U.S. Federal Water Pollution Control: How History Has Contributed to the Mismatch Between the Legal Framework and the Current State of the Science

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ABSTRACT

The current framework under which federal authorities regulate waters of the United States is in many ways constrained by our history. Regulatory policy and scientific understanding have developed on parallel but independent trajectories, with little crossover. In 2006, the Supreme Court addressed the scope of federal regulatory authority under the Clean Water Act in the case Rapanos v. United States, and reached a split-decision that left no clear mandate for the lower courts to follow. I examined the influence of Rapanos on the current regulatory landscape, and found highly variable application of the Supreme Court's split-decision in the lower courts. Some courts have begun to consider hydrologic connectivity and ecological function, but the mismatch between policy and scientific understanding largely remains. There are simple tools and techniques that can be used to identify which areas of a landscape are likely to be most influential to waters of the United States. To demonstrate, I used terrain analysis techniques to examine a watershed in Montana and identify influential areas based on spatial and temporal hydrologic connectivity.

INTRODUCTION

Dating back to the 19th Century, policy for federal regulation of the United States' water resources and the related scientific understanding have developed independently, leading to regulatory policy that has been only variably informed by the science. While the passage of the Clean Water Act in the 1970's signaled an unprecedented effort by Congress to protect waters of the United States, the mismatch between policy and the science has not only persisted, but has been exacerbated by several Supreme Court rulings that left an unclear mandate to be followed by federal regulators, the lower courts, and farmers and developers that rely directly on their land for their livelihoods. The lack of clarity with respect to the framework governing water resource regulation reached an arguable peak in 2006, when the Supreme Court addressed the scope of federal regulatory authority under the Clean Water Act in the case *Rapanos v. United States.*[1] The court reached a split-decision that not only left no clear mandate for the lower courts to follow, but placed a largely misguided emphasis on parts of the landscape that are most influential to waters of the United States and are thus most important to protect under the Clean Water Act.

The first section of this report examines critically the parallel development of the legal framework that has led the United States to federal water resource regulation through the Clean Water Act, and the state of water science understanding. The purpose of this segment is to evaluate how federal ability to regulate waters of the United States has been constrained by history, and what the gaps are between water science understanding and the legal framework used for regulation.

To attempt to quantify the impact of the *Rapanos* ruling, this project then examines the influence the *Rapanos* case has had on the state of water resource regulation in the United States. Since the *Rapanos* opinion was issued in June 2006, there have been 87 judicial

[1] Rapanos v. United States, 547 U.S. 715 (2006)

opinions written at the Federal District Court and Circuit Court levels that have cited the *Rapanos* case at least 3 times. These 87 judicial opinions were analyzed to determine how the *Rapanos* split-decision was interpreted, and how this interpretation was then applied to the respective case. Notable interpretations and trends were identified in order to better understand the influence *Rapanos* has had on the current regulatory landscape.

To demonstrate basic, applied ways to have scientific understanding better inform water resource policy and decisions, this project includes a GIS case study based on simple methods for identifying areas of the landscape that are likely to be most influential to waters of the United States. These terrain analysis techniques, which were performed on an example watershed in Montana, focused on the following areas of the landscape that are critical for watershed management:

- Where most of the water enters the stream
- Where riparian wetlands and floodplains are likely to exist
- Where there is strong connectivity potential to the stream channel

The areas that these terrain analysis techniques identify as most influential to waters of the United States were then compared to areas that a commonly used, static watershed management technique would prioritize.

PART I.

PARALLEL EVOLUTION OF LEGAL FRAMEWORK & WATER SCIENCE UNDERSTANDING

19th Century and Early 20th Century: Roots of Modern Day Regulation

At the turn of the century, the Rivers and Harbors Act of 1899 officially granted the United States Army Corps of Engineers (Corps) control over obstructions to navigable waters of the United States.[2] This legislation was the first in a series of actions that ensued over the 20th Century through which the federal government's role in the regulation of water pollution in the United States was defined on the basis of traditional "navigable waters." As it presently stands, if the federal courts have determined that a water body is navigable-in-fact under federal law for any purpose, that water body qualifies as a traditional "navigable water," and is subject to the jurisdiction of the United States Environmental Protection Agency (EPA) and the Corps under 33 C.F.R. § 328.3(a)(1) and 40 C.F.R. § 230.3(s)(1).[3]

The definition of the term "navigable waters," which has roots in 18th and 19th century admiralty jurisdictional matters, first evolved to include inland streams and rivers in an 1870 Supreme Court decision handed down in the case *The Daniel Ball.*[4] In *The Daniel Ball*, the Supreme Court defined a waterbody to be "navigable-in-fact" through the following test that expanded the scope of admiralty jurisdiction to include inland waters:

> Those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water.[5]

Over the next several years, the scope of *The Daniel Ball* rule to determine when a waterbody is "navigable in fact," and therefore it falls under federal jurisdiction, was extended through a series of Supreme Court rulings. This rule expanded to include smaller rivers that were exceedingly difficult to navigate in the 1874 case *The Montello,*[6] and in 1883 was broadened to include man made waterways in *Ex Parte Boyer.*[7] [8]

The term "navigable waters," which to this point had been defined in order to confer federal control over waterways via Congressional jurisdiction under the Commerce

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[2] Hankey, D. L. (1980). Sections 9 and 10 of the Rivers and Harbors Act of 1899: The Erosion of Administrative Control by Environmental Suits. *Duke Law Journal*, 170-204.
[3] United States Army Corps of Engineers. n.d. "Appendix D Legal Definition of 'Traditional Navigable Waters'." Accessed March 1, 2015. http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/cwa_guide/app_d_traditional_navigable_waters.pdf.
[4] *The Daniel Ball*, 77 U.S. (10 Wall.) 557, 19 L. Ed. 999 (1870).
[5] Guinn, D. M. (1966). Analysis of Navigable Waters of the United States, An. *Baylor L. Rev.*, *18*, 559.
[6] *The Montello*, 87 U.S. 20 Wall. 430 430 (1874)
[7] *Ex Parte Boyer*, 109 U.S. 629, 27 L. Ed. 1056 (1884).
[8] Guinn (1966)

Clause, reached a confluence with the earliest form of federal water pollution control legislation in 1899 when Congress passed the Rivers and Harbors Act of 1899. This legislation granted the Corps control over the obstruction to navigable waters, with Section 9 outlining the requirements for approval to construct dams, dikes, bridges or causeways in a navigable waterway,[9] and Section 10 establishing the first official permitting program for dredging, filling and construction in navigable waters.[10] Additionally, Section 13 of the statue, known as the Refuse Act, prohibited the discharge of refuse into navigable waters or their tributaries. Although the Rivers and Harbors Act of 1899 was largely ineffectual due to lack of support by Congress, it laid the foundation for modern water pollution control legislation. However, it took nearly 50 years before Congress made a subsequent significant attempt to advance water pollution control in the United States.[11]

State of Water Science Understanding: 19th Century & Early 20th Century

As the Federal government rolled out its initial attempts to regulate waterways in the late 19th century and early 20th century in order to protect commercial navigation, water-related scientific and engineering advancements were similarly stimulated by the need for water supply, riverine transportation, and floodplain protection. The earliest records of river discharge measurements in the United States were made on the Ohio River at Wheeling, West Virginia beginning in 1838 and on the Mississippi River at Memphis, Tennessee in 1851, but the first federally operated regular gaging station did not go into operation until 1889 on the Rio Grande in Embudo, New Mexico. This gage was operated by the United States Geological Survey (USGS), which had been established a decade earlier, as part of a systematic stream gaging program it was implementing throughout the country. Around this the same time that the USGS was created, a National Weather Service, which later became the United States Weather Bureau, was established to collect meteorological data, including rainfall data. Recognizing the destructive capacity of floods, Congress also began to show a concern for floodplain management during this era. In 1850, Congress authorized a large scale "topographical and hydrological survey" on the Mississippi River delta in order to determine the most practical plan for floodplain protection.[12]

While the United States federal government began to recognize the importance of hydrologic data during the 19th century, significant advancements in hydrology were concurrently being made abroad in the mid-to-late 19th century. In Ireland, engineer T.J. Mulvany developed the rational method to better understand the relationship between the runoff rate and the rate of rainfall in a catchment in 1851,[13] and engineer Robert Manning developed an empirical equation governing open channel flow as a function of channel

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[9] Hankey (1980)

[10] Spring, M. (1991). Clean Water Act Section 404 (f) Exceptions: A Call to End the Open Door Policy, The. *Duke Envtl. L. & Pol'y F.*, *1*, 57.

[11] Poe, G. L. (1995). *The evolution of federal water pollution control policies*. Department of Agricultural, Resource, and Managerial Economics, College of Agriculture and Life Sciences, Cornell University.

[12] Jones, P. B., Walker, G. D., Harden, R. W. and McDaniels, L. L. 1963. *The development of the science of hydrology*, Dallas: Texas Water Commission. Circular No. 63–03. http://www.twdb.texas.gov/publications/reports/other_reports/doc/Circ63-03.pdf

[13] Eagleson, P. S., Brutsaert, W. H., Colbeck, S. C., Cummins, K. W., Dozier, J., Dunne, T., ... & Zipser, E. J. (1991). Opportunities in the hydrologic sciences. *Natl. Acad. Press, Washington, DC*.

velocity, flow area, and channel slope in 1889.[14] In France, engineer Henry Darcy discovered the fundamental equation to describe the flow of water through porous media, which shed light on groundwater movement. Darcy's Law, as the equation came to be known, provided evidence that the water flow rate through a porous media is linear function of the hydraulic gradient, and is not just the difference in water pressure. Darcy's work, which also included the observation that an aquifer could significantly resist flow, established the foundation for modern day quantitative hydrogeology. Significant post-Darcy advancements in the field include those of French engineer Arsene Jules Dupuit and German engineer Adloph Thiem, who derived expressions for the steady radial flow of water in both confined and unconfined aquifers, and Austrian engineer Philipp Forchheimer, who recognized groundwater equipotential lines and used mathematical methods to solve steady state groundwater flow problems.[15]

These developments in science and engineering began to take a foothold in the United States around the turn of the century in large part through the work of American mathematics professor Charles S. Slichter, who collaborated with the USGS. Slichter built on the work of Darcy, Dupuit and Thiem, and extended a vertical flow component to existing groundwater theory which permitted horizontal groundwater flow only. Slichter sought to understand the physical terms of hydraulic conductivity and develop methods to measure it, and collaborated with the USGS by providing the agency with reports on his field work.[16]

Over the next three decades, scientific and engineering advancements came in the form qualitative descriptions and empiricism, with an understanding of the ongoing process still lacking. American engineers Leroy Sherman and Robert Horton initiated a more theoretical, quantitative approach 1930's and 1940's. Sherman introduced the unit hydrograph concept in 1932, in which he reasoned that for a given watershed, all hydrographs resulting from rains of the same period of excess have equal time bases. Sherman's basic ideas, with modern refinements, are still used today to explain river-basin behavior.[17] [18] Horton introduced ideas about soil infiltration capacity as a control on surface runoff, and suggested partitioning the discharge hydrograph into surface and subsurface flow components. His most well-known achievement was the development of a concept for storm hydrograph analysis and prediction, which held that storm water is primarily a result of overland flow generated by an excess of rainfall over the infiltration capacity of the soil. In combination with Sherman's unit hydrograph concept, the concept of infiltration excess overland flow (or "Hortonian" overland flow) established a

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[14] Fischenich, C. (2000). *Robert Manning: a historical perspective*, TN-EMRRP-SR-1O, US Army Corps of Engineers Research and Development Center, Environmental Laboratory.
[15] Simmons, C. T. (2008). Henry Darcy (1803–1858): Immortalised by his scientific legacy. *Hydrogeology Journal, 16(6)*, 1023-1038.
[16] Simmons (2008)
[17] Bras, R.L., "A brief history of hydrology -The Robert E. Horton Lecture," Bulletin of the American Meteorological Society, 80(6):1151-1164, 1999
[18] United States Department of Agriculture, Natural Resources Conservation Service. n.d. "Module 207 Hydrograph Development." United States Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1083020.pdf

foundation for further advances in hydrology over the next several decades.[19] [20] Despite these preliminary, yet significant developments in hydrology in mid-19th century and the early 20th century, the focus of federal protection of waters of the United States had already been made designed to in the context of navigation and commerce interests, not scientific and engineering understanding.

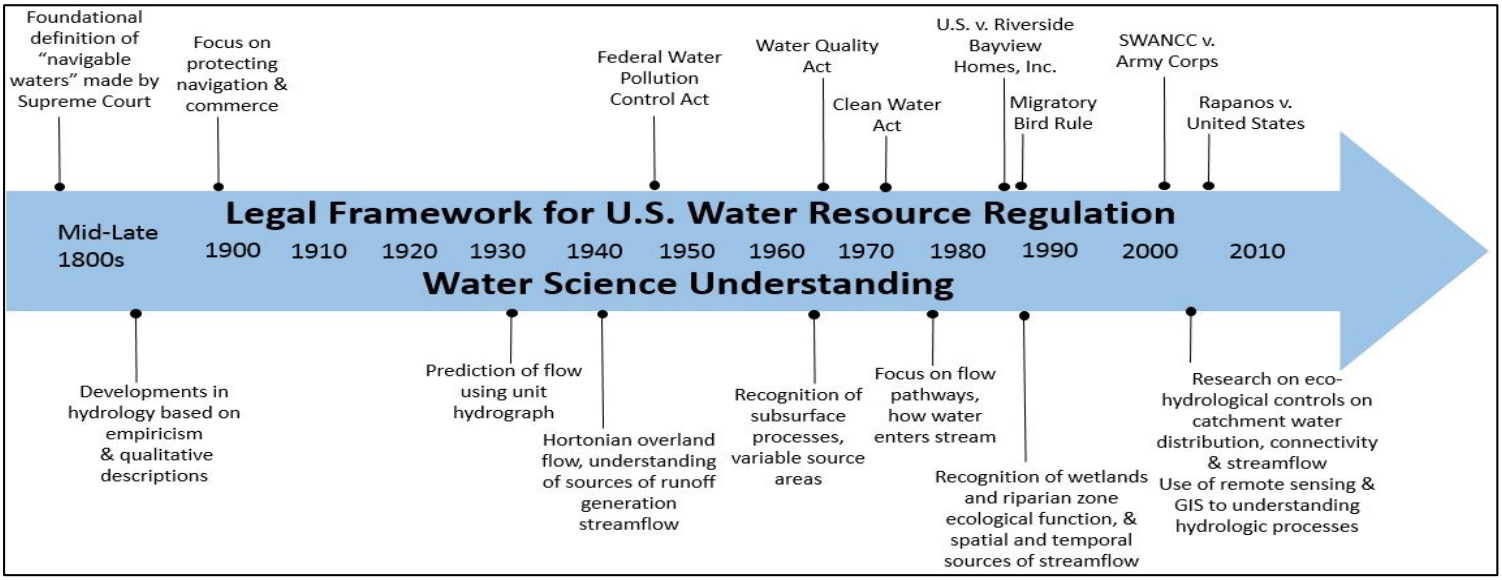

Figure 1. Timeline of Parallel Development of Legal Framework & Water Science Understanding

Federal Water Pollution Control in the Mid-20th Century

After almost a half-century without any notable advancements in federal water pollution control, Congress passed the Federal Water Pollution Control Act (FWPCA) of 1948, which marked the first comprehensive statement of federal interest in clean water programs.[21] This legislation did not confer federal authority to set water quality standards, limit discharges or engage in any type of enforcement,[22] [23] but instead placed the federal government in a secondary position with respect to the states on water quality issues. The role of the federal government was limited to providing support for research on water pollution problems, loans to help finance treatment facilities, and financial grants to state water pollution control programs.[24] [25] The only federal enforcement authority granted was narrow authorization for action relating to interstate pollution that endangered persons in a state other than the one in which the pollution originated.[26]

[19] Beven, K. (2004). Robert E. Horton's perceptual model of infiltration processes. *Hydrological processes*, *18*(17), 3447-3460.
[20] Hall, F. R. (1987). Contributions of Robert E. Horton. *History of Geophysics: Volume 3*, 113-117.
[21] Copeland, C. (1999). Clean Water Act: a summary of the law. Congressional Research Service, Library of Congress.
[22] Poe (1995)
[23] Murchison, K. M. (2005). Learning from more than five-and-a-half decades of federal water pollution control legislation: twenty lessons for the future. *BC Envtl. Aff. L. Rev.*, *32*, 527.
[24] Federal Water Pollution Control Act of 1948 § 2, 62 Stat. at 1155-1159
[25] Murchison (2005)
[26] Murchinson (2005)

While still conferring only minimal federal authority to enforce water pollution control, Amendments to the FWPCA made in 1956 signified a small shift in power away from the states and towards federal pollution control.[27] The 1956 Amendments established some minimal enforcement of interstate pollution and removed authority of the state in which pollution originated to veto court action, which was inconsistent with the idea of any federal abatement power. [28] [29] Further amendments made to the FWPCA in 1961 expanded the scope of this program to include all navigable waters for the first time.[30] The 1961 Amendments marked the first time that the FWPCA expressly covered "navigable waters," although the FWPCA did not define what "navigable waters" are. By neglecting to define the term, the courts would need to refer to previously offered definitions of "navigable waters" from past Supreme Court caselaw, which dated as far back as 1870 with *The Daniel Ball.*[31]

The Water Quality Act of 1965 substantially expanded the scope of federal regulatory authority. The 1965 Act set ambient water quality standards for interstate water courses, and required states to file implementation plans to meet these standards.[32] The 1965 Act required states to submit their standards to the newly created Federal Water Pollution Control Administration for approval, but did not allow for regulatory enforcement on individual polluters.[33] Although the Act did not achieve any significant improvements on water quality, it reflected a philosophical change at the Federal level in that it demonstrated a concern for ecological values and in-stream water uses that had not been reflected previously in legislation.[34]

Augmentations to the federal enforcement provisions of the FWPCA were enacted the following year with the Clean Water Restoration Act of 1966. This legislation required an alleged polluter to report to the federal authorities (administered at the time by the Secretary of Health, Education and Welfare) information concerning the "character, kind and quantity" of the discharges, creating a way for the Secretary to gather data needed to frame recommendations and to be used in any subsequent proceedings.[35] A further amendment to the Federal Water Pollution Control Act made in 1970 did not change the basic structure of water pollution control regulations.[36] [37]

While the FWPCA was amended five times between 1948 and 1970, the amendments achieved limited success in affecting the quality of the nation's water,[38] and left many

[27] Barry, F. J. (1970). The Evolution of the Enforcement Provisions of the Federal Water Pollution Control Act: A Study of the Difficulty in Developing Effective Legislation. *Michigan Law Review*, 1103-1130.
[28] Murchinson (2005)
[29] Barry (1970)
[30] Poe (1995)
[31] Barry (1970)
[32] Poe (1995)
[33] Murchinson (2005)
[34] Poe (1995)
[35] Barry (1970)
[36] Water Quality Improvement Act of 1970, Pub. L. No. 91-224, 84 Stat. 91 (codified prior to amendment at 33 U.S.C. §§ 466, 1152, 1155–1156, 1158, 1160–1175 (1970)).
[37] Murchinson (2005)
[38] Murchinson (2005)

problems with enforcement provisions unresolved.[39] To highlight how ineffective the enforcement procedures were, at this point the Department of Justice opted to use the Refuse Act from 1899 as a basis for legal actions against polluters instead of the FWPCA.[40]

Post-Horton Developments in Hydrology

Although it is apparent that Congress began to recognize the importance of water quality from 1948 to 1970, the mechanisms it used for water quality protection did not reflect the new understanding on how water moves across the landscape both through surface and sub-surface processes. During this same time period, scientific and engineering advancements that built upon the work of Sherman and Horton came to reflect a progressively better understanding of the dynamic nature of water movement in and out of catchment systems. Hydrologists casted doubt on usefulness of the Hortonian infiltration theory in analyzing runoff during the vast majority of storms, and investigated more complex mechanisms controlling storm runoff.[41]

In 1964, Roger Betson presented the concept of partial contributing area storm runoff, which held that Hortonian overland flow originates from small, but relatively consistent portions of a catchment.[42] [43] Hydrologists also began looking towards subsurface processes as a potential main source of storm runoff. Ronald Whipkey (1965) proposed that subsurface storm flow that reached the stream channel without entering the general groundwater[44], while M. J. Kirbky and R.J. Chorley (1967) described a similar concept called throughflow to describe downslope flow within the soil profile.[45] John Hewlett and Alden Hibbert (1963; 1967) argued the traditional focus in classical hydrology on channel processes that produce flood volumes downstream was misplaced, and called for greater attention to be paid to upstream hydrologic processes. One of their most significant contributions was the variable source area concept, which described the dynamic expansion of the area contributing to streamflow when subsurface flow exceeds the capacity of the soil profile to transmit it. Hewlett & Hibbert challenged the conventional model that baseflow was fed by deep ground, and instead posited that unsaturated flow through the soil profile can sustain baseflow. They also explained translatory flow, in which "new" precipitation inputs displace the "old" rainwater stored in the soil and cause the "old" rainwater to flow laterally through the profile.[46] [47]

In 1970, Thomas Dunne and Richard Black further promoted the variable source area concept, and posited that partial areas contributing quick runoff are dynamic and could

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[39] Barry (1970)
[40] Murchinson (2005)
[41] Dunne, T., & Black, R. D. (1970). Partial area contributions to storm runoff in a small New England watershed. *Water resources research*, *6*(5), 1296-1311.
[42] Betson, R. P. (1964). What is watershed runoff?. *Journal of Geophysical research*, *69*(8), 1541-1552.
[43] Van de Griend, A.A. & Engman, E.T. (1985). Partial area hydrology and remote sensing. *J. Hydrol*, *81*, 211-251.
[44] Whipkey, R. Z. (1965). Subsurface stormflow from forested slopes. *Hydrological Sciences Journal*, *10*(2), 74-85.
[45] Kirkby, M. J., & Chorley, R. J. (1967). Throughflow, overland flow and erosion. *Hydrological Sciences Journal*, *12*(3), 5-21.
[46] Hewlett, J. D., & Hibbert, A. R. (1963). Moisture and energy conditions within a sloping soil mass during drainage. Journal of Geophysical Research, 68(4), 1081-1087.
[47] Hewlett, J. D., & Hibbert, A. R. (1967). Factors affecting the response of small watersheds to precipitation in humid areas. *Forest hydrology*, 275-290.

expand or contract seasonally or during a storm. Additionally, Dunne & Black introduced the theories of saturation excess overland flow, in which saturated soils drive large amounts of surface runoff to the stream channel, and return flow, in which the quick return of water inputs to the soil surface contributes to runoff.[48] The gradual understanding of the spatially and temporally dynamic nature of hydrologic systems led to a deviation from the classical paradigm from which hydrologic processes were understood. While some of his ideas may have seemed outdated by the 1970's, the work of Horton laid the foundations for these future developments.

Legislation in the 1970's: Clean Water Act

In light of the shortcomings and ineffectiveness of preceding water pollution control legislation, as well as high-visibility incidents such as the Cuyahoga River fire of 1969, Congress passed a series of amendments to significantly reorganize and expand the FWPCA in 1972. With the 1972 Amendments, the FWPCA later became known as the "Clean Water Act." The 1972 Amendments established the modern structure of federal water pollution control legislation and statutory numbering that is used to the present day.[49] With the primary objective to "restore and maintain the chemical, physical and biological integrity of the Nation's waters,"[50] the 1972 Amendments declared, "it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985."[51] According to Section 502 of the 1972 Amendments, "the term 'navigable waters' means the waters of the United States, including the territorial seas."[52] However, the scope of this statutory definition was not further prescribed and was thus largely left for the courts to delineate.[53] To achieve its broad goals, the 1972 Amendments were broken into several separate Titles. The first, Title I,[54] called for a series of research programs to develop information and technology applicable to recently recognized problems of water pollution control. Title II of the 1972 Amendments[55] contained the major provisions of the Act relating to the construction of water treatment facilities.[56]

Title III, which addressed effluent limitations and water quality standards, commenced in Section 301(a) by stating that except as in compliance with the Act, "the discharge of any pollutant by any person shall be unlawful."[57] Key components of Title III include the requirement that industry apply the best practicable control technology (BPT) to eliminate the discharge of any pollutant from a point source, other than publicly owned treatment works, by July 1, 1977.[58] Subsequent and more ambitious objectives included the requirement to apply the best available technology (BAT) economically feasible and the requirement to eliminate totally the discharge of all pollutants, should the

[48] Dunne & Black (1970)
[49] Murchinson (2005)
[50] 33 U.S.C.A. § 1251(a)
[51] 33 U.S.C.A. § 1251(a)(1)
[52] 33 U.S.C.A. § 1362(7)
[53] McMahon Jr, M. J. (1972). Federal Water Pollution Control Act Amendments of 1972, The. *BC Indus. & Com. L. Rev.*, *14*, 672.
[54] 33 U.S.C.A. § 1251-65
[55] U.S.C.A. § 1281-92
[56] McMahon (1972)
[57] 33 U.S.C.A. § 1311(a)
[58] 33 U.S.C.A. § 1311(b)(1)(A)

Environmental Protection Agency deem it "technologically or economically achievable," by July 1, 1983.[59]

Section 303 required that each state identify which waters do not meet the water quality standard, and for those impaired waters establish a priority ranking based on the "severity of the pollution and the uses to be made of such waters" as well as determine a total maximum daily load (TMDL). The TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards.[60] With regard to controls on toxic pollutants, Section 307 tasked the EPA with the responsibility for publishing "a list which includes any toxic pollutant or combination of such pollutants for which an effluent standard (which may include a prohibition of the discharge of such pollutants or combination of such pollutants) will be established."[61]

Title IV established by the 1972 Amendments established several important programs relating to the discharge of pollutants.[62] Section 402 established the National Pollutant Discharge Elimination System (NPDES) permit program to control water pollution, to be administered by the EPA, by regulating point sources that discharge pollutants into waters of the United States. "The Administrator may, after opportunity for public hearing, issue a permit for the discharge of any pollutant, or combination of pollutants,"[63] as long as the individual discharge complies with various effluent, technology and reporting standards required by the 1972 Amendments. This section also allowed states that wish to assume NPDES permitting authority to do so,[64] stating "the Governor of each State desiring to administer its own permit program for discharges into navigable waters within its jurisdiction may submit to the Administrator a full and complete description of the program it proposes to establish and administer under State law or under an interstate compact."[65] Section 402 allowed the EPA to withdraw approval of the state's NPDES program if it determines that a State is not administering a program in accordance with the requirements outlined in the section.[66]

Section 404, entitled "Permits for Dredged or Fill Material," created a program under which the Army Corps of Engineers "may issue permits, after notice and opportunity for public hearings for the discharge of dredged or fill material into the navigable waters at specified disposal sites."[67] Through Section 404, the 1972 Amendments established the foundation for future expansion in scope of federal authority to regulate numerous activities that involve the discharge of dredged or fill materials in to waters of the United States, including wetlands.[68]

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[59] 33 U.S.C.A. § 1311(b)(2)(A)
[60] 33 U.S.C.A. § 1311(d)
[61] 33 U.S.C.A. § 1317
[62] McMahon (1972)
[63] 33 U.S.C.A. § 1342(a)(1)
[64] Wagner, K. G. (1999). State NPDES Programs and the ESA: Protecting Listed Species Under the Clean Water Act. *Environs: Envtl. L. & Pol'y J.*, *23*, 3.
[65] 33 U.S.C.A. § 1342(b
[66] 33 U.S.C.A. § 1342(c)(3)
[67] 33 U.S.C.A. § 1344(a)
[68] United States Environmental Protection Agency. *Water: Discharge of Dredged or Fill Materials (404).* n.d. http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/.

To provide the Corps with the means to effectively administer the new dredge-and-fill permitting program introduced at Section 404, the 1972 Amendments broadened the Corps' geographic jurisdiction to regulate activities in the "waters of the United States" beyond its historical scope. However, the Corps resisted a more expansive interpretation of "waters of the United States" by equating the term with the Corps' original definition of navigable waters that pre-dated the 1972 Amendments. The Corps regarded this definition as the broadest interpretation available under the Constitution, and the one in accord with the legislative intent of Section 404.[69] The refusal of the Corps to extend jurisdiction beyond this interpretation of navigability was challenged in the 1975 case *Natural Resources Defense Council v. Callaway*. In *Natural Resources Defense Council v. Callaway*, the District Court of the District of Columbia held that in the 1972 Amendments, Congress intended to "exercise maximum extent permissible under the Commerce Clause of the Constitution." [70]

Accordingly, the court ordered the Corps to issue revised regulations "clearly recognizing the full regulatory mandate" of the 1972 Amendments.[71] In response to this order, the Corps issued interim final regulations to expand the scope of its jurisdiction under Section 404 by redefining the term "navigable waters." Under this new definition, Corps jurisdiction extended beyond its historical scope to include wetlands, mudflats, swamps, and similar areas which are contiguous or adjacent to navigable waters, including wetlands that are periodically inundated by freshwater, saline water or brackish water.[72] [73] The Corps defined wetlands to be "those land and water areas subject to regular inundation by tidal, riverine, or lacustrine flowage," which included "inland and coastal shallows, marshes, mudflats, estuaries, swamps, and similar areas in coastal and inland navigable waters."[74]

Prompted by concern expressed by both the Corps and the public that the new regulations would overextend federal regulations over discharges of dredged or fill materials, further statutory changes to the Section 404 dredge-and-fill program were made in 1977 when Congress amended the FWPCA with the Clean Water Act of 1977.[75] While the 1977 Amendments called for the regulation of wetlands under Section 404, they limited the reach of the legislation by authorizing the issuance of general permits for deposits of dredge-and-fill materials deemed to have only minimal adverse environmental effects, and by exempting certain activities from Section 404 regulation such as activities associated with "normal farming, silviculture, and ranching."[76] [77]

In addition to the expansion of Section 404, the 1977 Amendments made improvements to Section 307 by strengthening the EPA's authority to regulate the discharge of toxic

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[69] Spring (1991)
[70] *Natural Resources Defense Council v. Callaway*, 392 F. Supp. 685 (D.D.C. 1975).
[71] Bianucci, L. R., & Goodenow, R. R. (1991). Impact of Section 404 of the Clean Water Act on Agricultural Land Use, The. *UCLA J. Envtl. L. & Pol'y*, *10*, 41.
[72] Permits for Activities in Navigable Waters or Ocean Waters; 40 Fed Reg 31,320 (July 25, 1975).
[73] Johnson, S. M. (1993). Federal Regulations of Isolated Wetlands. *Envtl. L.*, *23*, 1.
[74] Permits for Activities in Navigable Waters or Ocean Waters; 40 Fed Reg 31,320 (July 25, 1975).
[75] Spring (1991)
[76] Clean Water Act of 1977, Pub. L. No. 95-217, 91 Stat. 1600–1601.
[77] Murchinson (2005)

pollutants. The 1977 Amendments expanded the list of priority pollutants and gave the EPA the authority to promulgate BAT standards for all pollutants on the list, as well to revise the list as needed.[78]

In the wake of the 1977 Amendments, both the Corps and the EPA sought to further clarify the definition of wetlands. By 1982, the Corps and the EPA jointly defined wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."[79]

State of the Science: Clean Water Act through Modern Era

Despite the efforts of Congress with its Clean Water Act amendments, the federal government still restrained its water resource regulation to only surface waters, and exempted some of the activities that have the greatest influence on what enters waters of the United States. While Congress was passing this legislation, the focus in hydrology in the 1970's was still very much centered on subsurface flow pathways, and understanding details of how water enters streams. Hydrologists gained greater insight into how different hydrologic environments would lead to the dominance of certain flow mechanisms, such as overland flow or subsurface flow, and how soil structure and antecedent moisture conditions affect catchment response. For example, *Dunne* (1975) posited that humid regions with thin soils, gentle terrain, concave lower slopes, and wide valley bottoms would be dominated by saturated overland flow, while humid areas with steep, straight or convex clopped, incised channels, narrow valley bottoms, and very permeable soils, would dominated by subsurface flow. [80] [81]

Around this time, hydrologists also began to rely more heavily on tracer studies, which used isotopes such as tritium, deuterium, and oxygen 18 to better understand water origin and movements. [82] These types of findings, as Dunne reflected in a 1978 work, demonstrated that various attempts to model storm runoff differently are not contradictory, but are in fact complementary. These differences are reflective of the physical geography where experiments are carried out. [83]

By the 1980s, there was widespread recognition of the ecological functions wetlands and riparian zones provide, as well as new recognition of spatial and temporal sources of

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[78] Murchinson (2005)

[79] Finan, Michael. "Delineating Waters of the United States, Including Wetlands." *US Army Corps of Engineers: Sacramento District*. June 13, 2013. http://www.spk.usace.army.mil/Portals/12/documents/regulatory/wrda/Partner%20Outreach/13-Jun-2013/Delineating_Waters_of_the_United_States_including_wetlands.pdf.

[80] Dunne, T., Moore, T. R., & Taylor, C. H. (1975). Recognition and prediction of runoff-producing zones in humid regions. *Hydrol. Sci. Bull.*, *20*, 305-327.

[81] Pearce, A. J., Stewart, M. K., & Sklash, M. G. (1986). Storm runoff generation in humid headwater catchments: 1. Where does the water come from?. *Water Resources Research*, *22*(8), 1263-1272.

[82] Pearce, Stewart, & Sklash (1986)

[83] Dunne,T. (1978) Field studies of hillslope flow processes, Chapter 7. *Hillslope Hydrology*, (ed. M. J. Kirkby), Wiley, London, 227-293

streamflow. In studies commissioned by federal agencies such as the USGS and the Corps, scientists began to better appreciate wetland hydrologic functions such as flood control, groundwater recharge, and bank stabilization.[84] An example of this can be seen in Figure 2. Around the same time, studies such *Peterjohn and Correll* (1983), shed light on the filtering potential of riparian forests to reduce the amount of nutrients such as C, N and P from reaching the stream, and suggested that a coupling of natural systems with managed habitats could reduce the amount of pollution reaching the stream channel.[85]

Table 1. Summary of current status of knowledge of selected wetland functions - hydrology.

Function	Well authenticated	Fairly well authenticated	Poorly authenticated	Existing assessment methods	Remarks
1.Ground water recharge and discharge		Linder and Hubbard 1982	Carter et al. 1978 Reppert et al. 1979 Larson 1981 Adamus 1983	U.S.Army Engineer Div., N.E. 1972 Dee et al. 1973 Larson 1976 Solomon 1977 Galloway 1978 Kibby 1978 US. Soil Conservation Service 1978 Reppert et al. 1979 Schuldiner et al. 1979 Winchester 1979 Adamus 1983	The ground water recharge function of wetlands is by no means clear, but there is good evidence that many wetlands serve as ground water discharge areas. Wetlands perform a flood control function, but techniques for assessing the effectiveness and exact nature of their role have not been developed. There is some disagreement as to the effectiveness of wetlands in stabilization of shorelines, but recent studies indicate that wetland vegetation plays a significant role in dissipating erosion forces.
2.Flood control		Carter et al. 1978 Reppert et al. 1979 Verry and Boelter 1978 Clark and Clark 1979 Larson 1981 Adamus 1983			
3.Shoreline anchoring and dissipation of erosive forces	Carter et al. 1978 Clark and Clark 1979 Reppert et al. 1979 Knutsen et al. in press	Adamus 1983	Tilton et al. 1978 Larson 1981		

Figure 2. Example of state of wetland function understanding in the 1980s (Source: Sather & Smith, 1984)

Advances in geospatial analysis technologies, such as the techniques of *O'Callaghan and Mark* (1984), and later *Tarboton* (1997) and *Seibert and McGlynn* (2007), offered new methods for deriving drainage networks from the Digital Elevation Model (DEM). [86] [87] [88] These terrain analysis techniques have been used to supplement studies such as *Zinko et al.* (2005) and *Jensco et al.* (2011) that combined field observational data with digital terrain analysis to better understand how topography influences vegetation patterns and spatial and temporal sources of streamflow.[89] [90] These advances provided the capacity for much greater insight into the variety of controls on the way water moves throughout a watershed, and ultimately into waters of the United States.

[84] Sather, J. H., & Smith, R. D. (1984). *An overview of major wetland functions and values*. Western Energy and Land Use Team, Division of Biological Services, US FWS, FWS/OBS-84/18. Washington, D.C.
[85] Peterjohn, W. T., & Correll, D. L. (1984). Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest. *Ecology*, *65*(5), 1466-1475.
[86] O'Callaghan, J. F., & Mark, D. M. (1984). The extraction of drainage networks from digital elevation data. *Computer vision, graphics, and image processing*, *28*(3), 323-344.
[87] Tarboton, D. G. (1997). A new method for the determination of flow directions and upslope areas in grid digital elevation models. *Water resources research*, *33*(2), 309-319.
[88] Seibert, J., & McGlynn, B. L. (2007). A new triangular multiple flow direction algorithm for computing upslope areas from gridded digital elevation models. *Water Resources Research*, *43*(4).

[89] Zinko, U., Seibert, J., Dynesius, M., & Nilsson, C. (2005). Plant species numbers predicted by a topography-based groundwater flow index.*Ecosystems*, *8*(4), 430-441.
[90] Jencso, K. G., McGlynn, B. L., Gooseff, M. N., Wondzell, S. M., Bencala, K. E., & Marshall, L. A. (2009). Hydrologic connectivity between landscapes and streams: Transferring reach-and plot-scale understanding to the catchment scale. *Water Resources Research*, *45*(4).

Determining Federal Jurisdiction to Regulate Isolated Wetlands

The 1985 Supreme Court case *United States v. Riverside Bayview Homes, Inc.* brought greater clarity to the extent of the Corps' jurisdiction to regulate navigable waters pursuant to Section 404 of the Clean Water Act. In this case, the Corps brought action to prevent defendant Riverside Corporation from filling wetlands without the permission of the Corps.[91] While the Corps believed the property defendant Riverside Corporation was developing to be an "adjacent wetland" under the definition of the "waters of the United States," Riverside Corporation contended that the 80 acres of low-lying, marshy land near Lake St. Clair, Michigan it was developing did not constitute wetlands under the Corps' regulations and thus did not fall under the Corps' Section 404 jurisdiction.[92]

The Supreme Court unanimously held that: (1) Corps of Engineers regulations extended Corps regulatory authority to wetlands, and (2) Corps definition of waters as including wetlands adjacent to navigable waters, even if not inundated or frequently flooded by the navigable water, was reasonable under the statutory authority.[93] In addition to these holdings, *United States v. Riverside Bayview Homes, Inc.* was significant in that it was the Supreme Court's initial attempt to define the scope of the Corps' regulatory authority under the Clean Water Act[94].

In 1986, the Corps issued a clarification to its jurisdiction by defining the "waters of the United States" to include waters "which are or would be used as habitat by other migratory birds which cross state lines." This regulation promulgated to assert authority over wetlands populated by migratory birds became known as the "Migratory Bird Rule[95]." The issue of whether this was a proper exercise of jurisdiction under the Clean Water Act was challenged fifteen years later in the 2001 Supreme Court case *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers ("SWANCC").*

In the *SWANCC* case, a consortium of suburban Chicago municipalities challenged the Corps' refusal to grant it a Section 404 permit to fill in permanent and seasonal ponds on a 533-acre parcel in Illinois counties Cook and Kane for the development of a solid waste disposal site. The Court ruled that the use of the Migratory Bird Rule to assert jurisdiction exceeded the Corps' authority under Section 404, and that permitting the Corps "to claim federal jurisdiction over ponds and mudflats falling within the Migratory Bird Rule would also result in a significant impingement of the States' traditional and primary power over land and water use."[96] In the judicial opinion, the Court held that the text of the Clean Water Act does not allow for the extension of Corps jurisdiction "to ponds that are *not* adjacent to open water."[97] The significance of this component of the *SWANCC* decision is that this rationale would preclude federal regulation under Section 404 of the

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[91] *United States v. Riverside Bayview Homes, Inc.,* 474 U.S. 121, 106 S.Ct. 455

[92] Trichka, S. J. (1986). Affirmation of Section 404 Jurisdiction over Wetlands: United States v. Riverside Bayview Homes, Inc., An. *Wash. UJ Urb. & Contemp. L., 30,* 257.

[93] *United States v. Riverside Bayview Homes, Inc.,* 474 U.S. 121, 106 S.Ct. 455

[94] Trichka (1986)

[95] Final Rule for Regulatory Programs of the Corps of Engineers; 51 Fed Reg 41,217 (November 13, 1986)

[96] *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers,* 531 U.S. 159 (2001).

[97] *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers,* 531 U.S. 159 (2001).

Clean Water Act over geographically isolated, nonnavigable, intrastate waters, such as wetlands, that are not adjacent to "open water."[98]

By this point in time, scientists are recognizing the dynamic processes that control how and when water reaches streams, and are communicating the importance of areas such as low-lying wetlands and riparian zones that have capacity to buffer and filter water flowing through the landscape and into waters of the United States. At the same time, the Supreme Court is going back and forth trying to interpret Congress' original intent when it enacted the Clean Water Act. The way in which the Supreme Court is reducing protection of parts of the landscape that are likely to be most influential on waters of the United States is indicative of the mismatch between science and policy that continued to persist into the 21st century.

Rapanos v. United States (2006)

In 2006, the issue of "adjacent wetlands" was raised in two Sixth Circuit cases that reached the Supreme Court on appeal, *Rapanos v. United States* and *Carabell v. United States*. The *Rapanos* Sixth Circuit case involved three Michigan wetlands lying near ditches or man-made drains that eventually empty into traditional navigable waters.[99] These wetlands had been backfilled by the *Rapanos* petitioners without a permit. In the *Carabell* Sixth Circuit case, the Carabell petitioners were denied a permit to deposit fill in a wetland that was separated from a drainage ditch by an impermeable berm,[100] Upon reaching the Supreme Court on appeal from the Sixth Circuit, the two cases were consolidated and were jointly referred to as the *Rapanos* case. The Court split 4-1-4 as to whether the Corps had section 404 jurisdiction based on the definition of "waters of the United States."[101]

In the plurality opinion written by Justice Antonin Scalia on behalf of four Justices, Justice Scalia voided the ruling against the plaintiffs, and held that the case should be reconsidered in the lower courts based on the plurality's two-part test for determining when adjacent wetlands qualify as "waters of the United States." The first component of this test is that the wetland be adjacent to relatively permanent, standing or continuously flowing bodies of water, which do not include channels through which water flows intermittently or ephemerally, or channels that periodically provide drainage for rainfall. Secondly, the wetland in question must have a continuous surface connection to that water, such that there is no clear demarcation between "waters" and wetlands. Wetlands with only an intermittent, physically remote hydrologic connection to "waters of the United States" do not meet this criteria.[102]

Although concurring with the plurality's judgement that the ruling be voided and the case be reconsidered in the lower courts, Justice Kennedy provided wrote an alternate standard for when adjacent wetlands qualify as "waters of the United States." Justice Kennedy

[98] Meltz, R, Copeland, C. (2013). The Wetlands Coverage of the Clean Water Act (CWA): Rapanos and Beyond. *Cong. Research Serv., RL33263*
[99] Rapanos v. United States, 547 U.S. 715 (2006)
[100] Rapanos v. United States, 547 U.S. 715 (2006)
[101] Meltz & Copeland (2013)
[102] Rapanos v. United States, 547 U.S. 715 (2006)

held that what is required is a showing of "significant nexus" between the wetlands and traditionally navigable waters. Per Justice Kennedy, a significant nexus exists if the wetlands significantly affect the chemical, physical, and biological integrity of navigable waters. When the wetlands are geographically isolated, or adjacent only to a non-navigable tributary of a navigable water, those wetlands will meet the significant nexus criteria if it can be shown that wetlands significantly affect the chemical, physical, and biological integrity of navigable waters. If the wetlands are directly adjacent to a navigable water, the wetlands would automatically meet the significant nexus requirement based on solely on adjacency.[103]

Finally, four Justices dissented, and held that that the ruling against the Plaintiffs should stand. In an opinion written by Justice John Paul Stevens on behalf of four Justices, the dissenting Justices favored going back to the broader scope of Clean Water Act protection of wetlands as per the ruling in the Riverside Bayview case of 1985. Acknowledging that they case was going to be remanded and that either the plurality test or the Kennedy test was going to be relied upon in the lower federal court, Justice Stevens suggested that lower federal court find Clean Water Act jurisdiction if *either* the plurality test or the Kennedy test were met.[104]

With no single rationale for the courts to take from the *Rapanos* decision and use in future cases, interpretations by the lower courts of the ruling have varied greatly. While both the Corps and EPA have issued guidance in attempts to clarify the interpretation of the Court's rulings, the *Rapanos* decision remains shrouded in controversy and difficult to apply.[105]

[103] Rapanos v. United States, 547 U.S. 715 (2006)
[104] Rapanos v. United States, 547 U.S. 715 (2006)
[105] Meltz & Copeland (2013)

PART II.

INFLUENCE OF SPLIT DECISION ON POST-RAPANOS CASES

Since the June 19, 2006 fractured decision Supreme Court in *Rapanos*, the split-decision has been dealt with in both United States District Courts and United States Circuit Courts in every Federal Judicial Circuit in the country. To date, the case has been cited at least three times in 87 opinions, and has been interpreted in a myriad of different ways.

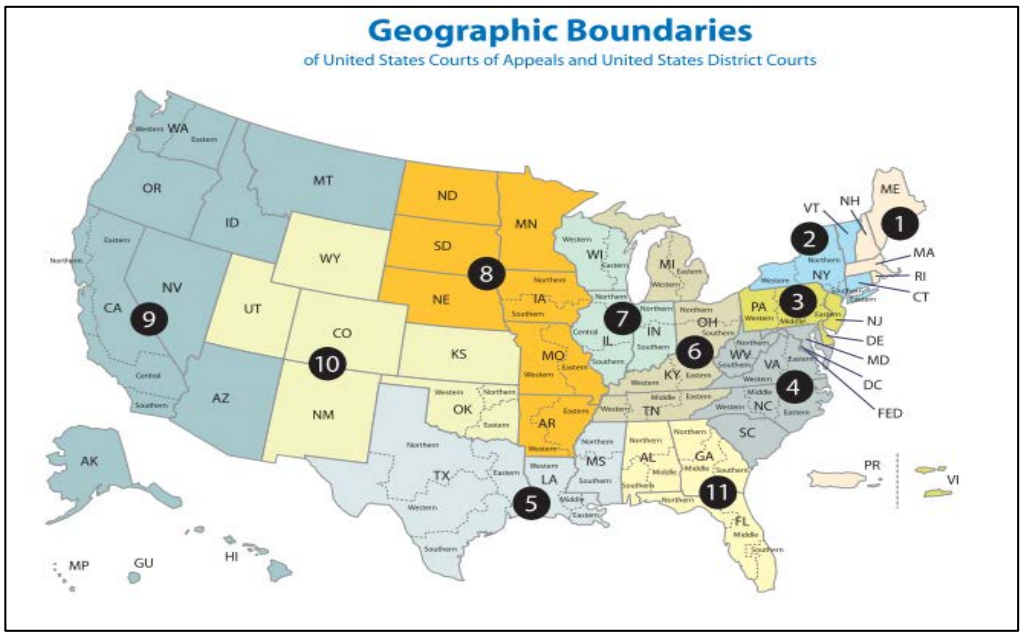

Figure 3. United States District Courts and Circuit (Appellate) Courts
Source: uscourts.gov

Controlling Standard Interpretations in 2006

Fifth Circuit: United States v. Chevron Pipe Line Co.

Less than two weeks after the split-decision in *Rapanos* was issued, the United States District Court for the Northern District of Texas, Lubbock Division became the first district court or circuit court to attempt to interpret *Rapanos* in the case *United States v. Chevron Pipe Line Co.*[106] In this matter, the United States filed suit against defendant Chevron in order to impose civil fines pertaining to a 2000 crude oil spill that reached an intermittent stream near Snyder, Texas. When faced with the possibility of using Justice Kennedy's significant nexus test from *Rapanos* to determine whether the intermittent stream qualified as a jurisdictional water under the Clean Water Act, the *Chevron* Court was puzzled, stating in its June, 2006 opinion: "This test leaves no guidance on how to implement its vague, subjective centerpiece. That is, exactly what is 'significant' and how is a 'nexus' determined?" The Court went on to conclude that "because Justice

[106] United States v. Chevron Pipe Line Co., 437 F. Supp. 2d 605, 63 ERC 1376 (N.D. Tex. 2006)

Kennedy failed to elaborate on the 'significant nexus' required, this Court will look to the prior reasoning in this circuit."[107] This led the Court to the Oil Pollution Act of 1990,[108] under which the Fifth Circuit had interpreted "the waters of the United States" narrowly. Based on the Oil Pollution Act, the Court held that "as a matter of fact of law in this circuit, the connection of generally dry channels and creek beds will not suffice to create a 'significant nexus' to a navigable water simply because one feeds into the next during the rare times of actual flow."[109] Thus, the first Court faced with interpreting the *Rapanos* decision felt that an interpretation was not possible, and simply looked past *Rapanos* in favor of prior caselaw in the circuit.

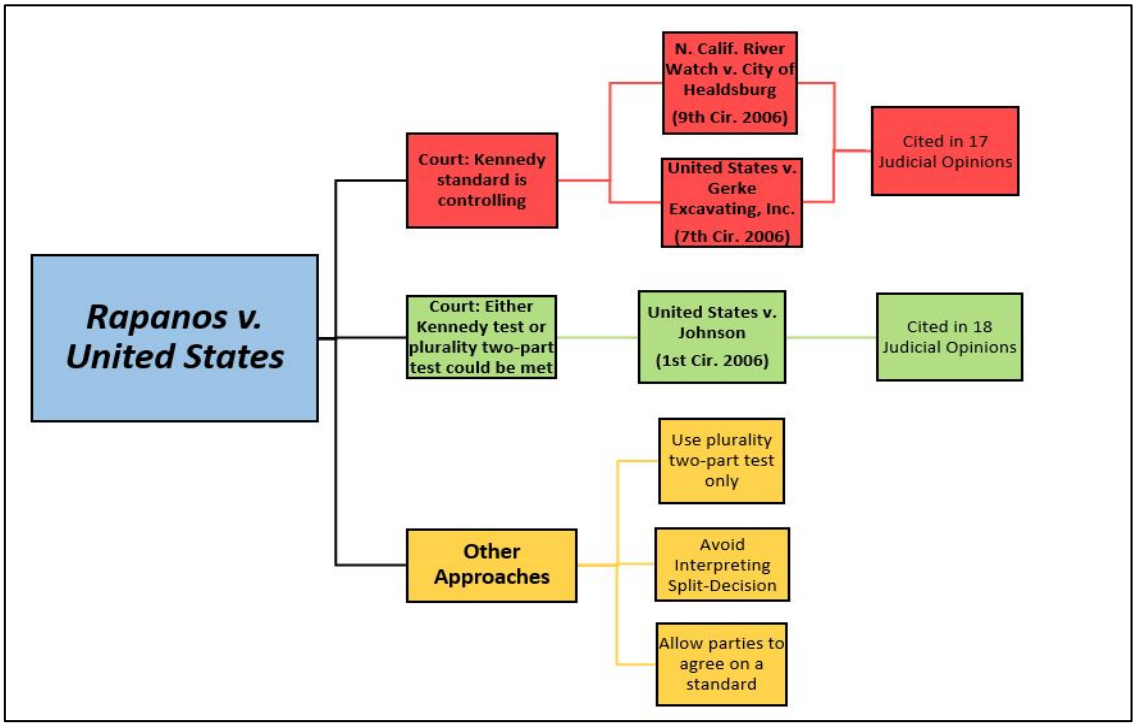

Figure 4. Breakdown of post-*Rapanos* court interpretations

Ninth Circuit: *N. Calif. River Watch v. City of Healdsburg*

The United States Court of Appeals, Ninth Circuit was the first court to take an influential position on the *Rapanos* in its August, 2006 opinion for the case *N. Calif. River Watch v. City of Healdsburg.*[110] Here, the circuit judges found Justice Kennedy's "significant nexus" rule to be controlling, on the basis that his vote constituted the fifth vote for reversal in the 4-1-4 split decision, and because he concurred only in the judgment.[111] The Ninth Circuit was the first court to reference the case *Marks v. United*

[107] United States v. Chevron Pipe Line Co., 437 F. Supp. 2d 605, 613 (N.D. Tex. 2006)
[108] U.S. Code, 33 U.S.C. § 2701. Definitions
[109] United States v. Chevron Pipe Line Co., 437 F. Supp. 2d 605, 613 (N.D. Tex. 2006)
[110] N. Calif. River Watch v. City of Healdsburg, 457 F.3d 1023, 62 ERC 2089 (9th Cir. 2006)
[111] N. Calif. River Watch v. City of Healdsburg, 457 F.3d 1023, 1030 (9th Cir. 2006)

States,[112] a widely cited Supreme Court case which provided a formula for interpreting fragmented decision. According to the *Marks* rule, "[w]hen a fragmented Court decides a case and no single rationale explaining the result enjoys the assent of five Justices, the holding of the Court may be viewed as that position taken by those Members who concurred in the judgments on the narrowest grounds." Finding Justice Kennedy's view to be the narrowest, the Ninth Circuit deemed Justice Kennedy's opinion to be controlling, stating that "to qualify as a navigable water under the CWA the body of water itself need not be continuously flowing, but that there must be a 'significant nexus' to a waterway that is in fact navigable." Using the Kennedy standard, the Ninth Circuit found that the hydrologic feature in question fell under Clean Water Act jurisdiction based solely on the fact that it is adjacent a navigable river of the United States. [113]

Seventh Circuit: *United States v. Gerke Excavating, Inc.*

Approximately one month later, the United States Court of Appeals, Seventh Circuit provided further support for the application of the *Marks* rule in the context of the *Rapanos* split-decision in its opinion for the case *United States v. Gerke Excavating, Inc.*[114] The Seventh Circuit provided a more extensive and persuasive argument as to why the lower courts ought to use the *Marks* rule as guidance. The Seventh Circuit held that "[w]hen a majority of the Supreme Court agrees only on the outcome of a case and not on the ground for that outcome, lower-court judges are to follow the narrowest ground to which a majority of the Justices would have assented if forced to choose." While acknowledging that there could be a rare case where Kennedy would vote against federal authority, only to be outvoted 8-1 by the plurality and dissenting Justices, the Seventh Circuit held that "as a practical matter the Kennedy concurrence is the least common denominator." By acknowledging that this interpretation was not completely airtight, but instead "a practical matter," Seventh Circuit made clear that its interpretation of *Rapanos* was intended for its case and that the possibility that the plurality's test may be appropriate when a "rare case" exists[115].

[112] Marks v. United States, 430 U.S. 188, 97 S. Ct. 990, 51 L. Ed. 2d 260, 2 Med. L. Rptr. 1401 (1977)
[113] N. Calif. River Watch v. City of Healdsburg, 457 F.3d 1023, 1025-1033 (9th Cir. 2006)
[114] United States v. Gerke Excavating, Inc., 464 F.3d 723, 63 ERC 1351 (7th Cir. 2006)
[115] United States v. Gerke Excavating, Inc., 464 F.3d 723, 725 (7th Cir. 2006)

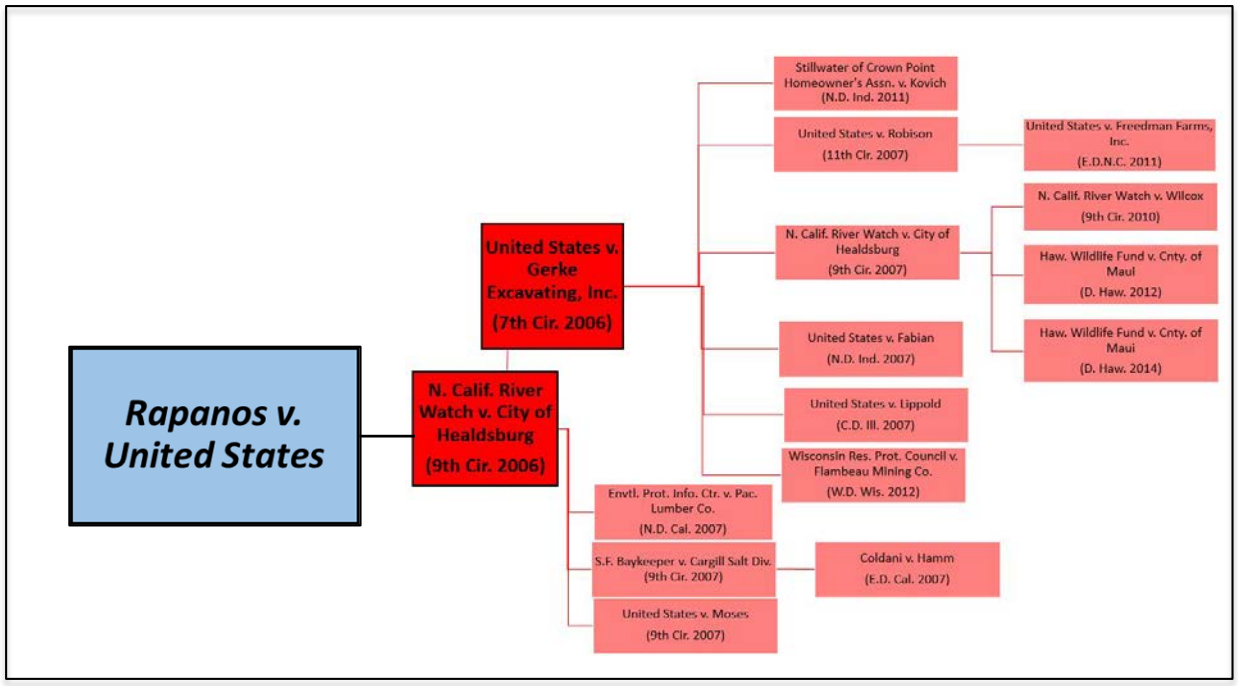

Figure 5. The position held by the Ninth and Seventh Circuits was influential, and to date has been followed in a total of 16 Federal *District Court* and *Circuit Court* judicial opinions.

First Circuit: *United States v. Johnson*

The United States Court of Appeals, First Circuit took a differing approach in interpreting *Rapanos* in its October, 2006 opinion for the case *United States vs. Johnson*[116]. The *Johnson* case, which involved a civil action filed by the United States alleging that a group of cranberry farmers in Massachusetts had violated the Clean Water Act by discharging pollutants, was remanded by the circuit court so that the new legal standards developed in *Rapanos* could be applied. However, the First Circuit court provided explicit instructions for the district court on how to interpret *Rapanos*, which came to be very influential in subsequent Clean Water Act cases. The *Johnson* majority questioned the suitability of the *Marks* rule for interpretation of the *Rapanos* decision on the grounds that several members of the Supreme Court have actually moved away from using *Marks* to derive a controlling opinion from a fragmented decision, and have instead "indicated that whenever a decision is fragmented such that no single opinion has the support of five Justices, lower courts should examine the plurality, concurring and dissenting opinions to extract the principles that a majority has embraced." Furthermore, the *Johnson* majority did not find the Kennedy standard to be a logical subset of the plurality's standard, thus meaning that the *Marks* rule does not translate well to interpretation of *Rapanos*.[117]

As an alternative approach to using the *Marks* to derive a controlling opinion, the *Johnson* majority found the approach suggested by Justice John Paul Stevens in his dissenting opinion to be most logical. Under the Stevens approach, satisfaction of either the Kennedy test or the plurality's test would be sufficient to confer Clean Water Act

[116] United States v. Johnson, 467 F.3d 56, 63 ERC 1289 (1st Cir. 2006)
[117] United States v. Johnson, 467 F.3d 56, 57-64 (1st Cir. 2006)

jurisdiction. The *Johnson* majority championed the fact that Justice Stevens recognized the possibility that the plurality might find jurisdiction in some cases where Justice Kennedy does not.[118] The fact that this situation was written off by the *Gerke* court as "a rare case" and was not otherwise addressed was considered by the *Johnson* court to be a demonstration of the shortcomings in applying the *Marks* rule to *Rapanos.* The *Johnson* majority acknowledged the existence of caselaw at odds with combining a dissent and a concurrence to form a *Marks* majority. However, the *Johnson* majority felt comfortable with its approach based on the fact, in its view, several post-*Marks* cases had examined dissenting opinions along with plurality and concurring opinions, and that the Supreme Court had moved away from the *Marks* formula.[119]

Notably, one judge in the *Johnson* panel authored a partial dissent, criticizing Justice Kennedy's "seemingly opaque 'significant nexus' test" for "[leaving] the door open to continued federal overreach." Accordingly, this dissenting judge favored the plurality's standard, which he held "strikes a constitutional balance between federal and state regulatory interests, and our nation's interest in clean water and the individual land owner's right to manage their property in accordance with their dreams and aspirations, whether economic or otherwise."[120] While this dissenting opinion did not carry any weight in the *Johnson* case, it demonstrated yet another distinct interpretation of *Rapanos* at the circuit level.

[118] United States v. Johnson, 467 F.3d 56, 62-66 (1st Cir. 2006)
[119] United States v. Johnson, 467 F.3d 56, 63-66 (1st Cir. 2006)
[120] United States v. Johnson, 467 F.3d 56, 67 (1st Cir. 2006)

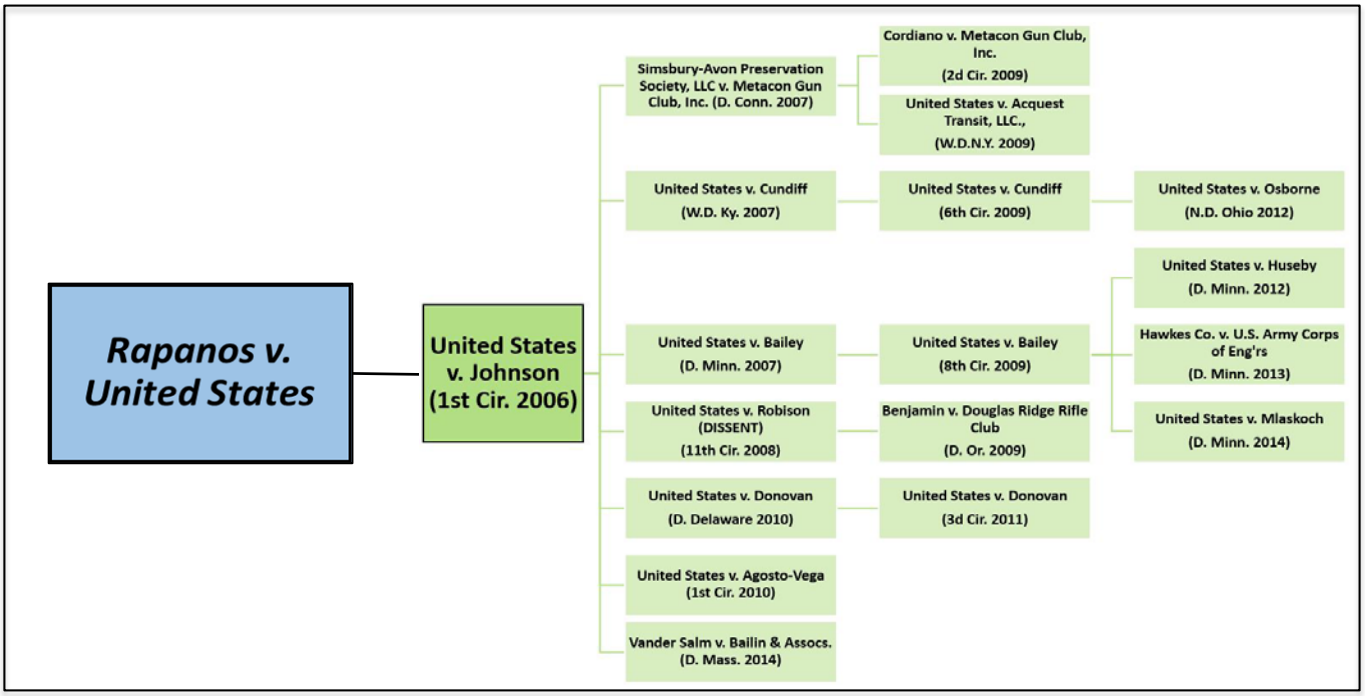

Figure 6. The position held by the First Circuits was also very influential, and to date has been followed in a total of 18 Federal *District Court* and *Circuit Court* judicial opinions.

Subsequent Activity within Five Years of *Rapanos*

In just a few short months, the First Circuit, Seventh Circuit, and Ninth Circuit had made what would become three of the most influential interpretations of *Rapanos* in the *Johnson*, *Gerke* and *Healdsburg* cases. The strategy taken by the Fifth Circuit in the United States v. Chevron Pipe Line Co. to look past *Rapanos* for guidance from previously existing caselaw was not taken up again.

Ninth Circuit Activity in 2007

Subsequent litigation in 2007 at the district and appellate level in the Ninth Circuits showed strong deference to the position taken by the *Healdsburg* court, which favored the Kennedy standard. Opinions both reinforced the reasoning used by the *Healdsburg* court, and offered small deviations.

In a January, 2007 opinion written by Judge Marilyn H. Patel of the United States District Court for the Northern District California for the case *Envtl. Prot. Info. Ctr. v. Pac. Lumber Co.,*[121] the judge followed the Ninth Circuit in the *Healdsburg* case and cited Justice Kennedy's standard as controlling. Judge Patel made explicitly clear that Justice Scalia's plurality opinion is not adopted by the Ninth Circuit[122].

[121] Envtl. Prot. Info. Ctr. v. Pac. Lumber Co., 469 F. Supp. 2d 803, 64 ERC 1880 (N.D. Cal. 2007)
[122] Envtl. Prot. Info. Ctr. v. Pac. Lumber Co., 469 F. Supp. 2d 803, 823-824 (N.D. Cal. 2007)

While the Ninth Circuit appellate court maintained the position it took in the *Healdsburg* case in a March, 2007 opinion written for the case *S.F. Baykeeper v. Cargill Salt*[123], it also developed a novel interpretation of the Kennedy standard. In this case, plaintiff San Francisco Baykeeper and Citizens Committee to Complete the Refuge (collectively "Baykeeper) filed a citizen suit alleging that defendant Cargill Salt violated the Clean Water Act by discharging pollutants into "water of the United States" without a permit. After summary judgment was granted in favor of Baykeeper at the district court level, defendant Cargill Salt brought the case on appeal. The hydrologic feature at issue in this case was a non-navigable, intrastate pond ("the Pond") that was not determined to be a wetland. The district court granted summary judgment on the grounds that "the Pond" is adjacent to a jurisdictional water of the United States called Mowry Slough. On appeal, the circuit judges reversed the decision, holding that conferring jurisdictional based on adjacency alone does not apply when the hydrologic feature in question is not a wetland[124]. The court stated:

> No Justice, even in dictum, addressed the question whether all waterbodies with a significant nexus to navigable waters are covered by the Act…. Nothing in Bayview, SWANCC, or Rapanos requires or supports the view that Cargill's Pond is a water of the United States because it is adjacent to Mowry Slough[125].

Thus, while adopting the Kennedy test as the controlling standard from *Rapanos*, the Ninth Circuit in the *S.F. Baykeeper v. Cargill Salt* case placed a new limitation on the extent of the Kennedy standard.

Just a few months later, the Ninth Circuit was again tasked with determining the extent of the Kennedy standard in *United States v. Moses.*[126] After reaffirming its stance from the *Healdsburg* case on the controlling standard, the *Moses* court was faced with determining whether a "seasonally intermittent" stream could be jurisdictional under *Rapanos*. Based on the *Moses* court's interpretation of *Rapanos*, "the Supreme Court unanimously agreed to that intermittent streams (at least those that are seasonal) can be waters of the United States."[127] While stopping short of unequivocally extending jurisdiction to all intermittent streams under *Rapanos*, the *Moses* court was comfortable holding that "seasonally intermittent" streams can be waters of the United States.

In August 2007, the Ninth Circuit revisited its 2006 opinion in *N. Calif. River Watch v. City of Healdsburg* in order to clarify its interpretation of *Rapanos*, and the grounds on which it found Clean Water Act jurisdiction in the case. The Ninth Circuit withdrew its 2006 opinion, and filed a new opinion in its place. First, the Ninth Circuit cited the Seventh Circuit in the *Gerke* case for providing a persuasive argument to support the use of the *Marks* rule to derive a controlling opinion in Rapanos. However, the primary motivation for the revised opinion was for the Ninth Circuit to clarify its stance in light of the position it took in *S.F. Baykeeper v. Cargill Salt*, where the Ninth Circuit determined

[123] S.F. Baykeeper v. Cargill Salt Div., 481 F.3d 700, 64 ERC 1109 (9th Cir. 2007)
[124] S.F. Baykeeper v. Cargill Salt Div., 481 F.3d 700, 701 (9th Cir. 2007)
[125] S.F. Baykeeper v. Cargill Salt Div., 481 F.3d 700, 706 (9th Cir. 2007)
[126] United States v. Moses, 496 F.3d 984, 64 ERC 1993 (9th Cir. 2007)
[127] United States v. Moses, 496 F.3d 984, 989-991, 2007 BL 75397 (9th Cir. 2007)

that an isolated pond at issue fell outside of Clean Water Act jurisdiction based on Justice Kennedy's adjacency standard because it was not considered an isolated wetland. In the revised *N. Calif. River Watch v. City of Healdsburg* opinion, the Ninth Circuit made the distinction between the pond in the *Healdsburg* case and the pond in the *Baykeeper* case, noting that the pond in the *Healdsburg* case was not isolated because it contained and was surrounded by wetlands. Thus, the Kennedy test was rightfully applied to pond. Notably, the Ninth Circuit specified that "Justice Kennedy's concurrence provides the controlling rule of law for our case." In noting that the Kennedy standard was the controlling rule of law for *its case*, the Ninth Circuit did not discount the possibility that a different interpretation of *Rapanos* might be suitable for other cases, an anecdote that would be picked up on in future Clean Water Act matters. [128]

A final significant Ninth Circuit opinion written in 2007 was penned by District Judge Ralph Beistline in the case *Coldani v. Hamm*[129]. In this case filed in the United States District Court for the Eastern District of California, property owner Raymond Coldani brought a Clean Water Act citizen suit against an adjacent farm, claiming that polluted groundwater from the farm migrates onto his property and into a jurisdictional water. Judge Beistline deferred to the Ninth Circuit's position taken in *Baykeeper* and *Healdsburg* and considered Justice Kennedy's concurrence to be the controlling standard in his court. In *Coldani v. Hamm*, Judge Beistline was required to determine if discharge of pollutants into groundwater which reach navigable waters could fall under Clean Water Act jurisdiction. While acknowledging that an abundance of caselaw exists holding that the Clean Water Act does not regulate discharges into groundwater, regardless of if the groundwater is hydrologically connected to surface water, Judge Beistline did not find this reasoning consistent with the objectives and of the Clean Water Act[130]. In explaining his position, Judge Beistline held:

> The court is not convinced that precluding such circumstances from the regulatory purview of the CWA serves Congress' declared goal "to restore and maintain the chemical, physical and biological integrity of the Nation's waters. Nor is the court convinced that precluding such circumstances squares with the broad construction given to "waters of the United States"[131]

Judge Beistline's position in *Coldani v. Hamm* represented yet another more specific, novel interpretation of *Rapanos* through the lens of the Kennedy standard.

Courts Following *Johnson* Interpretation

In 2007, the First Circuit's position in *Johnson* was followed by federal district courts covering the Second Circuit, Sixth Circuit and Eighth Circuit in the cases *Simsbury-Avon Preservation Society, LLC v. Metacon Gun Club, Inc.*,[132] *United States v. Cundiff*[133] and

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[128] N. Calif. River Watch v. City of Healdsburg, 496 F.3d 993, 994-1003, 2007 BL 71985 (9th Cir. 2007)
[129] Coldani v. Hamm, No. Civ. S-07-660 RRB EFB, 2007 BL 80755, 66 ERC 1069 (E.D. Cal. Aug. 14, 2007)
[130] Coldani v. Hamm, 2007 BL 80755, 1-11 (E.D. Cal. Aug. 14, 2007)
[131] Coldani v. Hamm, 2007 BL 80755, 7-8 (E.D. Cal. Aug. 14, 2007)
[132] Simsbury-Avon Preservation Society, LLC v. Metacon Gun Club, Inc., 472 F. Supp. 2d 219, 64 ERC 2081 (D. Conn. 2007)
[133] United States v. Cundiff, 480 F. Supp. 2d 940, 65 ERC 1346 (W.D. Ky. 2007)

United States v. Bailey[134], respectively. In *Cundiff*, the United States District Court for the Western District of Kentucky became one of the first courts to provide indicia for what constitutes a significant nexus. The *Cundiff* court found that a significant nexus existed between the wetlands in question in the case and a navigable water based on testimony of experts, who testified that that the wetlands perform significant ecological functions that enhance the physical, chemical and biological integrity of navigable waters. These functions included both temporary and long-term water storage, filtering of the acid mine runoff and sediment, and providing habitat for wetland plants and wildlife species. The experts went on to describe how the diminished water storage capacity caused by the defendant's degradation of the wetlands affects the frequency of downstream flooding, which in turn "impact[s] navigation, crop production in bottomlands, downstream bank erosion and sedimentation."[135] This provided a potential roadmap that could be referenced used in future litigation to determine what is required for a significant nexus to exist.

Courts Following the *Healdsburg* & *Gerke* Interpretations

In the Seventh Circuit, two judicial opinions pertaining to the Clean Water Act, Section 404 were written for the district court cases *United States v. Fabian*[136] and *United States v. Lippold.*[137] In both cases, the district court judges followed the Seventh Circuit's reading of *Rapanos* in the *Gerke* case and took the Kennedy standard to be controlling. Both courts were faced with determining how to apply the Kennedy standard based on the conditions of their respective cases.

In *United States v. Fabian*, the United States filed suit against defendant Rowland Fabian for activities on what the United States claimed were wetlands adjacent to a navigable waters. Since the alleged wetlands had been altered by the defendant, the United States relied on before-and-after wetland delineations and aerial photography to support its argument that the disputed area is a wetland. District Court Judge Rodolfo Lozano found this evidence to be satisfactory, especially in light of the fact that the defendant did not provide an expert opinion to refute the evidence. Based on adjacency alone, Judge Lozano found the wetlands in the *Fabian* case to be jurisdictional. Notably, the plurality would not have arrived at the same determination because there was no surface water connection between the wetlands and the river.[138]

In *United States v. Lippold*, District Judge Jeannie E. Scott was confronted with determining whether an intermittent stream could be regulated under the Clean Water Act. While Judge Scott stated that "Justice Kennedy's opinion suggests that all intermittent streams flowing into navigable-in-fact waters may possess a significant nexus to those navigable waters," she noted that Justice Kennedy did not explicitly hold that an intermittent stream is covered under the Clean Water Act.[139] Thus, an intermittent stream would not be regulated automatically, and regulation would be subject to the

[134] United States v. Bailey, 516 F. Supp. 2d 998 (D. Minn. 2007)
[135] United States v. Cundiff, 480 F. Supp.2d 940, 942-945 (W.D. Ky. 2007)
[136] United States v. Fabian, 522 F. Supp. 2d 1078, 65 ERC 1303 (N.D. Ind. 2007)
[137] United States v. Lippold, No. 06-30002, 2007 BL 138888, 66 ERC 1532 (C.D. Ill. Oct. 30, 2007)
[138] United States v. Fabian, 522 F. Supp. 2d 1078, 1079-1101, 2007 BL 192728, 2-23 (N.D. Ind. 2007)
[139] United States v. Lippold, 2007 BL 138888, 2-6 (C.D. Ill. Oct. 30, 2007)

government proving that the stream possess a significant nexus to a jurisdictional water. While the *Lippold* court was one of the initial post-*Rapanos* courts to wrangle with the issue of regulating intermittent or ephemeral streams, the issue continues to be subject to divergent opinions since the language in *Rapanos* simply does not provide enough clarity for a consensus to be reached on the issue.

The Eleventh Circuit also came to support the use of the Kennedy standard in 2007 after it was required to take a stance on the issue in the case *United States v. Robison.*[140] In its opinion, the Eleventh Circuit not only found the Kennedy standard to be controlling based on the Marks case, but argued that Marks would absolutely not allow for a dissenting opinion to be considered as the controlling opinion in a case. According to the Eleventh Circuit, "Marks does *not* direct lower courts interpreting fractured Supreme Court decisions to consider the positions of those who dissented."[141] Since the approach used in the *Johnson* case is the approach outlined by Justice Stevens' in his dissenting opinion, the Eleventh Circuit held that allowing satisfaction of the either the Kennedy standard or the plurality standard to determine Clean Water Act jurisdiction is an invalid approach, effectively leveling a strong counterargument against the position taken up by the First Circuit in *Johnson.*[142]

Other Notable *Rapanos* Interpretations

In 2008, the Fifth Circuit introduced a novel way to deal with interpreting *Rapanos* in its opinion for the case *United States v. Lucas*.[143] In this matter, the Fifth Circuit presented the tests that the plurality, Justice Kennedy, and the dissenting Justices would use to determine if the wetland in question falls under Clean Water Act jurisdiction. However, the Fifth Circuit did do as many courts had done to date and simply reference the dissent's suggestion for the lower federal court with regard to how to interpret the split-decision, which was that it should find Clean Water Act jurisdiction if *either* the plurality test or the Kennedy test were met. Instead, the Fifth Circuit paid greater attention to the true focal point of Justice Stevens' dissenting opinion, which was that *United States v. Riverside Bayview Homes, Inc.* controls the definition of waters of the United States, and that the Supreme Court should defer to the Corps to determine when "adjacent wetlands" are jurisdictional based on if they would "advance the congressional concern for protection of water quality and aquatic ecosystems."[144]

Before weighing the merits of the three aforementioned *Rapanos* standards, the Fifth Circuit determined that the evidence presented at trial, which included evidence that the wetlands in question control flooding in the area and prevent pollution in downstream navigable waters, sufficiently supported the all three standards. Thus, the Fifth Circuit was able to determine Clean Water Act jurisdiction without having to interpret the split-decision. [145]

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[140] United States v. Robison, 505 F.3d 1208, 65 ERC 1385 (11th Cir. 2007)
[141] United States v. Robison, 505 F.3d 1208, 1221, 2007 BL 133603, 11 (11th Cir. 2007)
[142] United States v. Robison, 505 F.3d 1208, 1220-1221, 2007 BL 133603, 10-11 (11th Cir. 2007)
[143] United States v. Lucas, 516 F.3d 316, 66 ERC 1778 (5th Cir. 2008)
[144] United States v. Lucas, 516 F.3d 316, 326-327, 2008 BL 21146, 5-6 (5th Cir. 2008)
[145] United States v. Lucas, 516 F.3d 316, 326-327, 2008 BL 21146, 5-6 (5th Cir. 2008

Another notable case in 2008 was the case *Sierra Club v. Honolulu,*[146] in which the United States District Court, District of Hawaii deviated from the existing Ninth Circuit precedent in its interpretation of the *Rapanos* split-decision. In this matter, District Judge David A. Ezra held that Justice Kennedy's significant nexus test was "irrelevant and inapplicable" since there were not isolated wetlands at issue in the case, and instead opted to evaluate the merits of the case using the plurality's standard.[147] By making an interpretation that that was seemingly at odds with the Ninth Circuit's holding from *Healdsburg* that the Kennedy standard was controlling, District Judge Ezra showed that District Courts were not afraid to break with precedent set by the governing Circuit Court if it saw fit.

In late 2008, the previously referenced District Court case *United States v. Cundiff* reached the Sixth Circuit on appeal from the Western District of Kentucky. In an opinion filed in February 2009, the Sixth Circuit built on the clarifications that the District Court had offered with regard to what is required for establishment of a significant nexus.[148] The Sixth Circuit supported the indicia used by the District Court, which included expert testimony that cited examples of the ecological functions the wetlands performed to enhance the physical, chemical and biological integrity of navigable waters, and how the wetland filling activities would cause "direct and significant impacts to navigation" and aquatic food webs. Additionally, the Sixth Circuit built on this criteria by holding that a quantitative laboratory analysis is not necessary to show a significant nexus between a wetland and navigable waters. Thus, an analysis based on qualitative physical evidence could be sufficient, and a party to a case could not claim that lack of quantitative evidence from a laboratory analysis is grounds for a favorable ruling.[149]

In an opinion written by for the case *Benjamin v. Douglas Ridge Rifle Club*,[150] U.S. District Judge Ancer L. Haggerty became yet another District Court judge within the Ninth Circuit that broke with the position established by the governing court of appeals in the *Healdsburg* case. In this case, which was venued in the U.S. District Court for the District of Oregon, District Judge Haggerty invoked reasoning similar to that used in the *Sierra Club v. Honolulu* case and held that Justice Kennedy's significant nexus test was not pertinent to his case because the significant nexus test is only meant to determine jurisdictionality of wetlands to waters of the United States. Since the *Benjamin v. Douglas Ridge Rifle Club* case involved of a tributary to a navigable water, and not a wetland, District Judge Haggerty held that Justice Kennedy's test was inapplicable to the case. The judge felt he had grounds to take a divergent position since the Ninth Circuit had indicated in its amended opinion in *City of Healdsburg* that the ruling was meant to be limited to the facts before them in *City of Healdsburg*, and thus should not necessarily be taken as the governing interpretation of *Rapanos* for the Ninth Circuit. [151]

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146 Sierra Club v. Honolulu, CV.NO. 04-00463 DAE-BMK., 2008 BL 195986, 68 ERC 1592 (D. Haw. Aug. 18, 2008)
147 Sierra Club v. Honolulu, 2008 BL 195986, 2-8 (D. Haw. Aug. 18, 2008)
148 United States v. Cundiff, 480 F. Supp. 2d 940, 65 ERC 1346 (W.D. Ky. 2007)
149 United States v. Cundiff, 555 F.3d 200, 201-211, 2009 BL 20250, 2-9 (6th Cir. 2009)
150 Benjamin v. Douglas Ridge Rifle Club, 673 F. Supp. 2d 1210, 71 ERC 1441 (D. Or. 2009)
151 Benjamin v. Douglas Ridge Rifle Club, 673 F. Supp.2d 1210, 1212-1223, 2009 BL 257737, 2-12 (D. Or. 2009)

Although the significant nexus test was not used in *Benjamin v. Douglas Ridge Rifle Club*, District Judge Haggerty provided an interpretation of the significant nexus test such that a demonstration of significant chemical, physical, *or* biological connection should satisfy Justice Kennedy's test. The judge felt that a strict requirement of all three components was "incongruous with the Act's objectives," and that it was more importance to place the greatest emphasis on the *significance* of the nexus, not merely the existence of all three components referenced in Justice Kennedy's concurrence.[152] Despite the fact that ten judicial opinions had been written in cases governed by the Ninth Circuit by the end of 2009, the Circuit remained without a broadly accepted standard more than three years after *Rapanos*.

In 2010, an opinion written by the U.S. District Court for the District of Columbia marked the first time a court within the D.C. Circuit was faced with interpreting the *Rapanos* split-decision. In the case, *National Association of Home Builders v. U.S. Army Corps of Engineers*,[153] District Judge Ricardo M. Urbina simply acknowledged the existence of the plurality opinion and Justice Kennedy's concurring opinion, and chose to evaluate the facts of the case in the context of the plurality test without explicitly explaining why that test was preferred over the Kennedy test. Due to what was at issue in the case, District Judge Urbina was required to determine whether a point source, such as a ditch, could qualify as a navigable water under the Clean Water Act. Judge Urbina concluded that the *Rapanos* "plurality opinion did not establish that that the terms 'point source' and 'navigable waters' are always mutually exclusive," thus meaning that a point source could qualify as a navigable water under the Clean Water Act.[154] This case exemplified well how seemingly minor differences in interpretations of language in *Rapanos*, such as "and" versus "or," could significant affect the extent of federal regulatory authority under the Clean Water Act.

Another novel perspective with regard to dealing with the *Rapanos* split-decision was taken by the Third Circuit in the 2011 case *United States v. Donovan*.[155] In its opinion for the case, the Third Circuit cited the fact that the four dissenting *Rapanos* Justices endorsed both the plurality and Justice Kennedy standards, and reasoned that this meant that both the plurality standard and Kennedy standard would independently enjoy the support of at least five of the nine Supreme Court Justices. Thus, the use of either standard is valid according to this logic.[156]

Five Years After *Rapanos*: Divergent Applications

By the five year anniversary of the *Rapanos* split-decision in mid-2011, all eleven Federal Circuits had had seen at least one case involving post-*Rapanos* Clean Water Act jurisdiction at either the District Court level or Circuit Court level. While the most influential stances on the *Rapanos* controlling opinion had already been established by this point, such as the Ninth Circuit and Seventh Circuit positions taken in the *City of*

[152] Benjamin v. Douglas Ridge Rifle Club, 673 F. Supp.2d 1210, 1223, 2009 BL 257737, 12 (D. Or. 2009)
[153] N.A. of Home Builders v. U.S. Army Corps of Eng'rs, 699 F. Supp. 2d 209, 211, 2010 BL 69140 (D.D.C. 2010)
[154] N.A. of Home Builders v. U.S. Army Corps of Eng'rs, 699 F. Supp. 2d 209, 211-217, 2010 BL 69140, 2-6 (D.D.C. 2010)
[155] United States v. Donovan, 661 F.3d 174, 73 ERC 1545 (3d Cir. 2011)
[156] United States v. Donovan, 661 F.3d 174, 189, 2011 BL 279526, 14 (3d Cir. 2011)

Healdsburg and *Gerke* cases, respectively, and the First Circuit position taken in the *Johnson* case, the courts continued to come out with a variety of divergent interpretations and applications of *Rapanos* as they dealt with contentious case-specific issues.

One such issue was the question of whether the significant nexus test applies to tributaries, or if it was meant only for wetlands, as in the *Rapanos* case. District Courts in South Carolina (in *Deerfield Plantation Phase II-B Prop. Owners Assn. v. U.S. Army Corps of Engineers*[157]) and Wisconsin (in *Wisconsin Res. Prot. Council v. Flambeau Mining Co.* [158]), and Circuit Courts such as the Eleventh Circuit (in *United States v. Robison*[159]) supported the application of the significant nexus test to tributaries. In these cases, metrics such as evidence of contribution of flow to navigable waters, pollutant transport downstream, and aquatic habitat for species were used to determine if a significant nexus between a tributary and navigable waters existed.[160] [161] Several courts took opposing positions, such as District Courts in Hawaii (in *Sierra Club v. Honolulu*[162]) and Oregon (in *Benjamin v. Douglas Ridge Rifle Club*[163]), and held that the significant nexus test was only applicable to cases involving wetlands.

Similarly, the jurisdictionality of streams that do not flow permanently throughout the year under *Rapanos* proved to be a contentious issue that generated a great amount of division among courts. The focus of this debate was centered on ephemeral streams, which are hydrologic features that only flow in direct response to precipitation, and intermittent streams, which are features that have well-defined channels that contain water for part of the year.[164] While courts such as the U.S. District Court for the District of Wyoming in the case *United States v. Hamilton*[165] relied on a strict reading of the plurality test and opined that intermittent or ephemeral channels are not covered under the Clean Water Act, other courts felt they were could interpret the *Rapanos* split-decision such that it could be more inclusive of non-perennial streams.[166] Such courts include the U.S. District Court for the District of Idaho in the case *United States v. Vierstra*,[167] which determined that a channel that flows for six to eight months a year can meet both the "relatively permanent" standard of the plurality test and Justice Kennedy's significant nexus test.[168] By applying the plurality standard "in light of common sense," the U.S. District Court for the Southern District of Texas determined that a hydrologic feature at issue in the case *United States v. Brink*[169] was "not simply an 'intermittent' and

[157] Deerfield Plantation Phase II-B Prop. Owners Assn. v. U.S. Army Corps of Engineers, 801 F. Supp. 2d 446, 74 ERC 1435 (D.S.C. 2011)
[158] Wisconsin Res. Prot. Council v. Flambeau Mining Co., 903 F. Supp. 2d 690 (W.D. Wis. 2012)
[159] United States v. Robison, 505 F.3d 1208, 65 ERC 1385 (11th Cir. 2007)
[160] Wisconsin Res. Prot. Council v. Flambeau Mining Co., 903 F. Supp. 2d 690, 715 (W.D. Wis. 2012)
[161] Deerfield Plantation Phase II-B Prop. Owners Assn. v. U.S. Army Corps of Engineers, 801 F. Supp. 2d 446, 465, 2011 BL 196547, 16 (D.S.C. 2011)
[162] Sierra Club v. Honolulu, CV.NO. 04-00463 DAE-BMK., 2008 BL 195986, 68 ERC 1592 (D. Haw. Aug. 18, 2008)
[163] Benjamin v. Douglas Ridge Rifle Club, 673 F. Supp. 2d 1210, 71 ERC 1441 (D. Or. 2009)
[164] N.C. Department of Environment and Natural Resources. 2015. *Water Resources- Frequently Asked Questions*. Accessed April 1, 2015. http://portal.ncdenr.org/web/wq/swp/ws/401/waterresources/faqs.
[165] United States v. Hamilton, 952 F. Supp. 2d 1271 (D. Wyo. 2013)
[166] United States v. Hamilton, 952 F. Supp. 2d 1271, 1274 (D. Wyo. 2013)
[167] United States v. Vierstra, 803 F. Supp. 2d 1166, 73 ERC 1566 (D. Idaho 2011)
[168] United States v. Vierstra, 803 F. Supp. 2d 1166, 1167-1172, 2011 BL 332135, 2-6 (D. Idaho 2011)
[169] United States v. Brink, 795 F. Supp. 2d 565, 74 ERC 1081 (S.D. Tex. 2011)

'ephemeral' waterway," but qualified as a "seasonal" creek that would fall under Clean Water Act jurisdiction.[170] In the case *United States v. Moses*,[171] the Ninth Circuit held that the plurality's requirement of permanent standing water or continuous flow made "little practical sense in a statute concerned with downstream water quality" since the plurality "seems to presume that such irregular flows are too insignificant to be of concern." Looking instead to Justice Kennedy's standard, the Ninth Circuit held that non-navigable, intermittent streams can qualify as waters of the United States if it contains a significant nexus with navigable waters, and deemed a channel that contained flow for only two months during the year to fall under Clean Water Act jurisdiction.[172] With regard to jurisdiction over non-perennial hydrologic features, the fact that the metrics provided in *Rapanos* were based on subjective language such as "relatively permanent" and "seasonal" allowed for a wide diversity of interpretation as to what waters are covered under the Clean Water Act.

Similar disagreement amongst the courts was seen in cases concerning Clean Water Act coverage of groundwater pollution that reaches navigable waters. Courts such as the U.S. District Court for the District of Hawaii, in the case *Sierra Club v. Honolulu*,[173] and the U.S. District Court for the Eastern District of Pennsylvania, in the case *Tri-Realty Co. v. Ursinus Coll.* did not support Clean Water Act coverage of pollution into groundwater that ultimately impacted navigable waters. As put by the District Judge Gene Pratter in *Tri-Realty Co. v. Ursinus Coll.*,[174] Congress did not intend for the Clean Water Act "to extend federal regulatory authority over groundwater, regardless of whether that groundwater is eventually or somehow 'hydrologically connected' to navigable surface waters."[175]

Other courts, such as the U.S. District Court for the District of Hawaii, took an alternative stance on the issue. In the case *Hawai'i Wildlife Fund v. County of Maui*,[176] District Judge Susan Mollway held that discharge of effluent from a wastewater treatment facility operated into a shallow groundwater aquifer fell under Clean Water Act jurisdiction because it significantly affected navigable waters, which in this case was a coastal zone of the Pacific Ocean. Persuaded by a tracer-dye study that the effluent flowed relatively rapidly from the aquifer to the ocean, and tests that showed elevated levels of nitrogen and phosphorus, ocean acidification, decreased salinity, decreased dissolved oxygen concentrations, and increased water temperature, Judge Mollway held that the effluent significantly affects the physical, chemical and biological integrity of navigable waters. Thus, she ruled that the discharge of the pollutants into the aquifer was a violation of the Clean Water Act based on Justice Kennedy's significant nexus test.[177]

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[170] United States v. Brink, 795 F. Supp. 2d 565, 568-578, 2011 BL 330981, 2-10 (S.D. Tex. 2011)
[171] United States v. Moses, 496 F.3d 984, 64 ERC 1993 (9th Cir. 2007)
[172] United States v. Moses, 496 F.3d 984, 985-993, 2007 BL 75397, 2-8 (9th Cir. 2007)
[173] Sierra Club v. Honolulu, CV.NO. 04-00463 DAE-BMK., 2008 BL 195986, 68 ERC 1592 (D. Haw. Aug. 18, 2008)
[174] Tri-Realty Co. v. Ursinus Coll., CIVIL ACTION NO. 11-5885., 2013 BL 325454, 78 ERC 1211 (E.D. Pa. Nov. 21, 2013)
[175] Tri-Realty Co. v. Ursinus Coll., 2013 BL 325454, 10 (E.D. Pa. Nov. 21, 2013)
[176] Haw. Wildlife Fund v. Cnty. of Maui, 24 F. Supp. 3d 980, 79 ERC 1589 (D. Haw. 2014)
[177] Haw. Wildlife Fund v. Cnty. of Maui, 24 F. Supp. 3d 980, 981-1005, 2014 BL 293200, 2-25 (D. Haw. 2014)

As is evident from the case details from several of the post-*Rapanos* cases mentioned, some courts that chose to rely on Justice Kennedy's significant nexus test were compelled to consider and evaluate in great detail factors affecting water quality that had not been focal points in the majority of post-*Rapanos* cases Clean Water Act cases. One such case was *Precon Development Corporation v. U.S. Army Corps of Engineers*,[178] which was ruled on by the U.S. District Court for the Eastern District of Virginia in 2013. To make a ruling on the existence of a significant nexus between wetlands at issue and a navigable water, the Northwest River, District Judge Tommy E. Miller evaluated supporting materials provided by the Corps. These materials included topographical survey and runoff calculations, surveys and historical maps showing regular hydrologic connectivity between the wetlands and the river, and evidence showing that the wetlands support the integrity of the river by removing nitrates and phosphorus, storing water, and slowing flow. Using this information, District Judge Miller determined that "based on their biological and ecological function," the wetlands at issue have a great deal of influence on the Northwest River, and thus meet the criteria Justice Kennedy's "significant nexus" test. [179]

The *Precon* demonstrated that in some instances, the legal system has begun to focus on water integrity and water quality, and consider the importance of function, history and data when making post-*Rapanos* determinations as to what waters are protected by the Clean Water Act. This case motivated me to think about auxiliary information, such as topography and terrain analysis, that we use to inform how we determine influence on the chemical, physical, and biological integrity of waters of the United States.

[178] Precon Dev. Corp. v. U.S. Army Corps of Eng'rs, 984 F. Supp. 2d 538 (E.D. Va. 2013)
[179] Precon Dev. Corp. v. U.S. Army Corps of Eng'rs, 984 F. Supp. 2d 538, 539-563, 2013 BL 363926, 2-25 (E.D. Va. 2013)

PART III.

GIS CASE STUDY

In this case study, I demonstrate simple terrain analysis techniques that could be used to map areas of strong influence onto navigable waters. I then compared the areas of the watershed that these techniques would prioritize for protection of waters of the United States with the areas of the watershed that would be prioritized using a static riparian buffer, a commonly used management technique to protect water quality. The example watershed used in this analysis is a 6400 hectare South Fork watershed located in southwestern Montana. The South Fork is a tributary of the West Fork of the Gallatin River, which itself a tributary of the Upper Missouri River. The South Fork watershed is characterized by steep slopes and thin soils with high hydraulic conductivities.[180] The terrain analysis was performed on a Digital Elevation Model (DEM) with 10 meter grid cell resolution.

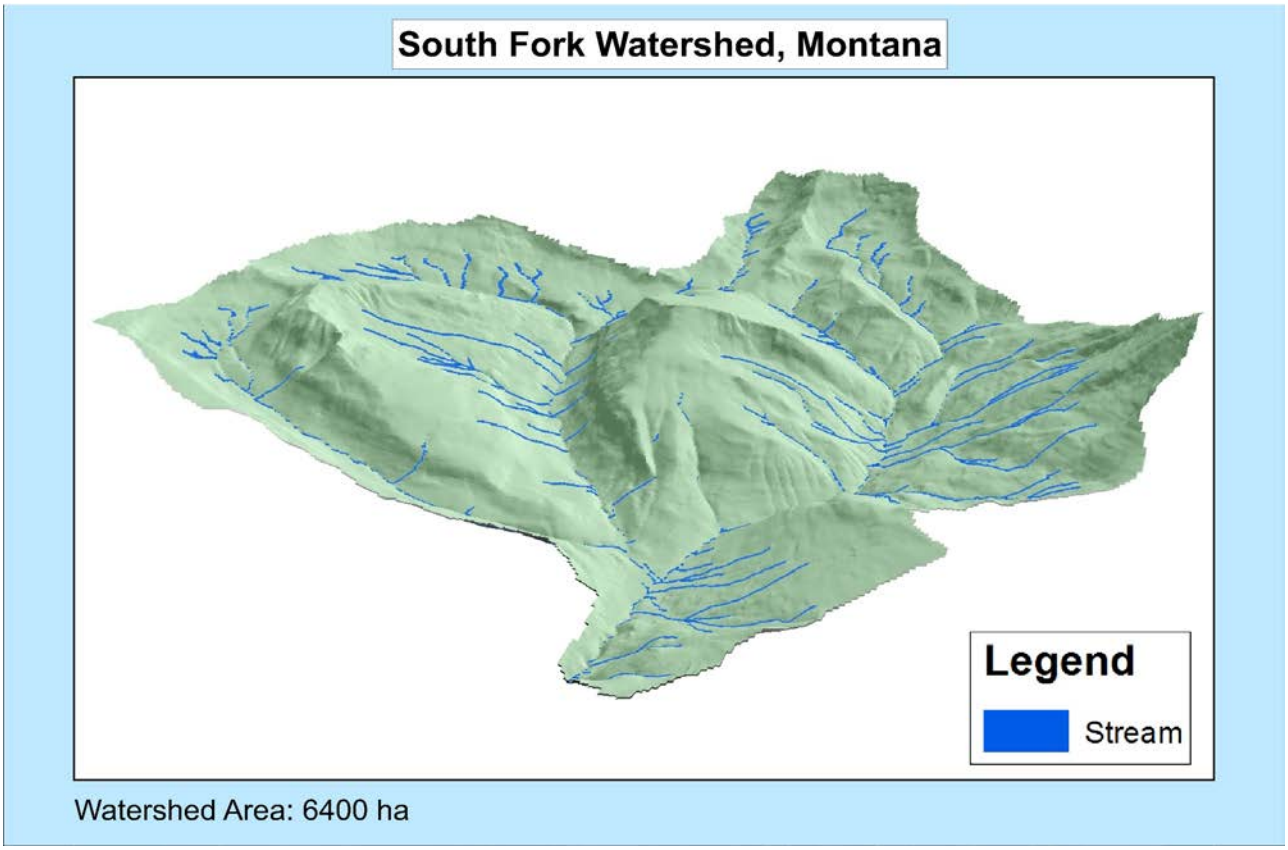

Figure 7. Overview of South Fork Watershed

[180] Gardner, K. K., & McGlynn, B. L. (2009). Seasonality in spatial variability and influence of land use/land cover and watershed characteristics on stream water nitrate concentrations in a developing watershed in the Rocky Mountain West. *Water Resources Research, 45*(8).

Lateral Inflows Analysis

For the first segment of the terrain analysis, I estimated lateral contributions to the stream in order to identify points in the watershed where most of the water enters the stream. As seen below in Figure 8, the height of the red bars sitting on top of the blue stream lines is an indication of how much water is entering the stream at a particular point. If one is concerned with the quantity of water entering the stream, and what that water is carrying, it is imperative to recognize that water not enter the stream equally across the landscape.

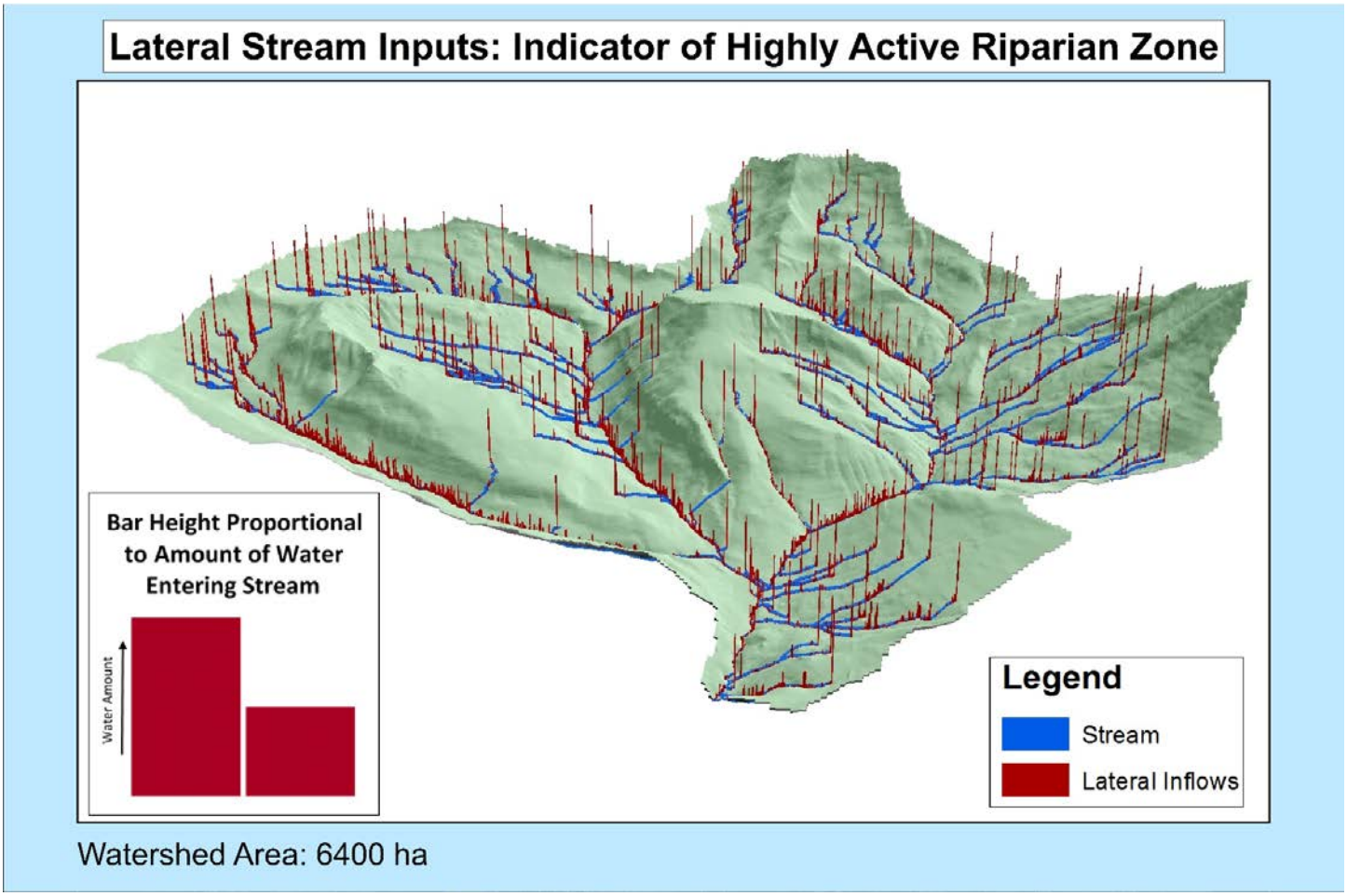

Figure 8. Analysis of Active Riparian Zone

Riparian Area Analysis

Typically, distance is considered to be the most important factor in determining what areas are most influential to streams. This is evidenced by the *Rapanos* decision, in which both the plurality and Justice Kennedy placed an emphasis on metrics such as adjacency and a continuous surface connection to determine jurisdiction. In Figure 9, a 20-meter buffer, in gray, has been placed around the stream network to represent the parts of the landscape that would be prioritized if adjacency was relied upon as an indicator of influential areas. I found that this buffering method would protect approximately 8.8% of the total 6400 hectare watershed area.

I then considered a different way to protect this same fraction of the watershed by evaluating other indicators of areas influential to the stream. To gain an idea as to where riparian wetlands and floodplains are likely to exist in the watershed, assessing the elevation above the stream along each hydrological flowpath provides a simple terrain analysis indicator of where those would exist on the landscape. The green area indicates the 8.8% of the watershed that is most sensitive areas based on this analysis.

As is evident in Figure 9, the areas prioritized by the 20-meter buffer and the elevation above the stream analysis do not match. There are areas that the buffer would protect that are unlikely to contain riparian wetlands and floodplains, and there are low-lying, valley bottom areas that are likely to be wetlands, but would fall well outside of the buffer zone.

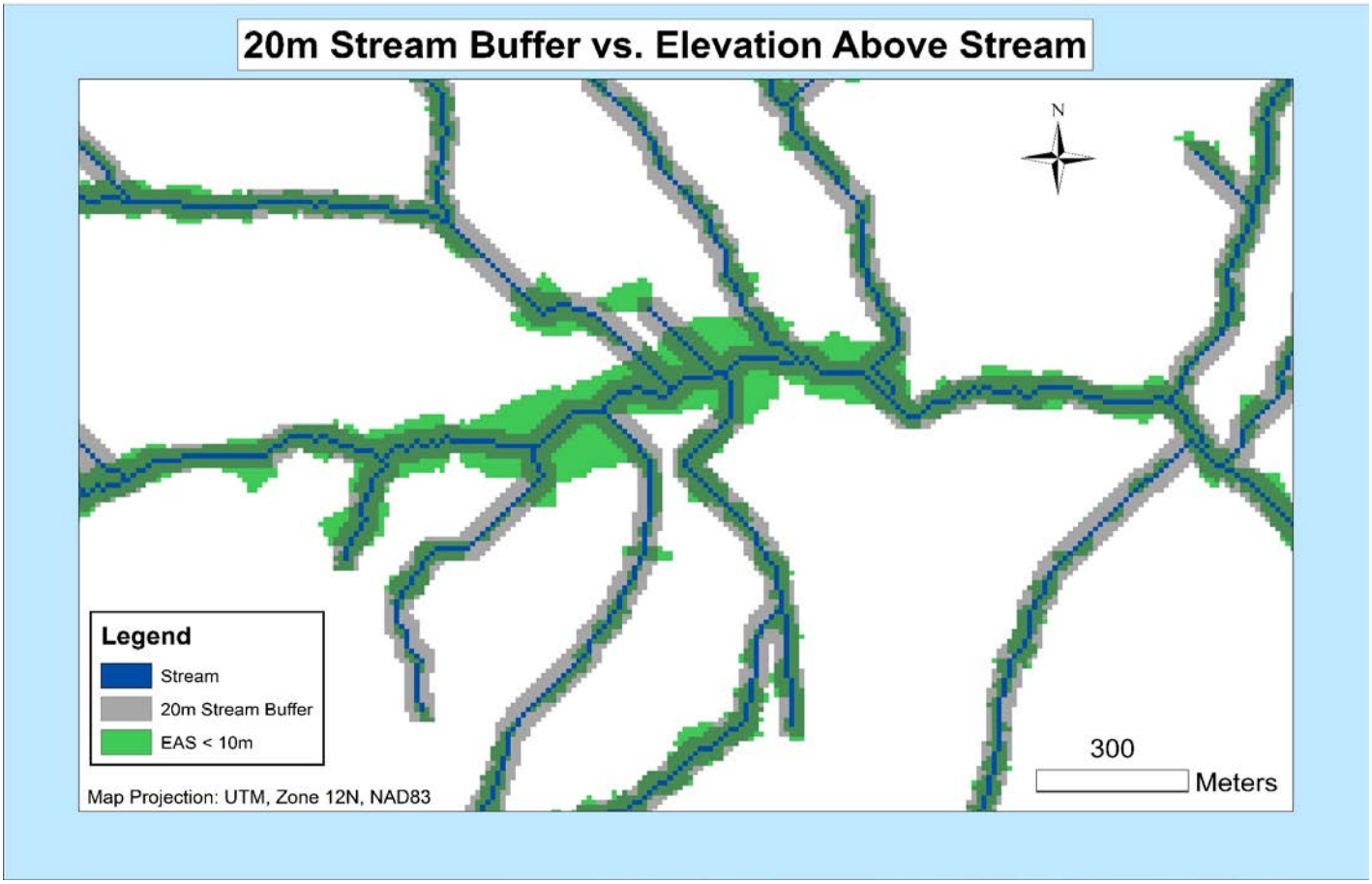

Figure 9. Riparian Area Analysis

Water Travel Time Analysis

A third terrain analysis indicator that could elucidate areas of the watershed with a great deal of potential for negative impact on navigable waters relates to water residence time. By using a terrain analysis technique introduced by *Gardner & McGlynn, 2009,*[181] based on the findings of *McGuire et al., 2005*[182] and a first approximation of Darcy's Law, I estimated the amount of time it would take for water to reach the stream channel for all grid cells in the watershed. I then identified the areas in the watershed estimated to have the shortest travel times to the stream, which are the green areas on the map, and cover just the same 8.8% of the total watershed area that the 20-meter riparian buffer does.

These areas are likely to be highly sensitive, and have potential for strong connectivity to the stream channel. As with the previous figure, it is evident in Figure 10 that the green areas of short travel time do not match up with those that would be protected by the static 20-meter riparian buffer.

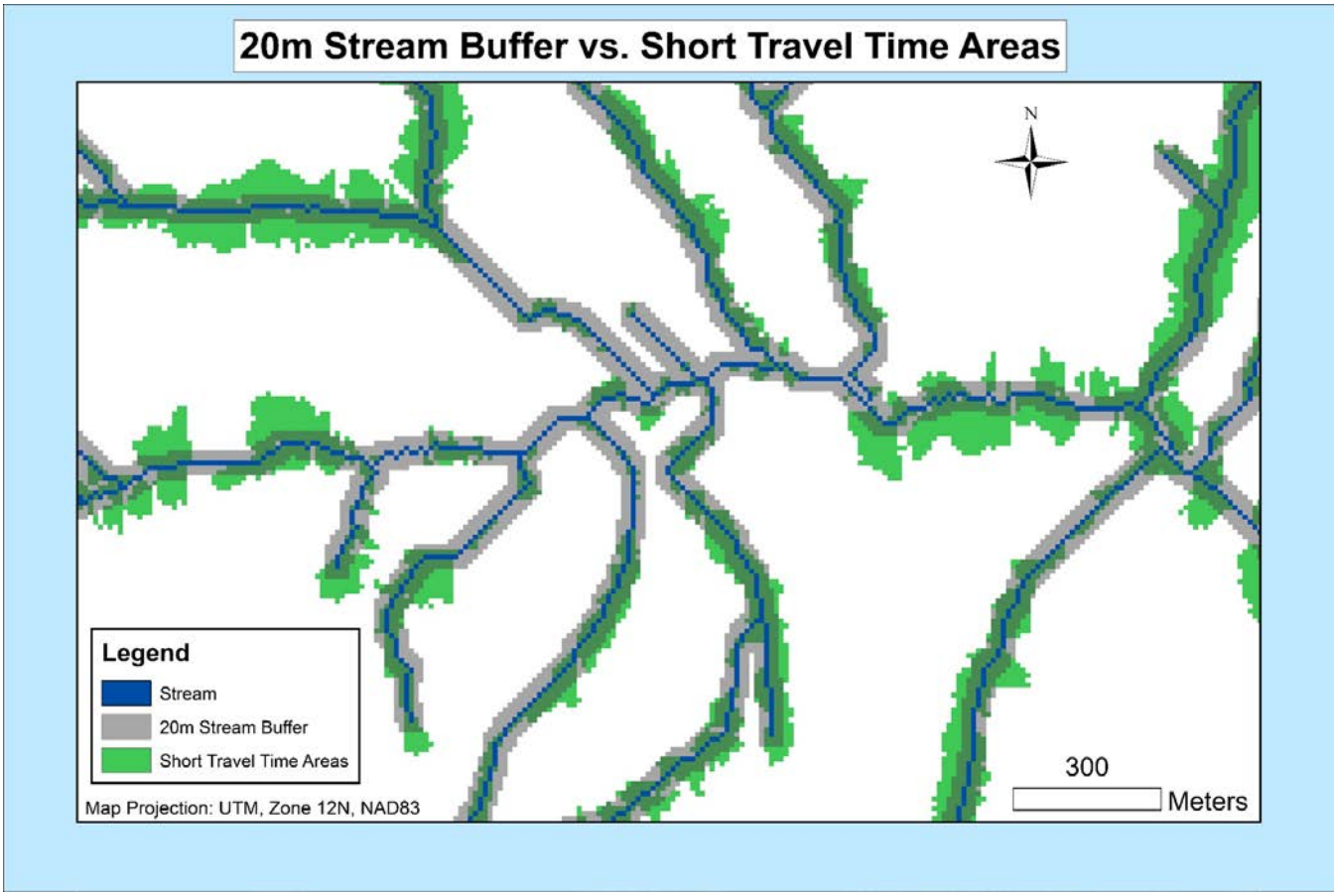

Figure 10. Water Travel Time Analysis

[181] Gardner & McGlynn (2009)
[182] McGuire, K. J., McDonnell, J. J., Weiler, M., Kendall, C., McGlynn, B. L., Welker, J. M., & Seibert, J. (2005). The role of topography on catchment-scale water residence time. *Water Resources Research, 41*(5).

The results of terrain analysis techniques demonstrate that proximity, which is the backbone of metrics currently used to determine regulatory jurisdiction such as adjacency and continuous surface connections, is not always the best indicator of areas with greatest potential for influence on waters of the United States. Speaking even more broadly, this case study provides simple examples of tools that are widely available to regulators and watershed managers that could be used to identify areas on the landscape that are most influential to waters of the United States. However, none of this information is typically used in the current regulatory framework to protect waters of the United States.

PART IV.

CONCLUSION

As seen in the *Precon* District Court case, the courts have in some instances started to incorporate factors such as ecological function and hydrologic connectivity into water resource regulation in the United States. The GIS case study served to demonstrate how these factors could be evaluated using auxiliary information such as topography, and how one could perform a simple terrain analysis to approximate areas most influential to waters of the United States. Despite this recognition and the widespread availability of resources such as GIS, we are in many ways still prevented from doing a better job of having the science inform our water resource policy in the United States due to the diversity and complexity of the legal framework governing water pollution. Many courts continue to evaluate whether or not a hydrologic feature should be protected under the Clean Water Act based on over-simplistic metrics such as the existence of permanence of flow and surface connections, while looking past instances of potentially more significant subsurface hydrologic connections.

This is not to say that courts are purposefully avoiding having science inform their rulings, but is more of a reflection of the degree to which a court feels constrained by the language used in the *Rapanos* decision and in the Clean Water Act. Efforts have made by federal agencies to have science better inform water resource policy in the United States, with the most notable recent instance the *Connectivity of Streams & Wetlands to Downstream Waters* synthesis document issued in 2015 by the EPA and Corps to inform rulemaking with regard to the definition of "waters of the United States" under the Clean Water Act. However, since this document is nothing more than a technical review of peer-reviewed scientific literature, it does not impact standards for Clean Water Act jurisdiction or establish policy.[183]

The EPA and Corps are also weighing a proposal from April 21, 2014 that is intended to increase clarity as to the scope of waters protected under the Clean Water Act. The language in the proposal indicates that the rule would expand coverage over intermittent and ephemeral waters, as well as geographically isolated wetlands. However, since a final version of the rule has still not been issued, it is difficult to evaluate the impact the rule would have on the regulatory framework governing water resources of the United States.[184]

Although the legal and regulatory challenges are formidable, the current state of flux of federal water resource regulation can also be seen as an opportunity. The state of scientific understanding and the availability of tools to identify influential areas on the landscape signify a ripe opportunity to better map science to the regulatory framework. Collectively, the current state of affairs provides an opportunity for managers, scientists

[183] U.S. EPA. Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-14/475F, 2015.
[184] Definition of "Waters of the United States" Under the Clean Water Act; 79 Fed. Reg. 22187 (April 21, 2014)

and legal professionals to start to put together a more coherent way forward to protect water resources of the United States.

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PART V.

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APPENDIX

Methods for GIS Case Study

All terrain analysis techniques were performed on a 10-meter, Lidar-derived Digital Elevation Model (DEM) using ArcGIS 10.2.2 and the Whitebox Geospatial Analysis Tools software package. The program is available at http://www.uoguelph.ca/~hydrogeo/Whitebox/index.html .

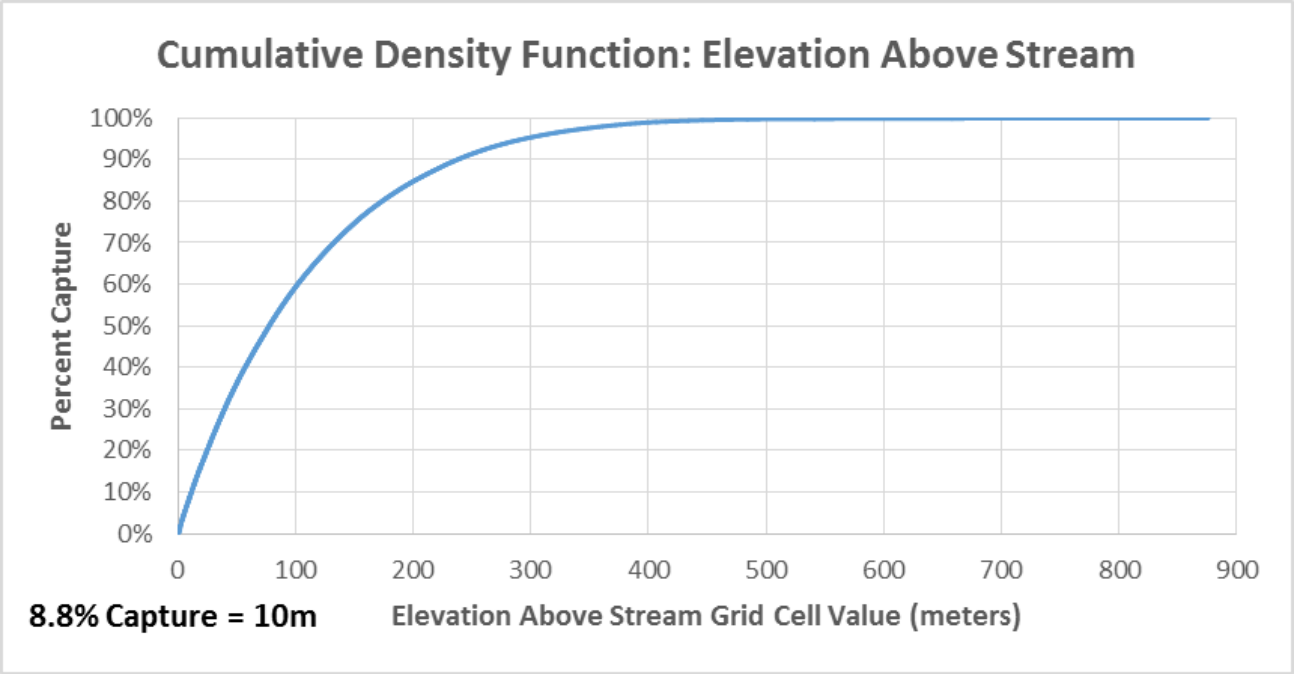
Lateral Inflows Analysis

The lateral inflows depicted in Figure 2 were generated using the *MDInf Flow Accumulation* tool in Whitebox, which is based on the previously referenced work of *Seibert & McGlynn* (2003). The inputs included a filled DEM that had been pre-processed using the *Fill Depressions* tool to ensure continuous flow from each grid cell to the outlet by removing depressions and flat areas, and a channelization threshold to create a *Streams* output grid from the flow accumulation image that could be used to extract a Streams file. The channelization threshold chosen for this analysis was 10ha of upslope accumulated area. The *LocalIn* output grid provided me with the local contribution to the stream. Using ArcScene, I displayed the output grid using vertical bars in order to emphasize the difference in magnitude of local stream inputs throughout the watershed.

Riparian Area Analysis

The 20-meter static riparian buffer, which was a basis for comparison for the GIS case study, was created in ArcGIS using the *Expand* tool, which expands specified zones of a raster file by a user-specified number of cells. To approximate a 20-meter buffer around the stream, I expanded the stream raster by two 10-meter cells on each side. Notably, this method resulted in some areas where the buffer around the stream was a few meters larger than 20 meters, depending on the configuration of the grid cells. Using this technique, I calculated the percent of non-stream grid cells in the watershed that the 20-meter riparian buffer encompassed, and found that the buffer covered 8.8% of the watershed.

To define the riparian area, the *Elevation Above Stream* tool in Whitebox was used. First, it was necessary to create a flow pointer grid from the filled DEM using the D8 Flow Algorithm developed by *O'Callaghan and Mark* (1984), which was previously referenced. The D8 Flow Pointer raster was used as an input, along with the filled DEM and the Streams file already generated using the *MdInf Flow Accumulation*, to create an Elevation Above Stream raster using the Elevation Above Stream tool in Whitebox. This tool calculates the elevation of each grid cell in a raster above the nearest stream cell, measured along the downslope flowpath. With the goal being to protect the same amount of the watershed that would be protected by the 20-meter riparian buffer, I used a cumulative density function, as seen in Appendix Figure 1, to determine the 8.8% of the Elevation Above Stream grid cells had the lowest values. I found the cutoff to be approximately 10 meters. I then compared the two output files, which can be seen in Figure 9 in the report.



Appendix Figure 1. Method to determine most sensitive 8.8% of watershed based on elevation above stream analysis

Water Travel Time Analysis

This step involved identifying areas in the watershed with potential for negative impact on the stream based on water residence time. The output is a raster file that can be used to estimate the water travel time from each grid cell to the stream channel. Travel time (*TT*) has been shown to have a correlation of 0.91 with mean water residence time[185] (*McGuire et al.*, 2005). The methodology for estimating travel time from a DEM is described by *Gardner & McGlynn* (2009):

> For each grid cell, the *TT* is the hydrological flowpath distance to the stream divided by the gradient over the flowpath. Assuming a constant hydraulic conductivity throughout the watershed, *TT* can be viewed as a first approximation of Darcy's Law:
>
> $$\bar{V} = \mathrm{K} * \mathrm{I} \rightarrow \mathrm{K} = \text{a constant} \rightarrow \bar{V} \approx \mathrm{I} \rightarrow \mathrm{TT} \approx \frac{D}{I}$$
>
> where, $\bar{V}$ is the average velocity, K is the hydraulic conductivity, I is the gradient (slope) along the flowpath to the stream, D is the flowpath distance to the stream, and *TT* is the travel time from each grid cell to the stream following the topographically driven flow routing algorithm. Assuming this first-order approximation, TT is a measure of the travel time from a grid cell to the stream channel.

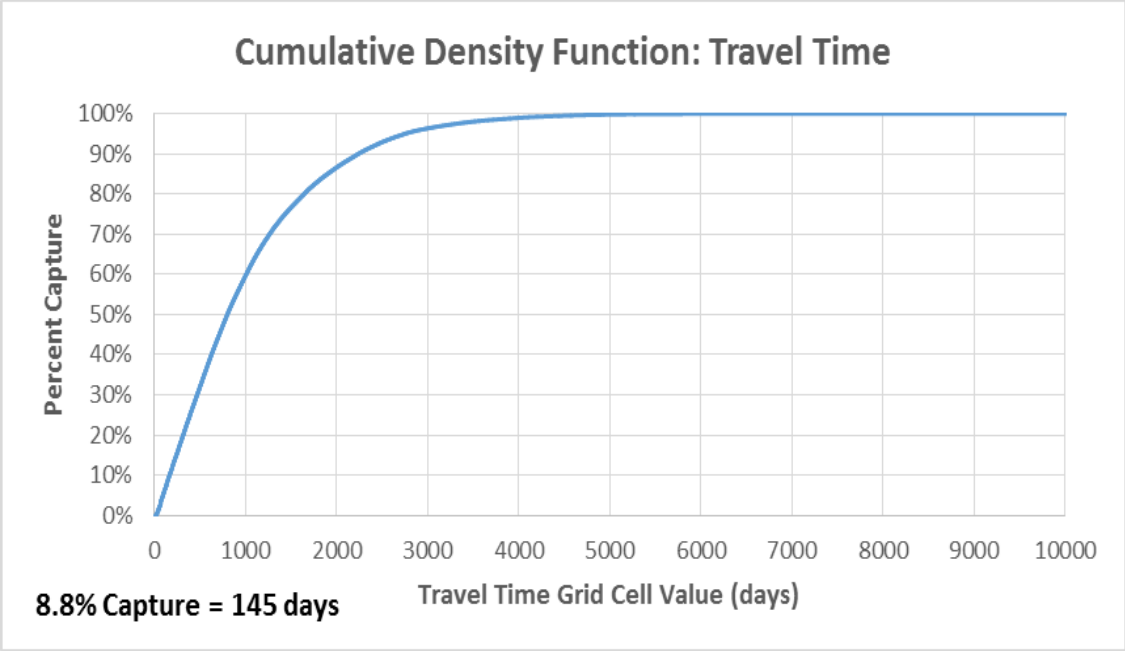
[185] McGuire et al. (2005)

The inputs include the following previously created files: the Filled DEM, Streams file, and D8 Flow Pointer. Hydraulic conductivity, which is the measure of how rapidly water moves through a porous media,[186] must be assumed to be constant throughout the watershed. Based jointly on the description in the literature of the shallow soils and high hydraulic conductivities in the South Fork watershed,[187] and estimations of hydraulic conductivities for different soil textures by *Clapp and Hornberger* (1978)[188], a constant hydraulic conductivity of 1.5 meters per day was chosen as the input value for this analysis.

Using the *Downslope Distance to Stream* tool in Whitebox, I determined the distance from each grid cell in the watershed to the nearest stream cell, measured along the downslope flowpath. The inputs for this tool were the Filled DEM and the D8 Flow Pointer raster, and the output was a Downslope Distance to Stream raster file in meters. I then divided the previously created Elevation Above Stream raster file by the newly created Downslope Distance to Stream raster file to derive *I*, the gradient along the flowpath to the stream. By multiplying *I* by the assumed constant hydraulic conductivity of the watershed, 1.5 meters per day, I approximated $\bar{V}$ in meters per day. Finally, I divided the Downslope Distance to Stream file, in meters, by $\bar{V}$, in meters per day, to create the Travel Time raster file, which is an estimate of *TT*, in days, for each grid cell in the watershed.

To compare the areas of the watershed that the travel time analysis would identify as most sensitive with the areas prioritized by the 20-meter static riparian buffer, I used a cumulative density function to identify the 8.8% of the Travel Time raster grid cells with the lowest values. As is seen in Appendix Figure 2, the 8.8% captured grid values with estimated travel times of 145 days or less to the stream channel. I found the cutoff to be approximately 10 meters. I then compared the two output files, which can be seen in Figure 10 in the report.

[186] Hornberger, G. M. (Ed.). (1998). *Elements of physical hydrology*. JHU Press.
[187] Gardner & McGlynn (2009)
[188] Clapp, R. B., & Hornberger, G. M. (1978). Empirical equations for some soil hydraulic properties. *Water resources research*, *14*(4), 601-604.



Appendix Figure 2. Method to determine most sensitive 8.8% of watershed based on water travel time analysis