan Lake averaging a higher score (p=0.0983).

Overall, there was not a statistically significant difference at the 0.05 level between the watersheds for the *Policy Flexibility* principle although there were statistically significant differences on individual topic areas (Overlay Zone and Variance). The moderate scores in this area suggest that these watersheds are incorporating some flexibility within their riparian buffer policies, but more investigation is necessary to understand the impact these levels of flexibility have on implementation.

6.3.3 Complexity

The *Complexity* principle measures the difficulty of administering a particular policy by gauging the effort necessary to navigate highly detailed provisions and intensive data demands. Thirty-six indicators from the *Fact Base*, *Policy Description*, and *Policy Restrictions* principles were used to operationalize this principle. Based on the assumption that more intensive data demands and more detailed policy provisions are a proxy for the complexity of administering the policy, the Enhanced level (i.e., the highest level of information and policy requirements) of these indicators were used to calculate scores.

The minimum overall *Complexity* score was 0.0 and the maximum was 6.67 for the overall sample. The mean *Complexity* score for the Gunpowder-Patapsco watershed was 2.01 and the mean score for the Jordan Lake watershed was 2.16. There was not a statistically significant difference between the overall Complexity mean scores of the two watersheds (*p=0.837*).

The interpretation of the *Complexity* Principle score is slightly different from the scores of other principles. A higher score on other principles may suggest that an ordinance incorporates more of the information and provisions described in the research literature, but a higher score on this principle should not be considered a uniformly positive finding. While a higher score on complexity may represent a higher level of protection based on the research literature, complexity may be associated with more deviation from policy provisions during implementation (Alterman & Hill, 1978). The scores on the *Complexity* principle reflect the relatively low scores for the *Fact Base*, *Policy Description*, and *Policy Restriction* principles (and by extension the limited incorporation of the information and policy requirements suggested by the research literature). Future research should investigate the relationship between this principle and implementation.

6.3.4 Discretion

The *Discretion* principle examines instances where staff charged with policy implementation have the authority to make an interpretation or judgment about the applicability or administration of particular policy provisions. Unlike the *Flexibility* principle (which provides approved rules, standards, and tools to adapt to changing conditions), the *Discretion* principle refers to decisions that may alter policy provisions and are based on the judgment of staff involved in the review process. There were three levels of discretion used for this principle:

> **Basic**: The reviewer of the application is granted authority in the interpretation or administration of an ordinance provision.
>
> **Standard:** The reviewer of the application is granted authority in the interpretation or administration of an ordinance provision AND an additional administrator, agency, or department is involved in the review process (i.e., may request additional information, set standards, or approve the application).
>
> **Enhanced**: The reviewer of the application is granted authority in the interpretation or administration of an ordinance provision AND an additional administrator, agency, or department are involved in review process (i.e., may request additional information, set standards or approve the application) AND there are clear limitations placed on the extent of the alterations can be made by these parties.

This principle was not operationalized using individual indicators, but was coded along with indicators from other principles to identify instances within the review process where interpretation or judgments could occur. Table 6.3 contains the frequency of discretion by five ordinance quality principles for each watershed.

Table 6.3: Frequency of Discretion by Principle by Watershed

	Goals	Fact Base	Policy Description	Policy Restrictions	Policy Flexibility	Total
Gunpowder-Patapsco n=5	2	1	11	1	6	21
Jordan Lake n=4	0	0	6	3	4	13

A total of nine jurisdictions (five in the Gunpowder-Patapsco watershed and four in the Jordan Lake watershed) included at least one instance of discretion. In total, there were 34 co-occurrences of discretion with other indicators. All but three of the Discretion codes[41] were at

[41] The remaining three instances were at the Basic level of Discretion.

the Standard level meaning an agency, department, or organization was identified as an additional party within the review process. These parties tended to hold higher positions within a bureaucracy (e.g., department or division directors) or be agencies with perceived expertise on environmental, health, or infrastructure issues (e.g., Department of Environmental Protection, Department of Natural Resources, Department of Health, Department of Public Works).

There were seven instances where discretion was found among coding for *Goals*, *Fact Base,* and *Policy Restrictions*. The co-occurrences of *Discretion* with *Goals* indicators limited the application of goals to particular areas[42] while the co-occurrence with *Fact Base* indicators provided staff with discretion in determining if informational requirements were satisfied. The *Policy Restriction* co-occurrences with *Discretion* were for septic systems, sewer pipes, impervious surfaces, and each of these instances allowed for the relaxation of the restrictions with justification.

Similar to the findings for *Policy Restrictions,* the co-occurrences of *Policy Description* indicators with *Discretion* relaxed policy provisions. Most frequently, these instances of discretion occurred with indicators for site design (i.e., clearing, grading) or allowable uses within the buffer and required staff or agency approval. Finally, *Discretion* with *Policy Flexibility* most frequently occurred with indicators dealing with variances with jurisdictions providing discretion for imposing additional requirements or conditions for variance applications.

[42] For example, in Havre de Grace, areas may be exempted from buffer requirements with approval from the State Critical Area Commission if it is demonstrated that the "existing pattern of development prevents the buffer from fulfilling its intended function" (City of Havre de Grace, 1996, p. 114).

6.4 Conclusion

The policy content framework (Goals, Fact Base, Policy Description, and Policy Restrictions) includes provisions that support the optimal design and functioning of riparian buffer policies. The ordinance quality scores for the policy content framework were relatively low with few plans scoring over half of the available points for any single principle. The low mean scores on these principles suggest there is an opportunity for the riparian policies in both watersheds to incorporate more of the best practices and design features suggested by the research literature and by model ordinances. Of the four principles, only one watershed averaged more than half of the available points on a single principle (Jordan Lake watershed, Goals principle).

Neither watershed averaged over 50% of the available points for the administration framework, but the interpretation of this framework is a bit different. While the low scores on Monitoring and Enforcement suggest ordinances could incorporate more policies that support on-going oversight and management, the lower scores on Flexibility and Complexity do not necessary signal barriers to administration of a riparian buffer policy. Instead, the lower Complexity score may indicate more straightforward administration and the presence of Flexibility or Discretion in ordinances may be necessary for adaptation to unique circumstances. Chapter 7 will investigate the role of these principles in policy implementation.

This chapter investigated how ordinance quality with respect to riparian buffer policies differed in states with different single purpose mandates. Based on the research literature, jurisdictions in a state with a mandate with design features that support implementation were expected to have higher quality buffer protection provisions within their development management ordinances than jurisdictions in a state with a mandate with fewer supportive features. Chapter 4 details the characterization of both mandates aimed at protecting environmentally sensitive areas and identified the Maryland Critical Areas mandate as including more supportive design features. Thus, the Gunpowder-Patapsco watershed in Maryland was expected to have higher scores on individual ordinance quality principles when compared to the scores from the Jordan Lake watershed in North Carolina. Contrary to this hypothesis, the two study watersheds were not statistically significantly different on any single principle at the 0.05 level. Further, although there was not a statistically significant difference between the two watersheds, Jordan Lake scored higher than the Gunpowder-Patapsco watershed on six of the seven scored ordinance quality principles.

It is possible that the mandate design features linked to plan quality by other studies were not a sufficient condition to promote higher ordinance quality given the definition of quality used in this study, which emphasized the inclusion of policy elements for the optimal design and functioning of riparian buffers drawn from the research literature. The North Carolina mandate provided only limited guidance on the range of actions and policies to include in the ordinance, which may contribute to the lower policy content score at the watershed level. The Maryland mandate included more guidance on the substantial content of policies affecting riparian buffers, but the suggestion to extend those provisions to areas outside of critical area may not sufficient to translate the high ordinance quality scores for riparian areas outside of the critical area and, thus, may not translate to better overall ordinance quality at the watershed level.

The overall scores for the administrative framework for both watersheds were slightly higher, but there was not a statistically significant difference between the watersheds. Although this study did not detect statistically significant differences, statistical conclusion validity, as discussed in Chapter 3, is a threat to the study's internal validity due to the small sample size. Subsequent studies should extend this analysis to include additional watersheds and more jurisdictions. Additionally, plan quality and community variables may be stronger predictors of ordinance quality. The relationships among the design of mandates, plan quality, policy slippage, and implementation will be further investigated in Chapter 7.

CHAPTER 7: PREDICTING POLICY SLIPPAGE AND THE IMPLEMENTATION OF RIPARIAN BUFFER POLICIES

7.1 Introduction

As articulated by Hoch, we develop plan and policies with the intention "to inform and influence" the decisions that shape our built environment (Hoch, 2002). Plan implementation studies provide an opportunity to examine how effective plans and policies are at shaping planning outcomes. This study joins a growing body of plan implementation research literature that examines the influence of planning inputs on land use outcomes (Chapin et al., 2008; Loh, 2011; Ozawa & Yeakley, 2007; Talen, 1996a).

This chapter reports the results of the analyses used to test the research questions posed in Chapter 1 about policy slippage and implementation[43]. First, how frequently does policy slippage occur between the riparian buffer policies outlined within development management ordinances and the provisions of approved development applications? Second, does the quality of policy inputs, the presence of mandates, and local context explain variation in implementation? The first section examines policy slippage, or deviations from development management ordinances found in approved development applications. The next section presents results about the implementation of the riparian buffer policies by investigating the vegetation and the encroachment of impervious surface within approved

[43] Three questions were originally posed, but the infrequent occurrence of policy slippage precluded the use of multivariate regression to answer the question: Does the quality of policy inputs, the presence of mandates, and local context explain variation in policy slippage?

buffer using high-resolution land cover classification maps. The chapter concludes with a discussion of the findings with respect to the hypotheses first introduced in Chapter 2.

7.2 Policy Slippage

This section examines the conversion of development management ordinances into approved development applications in order to investigate policy slippage, the deviation or difference between ordinances and the approved applications. This transition between ordinances and approved development applications is an important step in an overall study of implementation because 1) this is a point where necessary modifications to a policy may occur due to specific site conditions and 2) any modification at this level alters the ultimate land use outcome (i.e., riparian buffers of a constructed development). Mirroring the two prominent definitions of planning success discussed in Chapters 1 and 2 (conformance-based and performance-based evaluation), both negative slippage (unsanctioned deviations) and affirmative slippage (deviations accompanied by a justification) were investigated.

In total, 197 approved development applications were collected for 14 jurisdictions. Although the policy slippage coding protocol contained 64 indicators across seven categories (policy description, allowable uses, exemption/exceptions, site design, maps, variances, and monitoring), development applications varied widely in their inclusion of substantial data on these topics. To ensure comparability of data, the examination of policy slippage was limited to three factors: buffer width, vegetative target, and approved encroachments of impervious surface into the buffer. These three factors appeared in all of the applications within the sample and could be linked to observations measured from the high-resolution land cover classification maps used in the implementation analysis. Table 7.1 includes the number of approved permits, and policy slippage for width, vegetation, and impervious surface encroachment.

Table 7.1: Policy Slippage by Jurisdiction

	Development Applications	Width	Vegetation	Impervious Surface Encroachment
Jordan Lake				
Apex	20	2	0	0
Cary	17	0	0	0
Chapel Hill	15	0	0	1
Chatham Co.	19	0	0	0
Durham City/Co.	15	0	0	0
Morrisville	3	0	0	0
Orange Co.	19	0	0	0
Pittsboro	8	0	0	0
Wake Co.	3	0	0	0
TOTAL	119	2	0	1
Gunpowder-Patapsco				
Baltimore Co.	16	3	1	0
Bel Air	2	2	0	0
Carroll Co.	20	0	0	0
Harford Co.	20	0	0	0
Howard Co.	20	1	0	0
TOTAL	78	6	1	0

Buffer Width. Less than 5% of sample of approved development applications contained a deviation from the expected buffer width based on the development management ordinance. Approximately 1.7% of the applications in the Jordan Lake watershed contained policy slippage with respect to buffer width and 7.7% of the applications in the Gunpowder-Patapsco watershed contained policy slippage. Interpreted from a conformance-based definition of planning success, the frequency of policy slippage is relatively small, but there was a statistically significantly difference between the two watersheds using a Mann-Whitney U test ($p=0.037$).

An examination of policy slippage of buffer width, using a performance-based definition provides an additional layer of analysis. In some jurisdictions, the deviations are routinely accompanied by a robust justification. Specifically, of the three policy slippage cases within Baltimore County, two cases were due to buffer calculations that encompassed at least 90% of the site and one case dealt with an existing structure, lawn and septic field within the buffer area. Each policy slippage case was explained and deviations to buffer regulations were accompanied by additional requirements (e.g., off-site mitigation). Two jurisdictions within the same watershed as Baltimore County (Howard County and Bel Air) did not include the same level of justification for their cases of policy slippage. In Howard County, a reduction in buffer width from 75 feet to 50 feet around a perennial stream lacked a justification while the required 50 foot buffers around perennial streams in Bel Air were not discussed nor depicted in the development application.

In the Jordan Lake watershed, the two cases of policy slippage of buffer width were within the same jurisdiction (Apex). Although the state Water Supply Watershed Protection legislation and the local ordinances require a 30 foot buffer around perennial streams within the Jordan Lake Watershed Protection area, the developments were granted a variance allowing for a 25 foot buffer. There was no justification given for this reduction.

Buffer Vegetation & Impervious Surface Encroachment. There was only one case of policy slippage for buffer vegetation (Baltimore County, Gunpowder-Patapsco) and one case of approved encroachment within the buffer area (Chapel Hill, Jordan Lake). Again, the policy slippage around buffer vegetation in Baltimore County is accompanied by 1) a rationale [the farmer subdividing the land requested permission to continue mowing 1.37 acres, an activity he had performed his entire life] and 2) additional requirements for protection elsewhere on the site and re-vegetation if further subdivision is pursued. In contrast, the encroachment of a patio within the buffer area in Chapel Hill was not justified prior to its construction and post-construction impervious surface calculations are used to approve the amount of impervious surface, but not its location.

The small number of policy slippage cases precluded in-depth statistical analyses because of limited variation in the dependent variable and in the independent variables. Thus, the hypotheses about relationships between the frequency of policy slippage, the influence of mandates and the quality of policy inputs could not be tested. However, there are a number of interesting observations that can be made. First, the presence of only ten cases of policy spillage out of 197 developments suggests that, in general practice, local riparian buffer policies are frequently translated into development applications with few alterations. Second, the use of a conformance-based evaluation approach suggests policy slippage in Baltimore County (where policy slippage cases were accompanied by a rationale and additional requirements) is equivalent to policy slippage in Apex (variance to reduce buffer width without justification) and policy slippage in Bel Air (the complete absence of buffer discussion and depiction) even though each of these instances of policy slippage would have differential impacts on water resources. The performance-based approach suggests the higher frequency of policy slippage in the Gunpowder-Patapsco watershed is somewhat attenuated by Baltimore County's inclusion of justifications and highlights the possibility that nonconformance does not necessarily mean a lower level of water resource protection.

7.3 Implementation

This section explores the implementation of riparian buffer policies by using data collected from high resolution land cover classification maps. In Chapter 2, I hypothesized that the quality of policy inputs, the presence of mandates, and local context (both community and project characteristics) would help explain variation in implementation. For this study, implementation of riparian buffer policies was measured by delineating buffers using the widths required by approved development applications and examining the bare earth, tree cover, and impervious surfaces within buffers. These dependent variables violated assumptions of normality (particularly assumption of linearity) making the use of ordinary least squares regression inappropriate. Although the use of a transformation such as the Box-Cox power transformation might allow the nonnormal data to approximate a normal distribution, this transformation would complicate the interpretation of findings. The use of a logistic regression model enabled the exploration of the influence of the quality of planning inputs (plan quality and ordinance quality scores) on the probability of a development including a certain percentage of bare earth, vegetation, or impervious surface within its buffer controlling for community and project characteristics.[44] The thresholds used to create each of the dependent variables investigated in this chapter are described in the subsequent sections. Table 7.2 includes the descriptive statistics for dependent and independent variables tested in these analyses.[45]

[44] A logistic regression based on the raw data (i.e., pixel counts by land cover classes collected for approved buffer widths) is possible, but it would preclude an analysis of the effect of planning inputs on implementation as each pixel within a particular buffer (whether coded 0 or 1) would be assigned the same plan quality and ordinance quality scores.

[45] Data was gathered on a number of additional variables described in Chapter 3, but limited variation and interpretation ambiguity precluded their inclusion in these analyses. Descriptive statistics of land use type and whether or not a development was a subdivision or planned unit development revealed limited variation with the sample (i.e., 178 of the 197 were residential and 168 of the 197 developments were subdivisions or PUD). These two variables were not included in the regression.

Table 7.2: Descriptive Statistics for Dependent and Independent Variables

	Obs	Mean	Std Dev	Min	Max
Dependent Variables					
% of Bare Earth	197	2.689	5.393	0	44.415
% of Tree Cover	197	80.220	18.196	6.738	100
% of Impervious Surface	197	3.735	5.710	0	44.962
Planning Inputs					
Plan Quality					
Direction-Setting	178	3.096	1.555	0	5.942
Goals	178	3.303	2.221	0	7.000
Fact Base	178	2.944	1.268	0	5.441
Policy Framework	178	2.748	1.502	0	6.707
Action-Oriented	178	3.117	1.441	0	5.137
Implementation	178	2.682	1.741	0	5.883
Monitoring	178	3.017	2.492	0	9.000
Coordination	178	3.234	2.269	0	7.143
Participation	178	3.096	1.555	0	5.942
Ordinance Quality					
Content	197	3.812	1.464	0.796	6.735
Goals	197	5.421	1.729	2.0	8.0
Fact Base	197	3.575	2.100	0.0	7.619
Policy Description	197	3.798	1.413	0.230	6.321
Restrictions	197	2.455	1.629	0.0	5.0
Administration	197	3.845	1.410	0.427	6.647
Complexity	197	2.758	1.669	0.0	6.667
Flexibility	197	5.045	1.851	0.0	9.130
Enforcement	197	3.732	1.659	1.282	6.923
Community Characteristics					
Population Size	197	181900	195596	1436	754292
Growth Rate	197	0.52	0.81	0.07	3.07
Population Density	197	1025.14	818.96	72.24	3587.19
Median Home Value	197	174599	64913	62300	456200
Planning Capacity	197	25.39	20.16	1	69.88
Project Characteristics					
Development Size (in acres)	197	93.91	152.49	0.34	1589.36
Buffer Percentage	197	16.99	13.11	0.21	94.38
Number of Lots	197	103.14	172.60	1	1278
Image Lag	197	9.59	4.14	1	24

Three multivariate regressions were used to test the relationships between the dependent variables (i.e., percentage of bare earth within the buffer, percentage of tree cover within the buffer, and percentage of impervious surface within the buffer) and independent variables (plan quality, ordinance quality, community variables and project variables). Each of the dependent variables were recoded as binary variables in order to measure the likelihood that development's buffer including bare earth, tree cover, or impervious surface above a particular threshold.

There were three categories of independent variables: planning inputs, community characteristics, and project characteristics. Variance inflation factors (VIF) and tolerance calculations for the independent variables found multicollinearity among the individual principles under plan quality and ordinance quality beyond the maximum commonly acceptable levels for VIF (<10.0) [46]. To address concerns that multicollinearity would inflate standard errors and make coefficients unreliable, the conceptual groupings discussed in Chapters 5 and 6 were used for plan quality (direction-setting and action-oriented) and ordinance quality (policy content and policy administration).

In an attempt to find the most parsimonious model to explain the variation observed in the dependent variables, nested models using all of the community and site characteristics variables were run and compared using Log-Likelihood tests and Bayesian Information Criterion. The most parsimonious models rarely include any community characteristics and often excluded the variable for state policy context. Given the statistically significance of community variables in other studies examining plan quality and the integral role played by mandates in this research, the following set of community characteristics were included in all regression models: population density, growth rate, median home value, and dummy variable

[46] Multicollinearity appeared to be a particularly concern for the Gunpowder-Patapsco watershed where there was a VIF of 1.84 e+14 for the Restrict variable.

for state planning context. Past studies have found associations between these community variables and plan quality (Alterman & Hill, 1978; Berke et al., 1999, 1996; Berke, Backhurst, et al., 2006; Brody, 2003a; Burby, 2003; Burby et al., 1997; Dalton & Burby, 1994).

The following sections report the exponentiated log-odds model coefficients (odds ratio), standard errors, and p-values as well as measurements of model fit (i.e., Wald χ^2 tests, McFadden's R^2, AIC, and BIC) from regressions on bare earth, tree cover, and impervious surface within approved riparian buffers. Diagnostics (i.e., residual review and Cook's D) were used to identify potential influential outliers. These observations were first investigated for data errors. If no errors were found to be corrected, the model was run excluding the outliers. If the exclusion did not substantial change the model (i.e., alterations to the magnitude and direction of coefficients and statistical significance), the outliers were retained in the final model.

7.3.1 Predicting Bare Earth within Riparian Buffers

To function optimally a riparian buffer should minimize bare earth because, without vegetation, these areas are more likely to contribute sediment and are less able remove pollutants, reduce the velocity of stormwater runoff, or increase infiltration. The Bare Earth variable ranges from 0 to 44.96%, but is right-skewed with half of the developments having less than 0.55% bare earth within their buffers. The tight clustering of the data complicated the creation of a threshold with substantive meaning. For example, the division of the variable into developments with and without bare earth in the buffer would divide a development without bare earth from a development with 0.003% of bare earth within its buffer. Likewise, it is unclear that differentiating the likelihood that a buffer contained 1%

bare earth versus 2% bare earth would have practical implications. A threshold of 2.5% was used to create a binary dependent variable for Bare Earth because this threshold approximates the sample mean and the substantive findings could be related to the mean percentage of bare earth found within the study sample. Table 7.3 provides descriptive statistics for the Bare Earth by watershed.

Table 7.3: Descriptive Statistics for Bare Earth by Watershed[47]

	n	*Min*	*Max*	*Mean*	*SD*	*p-value*
Gunpowder-Patapsco	78	0	44.41	2.18	5.73	
Jordan Lake	119	0	30.27	3.02	5.16	
Total	197	0	44.41	2.69	5.39	0.0743*

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

Without exception, the riparian buffer policies in this study explicitly prohibited bare earth within the buffer area. The low overall mean scores for the *Bare Earth* for both study watersheds suggests jurisdictions are implementing stated policies. The presence of any bare earth, however, is a concern as is the statistically significant difference between the watersheds (p=0.074). Table 7.4 reports the results of the regression that examined the influence of planning inputs, community characteristics, and project characteristics on the likelihood a buffer contains 2.5% or more bare earth.

[47] Numerical tests for normality and graphic plots suggested Bare Earth was right-skewed and may violate assumptions for normality. A Mann-Whitney U test was performed and found a statistically significant difference at the 0.1 level.

Table 7.4: Predicting the Percentage of Bare Earth within Approved Buffer

Variable	Odds Ratio	Standard Error	z-value	p-value
State Planning Content				
Watershed	5.099	2.548	3.26	0.001***
Community Characteristics				
Population Density	1.073	0.038	1.96	0.050**
Growth Rate	0.993	0.005	-1.39	0.165
Median Home Value	0.995	0.005	-1.00	0.317
Project Characteristics				
Lots (in increments of 10)	1.009	0.011	0.91	0.363
Percentage of Site within Buffer	1.017	0.017	1.02	0.307
Image Lag	0.957	0.066	-0.64	0.524
Planning Inputs-Plan Quality				
Direction-Setting	1.294	0.210	1.57	0.115
Action-Oriented	1.978	0.481	2.81	0.005**
Planning Inputs- Ordinance Quality				
Policy Content	1.517	0.557	1.14	0.256
Administration	0.966	0.350	-0.10	0.924
Intercept	0.002	0.003	-3.62	0.000***

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

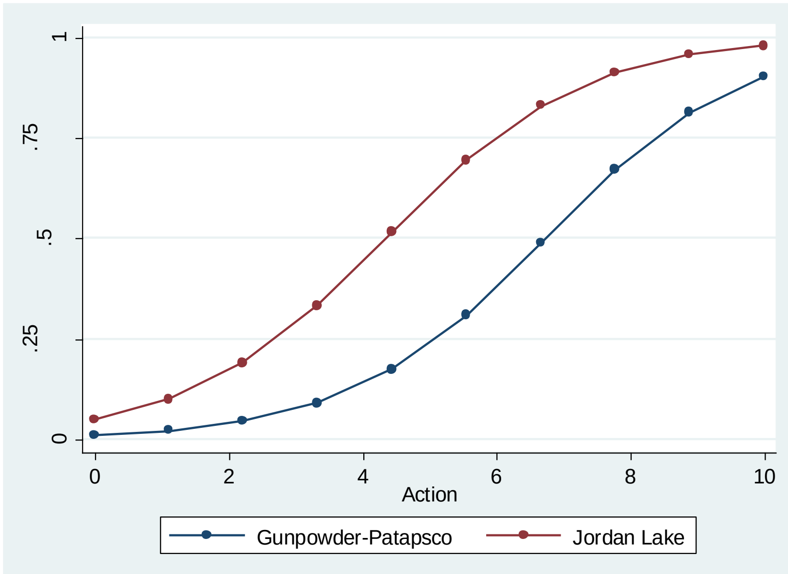
n	178
Wald χ^2	38.27 (p =0.006)
McFadden's R^2	0.192
AIC	1.038
BIC	223.00

Four variables achieved traditional levels of statistically significance holding the other variables constant. Although the intercept was statistically significant at the 0.001 level, it was not interpreted as there were variables included in the model that cannot take on a value of 0 in this sample (e.g. lots or percentage of site within the buffer). For the variable Population Density, a one point increase in population density (i.e., an increase of 100 people within a square mile) increases the odds that a riparian buffer includes more than 2.5% bare earth by a factor of 1.073, holding all other independent variables constant. Although this variable was statistically significant at the 0.05 level, its influence is relatively small as it corresponds to an increase of 7.3% in the likelihood a buffer includes 2.5% of more bare earth.

The interpretation of the statistically significant dummy variable for Watershed is the presence of a development in the Jordan Lake watershed increases the odds that the buffer includes more than 2.5% bare earth by a factor of 5.099, holding all other independent variables constant. Thus, a development within the Jordan Lake watershed is 5 times as likely to exceed the mean percentage of bare earth within its buffer compared to a Gunpowder-Patapsco development.

Action-Oriented—the conceptual group of the Implementation, Monitoring, Inter-jurisdictional Coordination and Participation plan quality principles—was statistically significant at the 0.05 level. A one point increase in Action-Oriented increases the odds that a riparian buffer includes more than 2.5% bare earth by a factor of 1.978, holding all other independent variables constant. This finding is contrary to the study's hypothesis that higher quality planning inputs would be associated with better implementation (in this case, less bare earth within an approved buffer). Although the overall low mean percentage of bare earth in a buffer is encouraging, the positive relationship between higher scores in one plan quality area and an undesirable buffer outcome runs counter to expectations. Figure 7.1 plots the predicted probability of bare earth against the scores for the Action-Oriented plan quality principles for each study watershed to help illustrate this finding.

Figure 7.1 Predicted Probability for Bare Earth by Action-Oriented and Watershed



At each level of the Action-Oriented variable, the predicted probability for bare earth in the buffer is higher for Jordan Lake. Further, for both watersheds, the increase in scores in accompanied by an increase in the predicted probability of bare earth. There are a number of possible explanations for this findings. First, these data may be an accurate representation of the relationships between plan quality and bare earth within buffers, and higher quality plans are not associated with better outcomes with respect to bare earth. Next, there could be missing variables that are highly correlated with the Action-Oriented variable that would result in a less counterintuitive interpretation. Finally, the limited sample size and narrow focus on two watersheds does not accurate portray the relationships between the variables. Additional research increase sample size, expand the number of watersheds explored, and explore the jurisdictions contributing in this relationship could clarify how these higher scores are related to this undesirable implementation outcome.

In summary, this regression found a number of variables predictive of bare earth within riparian buffer at or above the 2.5% threshold. In plan quality studies, population density has been both positively and negatively associated with plan quality (Alterman & Hill, 1978; Berke et al., 1996; Brody, Carrasco, et al., 2006; Brody, 2003a; Burby, 2003; Dalton & Burby, 1994). In this study, increases in population density are associated with a negative outcome (i.e., the increase in the likelihood of bare earth in the riparian buffer at or above the 2.5% threshold) although the effect is weak. While the direction of this effect is consistent with some previous studies, additional research is necessary to clarify the mechanism through which population density and bare earth are connected. Similarly, future research should examine how the two watershed's policies specific to bare earth are dissimilar in order to better understand the large observed difference. Unexpectedly, higher scores on plan quality (i.e., the Action-Oriented framework) were associated with a negative land use outcome, which contradicts the hypothesized relationship between higher quality planning inputs and better land use outcomes and warrants further study.

7.3.2 Predicting Tree Cover within Riparian Buffers

While both fine and coarse vegetation play roles in pollutant interception and removal and soil stabilization, coarse vegetation such as tree cover provides additional benefits including temperature regulation, habitat, and stream bank stabilization. The following section investigates tree cover within the buffer. The Tree Cover variable is left-skewed, ranging from about 6.7% to 100% with the majority of buffers including at least 70% tree cover. A threshold was set at 75% to create the dependent variable Tree Cover. The following table reports the descriptive statistics for Tree Cover by watershed.

Table 7.5: Descriptive Statistics for Tree Cover Scores by Watershed[48]

	n	*Min*	*Max*	*Mean*	*SD*	*p-value*
Gunpowder-Patapsco	78	6.73	99.55	75.37	21.40	
Jordan Lake	119	28.61	100	83.40	15.01	
Total	197	6.73	100	80.22	18.20	0.0125**

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

The riparian buffer policies reviewed from this study varied in their stipulations for tree cover. Although riparian buffers and approved development applications contained language about preserving existing tree cover, many policies only stipulated that buffers contain stable, undisturbed vegetation. However, the inclusion of tree cover within riparian buffers is considered a best practice. The high overall mean scores for the *Tree Cover* for both study watersheds suggest there are retention and cultivation efforts for forested buffers even in the absence of more explicit buffer vegetation policies. While the overall mean scores for both watersheds both exceeded 75%, there was a statistically significant difference between the watersheds with Gunpowder-Patapsco developments containing higher percentages of tree cover (p=0.0125). Table 7.6 reports on the regression that examined the influence of planning inputs, community characteristics, and development characteristics on the likelihood a buffer contains 75% or more tree cover.

[48] Numerical tests for normality and graphic plots suggested the *Tree Cover* variable was left-skewed and may violate assumptions for normality. A Mann-Whitney U test was performed and found a statistically significant difference at the 0.05 level.

Table 7.6: Predicting the Percentage of Tree Cover within Approved Buffer

Variable	Odds Ratio	Standard Error	z-value	p-value
State Planning Content				
Watershed	3.984	2.367	2.33	0.020**
Community Characteristics				
Population Density	1.029	0.033	0.91	0.364
Growth Rate	1.003	0.003	0.82	0.412
Median Home Value	0.999	0.004	-0.17	0.864
Project Characteristics				
Lots (in increments of 10)	0.967	0.013	-2.50	0.012**
Percentage of Site in Buffer	0.971	0.015	-1.90	0.058*
Image Lag	1.013	0.072	0.19	0.852
Planning Inputs- Plan Quality				
Direction-Setting	1.477	0.252	2.29	0.022**
Action-Oriented	1.228	0.271	0.93	0.351
Policy Inputs-Ordinance Quality				
Policy Content	2.037	0.659	2.20	0.028**
Administration	0.712	0.208	-1.16	0.245
Intercept	0.082	0.138	-1.48	0.139

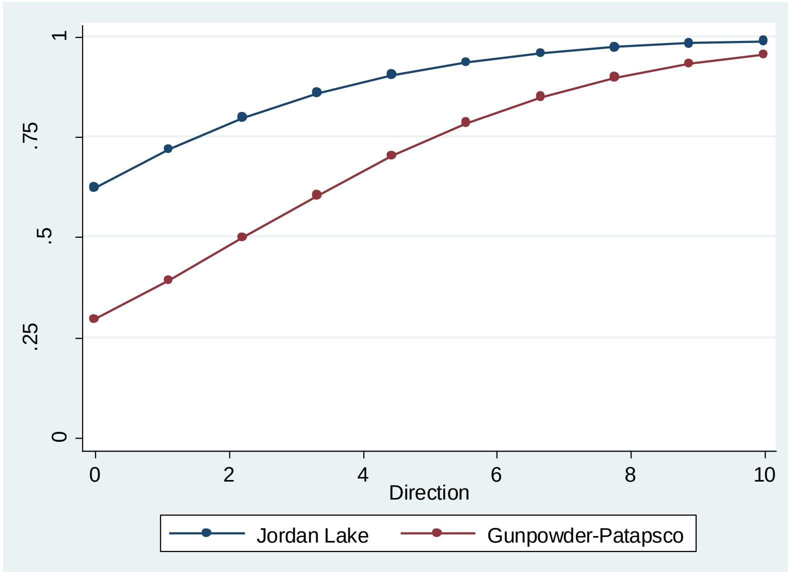
**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

n	178
Wald χ^2	29.28 (p =0.0026)
McFadden's R^2	0.14
AIC	1.147
BIC	242.385

This logistic regression models the change in the likelihood that a development's riparian buffer contains 75% or more tree cover given changes in the planning inputs and controlling for community and project characteristics. Five variables achieve traditional levels of statistical significance: the watershed dummy variable, the project variables for the number of lots within the development and percentage of the site within the buffer, the Direction-Setting plan quality variable, and the Policy Content ordinance quality variable. The interpretation of the statistically significant dummy variable for Watershed is the presence of a development in the Jordan Lake watershed increases the odds that the buffer includes more than 75% tree cover by a factor of 3.984, holding all other independent variables constant. Thus, a development within the Jordan Lake watershed is almost 4 times as likely to exceed 75% tree cover within its buffer compared to a Gunpowder-Patapsco development. For the variable Lots, a one point increase (i.e., an increase of 10 lots) decreases the odds that a riparian buffer includes more than 75% tree cover by a factor of 0.967, holding all other independent variables constant. Although this variable is statistically significant, the magnitude of the reduction is relatively small, roughly a 3% decrease in the odds. For the variable Percentage of Site within the Buffer, a one point increase decreases the odds that a riparian buffer includes more than 75% tree cover by a factor of 0.971, holding all other independent variables constant. This variable is statistically significant at the 0.1 level and the magnitude of the reduction is relatively small, roughly a 3% decrease in the odds.

Both of the statistically significant planning inputs have much larger influence on the odds of a development including more than 75% tree cover. A one point increase in the plan quality conceptual grouping of Direction-Setting (Goal, Fact Base and Policy Framework Principles) increases the odds that a riparian buffer includes more than 75% tree cover by a factor of 1.477, holding all other independent variables constant. Figure 7.2 plots the predicted probability of tree cover above 75% against the scores for the Direction-Setting variable for each study watershed to help illustrate this finding.

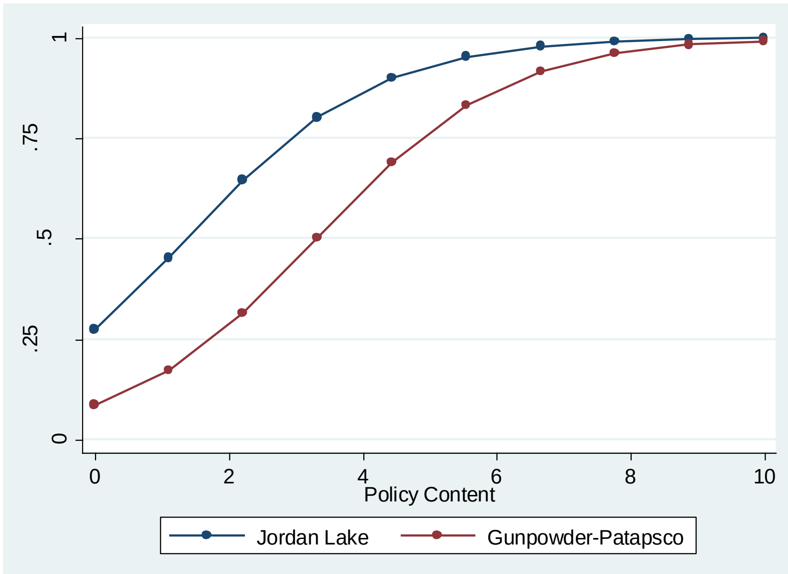
Figure 7.2 Predicted Probability for Tree Cover by Direction-Setting and Watershed



The figure shows that although developments within the Jordan Lake watershed are more likely to have buffers with more than 75% tree cover than developments in the Gunpowder-Patapsco watershed, the difference narrows as scores on the Direction-Setting principle increase. One interpretation of this finding is the jurisdictions within the Jordan Lake watershed, regardless of plan quality scores, begin with higher tree cover due to the more recent transition from rural to urban. The difference between the two watersheds decreases as Direction-Setting scores increases, which reflects that, regardless of which watershed a jurisdiction is located in, jurisdictions with plans with higher goals, fact base, and policy framework scores are more likely to be associated with the retention or restoration of tree cover within riparian buffers above the threshold.

The results for Policy Content mirror the pattern observed in Direction-Setting. A one point increase in the ordinance quality conceptual grouping of Policy Content (Goals, Fact Base, Policy Description, and Policy Restrictions) increases the odds that a riparian buffer includes more than 75% tree cover by a factor of 2.037, holding all other independent variables constant. Figure 7.3 plots the predicted probability of tree cover above 75% against the scores for the Policy Content variable for each study watershed.

Figure 7.3 Predicted Probability for Tree Cover by Policy Content and Watershed



Again, developments within Jordan Lake watershed with lower scores for policy content still have a higher probability of including more than 75% tree cover than jurisdictions within the Gunpowder-Patapsco watershed. However, the difference between watersheds observed at lower policy content scores decreases as policy content scores increase. Regardless of which watershed a development is in, an increase in a policy content scores is accompanied by an increase in the likelihood of including more than 75% of tree cover in the riparian buffer.

Returning to the conceptual model, some of the hypothesized linkages between intention (plan quality) and action (ordinance quality) are supported by these findings. In both cases, it is the conceptual groupings focused on the substance of plans and policies that have an effect on landscape features opposed to the frameworks aimed at facilitating plan and policy implementation (action-oriented and administration). Plans that include more goals, information and policies aimed at protecting water resources are associated with more tree cover within the buffer (a positive outcome). Likewise, and to a greater magnitude, development management ordinances that include of more goals, information, policies, and restrictions aimed at optimal riparian buffer design and functioning are more likely to include tree cover above the 75% threshold within their riparian buffers.

7.3.3 Predicting Impervious Surface in Riparian Buffers

Similar to the presence of bare earth, the presence of impervious surface within the buffer can negatively affect the functioning of the buffer. Unlike bare earth, there are instances when impervious surface is allowed in the buffer. For example, developments are routinely granted permission to cross riparian buffers with roads. This analysis excluded recorded roads from impervious surface calculations in an effort to focus on unapproved impervious surface within buffers[49].

The Impervious Surface variable was right-skewed, and ranging from 0.0% to 44.96% with the median value of 1.44% meaning the buffers of 50% of the study's developments included less than 2% impervious surface. A threshold was set at 5% to create the dependent variable Impervious Surface. The following tables first report the descriptive statistics for Impervious Surface by watershed and then reports the exponentiated log odds model coefficients, standard errors, and p-values are reported for variables as well as measurements of model fit.

[49] To limit the analysis to unapproved impervious surface within buffers, data on trails and greenways was gathered. Unfortunately, data was only available for nine of the fourteen study jurisdictions. Of the remaining five jurisdictions, at least one is known to have an extensive trails and greenway system. The small percentage of impervious surface attributable to trail/greenway impervious surface (mean percentage of 0.35%) was weighed against the possibility of biasing results due to data availability. The decision was made to not exclude trails and greenways even where data was available.

Table 7.7: Descriptive Statistics for Impervious Surface Scores by Watershed[50]

	n	*Min*	*Max*	*Mean*	*SD*	*p-value*
Gunpowder-Patapsco	78	0	27.97	2.50	4.74	
Jordan Lake	119	0	44.96	4.54	6.15	
Total	197	0	44.96	3.74	5.71	0.0018*

**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

Similar to bare earth, the riparian buffer policies reviewed from this study uniformly prohibited unapproved impervious surface within the riparian buffer. The low overall mean scores for the *Impervious Surface* for both study watersheds suggests that these prohibitions are largely being implemented. Still, the analysis only found 28 developments without any impervious surface in the buffer and there was a statistically significant difference between the two study watersheds with developments in the Jordan Lake watershed having a statistically significantly higher percentage of impervious surface in the buffer (*p=0.0018*). Table 7.8 reports on the regression that examined the influence of planning inputs, community characteristics, and development characteristics on the likelihood a buffer contains 5% or more impervious surface.

[50] Numerical tests for normality and graphic plots suggested the *Impervious Surface* variable was right-skewed and may violate assumptions for normality. A Mann-Whitney U test was performed and found a statistically significant difference at the 0.01 level.

Table 7.8: Predicting the Percentage of Impervious Surface within Approved Buffer

Variable	Odds Ratio	Standard Error	z-value	p-value
State Planning Content				
Watershed	0.668	0.416	-0.65	0.516
Community Characteristics				
Population Density	1.058	0.035	1.68	0.093*
Growth Rate	1.008	0.004	2.16	0.031**
Median Home Value	0.999	0.004	-0.25	0.802
Project Characteristics				
Lots (in increments of 10)	1.040	0.014	2.85	0.004**
Percentage of Site in Buffer	1.028	0.017	1.64	0.102*
Planning Inputs-Plan Quality				
Direction-Setting	1.007	0.182	0.04	0.969
Action-Oriented	0.823	0.191	-0.84	0.402
Policy Inputs-Ordinance Quality				
Policy Content	0.575	0.199	-1.60	0.110
Administration	1.251	0.392	0.72	0.474
Intercept	0.725	1.302	-0.18	0.858

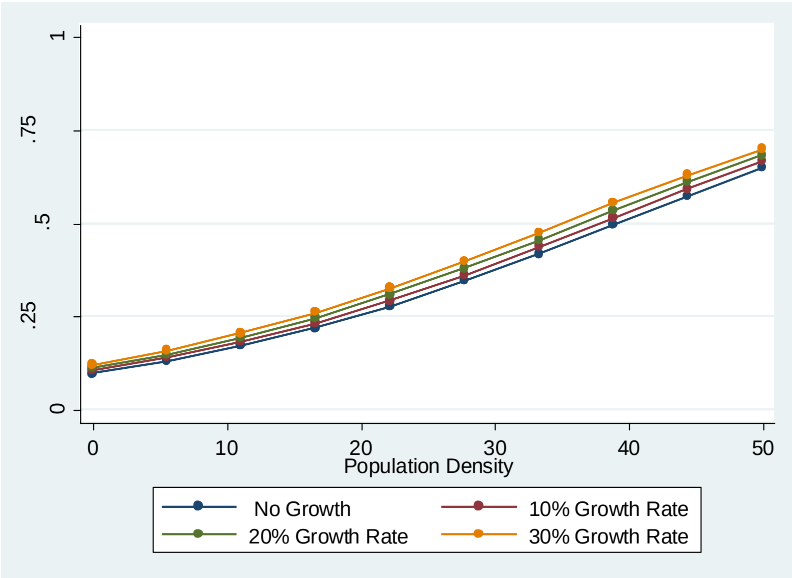
**p-values* ≤ 0.1, ** *p-values* ≤ 0.05, *** p-values≤0.001

n	178
Wald χ^2	66.28 (p =0.000)
McFadden's R^2	0.198
AIC	0.960
BIC	209.144

This logistic regression models the change in the likelihood that a development's riparian buffer contains more than 5% impervious surface given changes in the planning inputs and controlling for community and project characteristics. Three variables achieve traditional levels of statistically significance and two variables approached statistically significance at the 0.1 level.

A one point increase in the population density (i.e., an increase of 100 people per square mile) increases the odds that a riparian buffer includes more than 5% impervious surface by a factor of 1.058, holding all other independent variables constant. A one point increase in the growth rate increases the odds that a riparian buffer includes more than 5% impervious surface by a factor of 1.008, holding all other independent variables constant. These effects were statistically significant but were relatively small.

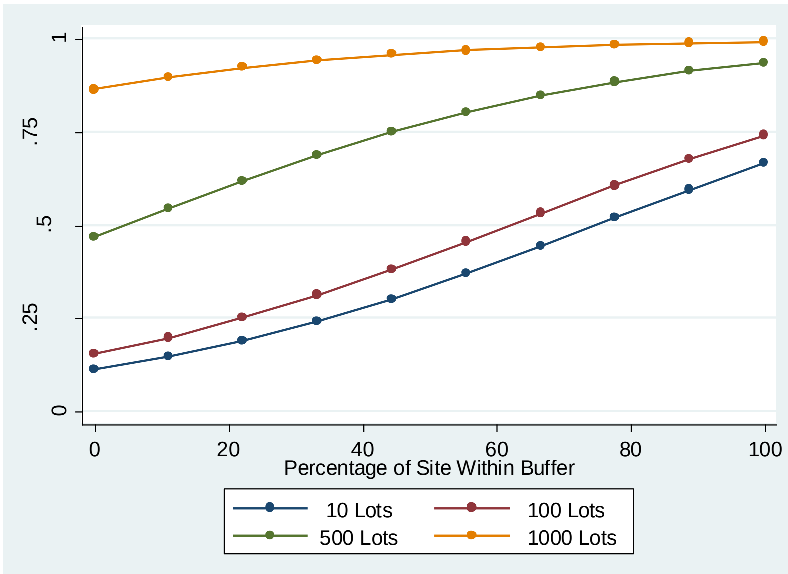
Figure 7.4 Predicted Probability for Impervious Surface by Population Density and Growth Rate



In short, developments in jurisdictions with higher population density and developments in jurisdictions experiencing higher growth rates were more likely to have more than 5% impervious surface within their buffers.

The effects of the statistically significant project variables was similarly small. A one point increase in the Lots variable (equivalent to 10 lots) increases the odds that a riparian buffer includes more than 5% impervious by a factor of 1.040, holding all other independent variables constant. For each one point increase in the percentage of the site that falls within the buffer, the odds that the buffer includes more than 5% impervious surface increased by a factor of 1.028, holding all other independent variable constant. Figure 7.5 plots the predicted probability of impervious surface above 5% against the Lots and Buffer Percentage variables.

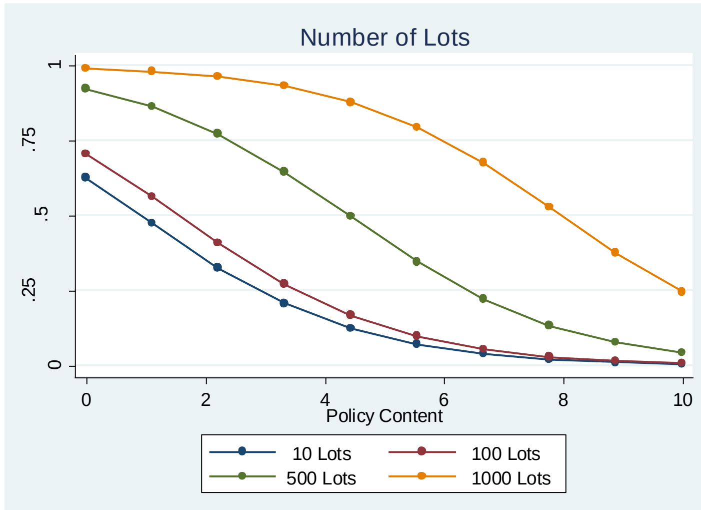
Figure 7.5 Predicted Probability for Impervious Surface by Number of Lots and Buffer Percentage

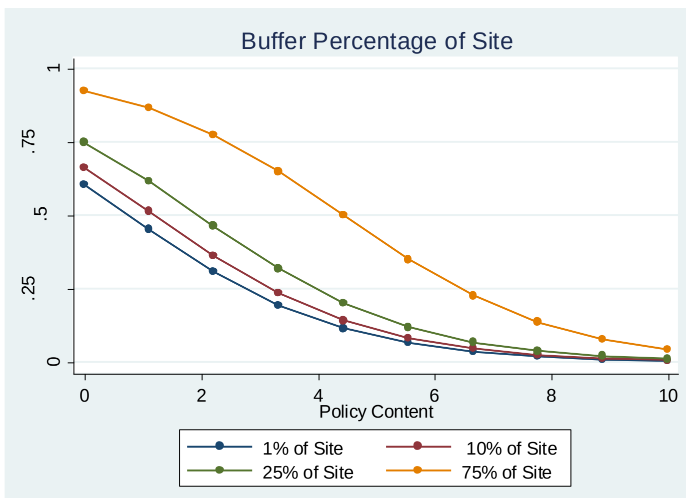


This figure illustrates the expected relationship between the percentage of the site within the buffer and probability of a buffer including more than 5% impervious surface. Developments with buffers that take up more of the site are more likely to have impervious surface above the threshold in their buffers. It also illustrates that developments with more lots, regardless of the overall percentage contained in buffers, are more likely to have more than 5% impervious surface within their buffers.

The final variable examined in this section approached statistical significant at the 0.1 level: Policy Content. A one point increase in the ordinance quality conceptual grouping of Policy Content (Goals, Fact Base, Policy Description, and Policy Restrictions) decreases the odds that a riparian buffer includes more than 5% impervious surface by a factor of 0.575, holding all other independent variables constant.

Figure 7.6 Predicted Probability for Impervious Surface by Policy Content with Number of Lots and Buffer Percentage





The effect is similar in both figures with increases in policy content scores being accompanied by decreases in the predicted probability of a development having more than 5% impervious surface in the buffer. The effect on developments with more lots is more attenuated meaning a higher policy content score is necessary to achieve reduction in the predicted probability, and the reduction is not of the same magnitude.

In sum, the findings for the impervious surface regression echo the effects observed in the tree cover analysis. The number of lots, the percentage of the site within the buffer, and population density were associated with negative land use outcomes (i.e., increased likelihood of impervious surface within the buffer above the threshold). Additionally, although Policy Content only approaches statistical significance at the 0.1 level, increases in this variable are associated with a positive land use outcome (i.e., decreased likelihood of impervious surface within the buffer above the threshold).

7.4 Conclusion

This chapter investigated the frequency of policy slippage and the factors that help explain variation in the implementation of riparian buffers policies. The small number of policy slippage cases precluded in-depth statistical analyses, but the limited variation in the variable does have practical implications as only 5% of developments were subject to policy slippage with respect to riparian buffer policies. Further, the use of a performance-based approach to evaluating success suggests when policy slippage is accompanied by a rationale and additional requirements (as was the case in Baltimore County), the nonconformance may not be equated with a lower level of water resource protection. Subsequent studies should expand beyond riparian buffer policies to examine policy slippage and use more in-depth qualitative methods to examine the discourse surrounding approved and denied variances.

The second section of this chapter investigated policy implementation using data collected from high resolution land cover classification maps. This study hypothesized that the state planning context, the quality of planning inputs, and local context (community and project characteristics) would help explain the variation observed in the implementation of riparian buffer policies (i.e., bare earth, tree cover, and impervious surface encroachment) such that higher quality policy inputs would be associated with better implementation outcomes controlling for state and local context. The results described in this chapter lend some support for this statement, but not without caveats.

The regressions exploring the percentage of tree cover and bare earth within buffers did result a statistically significant difference between the watersheds. It is unclear, however, if these observed differences are necessarily the result of the state planning context (i.e., mandates). With respect to tree cover, the differences may be an artifact of the recent development history in the Jordan Lake watershed (i.e., sunbelt development versus rustbelt development). There may be more tree cover in Jordan Lake buffers because there is more tree cover in the watershed to begin with due to a more recent development history. Additional research should utilize historic land cover maps to address this possibility. For the bare earth regression, it is possible that state planning context does help account for the large effect observed and additional research should focus on the specific differences in riparian buffer vegetation policies of the two watersheds.

There is some evidence that plan quality is associated with the percentage of bare earth, but the relationship was in the opposite direction from the hypotheses. A variety of possible explanations are possible including missing variables or slippage between higher quality plans with respect to plan implementation and actual implementation actions. An additional possibility is that the construction of the variable, which measures the overall quality of plan implementation is not an adequate measure of the quality of implementation for specific water resource protection policies. Refinement of the plan quality protocol to measure the plan implementation structure specifically for water resource protection is necessary to help determine if higher quality plans are truly not having their intended impact.

There is also some evidence that higher quality policy inputs are associated with the percentage of tree cover within a buffer. Both plan quality (Direction-Setting) and ordinance quality (Policy Content) occurred in the hypothesized direction with higher scores being associated with better implementation outcomes (i.e., percentage of tree cover in the buffer). Additionally, although the relationship with planning inputs (ordinance quality-Policy Content) only approached statistical significance at the 0.1 level, this finding is interesting because it suggests ordinance quality principles may effect this outcome, but this conceptual group does not include the policy administration principles (e.g. Monitoring and Enforcement). These findings suggest that improvements in the direction-setting elements of plans (Goals, Fact Base, and Policy Framework) and in the content of riparian buffer ordinances could have tangible impacts on positive land use outcomes. Additional research should expand the sample population to allow for regressions that including individual principles to clarify these relationships.

Finally, community and project variables helped explain some of the variation observed in all three implementation outcomes. Particularly, the results on the percentage of the buffer and number of lots variables could help local jurisdictions develop monitoring programs that utilize their limited resources more effectively by targeting developments with a larger number of lots or developments where the buffer accounts for a higher percentage of the parcel. Future studies should expand the sample population to allow regressions that including individual principles and include mediation analysis to help explain the pathway between plan quality and implementation outcomes.

CHAPTER 8: STUDY IMPLICATIONS AND FUTURE RESEARCH

> The current state of the art of plan-making and supporting analysis is based on minimal data inputs and, what is probably more important, insufficient feedback on the efficacy of plans or policies during their implementation” (Calkins, 1979, p. 745).
>
> The process of evaluation, which is essential if we are to learn from experience, has already begun, although there are as yet relatively few efforts at the comparative analysis or synthesis which is essential for the construction of a descriptive theory of planning (Alexander, 1981, p. 139).

8.1 Introduction

Although a complex array of variables contribute to the impairment of water bodies, land use decisions represent one local mechanism through which alterations to landscape features (i.e., land, water, vegetation, structures, and infrastructure that compose a landscape) can affect water quality. While a number of research projects link land use and water quality outcomes, there is limited research into how land use *planning* could be an essential point for intervention to protect water quality. In response to Calkins’ and Alexander’s call for plan and policy implementation studies that incorporate comparative analyses, this study begins with the comprehensive plan and follows the policy implementation process from development management ordinances through approved development applications to constructed development at the parcel level. By examining two watersheds located in two different states, this study addresses the spatial mismatch between jurisdictional and watershed boundaries and offers a comparative analysis of a cross-section of plan and policy implementation efforts.

A number of planning scholars suggest competing approaches to evaluation, timelines of implementation, and limited methodologies all complicate the evaluation of planning (Laurian, Day, Backhurst, et al., 2004; Mastop & Needham, 1997; Talen, 1996b). This project addresses each of these challenges. First, instead of selecting one of the two prominent definitions of planning success (i.e., conformance and performance), the two approaches are integrated into a single methodology to capitalize on their individual strengths. Structured protocols (characteristic of a conformance-based approach) for plan and ordinance quality enabled comparisons between the two study watersheds. The performance-based approach used for the content analysis of development applications better reflects real-world conditions where flexibility is an essential component of the development review process and helped elucidate the differences between sanctioned and unsanctioned policy slippage.

This project is the first to combine plan and ordinance quality with the content analysis of approved development applications. Each development application was linked to the comprehensive plan and development management ordinances in effect during its approval and to observations from high-resolution land cover classification maps. This extended timeline captures the development process from planning inputs to actual constructed development and helps make this project a unique contribution to the plan and policy implementation research. The following sections review the research questions and hypotheses (introduced in Chapters 1 and 2) that were the foundation of this project.

8.2 Hypotheses Revisited

8.2.1 Plan and Ordinance Quality

While a number of studies on water resource protection make recommendations for the development and spatial organization of the built environment, few studies investigate whether or not existing land use policies include these recommendations (Arkema, Abramson, & Dewsbury, 2006; Berke et al., 2013; Brody, 2003b). Thus, there is limited information on whether the vast body of literature about water resource protection actually informs land use policy or the profession charged with overseeing urban land development—land use planning. This state of practice and the limited research into the effectiveness of mandates to improve and protect water quality prompted the first two research questions of this project.

> RQ1: Do jurisdictions in a state with a mandate for comprehensive planning have higher quality comprehensive plans with respect to water resource protection than jurisdictions in a state without a mandate?

> RQ2: Does the design of a single purpose state mandate (i.e., complexity, inclusion of capacity and commitment-building elements, and implementation style) adopted to protect environmentally sensitive areas affect the quality of buffer protection provisions within development management ordinances?

First, with respect to comprehensive plans, I hypothesized that jurisdictions in a state with a mandate for comprehensive planning would have higher quality comprehensive plans with respect to water resource protection than jurisdictions in a state without a mandate. As detailed in the Chapter 2, research has found the presence of a mandate is associated with higher plan quality (Berke & French, 1994; Berke et al., 1996; Burby, 2005; Burby et al., 1997; Dalton & Burby, 1994). With the comprehensive planning mandate in Maryland, I expected jurisdictions within the Gunpowder-Patapsco watershed to have higher quality comprehensive plans, on average, compared to the jurisdictions in the Jordan Lake watershed in North Carolina. The results run counter to this hypothesis. There was only one plan quality principle (Inter-jurisdictional Coordination) where the Maryland watershed's score were statistically significantly higher than the North Carolina watershed.

For ordinance quality, the protocol focused on the optimal design and functioning of riparian buffer policies. Both study watersheds utilized mandates to protect environmentally sensitive areas (including riparian areas) and Chapter 4 details the how the mandates were differentiated based on their design using an methodology adapted from Burby, May, and colleagues (Burby et al., 1997). I hypothesized jurisdictions subject to a mandate with more design features supportive of implementation (the Gunpowder-Patapsco watershed in Maryland) would have higher ordinance quality scores, on average, compared to the Jordan Lake watershed in North Carolina. Again, the results ran counter to this hypothesis with no statistically significant differences between the two watersheds for the ordinance quality principles.

The key to understanding these findings lies in the design of the comprehensive planning mandate and the limited geographic coverage of the environmentally-sensitive mandate. The comprehensive planning mandates in Maryland requires the creation of a comprehensive plan, but does not provide substantial guidance in the content of the plan with regards to water resource protection. As a result, while Maryland plans must include a sensitive area element, mandate only requires 1) the inclusion of "goals, objectives, principles, policies, and standards" and 2) review by the Department of the Environment and the Department of Natural Resources for consistency with departmental programs and goals (Article 66B §3.05(a)(4)(ix)). I argue that the comprehensive planning mandate in effect during this study lacked the specificity necessary to improve plan quality above the levels of comprehensive plans created without a mandate.

Both states have mandates that effect riparian buffers— the best management practice selected for the policy implementation portion of this study. The assessment of the Maryland mandate in Chapter 4 suggested it included more design features supportive of implementation. However, the mandates of both states were geographically limited so this study investigated how the design of mandates aimed at designated areas influenced jurisdiction-wide ordinance quality. The mandate in Maryland encouraged the extension of mandated policy to other areas while the mandate in North Carolina allowed the extension, but emphasized procedural compliance with state law. As stated above, there were no statistically significant differences between the watersheds for ordinance quality. Given that previous research found jurisdictions often only adhere to the bare minimum requirements of mandates, it is, perhaps, not surprising that jurisdiction-wide development management ordinances did not incorporate policies that were merely encouraged (Berke & Beatley, 1992; May & Birkland, 1994). While the design features of Maryland's Critical Area mandate would support higher quality ordinances, the encouragement to extend the protection to riparian areas throughout the jurisdiction was not enough to improve ordinance quality above levels obtained with the North Carolina mandate, which covered a larger area with fewer policy requirements.

8.2.1 Policy Slippage

A community may have a high quality plan and high quality development management ordinances, but frequent deviations from policies can negate efforts to protect water quality. The third and fourth research questions investigated policy slippage, or the deviation or difference between a jurisdiction's policies and the provisions approved in a development application.

> RQ3: How frequently does policy slippage occur between the riparian buffer policies outlined within development management ordinances and the provisions of approved development applications?
>
> RQ4: Does the quality of policy inputs, the presence of mandates, and local context explain variation in policy slippage?

Out of 591 observations (197 applications reviewed for the variables of buffer width, vegetation, and impervious surface encroachment), only 10 policy slippage cases were observed. Thus, I concluded policy slippage was infrequent for these key riparian buffer variables.

The small number of policy slippage cases precluded the investigation of hypotheses associated with RQ4 as limited variation in the dependent and independent variables prevented the examination of the relationships among policy slippage, the quality of planning inputs, and the influence of mandates. These data did, however, provide interesting observations about the use of performance- and conformance-based approaches for the evaluation of policy slippage. A conformance-based approach considers all deviations (whether or not they are accompanied by a rationale) as a negative outcome. This project's findings suggest that the performance-based approach's more nuanced appraisal of deviation is necessary to accurately capture the relationship between deviation and negative water quality outcomes. For example, deviations from riparian buffer provisions within Baltimore County were routinely accompanied by a robust rationale and additional mitigation measures and would not necessarily result in a negative water quality outcome. Although a conformance-based approach enabled the plan and ordinance quality comparisons across multiple jurisdictions in the two study watersheds, a performance-based approach to policy slippage may more accurately capture the differential impacts that deviations can have on water quality, which has implications for the evaluation methodologies used for future studies.

8.2.3 Implementation

There is a growing body of implementation studies within the planning disciple that seeks to tie planning inputs to land use outcomes (Brody, Carrasco, et al., 2006; Chapin et al., 2008; Loh, 2011; Ozawa & Yeakley, 2007; Talen, 1996a). This project sought to build on this past research by using high resolution land cover classification maps to investigate the final research question.

> RQ5: Does the quality of policy inputs, the presence of mandates, and local context explain variation in implementation?

I hypothesized that higher quality policy inputs (i.e., comprehensive plans and development management ordinances) would be associated with better implementation outcomes controlling for local contextual factors and the presence and design of mandates. Although comparisons of means tests only found one statistically significant difference at the watershed level for plan quality and ordinance quality principles, the wide range of scores for individual jurisdictions indicates there was variation in these key independent variables.

Buffer widths from approved applications were used to delineate areas for measurements of three variables: bare earth, tree cover, and impervious surface. The selection of these three dependent variables allowed for an examination of 1) a dependent variable that should not appear in a buffer (bare earth), 2) a dependent variable that should be maximized within a buffer (tree cover), and 3) a dependent variable that should be minimized within a buffer (impervious surface). Three logistic regressions were completed to investigate this research question using these dependent variables as well as a set of community and site variables. The following section first reviews the statistically significant effects of the plan quality and ordinance quality variables and then covers the effects of the community and site variables.

All of the riparian buffer policies examined for this study explicitly prohibited bare earth within the buffer area. The threshold for the logistic regression was set at 2.5% of bare earth within the buffer using the mean variable of the sample. This threshold makes allowances for measurement error, avoids the creation of a threshold without substantive meaning (e.g., distinguishing between 0% bare earth and 0.04% bare earth), and facilitates substantive policy recommendations. Contrary to the study's hypothesis that higher quality policy inputs would be associated with better land use outcomes, the regression found higher scores on plan quality (specifically the Action-Oriented framework) were associated with a higher likelihood of having 2.5% or more bare earth within the buffer. Chapter 7 explores multiple possible explanations for these findings including 1) these data are evidence that higher quality plans are not being implemented, 2) missing variables or model misspecification are obscuring the actual relationships, or 3) small sample size limits statistical conclusion validity. Future research should increase the sample size and expand the number of study watersheds to determine if the associations remain and how these higher scores are related to this undesirable implementation outcome.

Although many of the major benefits of riparian buffers can be achieved with different vegetative targets, forested buffers play an important role in streambank stabilization, temperature regulation, and wildlife habitat. The policies reviewed in this study routinely encouraged tree preservation, but did not stipulate particular target percentages for tree cover. The threshold for the logistic regression was set at 75% of tree cover within the buffer with 1) the assumption that a higher percentage of tree cover was preferable and 2) using the means of the two study watersheds as guides. The findings for the tree cover regression were consistent with the hypothesis that higher quality policy inputs would be associated with better land use outcomes. Higher scores on the Direction-Setting framework (plan quality) and the Policy Content framework (ordinance quality) increased the likelihood that a development would exceed 75% tree cover within its buffer.

The presence of impervious surface within the buffer can negatively affect the functioning of the buffer, but, unlike bare earth, impervious surface often approved within the buffer (e.g., roads). This regression analysis focused on unapproved impervious surface within buffers. The Policy Content framework approached statistically significance with a p value of 0.110. A one point increase in the variable decreasing the odds that a riparian buffer includes more than 5% impervious surface by a factor of 0.575, holding all other independent variables constant.

The influence of community variables such as population density and growth rate on implementation were small in magnitude, but mirrored findings from the plan quality literature. Higher population density was associated negative outcomes for both bare earth and impervious surface, which is consistent with past studies that found an association between higher population density and lower quality plans (Alterman & Hill, 1978; Berke et al., 1996; Brody, 2003a; Burby, 2003; Dalton & Burby, 1994). For the site variables, developments with more lots or a higher percentage of the site covered by buffer were associated with negative land use outcomes (i.e., less tree cover and more impervious surface within the buffer). This finding, in particular, has practical applications for planning practice, which are discussed in the next section.

The influence of mandates on implementation is difficult to ascertain from these data. First, earlier plan quality and ordinance quality results did not clearly support any mandate effect. Second, with only two study watersheds and overlapping mandates, it is difficult to separate the effect of the comprehensive planning mandate from the environmentally-sensitive area mandate. Instead, I focus on the effect of a development's location within a particular watershed had on the dependent variables without attributing observed effects to the presence and design of mandates. The study found that the location of a development within a particular watershed could both increase 1) the likelihood of a negative land use outcome (i.e. developments within the Jordan Lake watershed were more likely to have bare earth within their buffers) and 2) the likelihood of a positive land use outcome (developments within the Jordan Lake watershed were more likely to have tree cover within their buffers). Future research should increase the number of watersheds and types of mandates under study to help differentiate mandate effects from watershed effects and to clarify if and how mandates are tied to implementation outcomes.

8.3 Scholarly and Practical Implications

When proposed, this study anticipated two major methodological and practical contributions: 1) the creation of a methodology to investigate the entire land use policy process and 2) substantive findings regarding the relationships among the quality of planning inputs and implementation. Methodologically, this study is the first project to examine the entire land use policy process by integrating content analysis and observations for high resolution land cover classifications maps. It adapted established plan quality content analysis methods for an examination of water resource protection and then extended this approach for an investigation of ordinance quality with respect to riparian buffers. The inclusion of development applications and the high resolution land cover classification maps synthesized approaches from previous research studies to facilitate the examination of policy slippage points and factors affecting policy implementation. This methodology opens up new avenues for the investigation of plan and policy implementation.

The research findings from this study will help improve planning practice. First, the findings reinforced conclusions from previous studies that the presence of a mandate is not sufficient to achieve better outcomes. Comprehensive mandates that do not provide substantive guidance or geographically-limited mandates that only encourage extension to other sensitive areas represent missed opportunities to safeguard water resources.

Second, the low overall plan quality and ordinance quality scores highlight topic areas where there is a gap between the substantial scientific knowledge accumulated about water resource protection and the planning inputs created and utilized by the planning profession. There are opportunities to improve both the substantive content of comprehensive plans and development management ordinances as well as the procedures in place to implement these plans and policies. Further, the study's findings connecting these planning inputs to better land use outcomes (i.e., more tree cover and less impervious surface within buffers) ties the aforementioned opportunities for improvement in these planning inputs to achieving better implementation outcomes.

Finally, these findings provide immediate recommendations for planning monitoring and enforcement programs. Developments with more lots and developments with a higher percentage of the site contained in the buffer should be prioritized for on-going monitoring as these factors are associated with a higher likelihood for negative outcomes. With limited funding and resources available to monitor riparian buffers, targeting these types of developments can help planning and inspection staff more efficiently utilize limited resources to protect water quality.

8.4 Future Research

There are a number of future research opportunities that will help clarify and build upon this study's important contributions to the plan and policy implementation literature. First, the investigation of plan quality and the assessment of Maryland's comprehensive planning mandate identified potential shortcomings in the mandate's design. Recent revisions to the mandate required the addition of a water resource element by 2009. A future study should evaluate the quality of plans created under this revised mandate and compare them to plans created under the previous mandate and updated plans from North Carolina.

Additionally, the number of watersheds (and, by extension, jurisdictions) should be increased to address threats to internal validity (i.e., statistical conclusion) that arises from the small sample size. Scaling up the study would allow for the analysis of individual principles and a more refined understanding of policy slippage and implementation. The larger sample should seek to increase the types of mandates examined as well as differing impairment histories of study watersheds.

The examination of policy slippage and implementation should be extended to more topics areas with implications for water quality. The consistency of data will remain an issue as approved applications from multiple jurisdictions may not include information on all of the variables of interest. However, there are opportunities to tie more policies to direct observations from high resolution land cover classification maps including the amount of impervious surface on the entire site, setbacks from the buffer, and the amount of approved impervious surfaces within riparian buffers (e.g., road crossings).

Finally, future study should complete the conceptual model and continue to close the gap between natural science research and social science research. This study sought to connect the use of scientific knowledge about water resource protection and the optimal design of riparian buffers with planning inputs and implementation. Future research should integrate the quality of planning inputs, policy slippage and implementation, and actual water quality outcomes. A longitudinal study utilizing historical data conducted at the subwatershed level would enable water quality outcomes to be tied to land use patterns that are the cumulative product of multiple plan and policy interventions.

APPENDIX A: PLAN QUALITY PROTOCOL

Principle: Goals

Indicator	Short Description	Detailed Description
1.1 Aquatic Diversity	Any goal to maintain or enhance the overall aquatic diversity in the watershed?	Preservation of species diversity protection of endangered species and/or specific aquatic plants and animals impacted by human water consumption or pollution as a goal, priority, or guiding principle.
1.2 Hydro Sensitive Areas	Any goal to protect hydrological environmentally sensitive areas (e.g. drinking water supply, watersheds, aquifer recharge areas, steep slopes, wetlands)?	Protection of natural environment as a goal, priority, or guiding principle with specific references: -area draining directly into the drinking water supply -watersheds -aquifer recharge areas -steep slopes (likely erosion impacts) -wetlands
1.3 Economic Development	Any goal to accommodate economic development in the watershed?	Development of residential, commercial, or industrial land uses within watershed protection areas with purpose of increasing economic output mentioned as a goal, priority, value, or guiding principle. For example, goals recognizing the potential impact of economic development (e.g., impervious surface) and creating goals to discuss how the balance economic development and protection of water resources.
1.4 Flood Damage Reduction	Any goal to reduce the amount of damage in flood- prone areas?	Reduction of development flood prone areas (areas in or near 100- and 500- year floodplains) as a goal, priority, value, or guiding principle.
1.5 Equitable Service Provision	Any goal for the equitable provision of services (e.g., water/sewer)?	Provision of water/sewer services to historically marginalized areas including low income neighborhoods, communities of color and areas with predominately non-English speakers as a goal, priority, or guiding principle
1.6 Reduce Pollutant Levels	Any goal to maintain or reduce the pollutant levels?	References to reducing the amount of pollutants into water. Examples: Nitrogen, phosphorus, pH, dissolved oxygen, arsenic, lead, microbial pathogens, fecal coliform, total maximum daily load (TMDL)

Principle: Goals, continued

Indicator	Short Description	Detailed Description
1.7 **Reduce Amt Runoff**	Any goal to reduce the amount of runoff into streams, rivers, and lakes?	References to reducing the amount or volume runoff as a goal, priority or guiding principle. For example, impervious surface reduction and efforts to increase absorption of stormwater (interception by vegetation)
1.8 **Reduce Rate Runoff**	Any goal to reduce the rate of runoff into streams, rivers, and lakes?	References to slowing the speed of runoff as a goal, priority or guiding principle Examples: Reduction in construction of surfaces engineered to conduct stormwater quickly
1.9 **Limit Sediment Runoff**	Any goal to limit the amount of sediment runoff into water bodies?	References to limiting or reducing sediment, limiting development on steep slopes, pollutants associated with sediment, increased sedimentation, turbidity as a goal, priority or guiding principle
1.10 **Public Awareness**	Any goal to increase public awareness and involvement in the protection of water resources?	References increasing knowledge and/or changing behavior to protect water resources (i.e., meetings, educational materials and workshops)

Principle: Fact Base-Drinking Water

Indicator	Short description	Detailed Description
2A.1 **Information Base**	Is the same information base used for land use, infrastructure, and water/sewer plans?	**Detailed:** Clear statements and references to the same information base (i.e., population estimates, growth rates, technical reports, etc). **Mentioned not detailed:** Vague references to using the same information without specific citations
2A.2 **Type_Location**	Description of water resources such as intermittent and perennial streams, lakes, river basins, estuaries, and wetlands	**Detailed:** Map with location of major water resources AND text describing the specific water resources within the jurisdiction **Mentioned not detailed:** Map OR text alone describing type and location of water resources. Text should be coded as "mentioned not detailed" if it does not provide detail beyond statements like “Map X contains the intermittent and perennial streams, wetlands, etc.".
2A.3 **Watershed Boundaries**	Boundaries of intermediate and small watersheds	**Detailed:** Map with watershed boundaries AND text description identifying watersheds **Mentioned not detailed:** Map OR text identifying watersheds
2A.4 **Aquifer Boundaries**	Boundaries of groundwater aquifers and their recharge areas	**Detailed:** Map AND text describing groundwater aquifers and recharge areas **Mentioned not detailed:** Map OR text identifying aquifers and recharge areas
2A.5 **State Water Quality Classification**	Description of state water quality classification for water resources	**Detailed:** Designations for each of major surface water bodies within jurisdictions **Mentioned not detailed:** Incomplete list of designations for major surface water bodies NOTE: Surface Water Classifications are designations applied to surface water bodies, such as streams, rivers and lakes, which define the best uses to be protected within these waters (for example swimming, fishing, drinking water supply) and carry with them an associated set of water quality standards to protect those uses.

Principle: Fact Base-Drinking Water, continued

Indicator	Short description	Detailed Description
2A.6 Drinking water supply sources & safe yields	Drinking water supply sources and safe yields for each source	**Detailed:** Description of water supply sources and safe yield in mgd (millions of gallons/day) **Mentioned not detailed:** Incomplete/vague description of water supply sources; missing safe yield values
2A.7 Water Supply System Inventory	An inventory of publically and privately owned small and larger drinking water supply systems	**Detailed**: Description clearly identifies drinking water supply systems and location of supply facilities **Mentioned not detailed:** Water supply systems mentioned without clear identification of system OR location of supply facilities
2A.8 DW Treatment Capacity	Drinking water treatment capacity, location of storage facilities, storage capacity and distribution of networks	**Detailed:** Description includes 1) treatment processes, 2) treatment capacity, 3) storage capacity and 4) distribution networks. **Mentioned not detailed:** Description missing 1 or more of the 4 elements: 1) treatment processes, 2) treatment capacity, 3) storage capacity and 4) distribution networks.
2A.9 Current Utility Service Boundaries_ DW	Description of current utility service boundaries for drinking water	**Detailed:** Map with actual utility service boundaries (i.e., area where infrastructure is currently available) AND text with clear references to boundary and its purpose **Mentioned not Detailed:** Map with actual utility service boundaries (i.e., where infrastructure is currently available) OR mention of current boundary of available service without details about its role in limiting drinking water infrastructure extension **May be located in same section with discussion of waste water**

Principle: Fact Base-Drinking Water, continued

Indicator	Short description	Detailed Description
2A.10 Projected Utility Service Boundaries_DW	Description of projected utility service boundaries for drinking water	**Detailed:** Map with projected utility service boundaries (i.e., future location of infrastructure) AND text with clear references to boundary and its purpose **Mentioned not detailed:** Map with projected utility service boundaries (i.e., future location of infrastructure) OR mention of boundary without details about its role in limiting drinking water infrastructure extension **May be located in same section with discussion of waste water**
2A.11 Unserved Areas_DW	Description of residential units and commercial developments where service currently unavailable	**Detailed:** Text describing the location AND number of unserved residential and commercial units AND reasons why area is unserved (e.g. cost, engineering difficulty) **Mentioned not detailed:** Text describing the presence of unserved areas but does not providing clear locations and/or number of unserved units
2A.12 Water Supply Projections	Projections for future water supply needs based on present and future population and economy	**Detailed:** Water supply projections based on size, socioeconomic structure and rate of change **Mentioned not detailed:** Water supply projections based on narrow set of elements (ex. projections based on population size alone)
2A.13 Infrastructure Projections	Projections for future infrastructure based on community's population, economy, and land development	**Detailed:** Infrastructure projections based on population, economy and land development data **Mentioned not detailed:** Infrastructure projections based on narrow set of elements (i.e., population alone)
2A.14 Contributors to Water Quality Issues	Possible contributors to water quality issues: (i.e., Steep slopes; poorly draining or highly erodible soils; aging infrastructure; soil conditions unsuitable for septic tanks or when installation triggers special conditions	**Detailed:** Map of possible threats to water quality AND text describing threats **Mentioned not detailed:** Map of possible threats to water quality OR text alone describing possible threats

Principle: Fact Base-Drinking Water, continued

Indicator	Short description	Detailed Description
2A.15 Agricultural_ Land	Description of agricultural land	**Detailed:** Map denoting agricultural land AND text describing type, location, AND quality of these lands **Mentioned not detailed:** Either Map denoting agricultural land OR text with type, location and/or quality alone
2A.16 Forestry_Land	Description of forestry land	**Detailed:** Map denoting forestry land AND text describing type, location, AND quality of these lands **Mentioned not detailed:** Either Map denoting forestry land OR text with type, location and/or quality alone
2A.17 CurrentProjected Land Use	Description of current and projected land use	**Detailed:** Map(s) AND text about current and projected land uses -residential - commercial -industrial -recreational - govt/utilities development -environmental sensitive **Mentioned Not Detailed:** Map(s) of land uses OR text describing uses alone. Text should also be coded as mentioned not detailed if information presented only for current OR projected land uses (not both)
2A.18 Brownfield	Description of brownfields where development could reduce current stormwater impacts	**Detailed:** Map denoting brownfields AND text describing location of where redevelopment could be a reduce current stormwater impacts **Mentioned not detailed:** Either map OR text alone describing brownfields with brief statement about potential positive redevelopment impact on water resources.
2A.19 Hazardous Land Uses	Description of potentially hazardous land uses specifically facilities 1) using industrial chemicals, 2) producing hazardous industrial wastes (e.g., manufacturing plant) or 3) animal waste (e.g., confined animal feeding operations (CAFOs)).	**Detailed:** Map denoting potentially hazardous land uses AND text describing potential threats to drinking water **Mentioned not detailed:** Map denoting potentially hazardous land uses OR text describing potential threats to drinking water

Principle: Fact Base-Drinking Water, continued

Indicator	Short description	Detailed Description
2A.20 Map_Land Use_Hydro	Map showing overlap of land use and hydrologically sensitive areas (e.g. drinking water supply, watersheds, aquifer recharge areas, steep slopes, wetlands)	**Detailed:** Map depicting overlap of **hydrologically sensitive** areas (e.g., criterial watershed areas, wetlands, recharge areas) AND development, agricultural and forestry lands and open space areas **Mentioned not Detailed:** Map depicts the overlap of hydrologically sensitive areas AND some combination of land uses (i.e., residential, commercial, open space) but NOT with all major categories of land uses Note: Development defined as residential, commercial, industrial, recreational, and governmental/utilities development
2A.21 Impact Studies	Studies of existing and future land uses including their differential impact on water resources.	**Detailed:** Descriptions references differential impact on water resources and references source water assessment reports (e.g., North Carolina Department of Environment and Natural Resources). May use classification system of current and future land uses as high, medium, or low risk to water resources **Mentioned not detailed:** Descriptions of differential impact on water resources of land use without references to either state or local reports

Principle: Fact Base-Waste Water

Indicator	Short description	Detailed Description
2B.1 Current Utility Service Boundaries_WW	Description of current utility service boundaries for sewer provision	**Detailed:** Map with actual utility service boundaries (i.e., area where infrastructure is currently available) AND text with clear references to boundary and its purpose **Mentioned not Detailed:** Map with actual utility service boundaries (i.e., where infrastructure is currently available) OR mention of current boundary of available service without details about its role in limiting drinking water infrastructure extension
2B.2 Projected Utility Service Boundaries_WW	Description of projected utility service boundaries for sewer provision	**Detailed:** Map with projected utility service boundaries (i.e., future location of infrastructure) AND text with clear references to boundary and its purpose **Mentioned not detailed:** Map with projected utility service boundaries (i.e., future location of infrastructure) OR mention of boundary without details about its role in limiting drinking water infrastructure extension
2B.3 Unserved Areas_WW	Description of residential units and commercial developments where service currently unavailable	**Detailed:** Text describing the location AND number of unserved residential and commercial units AND reasons why area is unserved (e.g. cost, engineering difficulty) **Mentioned not detailed:** Text describing the presence of unserved areas but does not providing clear locations and/or number of unserved units
2B.4 Collection & Treatment Processes	Description of the collection system and treatment processes	**Detailed:** Description includes 1) collection processes, 2) treatment processes, 3) treatment capacity for waste water **Mentioned not detailed:** Description missing 1 or more of the 3 elements: 1) collection processes, 2) treatment processes, 3) treatment capacity for waste water.
2B.5 Projected Collection TreatmentWW	Projections for future waste water needs	**Detailed:** Projections for wastewater treatment based on population size, socioeconomic structure and rate of change **Mentioned not detailed:** Projections for wastewater treatment based on narrow set of elements (e.g., population size alone)

Principle: Fact Base-Waste Water, continued

Indicator	Short description	Detailed Description
2B.6 Existing WW Problems	Description of existing waste water problems (i.e., unsewered areas, known public health threats, known overflows/ bypasses, and aging infrastructure)	**Detailed:** Description of existing problems with details about the location and extent of the problem (e.g., number of units effected) **Mentioned not detailed:** Description of existing problems without text about location and extent of the problem
2B.7 Threats to Aquatic Species WW	Description of environmental threats to aquatic species	**Detailed:** Description identifies the location AND type of threats posed by waste water for aquatic species **Mentioned not detailed:** Description identifies the location OR type of threat posed by waste water for aquatic species
2B.8 Septic System	Location of areas with concentrations of septic system use	**Detailed:** Clear description of locations with high concentration of septic tank use and discussion of threats posed by poor maintenance **Mentioned not detailed:** Description refers to localized areas of septic tank use, but does not mention threats posed to water resources

Principle: Fact Base-Stormwater

Indicator	Short description	Detailed Description
2C.1 Stormwater BMPs	Description of stormwater management BMPs Examples: -Detention and Infiltration basins -Curb cuts and other measures to direct runoff through vegetated areas	**Detailed:** Description contains type AND specific location of BMPs and makes statement about importance of maintenance. Type should identify at least a broad class of BMPs such as detention basin. Specific locations should allow the coder to pinpoint location on a Land Use map using available landmarks. **Mentioned not detailed:** Description contains type OR location of stormwater BMPs. May or may not include statement about importance of maintenance Note: Plans are not expected, at this time, to enumerate all stormwater BMPs within their jurisdiction.
2C.2 Floodplain Boundaries	Boundaries of floodplains	**Detailed:** Map AND text describing boundaries of 100- and 500-year floodplains **Mentioned not detailed:** Either map or text alone describing floodplain boundaries.
2C.3 Structures in Floodplain	Descriptions of structures in floodprone areas (in or near 100- and/or 500-year floodplains)	**Detailed:** Description contains number, type, AND specific location of structures. Type should identify at least a broad class of structure (e.g., residential, commercial, industrial). Specific locations should allow the coder to pinpoint location on a Land Use map using available landmarks. **Mentioned not detailed:** Description contains number, type, OR location of structures. Note: Given the requirements of Stafford Act, plans are expected to have access to an enumeration of structures in the floodplain.

Principle: Fact Base-Stormwater, continued

Indicator	Short description	Detailed Description
2C.4 Infrastructure in Floodplain	Description of infrastructure in flood-prone areas (in or near 100 and 500-year floodplains)	**Detailed:** Description contains type (e.g.,water, sewer, roads) AND specific location of infrastructure in or near 100 or 500 year floodplains. Specific locations would allow coder to pinpoint location on a Land Use map using available landmarks. **Mentioned not detailed:** Description does not identify specific types of infrastructure OR location of infrastructure is too vague to pinpoint location using a map (i.e., "infrastructure has been extended in or near 100 or 500 year floodplains in several plan study areas").
2C.5 Flood Control Measures	Description of flood control measures	**Detailed:** Description contains type AND specific location of flood control measures such as levees, reservoirs, diversion or dredging. Specific locations should allow the coder to pinpoint location on a Land Use map using available landmarks (with the exception of dredging). A segment of surface water would be an acceptable location for dredging. **Mentioned not detailed:** Description contains type OR location of flood control measures is too vague to pinpoint location using a map (i.e., "levees have been constructed along portions of X stream"). Note: Plans are not expected, at this time, to enumerate all flood control BMPs within their jurisdiction.

Principle: Policy Framework-Awareness

Indicator	Definition
Business Ed/Outreach	Educating businesses about steps they can take to reduce stormwater pollution and improve water quality and supply. -Automobile maintenance -Pollution prevention DEFINTIONS -Automobile Maintenance: Education for businesses and other groups running fleets of vehicles about prevention methods that control pollutants generated by automobile maintenance (e.g. hydrocarbon loads, trace metals, etc.). -Pollution Prevention for Business: Includes helping businesses take steps to reduce or eliminate chemical contaminants at their source.
Municipal Ed/Outreach	Educating the municipal workforce about stormwater in order to prevent contamination from municipal operations. -Employee Training DEFINITIONS -Employee Training and Education: Training staff about potential sources of stormwater contamination and ways to minimize the water quality impact of municipal activities.
Public Ed/Outreach	Educating the public about steps they can take to reduce stormwater pollution and improve water quality and supply. -Alternatives to Toxic Substances -Landscaping and Lawn Care -Pest Control -Pet Waste Management -Household Waste Disposal -Residential Car Washing -Trash & debris management -Water Conservation -Chlorinated Water Discharge Options DEFINITIONS -Alternatives to Toxic Substances: Includes information and outreach strategies to encourage replacement of common toxic substances (e.g. fertilizers, cleaners, automotive products, paint and pesticides) with less-toxic alternatives. -Landscaping and Lawn Care: Using education and outreach to control the effects of landscaping and lawn care practices on stormwater. Examples include raising awareness of the link between lawn care products and water quality, and education on sustainable lawn care. -Pest Control: Limiting the impact of pesticides on water quality by educating residents and businesses about proper pesticide storage and application, and on pesticide alternatives. -Pet Waste Management: Encouraging pet owners to pick up pet waste, preventing uptake in water bodies. -Proper Disposal of Household Hazardous Wastes: Actions intended to reduce the amount of household hazardous materials (i.e. cleaning, car care, and home improvement products) that are improperly disposed of. Actions can range from basic education to establishing a hazardous waste collection facility.

	-Residential Car Washing: Involves educating the general public, businesses, and municipal fleets on water quality impacts of the outdoor washing of automobiles and how to avoid allowing polluted runoff to enter the storm drain system. -Trash and Debris Management: A strategy to control trash and prevent it from entering water bodies. Strategies typically include a citizen awareness component, and can address both source (reducing or eliminating the trash source) and structural (collecting and removing trash) control. -Water Conservation Practices for Homeowners: Includes actions intended to reduce the amount of household water consumption. -Chlorinated Water Discharge Options: Encouraging the public, particularly swimming pool owners, not to discharge large amounts of chlorinated water into sanitary and storm sewer systems. Chlorinated water discharge options include: discharge permits, discharge to land, dechlorinate prior to discharge, and regulations on types of water that can be discharged.

Principle: Policy Framework-BMPs

Indicator	Definition
Erosion Control	Erosion-specific actions sites can take to prevent pollution of stormwater.
Hazard Mitigation	Any action taken to reduce or eliminate the long-term risk to human life and property from hazards, specifically flooding
Impervious Surface	Programs and policy municipalities undertake to ensure that limit the impact of impervious surface on water resources especially the pollutant levels contained in stormwater.
Information Gathering	Activities aimed at assembling data including reports, estimates or survey to inform the creation of policies that will impact water resources
Other BMPs	Other BMPs not captured under other codes in Policy Framework section
Planning as a Policy	Statements about planning as a policy that will impact water resources For example, the creation of water and sewer plans or the creation of plans for land acquisition around environmentally sensitive areas
Post-Construction_ Other	Alum injection and manufactured products for stormwater inlets. -Alum Injection: The process of adding aluminum sulfate salt (alum) to stormwater. Alum causes fine particles to coalesce into larger particles and can help reduce concentrations of fine particles and soluble phosphorus. -Manufactured Products for Stormwater Inlets: A variety of products called swirl separators or hydrodynamic structures have been widely applied to stormwater inlets in recent years. They contain an internal component that creates a swirling motion as stormwater flows through
Preservation of Native Vegetation	Promote the use of native vegetation in landscaping or the preservation of native vegetation during site development Prohibition of invasive non-native plants

Principle: Policy Framework-BMPs, continued

Indicator	Description
Retention/ Detention	Structures that detain or retain stormwater and achieve objectives such as: reducing peak flows, allowing sediment to settle and nutrient uptake. -Dry Detention ponds -In-Line Storage -On-Lot treatment -Stormwater Wetland -Wet Ponds DEFINITIONS -Dry Detention Ponds: AKA dry ponds, extended detention basins, detention ponds, and extended detention ponds. These are basins whose outlets have been designed to detain stormwater runoff for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. They do not have a large permanent pool of water. -In-Line Storage: Practices designed to use the storage within the storm drain system to detain flows. **EPA does not recommend using in-line storage practices in many circumstances because they are unable to improve water quality and offer limited protection of downstream channels.** -On-Lot Treatment: Practices designed to treat rooftop runoff and other types of runoff from individual residential lots (e.g. rain barrels, drywells, infiltration trenches, etc.). -Stormwater Wetland: AKA constructed wetlands. These structural are similar to wet ponds but also incorporate wetland plants into the design. -Wet Ponds: AKA stormwater ponds, wet retention ponds, and wet extended detention ponds. These are constructed basins that have a permanent pool of water throughout much of the year. They treat incoming stormwater runoff by allowing particles to settle and algae to take up nutrients.
Urban Forestry	Preserving individual trees and forests in urban areas
Water Conservation/ Reuse	References to reducing the usage of water and recycling of waste water for different purposes such as cleaning, manufacturing, and agricultural irrigation

Principle: Policy Framework-BMPs, continued

Indicator	Description
Runoff Control/ Infiltration	Structures which slow and/or divert runoff in order to minimize the amount of sediment that leaves sites. -Grass-Lines Channels -Permanent Slope Diversion -Vegetated Filter Strip -Grassed Swales -Infiltration Basins & Trenches -Permeable Interlocking Concrete Pavement -Pervious Concrete Pavement -Porous Asphalt Pavement DEFINITIONS -Grass-Lined Channels: Channels, lined with grass, through which runoff flows. The grass slows down the water. Typically these are not designed to handle peak loads. -Permanent Slope Diversions: Diversions that transport runoff down a slope in a manner that minimizes erosion, for instance a lateral channel intercepting the down-slope flow of runoff. -Vegetated Filter Strip: Vegetated surfaces that slow runoff velocities, filter out sediment and other pollutants, and provide infiltration into underlying soils. -Grassed Swales: A grass-covered open-channel through which stormwater runoff travels. Variations of the grassed swale include the grassed channel, dry swale, and wet swale. -Infiltration Basin & Trenches: Basin-A shallow impoundment which is designed to infiltrate stormwater into the soil. Trench-A rock-filled trench with no outlet that receives stormwater runoff. Stormwater runoff passes through some combination of pretreatment measures, such as a swale and detention basin, before entering the trench. -Permeable Interlocking Concrete Pavement: Manufactured concrete units designed with small openings between permeable joints that reduce stormwater runoff volume, rate, and pollutants. -Pervious Concrete Pavement: Concrete with reduced sand or fines (finely crushed or powdered materials) that allows water to drain through it. -Porous Asphalt Pavement: Standard hot-mix asphalt with reduced sand or fines that allows water to drain through it.
Sediment/ Pollution Control	Permanent features that promote water filtration at developed sites. -Bioretention: Shallow, landscaped depressions into which surface runoff is directed. Bioretention structures are designed to incorporate natural pollutant removal mechanisms. -Catch Basin Inserts: Inlets to the storm drain system that typically include a grate or curb inlet and a sump to capture sediment, debris and pollutants. -Sand and Organic Filters: Sand filters, or similar filters, that clean stormwater as it passes through them. -Vegetated Filter Strip: Vegetated surfaces that slow runoff velocities, filter out sediment and other pollutants, and provide infiltration into underlying soils.

Principle: Policy Framework- Illicit Discharge

Indicator	Description
Illicit Discharge	Preventing trash and waste materials from entering stormwater systems. -Illicit Discharge Detection and Elimination Program -Used Oil Recycling Program -Illegal Dumping Control -Trash Debris Management -Illicit Discharge Detection and Elimination Program Development: A comprehensive program to address non-stormwater discharge into the stormwater system. Includes the establishment of adequate legal authority to prohibit illicit discharges; assessment of potential areas, pollutants, or behaviors of concern for investigation; coordination of resources and activities; and establishment of measureable goals. -Used Oil Recycling Program: Includes identifying local collection facilities, promoting public awareness of the oil recycling program and why it is important, and oil filter collection. -Illegal Dumping Control: Actions taken to control and prevent the disposal of trash and waste materials in unpermitted areas. Examples include outlawing such actives and establishing punitive measures (e.g. fines, jail sentences, community service). -Trash and Debris Management: A strategy to control trash and prevent it from entering waterbodies. Strategies typically include a citizen awareness component, and can address both source (reducing or eliminating the trash source) and structural (collecting and removing trash) control. **May also fall under Homeowner Ed.**
Public Reporting	Using public reports to help monitor water quality. -Community Hotlines: A means for concerned citizens and agencies to contact the appropriate authority when they see people or businesses creating water quality problems. A hotline can be a toll-free number or an electronic form linked directly to a utility or local government agency.
Sanitary Sewer Overflows	Actions to prevent the overflow of sanitary sewer systems into stormwater systems. Includes programs to identify and eliminate overflows, and programs for preventative maintenance.
Sewerage Discharge	Taking steps to ensure that human waste is properly disposed of, and does not enter stormwater systems and waterbodies. -Preventing Septic System Failure: Includes establishing regulations to ensure that new septic systems are property sited and sized, site-evaluation services, and post-construction inspection. -Sewage from Recreational Activities: Establishing management measures to prevent discharges of sewage generated from recreational activities such as boating and camping. Examples include: pump-out installation and operation, no discharge area designations, education, enforcement, and signage.

Principle: Policy Framework- Municipal Operations

Indicator	Description
Municipal Maintenance	Taking steps to ensure minimum impact on stormwater from standard municipal activities such as those pertaining to street cleaning, road salting, road and bridge maintenance, and storm drain maintenance. -Parking Lot and Street Cleaning -Road Salt Application and Storage -Road and Bridge Maintenance -Storm Drain Maintenance Parking Lot and Street Cleaning: Using street sweeping to minimize the amount of pollutants from roads and parking lots (such as sediment, debris, trash, road salt, and trace metals) that enter the stormwater system. -Road Salt Application and Storage: Taking steps to mitigate the negative water quality effects of salting roads to reduce ice (e.g. proper storage of salt, and using salt alternatives). -Roadway and Bridge Maintenance: Using pollution prevention techniques to reduce or eliminate pollutant loadings from existing road surfaces as part of an operations and maintenance program. Examples of techniques include: maintaining roadside vegetation, street sweeping, litter control, general maintenance and minimizing deicer application. -Storm Drain System Cleaning: Routinely cleaning storm drains in order to increase dissolved oxygen and reduce overflows, levels of bacteria, and the amount of pollutants, trash, and debris
Regulatin g Municipal Activities	Taking steps to ensure minimum impact on stormwater from standard municipal activities such as those pertaining to landscaping, vehicles, and facilities -Municipal Landscaping -Municipal Vehicle Fueling -Municipal Vehicle and Equipment Maintenance -Hazardous Materials Storage -Municipal Vehicle and Equipment Washing -Spill Response and Prevention -Municipal Facilities Management Plan -Municipal Landscaping: Using landscape management techniques to reduce water use and contaminant runoff from landscaping activities (e.g. site planning, soil analysis, turf selection, mulching, judicious application of pesticides and fertilizers). -Municipal Vehicle Fueling: Taking steps to ensure that substances from spills and leaks during fueling are not washed into the storm drain system. BMPs include fueling only in designated areas, storing fuel in enclosed and covered tanks, and employee training. -Municipal Vehicle and Equipment Maintenance: Properly storing automotive fluids and thoroughly cleaning spills in order to reduce the amount of pollutants from automotive maintenance practices that enter stormwater runoff. -Municipal Vehicle and Equipment Washing: Practices that eliminate contaminated wash water discharges from entering the sanitary sewer system and/or stormwater system (e.g. installing wash racks, contracting the services of commercial car washes, employee training.) -Municipal Facilities: Management strategies and specific techniques for preventing stormwater pollution from municipal facilities.

	-Hazardous Materials Storage: Properly storing hazardous materials (e.g. covering them, providing adequate signage, storing them away from high-traffic areas). -Materials Management: Responsibly managing common chemicals, such as fertilizers, solvents, paints, cleaners and automotive products. -Municipal Facilities Management: Development of a stormwater pollution prevention plan. Includes taking inventory of facilities and associated activities that are a potential threat to water quality in order to assess potential impacts on stormwater and revise activities or implement new measures as needed. -Spill Response and Prevention: Having plans in place that clearly state how to stop the source of the spill, how to contain and clean up the spill, how to dispose of contaminated materials, and how to train personnel to prevent and control future spills.

Principle: Policy Framework- Public Participation

Indicator	Description
Hands On	Programs and activities in which the public can participate to protect and enhance water quality. Through these programs, the public learns about and takes ownership of local water resources. -Adopt-A-Stream Programs -Reforestation programs: -Storm Drain Marking -Stream Cleanup and Monitoring -Volunteer Monitoring -Wetland Plantings Definitions -Adopt-A-Stream Programs: Programs in which participants “adopt” a stream, creak or river to study, clean up, monitor, protect and/or restore. -Reforestation programs: Programs in which participants replant disappearing forested buffers and natural forests. -Storm Drain Marking: Involves labeling storm drain inlets with plaques, tiles, painted or precast messages warning citizens not to dump pollutants into the drain. -Stream Cleanup and Monitoring: Effort in which participants travel the length of a stream or river, collecting trash and recording information about the quantity and types of garbage that have been removed. -Volunteer Monitoring: Programs in which volunteers help to monitor water quality and learn about their local water resources. Examples of volunteer activities include: analyzing water samples, evaluating health of stream habitats and biological communities, taking inventory of stream conditions, cataloging debris, and restoring degraded habitat. -Wetland Plantings: Effort in which wetland species are planted to preserve existing wetlands and enhance degraded wetland plant communities.
Public Opinion	Asking stakeholders to give feedback and engage in the decision making process in order to build capacity for stormwater management. -Attitude Surveys -Stakeholder Meetings -Watershed Organizations Definitions -Attitude Surveys: Surveys of how the public perceives stormwater management. May include an educational component. -Stakeholder Meetings: Bringing together individuals from the community with a vested interest in a municipality’s stormwater program to discuss stormwater issues. -Watershed Organizations: Watershed organizations consist of a coalition of partner organizations who act together to restore, protect and promote the natural resources of a watershed.

Principle: Policy Framework- Land Acquisition

Indicator	Description
Acquisition for Buffers	Land acquired specifically for buffers through purchase
Conservation Easements	Conservation easements are voluntary agreements that allow individuals or groups to limit the type or amount of development on their property.
Fee simple purchases	Purchase for private ownership of property (real estate) in which the owner has the right to control, use and transfer the property at will
Land Acquisition General	Land acquisition stated as a general policy without specific demarcation into the policies used to acquire land

Principle: Policy Framework- Low Impact Development

Indicator	Description
Conservation Development	Also known as open space design or cluster development This design technique concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site.
Green Building	Green construction or sustainable building, is the practice of creating structures and using processes that are environmentally responsible and resource-efficient. Emphasis on efficiently using energy, water, and other resources
Green Site Design	Alternative development strategies that seek to control stormwater at its source and restore the natural, pre-developed ability of an urban site to absorb stormwater. Involves protecting natural features that provide environmental, aesthetic, and recreational benefits such as: wetlands, riparian areas, floodplains, aquifer recharge areas, mature trees, woodlands, and other wildlife habitat.
Infill Development	The process of developing vacant or under-used parcels within existing urban areas that are already largely developed.
Infrastructure Planning	Infrastructure planning involves changes in the growth planning process (i.e., extension of infrastructure) to contain 'sprawl.
Redevelopment	Ensuring that redevelopment includes stormwater management and takes advantage of opportunities to improve upon existing infrastructure.
Street Design	Using "green street" design that focuses on narrower widths, infiltration opportunities, and eliminating curbs and gutters. Also involves taking into consideration the underlying street patterns as they relate to local development.

Principle: Policy Framework- Regulatory Tools

Indicator	Description
Buffer Requirements	Riparian/Forested Buffer: An area along a shoreline, wetland, or stream where development is restricted or prohibited.
Conservation Zones & Overlay Districts	Conservation Zones & Overlay District: Underlying general-use zoning establishes what uses are permitted on a property, along with dimensional standards for structures. Overlay zones, such as a Conservation District, place additional restrictions on properties because of special considerations.
Municipal Oversight	Programs and actions municipalities take to ensure that construction sites are properly planning and implementing stormwater BMPs to prevent polluted runoff. -Development Review -Construction phase plan review -Contractor Training and Certification -Local Ordinances -Municipal Inspection DEFINITIONS -Construction Phase Plan Review: Review of construction site stormwater plans by municipal staff to ensure that they include BMPs to protect water quality and reduce pollutant runoff. -Contractor Training and Certification: Education for contractors about erosion and sediment control BMPs, often formalized through a certification course. -Local Ordinances for Runoff Control: Municipal laws that control allowable erosion and sedimentation from sites. Many municipalities use their grading ordinance or their stormwater code to achieve this. -Municipal Inspection Program: Involves municipalities inspecting sites to ensure that appropriate BMPs are installed and maintained.
Urban Growth/Service Boundaries	Urban Growth Boundary: Regional boundary established in an attempt to regulate growth by mandating that the area inside the boundary be used for higher density urban development and the area outside be used for lower density development. Urban Service Boundary: Area beyond which urban service such as water and sewer will not be extended
Zoning_Density Restrictions	Use of zoning to restrict density in or near hydrologically sensitive areas
Zoning_General	Uses of zoning with intention to protect water resources not covered in codes for conservation zones or overlay districts, density restrictions and density bonuses

Principle: Implementation

Indicator	Short description	Detailed Description
4.1 Clearly Identified Policies_Global	Are actions for implementing policies clearly identified?	**Detailed:** Actions follow a logical progression and seem feasible to accomplish **Mentioned not detailed:** Actions lack clear and logical progression (e.g. may lack important intervening steps)
4.2 Prioritization_Global	Are the actions for implementing plans prioritied?	**Detailed:** Actions receive priorities (e.g., high, medium or low priority) with clear discussion of how prioritization process took place **Mentioned not detailed:** Priorities present but process not clearly described
4.3 Implementation Timeline_Global	Are timelines for implementation identified?	**Detailed:** A clear timeline for each policy including target start and end dates **Mentioned not detailed:** Dates associated with policies, but lacks detailed start and end dates/deadlines
4.4 Responsibility_Global	Are organizations with responsibilities to implement policies identified?	**Detailed:** Organizational staff or board associated with each policy's implementation **Mentioned not detailed:** Responsibility for policies broadly assigned to organization or agencies but not assigned to each objective
4.5 Funding	Does the plan identify sources of funding to implement the plan?	**Detailed:** Potential funding sources clearly described and associated with particular objectives **Mentioned not detailed:** The *need* for funding sources to implement the plan is described, but the plan does not include specific potential funding sources
4.6 Sanctions	Are there sanctions for failure to implement policies?	**Detailed:** Clear ramifications for failure to implement policies **Mentioned:** Vague referrals to actions taken if policies not implemented

Principle: Monitoring

Indicator	Short description	Detailed Description
5.1 Measurable Objectives_Global	Goals quantified based on measureable objective	**Detailed:** Measureable objectives (e.g., what, who, where, when, and by how much) to measure progress toward goals **Mentioned not detailed:** Objectives mentioned but lack clear description of how progress will be measured
5.2 Indicators_Global	Indicators of each objective	**Detailed:** Clear descriptions of the types of data need to measure objectives **Mentioned not detailed:** Data resources mentioned, but lack specifics about the types of data necessary to monitor progress
5.3 Monitoring Organizations_Global	Organizations identified that are responsible for monitoring and/or providing data for indicators	**Detailed:** Clear assignment of responsibility to specific organizations to provide/gather data necessary to measure progress **Mentioned not detailed:** Assignment of responsibility is vague or multiple organizations responsible without clear explanation of coordination
5.4 Evaluation/Feedback	Processes in place to evaluate plan regularly	**Detailed:** Description of when analyses about progress toward objectives will take place and how results will be used to revise the plan **Mentioned not detailed:** Analysis mentioned but not how it will feedback into plan
5.5 Update Basis	Timetable for updating the plan based, in part, on results of monitoring changing conditions	**Detailed:** Timetable for updating plan with both short term updates and more substantial long-term updates **Mentioned not detailed:** Timetable mentioned by may only offer vague deadlines such as “ updated as needed"

Principle: Inter-jurisdictional Coordination

Indicator	Short description	Detailed Description
6.1 Horizontal Connections	Horizontal connections for inter-jurisdictional communication (within a watershed for instance) with respect to water resources	**Detailed:** Descriptions of connections made between local jurisdictions with respect to water resources. Identifies of key inter-jurisdictional stakeholders AND issues under discussion **Mentioned not detailed:** Brief references to coordination but does not provide details about stakeholders or issues under discussion
6.2 Vertical Connections	Vertical connections with state policies and programs with respect to water resources	**Detailed:** Descriptions of connections made between local jurisdiction and state with respect to water resources. Identifies of key inter-jurisdictional stakeholders and issues under discussion **Mentioned not detailed:** Brief references to coordination but does not provide details about stakeholders or issues under discussion
6.3 Intergovt Coordination Process	Description of processes for intergovernmental coordination with public and private entities (e.g., entities providing infrastructure and services with municipalities)	**Detailed:** Description references a coordinated process in planning such as joint review of subdivisions, development proposals, master plans, and annexations, systematized attendance to meetings in order to stay appraised of planning related activities in the other jurisdiction. **Mentioned not detailed:** Description references a coordinated process without providing details about how the process is maintained
6.4 Information Sharing	Policies to promote information sharing	**Detailed:** Description provides information about the methods of information sharing (e.g., joint fact-findings or database production) among public/private entities across jurisdictional boundaries **Mentioned not detailed:** Description references information sharing among public/private entities across jurisdictional boundaries without providing details about specific methods of information sharing (e.g., joint fact-findings or database production)

Principle: Inter-jurisdictional Coordination, continued

Indicator	Short description	Detailed Description
6.5 Intergovt Agreements	Policies governing the creating and maintenance of inter- governmental agreements or other cooperative agreements	**Detailed:** Description of procedures to create/maintain agreements (e.g., Memorandums of Understanding) among multiple jurisdictions **Mentioned not detailed:** References to the creation of agreements among multiple jurisdictions without description actual processes used to create and maintain the agreements
6.6 Conflict Management	Are there conflict management and/or arbitration procedures in place?	**Detailed:** Description of procedures to address potential conflicts and disagreements arising from inter-jurisdictional coordination **Mentioned not detailed:** References to conflict management or arbitration procedures without description of actual processes
6.7 Intergovt Commitment Financial Resources	Policies governing the commitment of financial resources from multiple jurisdictions (and public and private sources)	**Detailed:** Description of processes used to govern financial resources from multiple jurisdictions for inter-jurisdictional coordination activities (e.g., Information Sharing or Conflict Management) **Mentioned not detailed:** References to the processes governing inter-jurisdictional finances for coordination activities without description of actual processes or policies

Principle: Participation

Indicator	Short description	Detailed Description
7.1 Plan Preparation Involvement	Organizations and individuals involved in the plan preparation	**Detailed:** Clear description of organizations and individuals involved in plan preparation including number of stakeholders and the general categories of stakeholders including residents, private for-profit companies, non-profits, governmental agencies, etc. **Mentioned not detailed:** Description gives a rough approximation of the stakeholders involved (e.g., a list of names without affiliations)
7.2 Stakeholder Representative?	Discussion of how stakeholders who were involved representative of all the groups affected by proposed policies	**Detailed:** Discussion of how stakeholders involved in plan preparation are representative of the entire jurisdiction with respect to demographics, socioeconomics, and key interest groups. **Mentioned not detailed:** Vague description of participants including number or assurance that they represented a broad range of community interests and viewpoints
7.3 Recruitment Explanation	Explanation of why the organizations and individuals in the plan were recruited for participation	**Detailed:** Clear description why certain stakeholders were recruited for plan preparation **Mentioned not detailed:** Description gives a rough approximation of the why stakeholders involved but justification is vague
7.4 Public Agency Support	Plan explanation of the support and involvement of key public agencies (e.g., public works, economic development, parks and recreation)	**Detailed:** Range of public agencies involved with clear explanation of their responsibilities and demonstration of their support in the creation of the plan **Mentioned not detailed:** Single agency dominates description with only brief mention of involvement of other agencies in plan preparation
7.5 Participation Techniques	An explanation of participation techniques that were used	**Detailed:** Description of various types of participation used (e.g., meetings, surveys, design workshops) with details about each method (e.g., number of participants, main topics covered, activities used to elicit input) **Mentioned not detailed:** Description mentioned participation techniques such as meetings but does not provide details about the number of participants, topics covered or how information was gathered.

Principle: Participation, continued

Indicator	Short description	Detailed Description
7.6 Prior Planning Activities	An explanation of how planning/participation process was influenced by previous planning activities	**Detailed:** Description of previous planning activities (especially participation) with details about how previous planning activities influenced the current planning effort **Mentioned not detailed:** Description of prior planning activities with general connection to current planning process
7.7 Plan Evolution	Description of plan's evolution based stakeholder group input	**Detailed:** Explanation of how input for public and private stakeholders influenced/changed the plan **Mentioned not detailed:** Allusion to how input from public and private stakeholders influenced plan without clear description of the input and how it specifically influenced the plan

APPENDIX B: ORDINANCE QUALITY PROTOCOL

Principle: Goals

Indicator	Detailed Description
Conformance	Is there a statement (or statements) about conformance of comprehensive plan to the ordinance (i.e., encouraging development/ action in accordance with comprehensive plan)?
Continuous	Is there a goal, objective, or purpose statement about establishing a continuous buffer system (i.e., minimize or eliminate gaps)?
General Welfare	Is there a goal, objective, or purpose statement to protect/preserve public health, safety and general welfare?
Natural Resource Protection	Is there a goal, objective, or purpose statement about specifically protecting natural resources and/ or environmentally sensitive areas? *Examples of environmental sensitive areas include wetlands, shorelines, floodplains, etc. but occur without connection to water quality*
Water Resource Protection	Is there a goal, objective or purpose statement about specifically protecting water quality?

Principle: Fact Base

Indicator	Short description	Detailed Description
Floodplain	Fact base for the 100yr floodplain	**Standard**: Requirement for the identification of 100yr floodplain using a state or national dataset like the Federal Flood Insurance Rate Maps **Enhanced**: Requirement for the identification of 100yr floodplain using both a state or national dataset like Federal Flood Insurance Rate Maps **AND** local dataset like local floodplain delineation maps or soil maps with identification of soils that are "subject to frequent flooding"
Soil	Fact base for soil types and drainage	**Standard**: Requirement for the identification of erodible soil types without clear standards to define erodibility. **Enhanced**: Requirement for the identification of erodible soil types and other drainage factors (i.e., the level of compaction) using infiltration rates (i.e., K values).
Stream ID	The number of sources used to identify and/or classify of water bodies subject to the ordinance	**Standard**: Allows the use of a single source (i.e., soil survey or USGS) to identify water bodies subject to ordinance. Includes policies that list two of more acceptable resources to identify water bodies but the require the use of only one source **Enhanced**: Requires the use of multiple sources to identify streams in order to apply policy to all applicable streams on a parcel
Sub-drainage Assessment	Fact Base for drainage for the site	**Standard**: A local official (i.e., engineer or zoning administrator) has discretion to require an assessment of sub-drainage assessment **Enhanced**: Policy includes clearly delineation triggers for an assessment of sub-drainage on a site with scoring protocol that includes multiple factors such as slope, slope length, soil erodibility, vegetative cover, sediment delivery (distance to water body).
Topography	Fact base for topographic Information	**Standard**: Requirement of topographic information from a certified survey without requirement of a particular elevation contour **Enhanced**: Requirement of topographic information WITH minimum elevation contour specified.
Vegetative Cover	Fact base for the vegetation within buffer before development	**Standard**: Requirement for the classification of vegetation on site (i.e., native species, invasive species, canopy coverage, etc.) before development **Enhanced**: Classification of vegetation on site by condition (i.e., bare soil; fallow land; crops; active pasture in poor or fair condition; orchard-tree farm in poor or fair condition; brush-weeds in poor condition; or woods in poor condition) before development.

Principle: Fact Base, continued

Indicator	Short description	Detailed Description
Wetlands	Fact base for the delineation of wetlands	**Standard**: Wetland identified based solely on the presence of hydric soils **Enhanced**: Wetlands identification based on multiple item standardized assessment that may take into account factors such as floral diversity, fish and wildlife habitat, flood protection, groundwater recharge and discharge, etc..
Acceptable Source	Modifier	Statement(s) identifying an acceptable source of information for one of the 10 fact base indicators. *Ex. The 2000 county soil survey is an acceptable source to identify wetlands.*
Outside Reference	Modifier	Statement(s) identifying an outside source of information without clearly referencing the type of information and standards contained within the resource.
Illustration	Modifier	Use of figure or table to clarify a fact base requirement or illustrate a policy

Principle: Policy Description

Indicator	Short description	Detailed Description
Variable Width	Fixed buffer width vs. Variable buffer width?	**Standard**: Fixed and uniform buffer width (May or may not depending on stream order or size of drainage basin) *Ex. Riparian buffer shall be designated as 50ft on either side of a perennial, intermittent or ephemeral stream.* *Ex. Riparian buffer shall be designated as 50ft for perennial streams and 25ft for intermittent streams.* **Enhanced**: Variable width (i.e., width depended on other characteristics present such as location within a particular drainage basin, wetlands, steep slopes and other critical habitat areas)
Minimum	The riparian buffer policy includes a minimum width for the buffer	**Standard**: Minimum width of buffer set at less than 100ft **Enhanced**: Minimum width of buffer set at 100ft or more
Classification	Are there different policies for each stream classification?	**Standard**: The same riparian buffer guidelines apply to all streams regardless of their classification or drainage area. **Enhanced**: The policy contains two or more sets of riparian buffer guidelines that depend on the classification or drainage area of the water body. *Note: Do NOT include policies that do not require a buffer for ephemeral streams but require policies or actions like bank stabilization*
Designated Use	Policies governing whether or not the buffer policy varies for different designated uses such as public water supply, protection of fish, shellfish, and wildlife, recreation, agricultural, industrial or navigational purposes.	**Standard**: The same riparian buffer policy applies to all streams regardless of their designated use. **Enhanced**: The riparian buffer policy differs based on designated use of the water body.
ID Dispute	The dispute resolution process if the identification, classification or origin point of a stream is in question	**Standard**: Statements about the existence of a dispute process but no details about the process. **Enhanced**: Description of the dispute process with details including the completion of an on-site determination with clear description of the type of training/certification that is acceptable for the individual completing the on-site assessment.

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
LateralZones	Division of the buffer into two or more lateral zones with different functions, widths, and/or management schemes	**Standard**: Definition of single streamside zone (with description of vegetative target and management schemes) *Ex. The riparian buffer shall extend 50ft from the streambank and shall be unmanaged riparian forest.* **Enhanced**: Definition of two or more lateral zones (with differing vegetative targets, widths, and management schemes) *Ex. The riparian buffer shall extend 100 ft from streambank. It will be divided into two zones. The inner zone shall extend 50 ft from the streambank and consist of undisturbed native forest. The outer zone shall extend an additional 50ft from the outer boundary of the inner zone and consist of managed forest.* *Ex. The 100ft riparian buffer shall be divided into 3 zones (streamside, middle core, and outer zone). The streamside zone will be 25ft wide and shall be unmanaged riparian forest. The middle core will be 50ft wide and shall be managed riparian forest. The outer zone will be 25ft wide and may be managed turf such as lawn and shrubs.*
Floodplain Inclusion	Policies governing the inclusion of the floodplain within buffer	**Standard**: The riparian buffer policy accounts for the floodplain in the calculation of width **BUT** the buffer extends to an area less than the 100yr floodplain. **Enhanced**: The riparian buffer policy accounts for the floodplain in calculation of width **AND** extends the buffer to include the 100yr floodplain.
Erodible	Presence erodible soils incorporated into the policy	**Standard**: Buffer width increased to contain highly erodible soils but threshold of erodibility is unclear **Enhanced**: Buffer width increased to contain highly erodible soils when a set threshold is exceeded (e.g., soil erodibility K values exceed .24)
Slope	Policies governing the inclusion of steep slopes within the buffer	**Standard**: The riparian buffer policy accounts undevelopable steep slopes (i.e., slope greater than 25%) in the calculation of width **Enhanced**: The riparian buffer policy accounts for slopes between 5-25% AND undevelopable slope (>25%) in the calculation of width

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
Wetlands	Presence of wetlands incorporated into the buffer policy	**Standard**: The riparian buffer policy accounts for wetlands in the calculation of buffer width by extending the buffer beyond wetland boundary. **Enhanced**: The riparian buffer policy accounts for wetlands in the calculation of buffer width by not including portions of parcel with identified as wetland in determination of buffer width (i.e., the buffer extends beyond wetland boundary AND does not crediting areas of wetland in overall width calculation)
Intensity	The intensity of the surrounding land uses impacts the width of buffer	**Standard**: The intensity of the *proposed land use on a particular parcel* impacts the width of buffer (i.e., a commercial use has a wider buffer requirement than a residential use) **Enhanced**: The intensity of the proposed land use surrounding a particular parcel (i.e., the intensity of use parcels around site or the location within a particular zoning district) impacts the width of buffer
Other Critical Areas	Other environmental reasons for buffer extension	Other reasons buffer may be extended (i.e., higher nutrient content, proximity to fertilizer/manure application, other critical areas)
Vegetative Target	The type of vegetation to be established/retained within the buffer	**Standard**: Requirement for predevelopment plant community (i.e., does not specifically state native or indigenous plant life. May allow for invasive plants if benefits such as soil stabilization occurring). May use term “Natural”. **Enhanced**: Requirement for indigenous or native riparian forest in some portion of the buffer.
Different Vegetative Target	Type of vegetation differs across the buffer	**Standard**: Entire buffer has the same vegetative target (i.e., predevelopment or native plants) **Enhanced**: The vegetative target for the buffer differs based in distance from the stream channel (i.e., the requirement of riparian forest adjacent to the stream)
Vegetative Management	Policies governing the maintenance of vegetation within the riparian buffer	**Standard**: Entire buffer has a basic vegetative management scheme (i.e., no herbicides, no mowing, limited pruning) **Enhanced**: The vegetative management for the buffer differs based in distance from the stream channel. The policy governs the disturbance of existing vegetation, plant removal, clearing/mowing/ burning and herbicide use using set distances and strict standards.

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
Allowable Uses	Policies governing the uses allowed within the buffer. Usually create minimal or temporary changes to buffer. In some cases, uses can't be located elsewhere (i.e., utility crossing and water-dependent access).	**Basic**: Allowable uses listed without distance restriction and little information provided to gauge their impact *Ex. Passive or low impact recreational activities are encouraged so long as the functioning of the riparian buffer is maintained.* **Standard**: Allowable uses become more restricted closer to the stream channel WITH clearly defined distances from the stream channel **Enhanced**: Allowable uses become more restricted closer to the stream channel with clearly defined distances from the stream channel AND there are standards or regulations in place to mitigate their impact. *Description about standards and regulations should be provided for the majority of uses described.*
Buffer Crossings	Regulations governing buffer crossing like utilities, roads, etc.	**Basic**: Either the width, angle, frequency **OR** elevation of buffer crossings are regulated by the ordinance but not all four. **Standard**: Requirements account for the width, angle, frequency **AND** elevation of buffer crossings **BUT** do not place standards for highest level of protection for the riparian area (see below). **Enhanced**: Requirements specify the minimum width of right-of-way for maintenance access, require a 90º crossing angle, strictly limit the number of crossings (i.e., one crossing for every 1,000ft of buffer) **AND** call for the inverted elevation for all direct outfall channels.
Forestry	Policies governing timber harvesting within buffer	**Basic**: Timber harvesting allowed within the riparian buffer. **Standard**: Selective timber harvesting allowed **WITH** approved plan and oversight (inspection) by local officials **Enhanced**: Selective timber harvesting allowed **WITH** approved plan and oversight (inspection) from local officials **AND** there is an imposition of a waiting period on new development on sites where buffers were harvested.

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
Stormwater BMPs	Policies governing the use and location of structural stormwater BMPs within the buffer	**Basic:** Structural BMPs are prohibited in connection with the riparian buffer. **Standard**: Structural BMPs are permitted in connection with the riparian buffer **BUT** the location is not regulated. **Enhanced**: Structural BMPs are permitted **AND** performance criteria (e.g., max contributing area, specific distance along perennial streams, limits clearing for outflow channel, etc.) are used to determine the optimal type and location.
Setbacks	Policies governing building setbacks from outer boundary of the buffer	**Basic**: There is no setback for structures in addition to the riparian buffer. **Standard**: There is a setback from the boundary of the riparian area based on development type. Appurtenant or accessory structures including roads and driveways, utilities, recreational facilities, patios, etc., are permitted within the setback area. **Enhanced**: There is a setback from the boundary of the riparian area based on development type. Appurtenant or accessory structures (including roads and driveways, utilities, recreational facilities, patios, etc.) are permitted within the setback area **AND** are subject to regulations to mitigate their impact (e.g., impervious surface policies, BMPs, etc.).
Grading	Policies governing soil stabilization within the riparian buffer	**Basic**: Proposed grading or land disturbance activity (stripping of topsoil, plowing, cultivating, or other practices) is allowed within the riparian buffer **Standard**: Proposed grading or land disturbance activity is allowed within the riparian buffer BUT there are limitations placed on grading activities (ex. the requirement of an approved plan, temporary or permanent soil stabilization, erosion controls, and/or the implementation and maintenance of final erosion control structures). **Enhanced**: Grading and land disturbance activities such as stripping of topsoil, plowing, cultivating, or other practices are prohibited within the riparian buffer.

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
Clearing	Policy about the removal of vegetation or filling within the riparian buffer	**Basic**: Clearing activities is allowed within the riparian buffer **Standard**: Clearing activities can occur within the riparian buffer BUT there are limitations on vegetation removal or filling activities. *Ex. Minor filling (10 cubic yards or less) and grading within the buffer shall only be allowed in for the establishment of access paths and approved accessory structures.* **Enhanced**: Clearing activities as well as filling or dumping are prohibited within the riparian buffer
Habitat Plan	Plan to protect important aquatic and wildfire habitat within the buffer	**Standard**: Requirement for riparian habitat management plan by registered civic engineer or landscape architect without clear elements **Enhanced**: Requirement for riparian habitat management plan by registered civic engineer or landscape architect with required account for 1) topography, 2) vegetation removal/loss, 3) vegetation retention, 4) native vegetation.
Ownership	Policies governing ownership (and thus, the control of access, use and maintenance) of property contained within riparian buffers.	**Basic**: Ownership remains with the property owner. *The jurisdiction may have access easements and determine the number, locations, and design standards of access easements for buffer crossings such as utilities or roads.* **Standard**: Property remains under owner's control but with permanent restrictions on development, use, and activities (ex. easement). **Enhanced**: Riparian buffers (usually in the form of easements) are dedicated by the applicant to the jurisdiction or a conservation organization.
Owner Actions	Governing policies property owners for invasive plants and tree removal	**Standard**: Property owner is allowed to manage vegetation within riparian buffer without consultation. Includes the management of invasive plants with or without herbicides, prune and/or remove trees (including dead, diseased, or storm damaged trees) **Enhanced**: Property owners must gain approval from Department/Council/Board to manage vegetation within the riparian buffer. Includes the management of invasive plants with or without herbicides, prune and/or remove trees (including dead, diseased, or storm damaged trees)

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
Restoration	Restoration of vegetation in riparian buffer	**Basic**: If there is no buffer vegetation or if buffer vegetation is of low quality, buffer is allowed to succeed naturally to a wooded state **Standard**: If there is no buffer vegetation or if buffer vegetation is of low quality, developers *may be required* to restore buffer vegetation. **Enhanced**: If there is no buffer vegetation or if buffer vegetation is of low quality, developers are *required* to restore buffer vegetation.
Exemption	Exemptions from buffer policy	**Standard**: Clear statements of the exemptions from buffer policies. For example, these activities may be exempt for the buffer policy: 1) unpaved foot paths, 2) perpendicular stream crossing for driveway, 3) transportation route or utilities, 4) public water intakes or waste water outfalls, and 5) public access facilities needing water-access. **Enhanced**: Clear statements of the exemptions from buffer policies **AND** mitigation of impacts. For example, these activities may be exempt for the buffer policy: 1) unpaved foot paths, 2) perpendicular stream crossing for driveway, 3) transportation route or utilities, 4) public water intakes or waste water outfalls, and 5) public access facilities needing water-access **BUT** there is a requirement of mitigation measures or limitations on construction to offset impacts due to these exemptions.
Agriculture Exceptions	Policies governing agriculture exceptions to buffer policy	**Basic**: Agricultural use is permitted within the buffer. **Standard**: Agricultural use is permitted in the buffer policy but there is NOT a clear process to ensure use is not adversely impacting the buffer or water resources (e.g., administrative approval required). **Enhanced**: Agricultural use is an exception to the buffer policy AND there is a clear process to ensure use is not adversely impacting the buffer (e.g., administrative approval required).

Principle: Policy Description, continued

Indicator	Short description	Detailed Description
Recreation Exception	Policies governing the recreation exceptions to the buffer policy	**Basic**: Passive recreation facilities such as boardwalks, trails, and pathways are permitted within the buffer. **Standard**: Passive recreation facilities such as boardwalks, trails and pathways are permitted within the buffer **BUT** there are not a clear process to ensure these uses do not adversely impact the buffer **Enhanced**: Passive recreation facilities such as boardwalks, trails and pathways are exceptions to buffer policy **AND** there is a clear process to ensure use is not adversely impacting the buffer (i.e., administrative approval required)
Sewer Pipes	Polices that govern sewer pipe crossings of the riparian buffer	**Basic**: The number of sewer pipe crossings of the riparian buffer is not limited **Standard**: Sewer pipes crossings of riparian buffer are limited **Enhanced**: Sewer pipes crossings of riparian buffer are limited **AND** there is a discussion of maintenance and inspections to detect and address discharge
Waste Disposal	Policies governing the location of waste disposal facilities	**Basic**: Waste disposal facilities are allowed within the riparian buffer **Standard**: Waste disposal facilities are prohibited within in riparian buffer **Enhanced**: Waste disposal facilities are not allowed with riparian buffer **AND** new facilities are banned with specified within a specified distance of key water resources (e.g.., within 200 ft of water supply watersheds)
Waste Treatment	Policies governing the location of waste water treatment facilities	**Basic**: Wastewater treatment facilities are allowed within the riparian buffer without any limitations or regulations **Standard**: Wastewater treatment facilities are allowed within the riparian buffer **WITH** brief or vague description of limitations or regulations **Enhanced**: Wastewater treatment facilities are allowed within the riparian buffer **AND** there are clear statements that pollutant load shall not be increased beyond presently permitted levels

Principle: Policy Restrictions

Indicator	Short description	Detailed Description
AgFields	Policies about the use of fertilizers in agricultural fields within the riparian buffer	**Basic**: Agricultural fields located within the riparian buffer may use fertilizers **Standard**: Agricultural fields located within the riparian buffer are prohibited from using fertilizers **Enhanced**: Agricultural fields located within the riparian buffer are prohibited from using fertilizers AND the use of fertilizers on agricultural land is prohibited for a specified distance from key water resources (e.g., within 200 ft of water supply watersheds)
CAFOs	Policies about the presence of Concentrated Animal Feeding Operations (CAFO) within the riparian buffer	**Basic**: CAFOs are allowed within the riparian buffer **Standard**: CAFOs are not allowed in riparian buffer **Enhanced**: CAFOs are not allowed within riparian buffer AND new facilities are banned within a specified distance of key water resources (e.g., within 200 ft of water supply watersheds)
HazMat	Policies governing the storage of hazardous materials (i.e., chemicals, biohazardous waste, fuel, lubricants, hydraulic fluid, etc.)	**Basic**: Hazardous materials storage is allowed within the riparian buffer. **Standard**: Hazardous material storage is not allowed in riparian buffer **Enhanced**: Hazardous material storage is not allowed with riparian buffer AND new facilities are banned with specified radius of key water resources (e.g., within 200 ft of water supply watershed
Impervious Surface	Policies governing the presence of impervious surface within the buffer	**Basic**: Some types of impervious surface are allowed in the buffer such as roads and driveways, utilities, recreational facilities, patios, etc.. **Standard**: Some types of impervious surface are allowed in the buffer such as roads and driveways, utilities, recreational facilities, patios, etc. AND are subject to impervious surface policies **Enhanced**: All impervious surface is prohibited within the buffer with exception of buffer crossings
Livestock	Policies about livestock activity such as grazing and housing within the riparian buffer	**Basic**: Livestock activity is allowed within the riparian buffer **Standard**: Livestock activity is prohibited within the riparian buffer **BUT** exceptions exist (e.g., during drought conditions) **Enhanced**: Livestock cannot be housed, grazed or otherwise maintained within the riparian buffer

Principle: Policy Restrictions, continued

Indicator	Short description	Detailed Description
Mining	Policies governing mining activities (including gravel dredging) within the riparian buffer	**Basic**: Mining activities are allowed within the riparian buffer **Standard**: Mining activities within the riparian buffer are allowed **BUT** are subject to oversight **Enhanced**: Mining activities within the riparian buffer are prohibited
Septic System	Policies governing the location of septic tanks and septic tank drain fields	**Basic**: Septic tanks and septic drain fields are allowed within the riparian buffer **Standard**: Septic tanks and septic drain fields are prohibited within the riparian buffer **Enhanced**: Septic tanks and septic drain fields are prohibited within the riparian buffer **AND** are prohibited within a specified distance of the buffer (e.g., an additional setback from the outer boundary of riparian buffer)
Sewer Pipes	Polices that govern sewer pipe crossings of the riparian buffer	**Basic**: The number of sewer pipe crossings of the riparian buffer is not limited **Standard**: Sewer pipes crossings of riparian buffer are limited **Enhanced**: Sewer pipes crossings of riparian buffer are limited **AND** there is a discussion of maintenance and inspections to detect and address discharge
Waste Disposal	Policies governing the location of waste disposal facilities	**Basic**: Waste disposal facilities are allowed within the riparian buffer **Standard**: Waste disposal facilities are prohibited within in riparian buffer **Enhanced**: Waste disposal facilities are not allowed with riparian buffer **AND** new facilities are banned with specified within a specified distance of key water resources (e.g.., within 200 ft of water supply watersheds)
Waste Treatment	Policies governing the location of waste water treatment facilities	**Basic**: Wastewater treatment facilities are allowed within the riparian buffer without any limitations or regulations **Standard**: Wastewater treatment facilities are allowed within the riparian buffer **WITH** brief or vague description of limitations or regulations **Enhanced**: Wastewater treatment facilities are allowed within the riparian buffer **AND** there are clear statements that pollutant load shall not be increased beyond presently permitted levels

Principle: Complexity
Summation of indicators coded at enhanced level

Indicator	Detailed Description
Floodplain	**Enhanced**: Requirement for the identification of 100yr floodplain using both a state or national dataset like Federal Flood Insurance Rate Maps **AND** local dataset like local floodplain delineation maps or soil maps with identification of soils that are "subject to frequent flooding"
Soil	**Enhanced**: Requirement for the identification of erodible soil types and other drainage factors (i.e., the level of compaction) using infiltration rates (i.e., K values).
Stream ID	**Enhanced**: Requires the use of multiple sources to identify streams in order to apply policy to all applicable streams on a parcel
Sub-drainage Assessment	**Enhanced**: Policy includes clearly delineation triggers for an assessment of sub-drainage on a site with scoring protocol that includes multiple factors such as slope, slope length, soil erodibility, vegetative cover, sediment delivery (distance to water body).
Topography	**Enhanced**: Requirement of topographic information WITH minimum elevation contour specified.
Vegetative Cover	**Enhanced**: Classification of vegetation on site by condition (i.e., bare soil; fallow land; crops; active pasture in poor or fair condition; orchard-tree farm in poor or fair condition; brush-weeds in poor condition; or woods in poor condition) before development.
Wetlands	**Enhanced**: Wetlands identification based on multiple item standardized assessment that may take into account factors such as floral diversity, fish and wildlife habitat, flood protection, groundwater recharge and discharge, etc..
Variable Width	**Enhanced**: Variable width (i.e., width depended on other characteristics present such as location within a particular drainage basin, wetlands, steep slopes and other critical habitat areas)
Minimum	**Enhanced**: Minimum width of buffer set at 100ft or more
Classification	**Enhanced**: The policy contains two or more sets of riparian buffer guidelines that depend on the classification or drainage area of the water body. *Note: Do NOT include policies that do not require a buffer for ephemeral streams but require policies or actions like bank stabilization*
Designated Use	**Enhanced**: The riparian buffer policy differs based on designated use of the water body.
ID Dispute	**Enhanced**: Description of the dispute process with details including the completion of an on-site determination with clear description of the type of training/certification that is acceptable for the individual completing the on-site assessment.
LateralZones	**Enhanced**: Definition of two or more lateral zones (with differing vegetative targets, widths, and management schemes)
Floodplain Inclusion	**Enhanced**: The riparian buffer policy accounts for the floodplain in calculation of width **AND** extends the buffer to include the 100yr floodplain.
Erodible	**Enhanced**: Buffer width increased to contain highly erodible soils when a set threshold is exceeded (e.g., soil erodibility K values exceed .24)
Slope	**Enhanced**: The riparian buffer policy accounts for slopes between 5-25% AND undevelopable slope (>25%) in the calculation of width
Wetlands	**Enhanced**: The riparian buffer policy accounts for wetlands in the calculation of buffer width by not including portions of parcel with identified as wetland in determination of buffer width (i.e., the buffer extends beyond wetland boundary AND does not crediting areas of wetland in overall width calculation)
Intensity	**Enhanced**: The intensity of the proposed land use surrounding a particular parcel (i.e., the intensity of use parcels around site or the location within a particular zoning district) impacts the width of buffer

Principle: Complexity, continued

Vegetative Target	**Enhanced**: Requirement for indigenous or native riparian forest in some portion of the buffer.
Different Vegetative Target	**Enhanced**: The vegetative target for the buffer differs based in distance from the stream channel (i.e., the requirement of riparian forest adjacent to the stream)
Vegetative Management	**Enhanced**: The vegetative management for the buffer differs based in distance from the stream channel. The policy governs the disturbance of existing vegetation, plant removal, clearing/mowing/ burning and herbicide use using set distances and strict standards.
Forestry	**Enhanced**: Selective timber harvesting allowed **WITH** approved plan and oversight (inspection) from local officials **AND** there is an imposition of a waiting period on new development on sites where buffers were harvested.
Buffer Crossings	**Enhanced**: Requirements specify the minimum width of right-of-way for maintenance access, require a 90º crossing angle, strictly limit the number of crossings (i.e., one crossing for every 1,000ft of buffer) **AND** call for the inverted elevation for all direct outfall channels.
Stormwater BMPs	**Enhanced**: Structural BMPs are permitted **AND** performance criteria (e.g., max contributing area, specific distance along perennial streams, limits clearing for outflow channel, etc.) are used to determine the optimal type and location.
Setbacks	**Enhanced**: There is a setback from the boundary of the riparian area based on development type. Appurtenant or accessory structures (including roads and driveways, utilities, recreational facilities, patios, etc.) are permitted within the setback area **AND** are subject to regulations to mitigate their impact (e.g., impervious surface policies, BMPs, etc.).
Grading	**Enhanced**: Grading and land disturbance activities such as stripping of topsoil, plowing, cultivating, or other practices are prohibited within the riparian buffer.
Clearing	**Enhanced**: Clearing activities as well as filling or dumping are prohibited within the riparian buffer
Habitat Plan	**Enhanced**: Requirement for riparian habitat management plan by registered civic engineer or landscape architect with required account for 1) topography, 2) vegetation removal/loss, 3) vegetation retention, 4) native vegetation.
Ownership	**Enhanced**: Riparian buffers (usually in the form of easements) are dedicated by the applicant to the jurisdiction or a conservation organization.
Owner Actions	**Enhanced**: Property owners must gain approval from Department/Council/Board to manage vegetation within the riparian buffer. Includes the management of invasive plants with or without herbicides, prune and/or remove trees (including dead, diseased, or storm damaged trees)
Restoration	**Enhanced**: If there is no buffer vegetation or if buffer vegetation is of low quality, developers are *required* to restore buffer vegetation.
Exemption	**Enhanced**: Clear statements of the exemptions from buffer policies **AND** mitigation of impacts. For example, these activities may be exempt for the buffer policy: 1) unpaved foot paths, 2) perpendicular stream crossing for driveway, 3) transportation route or utilities, 4) public water intakes or waste water outfalls, and 5) public access facilities needing water-access **BUT** there is a requirement of mitigation measures or limitations on construction to offset impacts due to these exemptions.
Agriculture Exceptions	**Enhanced**: Agricultural use is an exception to the buffer policy AND there is a clear process to ensure use is not adversely impacting the buffer (e.g., administrative approval required).
Recreation Exception	**Enhanced**: Passive recreation facilities such as boardwalks, trails and pathways are exceptions to buffer policy **AND** there is a clear process to ensure use is not adversely impacting the buffer (i.e., administrative approval required)

Principle: Complexity, continued

AgFields	**Enhanced**: Agricultural fields located within the riparian buffer are prohibited from using fertilizers AND the use of fertilizers on agricultural land is prohibited for a specified distance from key water resources (e.g., within 200 ft of water supply watersheds)
CAFOs	**Enhanced**: CAFOs are not allowed within riparian buffer AND new facilities are banned within a specified distance of key water resources (e.g., within 200 ft of water supply watersheds)
HazMat	**Enhanced**: Hazardous material storage is not allowed with riparian buffer AND new facilities are banned with specified radius of key water resources (e.g., within 200 ft of water supply watershed
Impervious Surface	**Enhanced**: All impervious surface is prohibited within the buffer with exception of buffer crossings
Livestock	**Enhanced**: Livestock cannot be housed, grazed or otherwise maintained within the riparian buffer
Mining	**Enhanced**: Mining activities within the riparian buffer are prohibited
Septic System	**Enhanced**: Septic tanks and septic drain fields are prohibited within the riparian buffer **AND** are prohibited within a specified distance of the buffer (e.g., an additional setback from the outer boundary of riparian buffer)
Sewer Pipes	**Enhanced**: Sewer pipes crossings of riparian buffer are limited **AND** there is a discussion of maintenance and inspections to detect and address discharge
Waste Disposal	**Enhanced**: Waste disposal facilities are not allowed with riparian buffer **AND** new facilities are banned with specified within a specified distance of key water resources (e.g.., within 200 ft of water supply watersheds)
Waste Treatment	**Enhanced**: Wastewater treatment facilities are allowed within the riparian buffer **AND** there are clear statements that pollutant load shall not be increased beyond presently permitted levels

Principle: Flexibility

Indicator	Short description	Detailed Description
Buffer Averaging	Policy allows for buffer averaging	**Standard**: Policy allows for a reduction in buffer as long as overall buffer width averages the width set by ordinance **Enhanced**: Policy allows for a reduction in buffer as long as overall buffer width averages the width set by ordinance AND sets clear minimum width (i.e., no portion of the buffer can be reduced beyond a set minimum regardless if buffer averaging would allow the buffer to reach the standard set by the ordinance).
Overlay Zone	Overlay zone used to implement riparian buffer protections	**Standard**: Overlay zone encompasses all land less than 100ft on either side of all streams. **Enhanced**: Overlay zone encompasses all land at least 100ft on either side of all streams.
Conservation Development	Protection or Incentive Policy	Also known as open space design or cluster development This design technique concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site.
Conservation Easement	Protection or Incentive Policy	Agreements that allow individuals or groups to limit the type or amount of development on their property for the purpose of conservation
Density Compensation	Protection or Incentive Policy	Programs that allow property owners to alter the density of development on site. For example, policies that allow the sell and purchase development rights to *other areas selected as higher density areas (transfer of development rights programs).*
FeeSimple Acquisition	Protection or Incentive Policy	Purchase for private ownership of property (real estate) in which the owner has the right to control, use and transfer the property at will
Off-site Mitigation	Protection or Incentive Policy	Use of compensatory mitigation credits to offset the loss of critical habitat areas such as streams or wetlands
Open Space	Protection or Incentive Policy	The designation of riparian buffers as open space. May offer flexibility in site design and protection of buffers if limitations placed on the open space (i.e., undisturbed open space). In other instances, the open space designation could be detrimental to buffer areas. *Use a memo when detrimental impact is possible.*
Restoration Incentive	Protection or Incentive Policy	Restoration activities for streams or wetlands. May occur on or away from the parcel under development

Principle: Policy Flexibility, continued

Indicator	Short description	Detailed Description
Site Design	Protection or Incentive Policy	The relaxation of site design policies such as setback requirements or lot size. These policies offer flexibility in the configuration of development and help offset limitations imposed by the presence of a buffer.
Administrative Variance	Policies governing the granting of administrative variances	**Standard**: Variances may be granted administratively if certain conditions met BUT the conditions are not clearly defined **Enhanced**: Variances may be granted administratively based on a clear set of conditions (i.e., buffer size to lot size ratio exceeds a set standard; location with a well-defined area)
VarianceLimit	Policies that limit how much the buffer can be altered. Alterations may include buffer width, vegetation, use, maintenance, or management, etc.	**Standard**: Variance can be granted to a property owner BUT there are no set standards to guide how much the buffer can be altered **Enhanced**: Variance can be granted to a property owner AND there are set standards to guide how much the buffer can be altered.
Variance	Circumstances under which a variance can be granted	**Basic**: Variances granted based on demonstration of economic hardship or unique circumstances. Lacks specific standards for riparian buffers. **Standard**: Variances granted if there is no opportunity for development under any design configuration when accounting for riparian buffers OR nature of development necessitates location in the buffer (i.e., dock). **Enhanced**: Variances granted if there is no opportunity for development under any design configuration when accounting for riparian buffers OR nature of development necessitates location in the buffer (i.e., dock) AND ordinance requires evidence to demonstrate buffer alteration will at least maintained (perhaps improved) predevelopment stormwater runoff and/or water quality
Variance authority	The number of agencies with authority to grant variances	**Standard**: Multiple agencies have the authority to grant variances BUT there is no discussion of coordination when granting variances **Enhanced**: A single agency has the authority to grant variances OR there is a clear coordinated process among the multiple agencies with authority to grant variances

Principle: Monitoring and Enforcement

Indicator	Short description	Detailed Description
BMP Inspection	Inspection of structural stormwater best management practices	**Standard**: Conduct "as-built" inspections of all structural stormwater BMPs as they are brought on-line to ensure they were installed properly and protected from construction impacts. **Enhanced**: Enforceable maintenance agreement requiring structural stormwater BMPs be inspected annually to ensure they are functioning and properly maintained.
BMP Maintenance	Who is responsibility for the long-term maintenance of structural stormwater BMPs	**Standard**: The long-term maintenance of structural stormwater BMPs remains the responsibility of the property owner **Enhanced**: A process exists for maintenance responsibility of structural stormwater BMPs to be transferred to local government or local conservation organization
Buffer Notification	How property owners are notified of buffer	**Standard**: Buffers are identified on household level documents (e.g., deeds or homeowner association documents) **Enhanced**: Permanent signs are erected to identify buffers *Does not include signs along roadways that delineate buffer or drainage boundaries*
Complaint Random	Policies governing inspections occurring post-development	**Standard**: Inspection are triggered by complaints (i.e., an outside complaint initiates an inspection) AND there is no institutional inspection process described **Enhanced**: Inspection can be triggered by complaints (i.e., an outside complaint initiates an inspection) AND there is an institutional inspection process (i.e., a program of periodic and/or random inspections
Coordination	Coordination amongst multiple agencies with respect to inspections	**Standard**: Multiple agencies inspect a site based on their particular expertise BUT there is no formal coordination mentioned in the ordinance (Informal coordination may also be mentioned) **Enhanced**: Multiple agencies responsible for inspection coordinate their efforts using a formal process (i.e., requirement of official sign-offs)
Fees	Ordinance authorizes the collection of fees to support its implementation	**Standard**: Agency has authority to levy fees to cover the cost of administering the ordinance **Enhanced**: Agency has authority to levy fees to cover the cost of administering the ordinance AND has authority to require additional fees to support the implementation of the ordinance (i.e., performance bonds for BMPs)

Principle: Monitoring and Enforcement, continued

Indicator	Short description	Detailed Description
Inspections	Inspections of the riparian area after the completion of construction	**Basic**: Inspections occur during construction and for a short period after development (i.e., until occupancy permits granted) **Standard**: Inspections of the riparian area occur during construction AND post-development on an annual basis. **Enhanced**: Inspections of the riparian area occur during construction AND post-development on an annual basis WITH additional inspections occur under specified circumstances. *For example, additional inspections occur after within a few days of severe storms for evidence of sediment deposit, erosion or gully formation for all buffers. Multiple annual inspections may be required for newly established riparian forested buffer (e.g., at least four annual inspections).*
Planner Inspection	Planner expertise involved in the inspections process	**Standard**: Site design and improvements inspected by a local official other than the planner involved in site plan review **Enhanced**: Site design and improvements inspected by planner involved in site plan review
Recorded Buffers	Buffers are recorded on maps	**Standard**: Buffers are recorded on at least one of the following types of plans (i.e., site plans, Construction plans, clearing and grading plans, erosion and sediment control plans, landscaping plans) **Enhanced**: Buffers are recorded on two or more of the following types of plans (i.e., site plans, Construction plans, clearing and grading plans, erosion and sediment control plans, landscaping plans)
Septic Inspection	Inspection of septic systems within or near the riparian buffer	**Standard**: Post-development inspection of properties with septic system to assure no damage to the septic system occur during or following construction **Enhanced**: On-going post-development inspection of septic systems within or near riparian buffers to ensure proper functioning
WaterQuality	Water monitoring to assess performance of riparian buffers and other BMPs	**Standard**: No on-going water quality monitoring associated with the establishment and development subject to the riparian buffer policy **Enhanced**: There is some on-going water quality monitoring associated with development (i.e., performance standard for sedimentation set at 25 NTU (nephelometric turbidity units) measured at end of designated segment)

Principle: Monitoring and Enforcement, continued

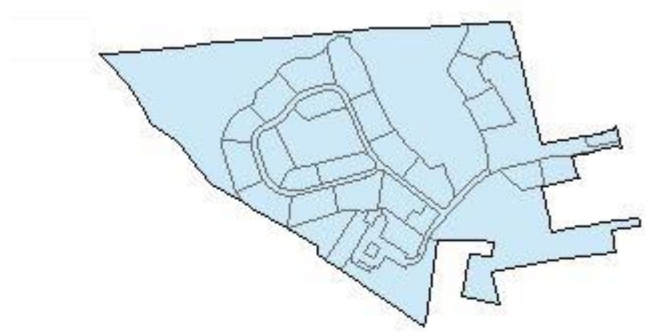
Indicator	Short description	Detailed Description
Violation	Clear statements about what is a considered a violation in order to enhance enforceability	**Standard**: Ordinance includes general violation section **Enhanced**: Ordinance includes general violation section as well as clear statements about violations within the riparian buffer (i.e., clearing, grading, development)
Violation Sanctions	Sanctions for the violation of regulations	**Standard**: Stop-work orders on construction projects based on violations of zoning and land use regulations **Enhanced**: In addition to stop-work orders, agency has the ability to denial further approvals in the face of a violation, revoke existing permits, and/or pursue civil penalties

Principle: Discretion

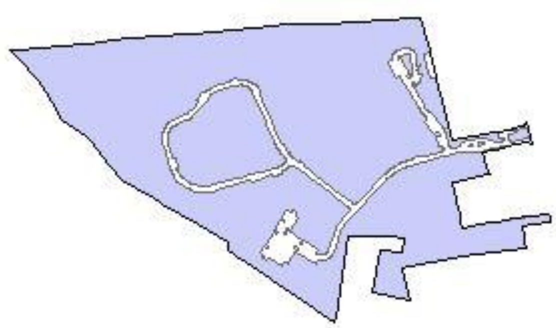
Indicator	Short description	Detailed Description
Discretion	Statement or statements where discretion in the interpretation and implementation of the ordinance. Includes statements about use of equivalent information if no specific source is provided.	**Basic**: The reviewer of the application is granted authority in the interpretation or implementation of an ordinance provision. **Standard:** The reviewer of the application is granted authority in the interpretation or implementation of an ordinance provisions AND an additional administrator, agency, or department are involved in the review process (i.e., may request additional information, set standards, or approve the application). *Ex. The Planning and Zoning Director shall have the authority to request additional information not specifically listed on the application forms to ensure compliance with this code.* **Enhanced**: The reviewer of the application is granted authority in the interpretation or implementation of an ordinance provision AND an additional administrator, agency, or department are involved in review process AND there are clear limitations placed on the extent of the alterations that can be made by these parties. *Ex. The Planning and Zoning Director, subject to the limitations of this chapter, is authorized to render a decision on the interpretation of the provisions of this Zoning Code as applied to specific cases.* *Ex. Administrative adjustments from the regulations of this Zoning Code may be granted by the Planning and Zoning Director only in accordance with the criteria established in this Chapter, and may be granted only for the following:* *1. Setbacks. To permit any yard or setback of up to twenty percent less than a yard or a setback required by the applicable regulations.*

APPENDIX C: LAND COVER CLASSIFICATION MAP MEASUREMENTS

Step 1: Delineate development boundaries using parcel data



Step 2: Dissolve outlines of individual parcels and clip out approved impervious surfaces (i.e., roads and parking lots).



Step 3: Use clipped development polygon to extract rasterized high resolution land cover classification data for entire development. Use attribute data to obtain pixel data by land cover classification.

Pixel Count for Entire Development

Tree Canopy	Water	Impervious Surface	Grass/Shrub	Bare Earth	Total
65031	1128	46154	22127	15740	150180

Step 4: Buffer stream lines to width taken from approved development application, dissolve, and clip to development boundary. Extract rasterized high resolution land cover classification data using the dissolved buffer outline and obtain pixel data by land cover classification for riparian buffer area.

Pixel Count for Riparian Buffer Area

Tree Canopy	Water	Impervious Surface	Grass/Shrub	Bare Earth	Total
37418	804	1904	3504	324	43954

REFERENCES

Alberti, M. (1999). Urban patterns and environmental performance: What do we know? *Journal of Planning Education and Research*, *19*, 151–163.

Alberti, M. (2005). The Effects of Urban Patterns on Ecosystem Function. *International Regional Science Review*, *28*(2), 168–192.

Alexander, E. R. (1981). If planning isn't everything, maybe it is something. *The Town Planning Review*, *52*(2), 131–142.

Alexander, E. R., & Faludi, A. (1989). Planning and Plan Implementation: Notes on Evaluation Criteria. *Environment and Planning B: Planning and Design*, *16*, 127–140.

Allan, J. D. (2004). Landscapes and riverscapes: The influence of land use on stream ecosystems. *Annual Review of Ecology, Evolution, and Systematics*, *35*, 257–284.

Alterman, R., & Hill, M. (1978). Implementation of Urban Land Use Plans. *Journal of the American Institute of Planners*, *44*(3), 274–285.

Altshuler, A. (1965a). *The city planning process: A political analysis*. Ithaca, NY: Cornell University Press.

Altshuler, A. (1965b). The goals of comprehensive planning. *Journal of the American Institute of Planners*, *31*(3), 186–195.

American Society of Civil Engineers, & Engineers, A. S. of C. (2004). *Regulated riparian model water code*. Reston, VA.

Arkema, K. K., Abramson, S. C., & Dewsbury, B. M. (2006). Marine ecosystem-based management: from characterization to implementation. *Frontiers in Ecology and the Environment*, *4*(10), 525–532.

Arnold, C., & Gibbons, C. J. (1996). Impervious surface coverage: The emergence of a key environmental indicator. *Journal of the American Planning Association*, *62*(6), 243–258.

Ausness, R. (1987). Influence of the model water code on water resources management policy in Florida. *Journal of Land Use and Environmental Law*, *3*(1), 1–32.

Backhurst, M., Day, M., Crawford, J., Ericksen, N., Berke, P., Laurian, L., … Chapman, S. (2002). *The Quality of District Plans and their Implementation: Towards Environmental Quality* (pp. 1–17). Wellington, NZ.

Baer, W. C. (1997). General Plan Evaluation Criteria: An Approach to Making Better Plans. *Journal of the American Planning Association*, *63*(3), 329–345.

Baker, A. (2003). Land use and water quality. *Hydrological Processes*, *17*(12), 2499–2501.

Bennett, C. (1976). *Analyzing impacts of extension programs* (Vol. ESC-575). Washington, D.C.: Extension Service- U.S. Department of Agriculture.

Berke, P. (1998). Reducing natural hazard risks through state growth management. *Journal of the American Planning Association*, *64*(1), 76–87.

Berke, P., Backhurst, M., Day, M., Ericksen, N., Laurian, L., Crawford, J., & Dixon, J. (2006). What Makes Plan Implementation Successful? An Evaluation of Local Plans and Implementation Practices in New Zealand. *Environment and Planning B: Planning and Design*, *33*, 581–600.

Berke, P., & Beatley, T. (1992). *Planning for earthquakes: risk, policy and politics*. Baltimore: Johns Hopkins University Press.

Berke, P., Crawford, J., Dixon, J., & Ericksen, N. (1999). Do Cooperative Environmental Planning Mandates Produce Good Plans? Empirical Results from the New Zealand Experience. *Environment and Planning B: Planning and Design*, *26*, 643–664.

Berke, P., Dixon, J., & Ericksen, N. (1997). Coercive and cooperative intergovernmental mandates: a comparative analysis of Florida and New Zealand environmental plans. *Environment and Planning B: Planning and Design*, *24*, 451–468.

Berke, P., Ericksen, N., Crawford, J., & Dixon, J. (2002). Planning and Indigenous People: Human Rights and Environmental Protection in New Zealand. *Journal of Planning Education and Research*, *22*, 115–134.

Berke, P., & French, S. (1994). The Influence of State Planning Mandates on Local Plan Quality. *Journal of Planning Education and Research*, *13*, 237–250.

Berke, P., & Godschalk, D. (2009). Searching for the Good Plan: A Meta-Analysis of Plan Quality Studies. *Journal of Planning Literature*, *23*(3), 227–240.

Berke, P., Godschalk, D., Kaiser, E., & Rodriguez, D. (2006). *Urban Land Use Planning* (5th ed.). Chicago: University of Illinois.

Berke, P., Roenigk, D., Kaiser, E., & Burby, R. (1996). Enhancing Plan Quality: Evaluating the Role of State Planning Mandates for Natural Hazard Mitigation. *Journal of Environmental Planning and Management*, *39*(1), 79–96.

Berke, P., Smith, G., & Lyles, W. (2012). Planning for Resiliency: Evaluation of state hazard mitigation plans under the Disaster Mitigation Act. *Natural Hazards Review*, *13*, 139–150.

Berke, P., Spurlock, D., Hess, G., & Band, L. E. (2013). Local comprehensive plan quality and regional ecosystem protection: The case of the Jordan Lake watershed, North Carolina. *Land Use Policy*, *31*, 450–459.

Berman, P. (1978). The study of macro and micro implementation of social policy. *Public Policy*, *26*(2), 157–184.

Booth, D., & Keinfelt. (1993). Consequences of urbanization of aquatic systems: Measured effects, degradation thresholds, and corrective strategies. In *Watershed 1993 Conference*. Alexandria, VA.

Brabec, E., Schulte, S., & Richards, P. (2002). Impervious surfaces and water quality: A review of current literature and its implications for watershed planning. *Journal of Planning Literature*, *16*(4), 499–514.

Brody, S. (2003a). Are We Learning to Make Better Plans? A Longitudinal Analysis of Plan Quality Associated with Natural Hazards. *Journal of Planning Education and Research*, *23*, 191–201.

Brody, S. (2003b). Implementing the Principles of Ecosystem Management Through Local Land Use Planning. *Population and Environment*, *24*(6), 511–540.

Brody, S., Carrasco, V., & Highfield, W. (2006). Measuring the Adoption of Local Sprawl: Reduction Planning Processes in Florida. *Journal of Planning Education and Research*, *25*, 294–310.

Brody, S., Godschalk, D., & Burby, R. (2003). Mandating Citizen Participation in Plan Making: Six Strategic Planning Choices. *Journal of the American Planning Association*, *69*(3), 245–264.

Brody, S., & Highfield, W. (2005). Does Planning Work? Testing the Implementation of Local Environmental Planning in Florida. *Journal of the American Planning Association*, *71*(2), 159–175.

Brody, S., Highfield, W., & Carrasco, V. (2004). Measuring the Collective Planning Capabilities of Local Jurisdictions to Manage Ecological Systems in Southern Florida. *Landscape and Urban Planning*, *64*, 33–50.

Brody, S., Highfield, W., & Thorton, S. (2006). Planning at the urban fringe: An examination of the factors influencing nonconforming development patterns in southern Florida. *Environment and Planning B: Planning and Design*, *33*(1), 75–96.

Brotherton, I. (1992). On the Quantity and Quality of Permit Applications. *Environment and Planning B: Planning and Design*, *19*, 465–478.

Burby, R. (2003). Making Plans that Matter: Citizen Involvement and Government Action. *Journal of the American Planning Association*, *69*(1), 33–49.

Burby, R. (2005). Have state comprehensive planning mandates reduced insured losses from natural disasters? *Natural Hazards Review*, *6*(2), 67–81.

Burby, R., Berke, P., Dalton, L., DeGrove, J., French, S., Kaiser, E., … Roenigk, D. (1993). Is state-mandated planning effective? *Land Use Law & Zoning Digest*, *45*(10), 3–9.

Burby, R., & Dalton, L. (1994). Plans Can Matter! The Role of Land Use Plans and State Mandates in Limiting the Development of Hazardous Areas. *Public Administration Review*, *54*(3), 229–238.

Burby, R., & May, P. (1998). Intergovernmental Environmental Planning: Addressing the Commitment Conundrum. *Journal of Environmental Planning and Management*, *41*(1), 95–110.

Burby, R., May, P., Berke, P., Dalton, L., French, S., & Kaiser, E. (1997). *Making governments plan: State experiments in managing land use*. Baltimore: The John Hopkins University Press.

Burby, R., May, P., & Paterson, R. (1998). Improving Compliance with Regulations: Choices and Outcomes for Local Government. *Journal of the American Planning Association*, *64*(3), 324–334.

Burby, R., Moreau, E. J., Miller, T., & Moreau, D. (1983). *Drinking water supplies: Protection through watershed management*. Ann Arbor, MI: Ann Arbor Science Publishers.

Burby, R., & Paterson, R. (1993). Improving Compliance with State Environmental Regulations. *Journal of Policy Analysis and Management*, *12*(4), 753–772.

Burke. (2002). *Understanding the Law of Zoning and Land Use Control*.

Calkins, H. W. (1979). The Planning Monitor: An Accountability Theory of Plan Evaluation. *Environment and Planning A*, *11*, 745–758.

Campbell, S. (1996). Green Cities , Growing Cities , Just Cities ? Urban Planning and the Contradictions of Sustainable Development. *Journal of the American Planning Association*, *62*(3), 296–312.

Carruthers, J. I., & Ulfarsson, G. F. (2002). Fragmentation and Sprawl: Evidence from Interregional Analysis. *Growth and Change*, *33*(Summer 2002), 312–340.

Center for Watershed Protection. (1998). *Rapid watershed planning handbook: A comprehensive guide for managing urbanizing watershed*. Ellicott City, MD.

Center for Watershed Protection, & Schueler, T. (1995). The architecture of urban stream buffers. *Watershed Protection Techniques*, *1*(4), 155–163.

Chapin, T., Deyle, R., Baker, E., Chapin, Doyle, & Baker. (2008). A parcel-based GIS method for evaluating conformance of local land-use planning with a state mandate to reduce exposure to hurricane flooding. *Environment and Planning B: Planning and Design*, *35*, 261–279.

Chen, H.-T. (1990). *Theory-driven evaluations*. Newbury Park: Sage Publications.

Chen, W., Cato, B., & Rainford, N. (1999). Using a logic model to plan and evaluate a community intervention program: A case study. *International Quarterly of Community Health Education*, *18*(4), 449–458.

Chesapeake Stormwater Network. (2011). Environmental site design criteria for the Maryland critical area. Retrieved from http://www.dnr.state.md.us/criticalarea/pdfs/DraftManual_ESD_Feb_2013.pdf

City of Havre de Grace. (1996). *Comprehensive Plan* (p. 324).

Clawson, M. (1971). *Suburban land conversion in the United States: An economic and governmental process*. Baltimore, MD: Johns Hopkins Press.

Clawson, M. (1981). *New Deal Planning: The National Resources Planning Board*. Baltimore: Johns Hopkins University Press for Resources for the Future.

Cobb, R., & Elder, C. (1972). *Participation in American politics: The dynamics of agenda-building*. Baltimore: Johns Hopkins University Press.

Cohen, J. (2002). Maryland's "smart growth": Using incentives to combat sprawl. In G. Squires (Ed.), *Urban sprawl: Causes, consequences, and policy responses* (pp. 293–324). Washington DC: Urban Institute.

Congalton, R. G. (1991). A Review of Assessing the Accuracy of Classifications of Remotely Sensed Data, *46*(October 1990), 35–46.

Cutler, D., & Miller, G. (2005). The role of public health improvements in health advances: The twentieth-century United States. *Demography*, *42*(1), 1–22.

Dalton, L., & Burby, R. (1994). Mandates, Plans, and Planners: Building Local Commitment to Development Management. *Journal of the American Planning Association*, *60*(4), 444–461.

De Lange, M., Mastop, H., & Spit, T. (1997). Performance of national policies. *Environment and Planning B: Planning and Design*, *24*(6), 845–858.

DeGrove, J., & Stroud, N. (1988). New developments and future trends in local government comprehensive planning. *Stetson Law Review*, *XVII*(3), 573–605.

Department of Commerce. (1926). A Standard State Zoning Enabling Act. Washington, D.C.: U.S. Government Printing Office.

Department of Commerce. (1928). A Standard City Planning Enabling Act. Washington, D.C.: U.S. Government Printing Office.

Dougherty, M., Dymond, R., Grizzard, T., FGodrej, A., Zipper, C., & Randolph, J. (2006). Quantifying long-term NPS pollutant flux in an urbanizing watershed. *Journal of Environmental Engineering*, *132*(4), 547–554.

Driessen, P. (1997). Performance and implementing institutions in rural land development. *Environment and Planning B: Planning and Design*, *24*(6), 859–869.

Dunne, T., & Leopold, L. (1978). *Water in environmental planning* (1st ed.). New York: W.H. Freeman.

Earp, J. A., & Ennett, S. T. (1991). Conceptual models for health education research and practice. *Health Education Research*, *6*(2), 163–171.

Elmore, R. (1980). Backward Mapping: Implementation Research and Policy Decisions. *Political Science Quarterly*, *94*(4), 601–616.

Faludi, A. (2000). The performance of spatial planning. *Planning Practice & Research*, *15*(4), 299–318.

Faludi, A. (2006). Evaluating plans: The application of the European spatial development perspective. (E. R. Alexander, Ed.)*Evaluation in Planning: Evolution and Prospects*. Aldershot:UK: Ashgate.

Farber, D. (1999). Taking slippage seriously: Noncompliance and creative compliance in environmental law. *Harvard Environmental Law Review*, *297*.

Feagin, J. (1988). *Free enterprise city: Houston in political-economic perspective*. New Brunswick, NJ: Rutgers University Press.

Forester, J. (1993). *Critical theory, public policy, and planning practice: Toward a critical pragmatism*. Albany: SUNY Press.

Girling, C., & Kellett, R. (2002). Comparing stormwater impacts and costs on three neighborhood plan types. *Landscape Journal*, *21*(1), 100–109.

Glanz, K., Lewis, F., & Rimer, B. (1997). Linking Theory, Research, and Practice. In K. Glanz, F. Lewis, & B. Rimer (Eds.), *Health Behavior and Health Education: Theory, Research, and Practice* (pp. 19–31). San Francisco, CA: Jossey-Bass Publishers.

Goonetilleke, A., Thomas, E., Ginn, S., & Gilbert, D. (2005). Understanding the role of land use in urban stormwater quality management. *Journal of Environmental Management*, *74*(1), 31–42.

Greenberg, M., Mayer, H., Miller, T., Hordon, R., & Knee, D. (2003). Reestablishing public health and land use planning to protect public water supplies. *American Journal of Public Health*, *93*(9), 1522–1526.

Griffin, D. (1980). Analysis of non-point pollution export from small catchments. *Journal of the Water Pollution Control Federation*, *52*(4), 780–790.

Hall, P. (1980). *Great Planning Disasters*. London: Weidenfeld and Nicolson.

Hansen, A., Knight, R., Marzluff, J., Powell, S., Brown, K., Gude, P., & Jones, K. (2005). Effects of exurban development on biodiversity: Patterns, mechanisms, and research needs. *Ecological Applications*, *15*(6), 1893–1905.

Hardin, G. (1968). The Tragedy of the Commons. *Science*, *162*(3854), 1243–1248.

Hey, D. (2001). Modern drainage design: the pros, the cons, and the future. *Hydrologic Science: Challenges for the 21st Century*. Bloomington, Minnesota: The Annual Meeting of the American Institute of Hydrology.

Hill, E., Dorfman, J., & Kramer, E. (2010). Evaluating the impact of government land use policies on tree canopy coverage. *Land Use Policy*, *27*(2), 407–414.

Hoch, C. (2002). Evaluating Plans Pragmatically. *Planning Theory*, *1*(1), 53–74.

Hoch, C. (2007a). How plan mandates work: Affordable Housing in Illinois. *Journal of the American Planning Association*, *73*(1), 86–99.

Hoch, C. (2007b). Making Plans: Representation and Intention. *Planning Theory*, *6*(1), 16–35.

Hopkins, L. (2001). *Urban Development: The Logic of Making Plans*. Washington: Island Press.

Hornberger, G., Raffensperger, J., Wiberg, P., & Eshleman, K. (1998). *Elements of Physical Hydrology*. Baltimore: The Johns Hopkins University Press.

Howland, M., & Sohn, J. (2007). Will Maryland's priority funding areas initiative contain urban sprawl? *Land Use Policy*, *24*(1), 175–186.

Innes, J. (1992). Planning Theory's Emerging Paradigm: Communicative Action and Interactive Practice. *Journal of Planning Education and Research*, *14*, 183–189.

Innes, J. (1998). Information in Communication Planning. *Journal of the American Planning Association*, *64*(1), 52–63.

Kaiser, E., & Davies, J. (1999). What a good plan should contain: A proposed model. *Carolina Planning*, *24*(2), 29–41.

Kaiser, E., & Godschalk, D. (1995). Twentieth century land use planning: A stalwart family tree. *Journal of the American Planning Association*, *61*(3), 365–385.

Kaiser, E., Godschalk, D., & Chapin, F. S. (1995). *Urban Land Use Planning*. Urbana: University of Illinois Press.

Kelly, E. (1988). *Enforcing zoning and land-use controls*. Chicago, IL: American Planning Association.

Kent, T. J. (1991). *The Urban General Plan*. Chicago, IL: American Planning Association.

Klein, R. (1979). Urbanization and stream quality impairment. *Water Resources Bulletin*, *15*(4), 948–963.

Knaap, G., & Schmidt-Perkins, D. (2006). Smart growth in Maryland: Facing a new reality. *Land Lines*, *18*(3).

Krippendorff, K. (2004). *Content Analysis: An Introduction to its Methodology* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Kusler, J. (1980). *Regulating sensitive lands: a guidebook*. Washington, DC: Ballinger.

Laurian, L., Day, M., Backhurst, M., Berke, P., Ericksen, N., Crawford, J., … Chapman, S. (2004). What drives plan implementation? Plans, planning agencies and developers. *Journal of Environmental Planning and Management*, *47*(4), 555–577.

Laurian, L., Day, M., Berke, P., Ericksen, N., Crawford, J., & Dixon, J. (2004). Evaluating Plan Implementation: A Conformance-Based Methodology. *Journal of the American Planning Association*, *40*(4), 471–480.

Lee, J., & Heaney, J. (2003). Estimation of urban imperviousness and its impacts on storm water systems. *Journal of Water Resources Planning and Management*, *129*(5), 420–426.

Lee, P., Smyth, C., & Boutin, S. (2004). Quantitative review of riparian buffer width guidelines from Canada and the United States. *Journal of Environmental Management*, *70*, 165–180.

Lerable, C. (1995). *Preparing a conventional zoning ordinance*. Chicago, IL: American Planning Association.

Lewis, R., Knaap, G., & Sohn, J. (2009). Managing growth with priority funding areas: A good idea whose time has yet to come. *Journal of the American Planning Association*, *75*(4), 457–478.

Lincoln, R. (1996). *Implementing the consistency doctrine*. *The Growing Smart Working Papers*. Chicago: American Planning Association .

Lipsky, M. (1980). *Street-level Bureaucracy: Dilemmas of the Individual in Public Services*. Russell Sage Foundation.

Logan, J., & Molotch, H. (1987). *Urban Fortunes: The political economy of place*. Berkeley: University of California Press.

Loh, C. (2011). Assessing and interpreting non-conformance in land use planning implementation. *Planning Practice & Research*, *26*(3), 271–287.

Loh, C. (2012). Four potential disconnects in the community planning process. *Journal of Planning Education and Research*, *32*(1), 33–47.

Lowrance, R., Altier, L., Newbold, J. D., Schnabel, R., Groffman, P. M., Denver, J., … Todd, A. (1997). Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. *Environmental Management*, *21*(5), 687–712.

Lowry, K. (1985). Assessing the implementation of federal coastal policy. *Journal of the American Planning Association*, *51*(3), 288–298.

Lyles, L. W., Berke, P., Smith, G., Lyles, W., Berke, P., & Smith, G. (2014). Do planners matter? Examining factors driving incorporation of land use approaches in hazard mitgation plans. *Journal of Environmental Planning and Management*, *57*(5), 792–811. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/09640568.2013.768973

Maloney, F., Ausness, R., & Morris, J. S. (1972). *A Model Water Code*. Gainsville, FL: University of Florida Press.

Maloney, F., Hamann, R., & Canter, B. (1980). Stormwater runoff control: A model ordinance for meeting local water quality management needs. *Natural Resources Journal*, *20*, 719–764.

Mandelker, D. (1976). The role of the local comprehensive plan in land use regulation. *Michigan Law Review*, *74*(5), 899–973.

Maryland Department of Planning. (2014). Our Work. Retrieved from http://planning.maryland.gov/OurWork/ourwork.shtml

Maryland Department of the Environment. (2008a). Maryland stormwater design manual. Retrieved from http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Pages/programs/waterprograms/sedimentandstormwater/stormwater_design/index.aspx

Maryland Department of the Environment. (2008b). Maryland's Chesapeake Bay tributary strategy statewide implementation plan. Retrieved from http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Pages/programs/waterprograms/sedimentandstormwater/stormwater_design/index.aspx

Maryland State Archives. (2013). Department of Planning: Historical Evolution. Retrieved from http://msa.maryland.gov/msa/mdmanual/21dop/html/doph.html

Mastop, H., & Faludi, A. (1997). Evaluation of strategic plans: The performance principle. *Environment and Planning B: Planning and Design*, *24*(6), 815–832.

Mastop, H., & Needham, B. (1997). Performance studies in spatial planning: The state of the art. *Environment and Planning B: Planning and Design*, *24*(6), 881–888.

May, P. (1991). Reconsidering Policy Design: Policies and Publics. *Journal of Public Policy*, *11*(2), 187–206.

May, P., & Birkland, T. (1994). Earthquake Risk Reduction: An examination of local regulatory efforts. *Environmental Management*, *18*(6), 923–937.

May, P., & Burby, R. (1996). Coercive versus Cooperative Policies: Comparing Intergovernmental Mandate Performance. *Journal of Policy Analysis and Management*, *15*(2), 171–201.

May, P., & Williams, W. (1986). *Disaster Policy Implementation: Managing Programs under Shared Governance*. New York: Plenum Press.

Mayer, P., Reynolds, S., Canfield, T., & McCutchen, M. (2005). *Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of current science and regulations*. (E. P. Agency, Ed.) (Vol. EPA/600/R-). Ada, OK: Environmental Protection Agency.

Mazmanian, D. A., & Sabatier, P. A. (1983). *Implementation and Public Policy*. (A. Meltsner & M. Moore, Eds.)*The Scott, Foresman Public Policy Analysis and Management Series*. Glenview, IL: Scott, Foresman and Company.

McClendon, B. (2003). A bold vision and brand identify for the planning profession. *Journal of the American Planning Association*, *69*(3), 221–232.

McPherson, E. G. (2001). Sacramento's parking lot shading ordinance: Environmental and economic costs of compliance. *Landscape and Urban Planning*, *57*(2), 105–123.

Md. Code Ann. Art. 66B. (n.d.). No Title.

Molotch, H. (1976). The City as a Growth Machine: Towards a Political Economy of Place. *American Journal of Sociology*, *82*(2), 309–322.

Nassauer, J., Allan, J. D., Johengen, T., Kosek, S., & Infante, D. (2004). Exurban residential subdivision development: Effects on water quality and public perception. *Urban Ecosystems*, *7*, 267–281.

Needham, B., Zwanikken, T., & Faludi, A. (1997). Strategies for improving the performance of planning: Some empirical research. *Environment and Planning B: Planning and Design*, *24*(6), 871–880.

Nelson, A., & French, S. (2002). Plan Quality and Mitigating Damage from Natural Disasters: A Case Study of the Northridge Earthquake with Planning Policy Considerations. *Journal of the American Planning Association*, *68*(2), 194–207.

North Carolina Department of Environment and Natural Resources. (2009). The Environmental Management Commission. Retrieved from http://portal.ncdenr.org/web/emc/

North Carolina Division of Water Quality. (2009a). Jordan Lake Nutrient Strategy. Retrieved from http://portal.ncdenr.org/web/jordanlake

North Carolina Division of Water Quality. (2009b). *Modeling and TMDL Unit: The N.C. water quality assessment and impaired waters list 305(b) and 303(d) report*. Retrieved from http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls#Jordan_Lake

Norton, R. (2008). Using content analysis to evaluate local master plans and zoning codes. *Land Use Policy*, *25*(3), 432–454.

Oliveira, V., & Pinho, P. (2010). Evaluation in Urban Planning: Advances and Prospects. *Journal of Planning Literature*, *24*(4), 1–19.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. New York, NY: Cambridge University Press.

Ostrom, E. (2008). The challenge of common-pool resources. *Environment: Science and Policy for Sustainable Development*, *50*(4), 8–21.

Owens, D. (2006). *Land use law in North Carolina*. Chapel Hill, NC: University of North Carolina School of Government.

Ozawa, C., & Yeakley, J. A. (2007). Performance of management strategies in the protection of riparian vegetation in three Oregon cities. *Journal of Environmental Planning and Management*, *5*(6), 83–822.

Perdue, W., Gostin, L., & Stone, L. (2003). Public health and the built environment: Historical, empirical, and theoretical foundations for an expanded role. *The Journal of Law, Medicine & Ethics*, *31*(4), 557–566.

Peterson. (1979). The impact of sanitary reform upon American urban planning, 1840-1890. *Journal of Social History, 13*(1), 83–103.

Phillips, J. (1989). An evaluation of the factors determining the effectiveness of water quality buffer zones. *Journal of Hydrology*, *107,* 133–145.

Pickett, S., Cadenasso, M., Grove, J. M., Nilon, C., Pouyant, R. V, Zipperer, W., & Costanza, R. (2001). Urban ecological systems: Linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Annual Review of Ecological Systems*, *32*, 127–157.

Popper, F. (1988). Understanding American land use regulation since 1970: A revisionist interpretation. *Journal of the American Planning Association*, *54*(3), 291–301.

Pressman, J., & Wildavsky, A. (1973). *Implementation: How Great Expectations in Washington are Dashed in Oakland*. Berkeley, CA: University of California Press.

Renger, R., & Titcomb, A. (2002). A three-step approach to teaching logic models. *American Journal of Evaluation*, *23*(4), 493–503.

Richards, L., Anderson, G., Santore, M. K., & United States Environmental Protection Agency. (2006). *Protecting water resources with higher density developments*. Office of Sustainable Communities, Smart Growth Program.

Schueler, T. (1994). The importance of imperviousness. *Watershed Protection Techniques*, *1*(3), 100–111.

Schueler, T., & Governments, W. M. C. of. (1987). *Controlling urban runoff: A practical manual for planning and designing urban BMPs* (Publicatio). Washington DC.

Schueler, T., & Holland, H. (2000). The practice of watershed protection. Ellicott City, MD: Center for Watershed Protection.

Shadish, W., Cook, T., & Campbell, D. (2002). *Experimental and Quasi-Experimental Designs of Generalized Causal Inference*. Boston, MA: Houghton Mifflin Company.

Shuster, W., Bonta, J., Thurston, H., Warnemuended, E., & Smith, D. (2005). Impacts of impervious surface on watershed hydrology: A review. *Urban Water Journal*, *2*(4), 263–275.

Singleton, R., & Straits, B. (1999). *Approaches to Social Research* (3rd ed.). New York: Oxford University Press.

Sohn, J., & Knaap, G. (2005). Does the job creation tax credit program in Maryland help concentrate employment growth? *Economic Development Quarterly*, *19*(4), 313–326.

Solem, R. (1987). *The logical framework approach to project design, review, and evaluation in A.I.D.: Genesis, impact, problems, and opportunities* (Vol. Working pa). Washington, D.C.: Agency for International Development.

Stevens, M., & Berke, P. (2008). *Can individual planners make communities safer? A study of the use of discretion in managing urban development*. *Department of City and Regional Planning*. University of North Carolina at Chapel Hill, Chapel Hill.

Stevens, M., & Hanschka, S. (2014). Multi-Level governance of flood hazards: The case of municipal flood bylaws in British Columbia, Canada. *Natural Hazards Review*, *15*(1), 74–87.

Sweeney, B. (1992). Streamside forests and the physical, chemical, and trophic characteristics of Piedmont streams in eastern North America. *Water Science Technology*, *26*, 2653–2673.

Talen, E. (1996a). After the Plans: Methods to Evaluate the Implementation Success of Plans. *Journal of Planning Education and Research*, *16*, 79–91.

Talen, E. (1996b). Do Plans Get Implemented? A Review of Evaluation in Planning. *Journal of Planning Literature*, *10*(3), 248–259.

Talen, E. (1997). Success, Failure, and Conformance: An alternative Approach to Planning Evaluation. *Environment and Planning B: Planning and Design*, *24*, 573–587.

The Chesapeake Bay Agreement of 1983. (1983). Retrieved from http://www.chesapeakebay.net/documents/1983_CB_Agreement2.pdf

The Constitution of the United States of America. (1791). United States Government Printing Office. Retrieved from http://www.gpo.gov/fdsys/pkg/GPO-CONAN-1992/html/GPO-CONAN-1992-10-11.htm

Todd, D. (1989). Impact of land use and nonpoint source loads on lake quality. *Journal of Environmental Engineering*, *115*(3), 633–649.

UNICEF and World Health Organization. (2012). *Progress on drinking water and sanitation: 2012 update*. New York: UNICEF and World Health Organization Joint Monitoring Programme for Water Supply and Sanitation.

United States Agency for International Development. (2000). *Building a results framework: Performance monitoring and evaluation tips*. Washington, D.C.: USAID Center for Development Information and Evaluation.

United States Environmental Protection Agency. (2002). Assessment data for Maryland, Gunpowder-Patapsco. Retrieved from http://epadev.induscorp.com/epadevdb_tmdl_web/w305b_report_v2.huc?p_huc=02060003&p_state=MD

United States Environmental Protection Agency. (2006). Model ordinances to prevent and control nonpoint source pollution. Retrieved from http://water.epa.gov/polwaste/nps/ordinance_index.cfm

United States Environmental Protection Agency. (2013). National summary of impaired waters and TMDL information. Retrieved from http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T

United States Geographic Survey. (2013). What is the watershed boundary dataset? Retrieved from http://nhd.usgs.gov/wbd.html

Van Damme, L., Galle, E., Pen-Soetermeer, M., & Verdaas, K. (1997). Improving the performance of local land-use plans. *Environment and Planning B: Planning and Design*, *24*(6), 833–844.

Vidon, P., & Hill, A. (2004). Landscape controls on nitrate removal in stream riparian zones. *Water Resources Research*, *40*(3), W03201.

Wear, D., Turner, M., & Naiman, R. (1998). Land cover along a urban-rural gradient: Implications for water quality. *Ecological Applications*, *8*(3), 619–630.

Wenger, S. (1999). *A review of the scientific literature on riparian buffer width, extent, and vegetation*. (O. of P. S. & Outreach, Ed.). Athens, GA: Institute of Ecology, University of Georgia.

Wheaton, W. L. C. (1969). The federal role as an incentive to local development. In M. H. Hufschmidt (Ed.), *Regional planning: Challenges and prospects* (pp. 238–259). New York: Frederick A. Praeger.

Wholey, J. (1979). *Evaluation: Promise and performance*. Washington, D.C.: The Urban Institute.

Wickham, J., O'Neill, R., Riitters, K., Smith, E., Wade, T., & Jones, K. B. (2002). Geographic targeting of increases in nutrient export due to future urbanization. *Ecological Applications*, *12*(1), 93–106.

Wildavsky, A. (1973). If Planning is Everything, Maybe it's Nothing. *Policy Sciences*, *4*(2), 127–153.

Winter, S., & May, P. (2001). Motivation for compliance with environmental regulations. *Journal of Policy Analysis and Management*, *20*(4), 675–698.

World Water Assessment Programme. (2009). *The United Nations World Water Development Report 3: Water in a changing world*. *The United Nations World Water Development Report 3*. Paris: UNESCO.

Wyner, A., & Mann, D. (1986). *Preparing for California's earthquakes: Local government and seismic safety*. Berkeley, CA: Institute of Governmental Studies, University of California.