Pathogen Pollution in the Navesink River

Addressing Fecal Contamination in the Navesink River Watershed

A Clean Ocean Action Report

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June 2016

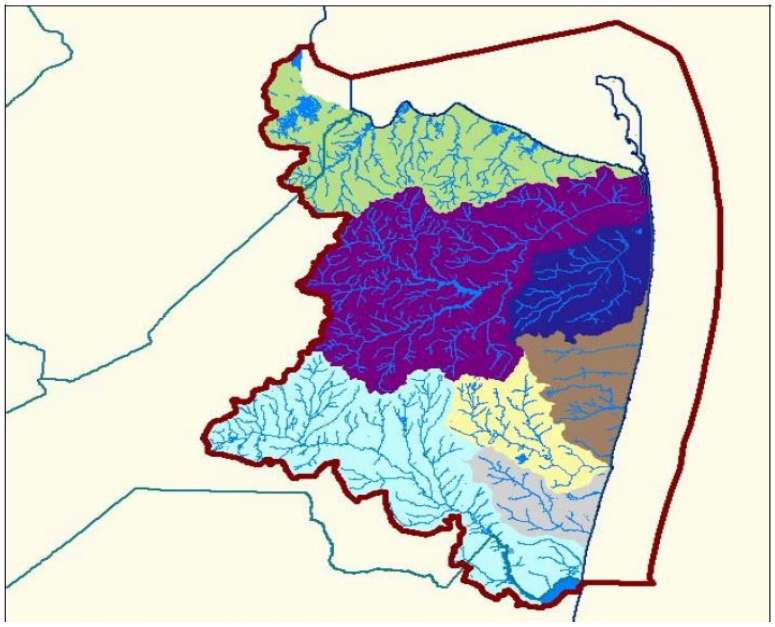

Figure 1: The Navesink Watershed highlighted in purple[1]

What is a Watershed? A Watershed is the area of land where all of the water that falls in it and courses under and over it, flows to a common waterway.

The Navesink River Watershed is a roughly 95 square mile tract of northeast Monmouth County containing uplands, bogs, fresh and tidal wetlands, streams, and tidal rivers. Numerous streams and brooks flow through a diverse mix of small farms, tracts of forest, green, and open space, sprawling residential and suburban development, and densely built out urban areas. The Headwaters of the Navesink include Yellow Brook, Big Brook and Mine Brook flowing from western Colts Neck Township. These tributaries flow into the Swimming River Reservoir: a critical potable water source for the area, which then feeds the Swimming River, before opening into the wide, tidally flushed coastal lagoon of the Navesink River. Numerous other tributaries feed the Navesink, including the Hockhockson and Pine Brook Rivers from the southwest, Ramanessin Brook, Willow Brook, and Hop Brook from the hills of Colts Neck and Middletown, Nut Swamp and Jumping Brook which flow into Shadow Lake before reaching the Navesin;, and Poricy Brook, McClees Creek and Claypit Creek all emptying in to the Navesink from the North.[2] *All told, these waters flow through seven municipalities; Colts Neck, Middletown, Tinton Falls, Red Bank, Fair Haven, Rumson, and Sea Bright before the Navesink River meets the Shrewsbury River, Sandy Hook Bay, and the wide angle of the New York New Jersey Harbor*

As Kate Kellen and Jerry Keelen wrote in their 2003 short history of the Navesink, "Water imbues the land with great beauty, but also with resources that have attracted people from pre-history through European colonial times and to the present."[3]

From subsistence hunting, fishing, and gathering, colonial iron works and waterwheel powered mills, the clearing of forest for agricultural operations and homesteads, the establishment and fall of utopian communes, the sustaining and collapse of immense fishing and shellfishing industries, the rise of vibrant residential communities, and today, a watershed striving to balance an agrarian and rural character with the pressures of residential and commercial development, the Navesink continues to assert an undeniable pull, both ecologically and economically.

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[1] Kate Kellen & Jerry Keelen, The Navesink Watershed: A Short History (2003), Swimming River Group, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/17173/PDF/1/

[2] *Id*., *see also* Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP, 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/

[3] *Id*. at 1.

Table of Contents

I. Executive Summary 5

II. Overview 7

III. Fecal Contamination in Water and Human Illness 9
- a. Testing Water for Fecal Contamination 9
- b. Constraints and Limitations of Fecal Indicator Bacteria 11

IV. Turning Bacteria into Criteria 12
- a. Swimming and Wading, Paddling and Sailing: Primary and Secondary Contact Recreation Criteria 13
- b. Shellfish Harvesting Criteria 13
- c. Other Water Quality Criteria 16

V. The Navesink River Today 16
- a. Current Designations 16
- b. Swimming in the Navesink 17
- c. Shellfish Harvesting in the Navesink River 19
- d. EPA's 303(d) List 20
- e. The Navesink River in a Statewide Context 21

VI. Land Use and Water Quality 23
- a. Land Use Trends in Monmouth County 23
- b. The Upper Watershed 26
- c. The Lower Watershed 27
- d. Land Use and Water Quality Impacts 28

VII. Pollution Sources and Source Tracking 30
- a. Urban Stormwater Runoff 30
- b. Human Sources and Source Tracking 33
  - i. Microbial Source Tracking 33
  - ii. 2008 NJDEP MST Study 33
- c. Agricultural and Animal Sources 35
  - i. Horses and Livestock 35
  - ii. Wildlife and Other Domestic Animal Sources of Pollution 37
- d. Marinas and Boat Discharges 37
- e. Interaction between Upper and Lower Watershed 38

VIII. TMDLS and Stormwater Regulations 39
- a. The 2006 Total Maximum Daily Load (TMDL) 39
- b. Stormwater Regulations in New Jersey 40

IX. Next Steps, Funding Options, and the Future of the Navesink River 43
a. Source Tracking and Water Monitoring 44
b. Stormwater Volume Reduction..... 45

X. Conclusion 45

Appendix A: List of Commonly Used Acronyms 46

Appendix B: Water Quality Chronology of the Navesink Watershed 48

Appendix C: NJDEP's NSSP 2011-2014 Fecal Coliform Sampling Data For Select Sites in the Navesink River..... 55

Appendix D: Monmouth County Health Department Navesink River Sampling Data..... 76

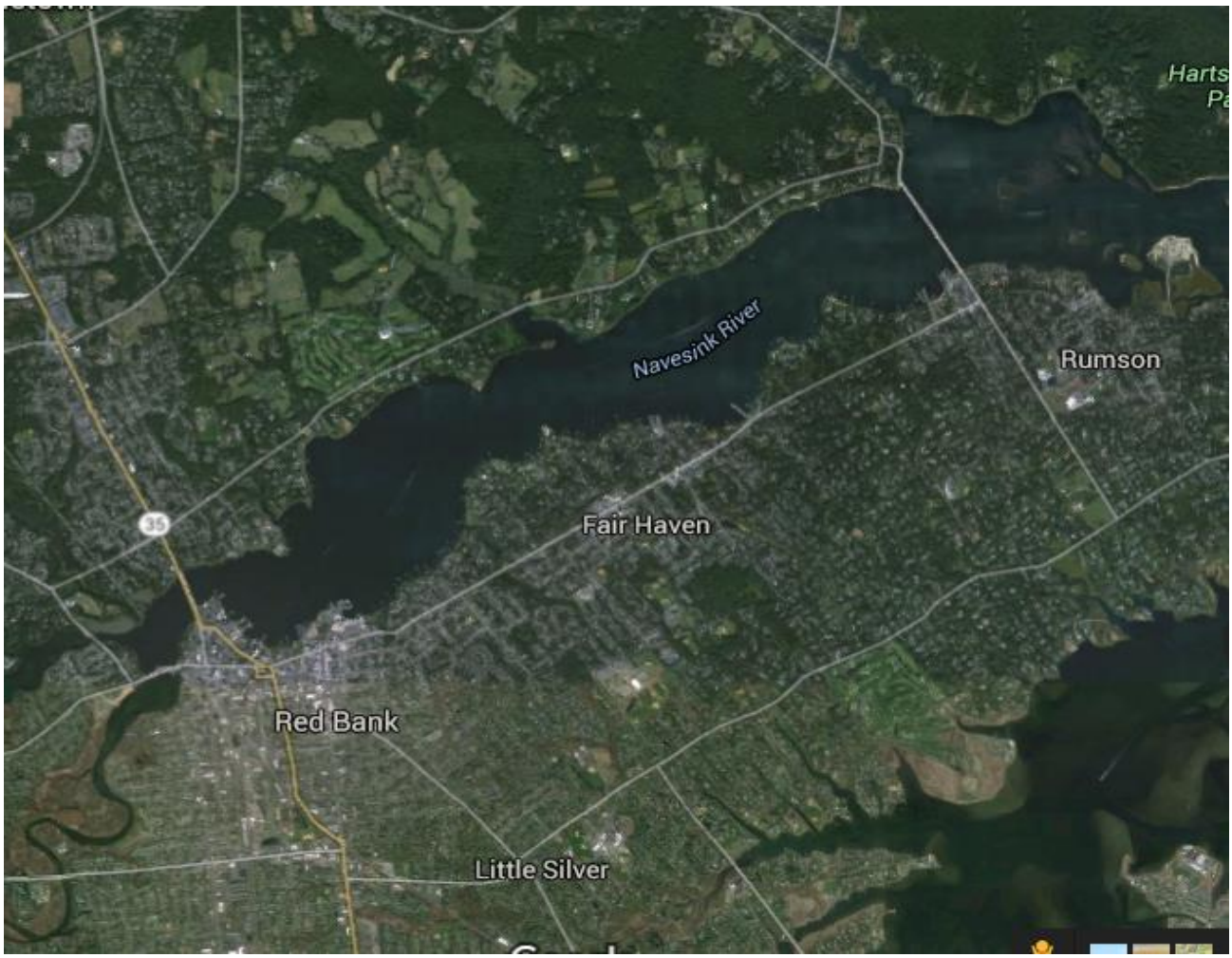


Figure 2: The narrow Swimming River in the lower left corner of the image opens up into the wide, coastal estuary of *The Navesink River.*

I. Executive Summary

For centuries, society's relationship with the Navesink River has been rich, storied, and complex. It has been captured in books, chronicles, journals, newspapers, and even ships' logs dating from the 1600s. These writings, along with drawings and photographs, document and highlight the extraordinary cultural, social, ecological, and economic value of the river system. Today, the Navesink River remains beloved by those who live, work, or enjoy the vibrant natural resources, and with good reason.

The Navesink River has one of the highest water quality designations in the State. It has one of the last remaining direct harvest shellfishing areas in the entire NY/NJ metropolitan region from Jamaica Bay to the Shark River. The diversity of wildlife and marine life which are thriving within the river is remarkable and includes many endangered or threatened species.

However, all is not well within the waters of the Navesink River. In February 2016, state officials finalized a downgrade which prohibits shellfish harvesting in over 560 acres of the river. Also, surprising to many, the river does not meet recreational standards—it is impaired for swimming and other direct contact activities, especially after it rains. In fact, recently, New Jersey Department of Environmental Protection confirmed that the waterway "remains safe for boating"; a low bar that is not nearly good enough.

For nearly a year, Clean Ocean Action has been investigating issues, researching the problems, compiling data, interviewing officials, identifying solutions, and organizing community leaders. The purpose of this report is to review and discuss the pollution, public health risks, and potential sources, as well as inadequacies of current regulations. The report also reviews the efforts made over the last 40 years to glean insights for the future.

Most importantly the report urges a call to action to reverse the trend.

It should be noted that the Navesink River is not alone; most waterways in New Jersey are facing similar problems. However, the recent downgrade is a call to action. It is an opportunity for the citizens and communities of the Navesink River to establish new a paradigm of local action to improve water quality and re-open the beds for clamming, and to make waters safe for families and fish---rain or shine.

COA's recommendations include:

- Increase water quality testing in areas of stormwater outfalls and high public use, especially after rainfall.
- Post signage where exceedances occur and near outfalls to avoid swimming after rain.
- Track down sources of pollution with a find-it fix it approach that avoids the blame-game.
- Quantify and reduce the flow of stormwater directed into the Navesink River.
- Enforce existing laws that minimize pollution such as stormwater management, pump-outs, littering, soil erosion, -- every drop counts.
- Increase nature's ability to help. Increase natural areas along shorelines and tributaries to absorb water allowing nature to restore the area. Return oysters and other filtering critters to the river to help clean the water. Implement alternatives to bulkheads, which block water filtration and are nursery grounds for jellyfish.
- Engage all communities within the watershed through education, outreach, and action
    - Everyone should know their "water address."
    - Become a stormwater detective; know where your stormwater goes and how to keep it clean.

- Create K-12 programs to inspire youth involvement

Clean Ocean Action has recently called for a Rally for the Navesink. Already nine groups have stepped up to work collaboratively by implementing their many talents, skills and programs to improve the river. At present, the groups include: ***American Littoral Society, Bayshore Regional Watershed Council, Clean Ocean Action, Hartshorne Woods Association, Monmouth Conservation Foundation, Navesink Maritime Heritage Association, Navesink Shrewsbury River Fishing Club, NY/NJ Baykeeper, and the NJ Chapter of the Recreational Fishing Alliance.***

Bringing new and innovative solutions can be a hallmark of this citizens' campaign. COA has stepped-up to help track-down sources by partnering with Environmental Canine Services, LLC, who have specially trained dogs that help sniff out pollution. Others are taking actions, as well; some are filtering out pollution and others are uniting municipalities. All will be needed and welcome.

It will be challenging—it's all hands on deck. Every home, business, and citizen—the small and the tall—will be needed. Let's show the state and the nation how a dedicated group of citizens decided to win back their watershed and in the process created a new model of waterway restoration. Rally for the Navesink for today and to ensure the joys of the Navesink River continue long into the next century.

Join the Rally for the Navesink!

Cindy Zipf
Executive Director

About Clean Ocean Action:

Clean Ocean Action (COA), a coalition of 115 groups, is dedicated to reducing marine water pollution in the NY/NJ Bight from Montauk, NY, to Cape May, NJ. Since 1984, COA has achieved many successes, including closing all eight ocean dumpsites by implementing environmentally sound alternatives by 1997, collaborating with the NJDEP to institute NJ's premier water quality testing programs of the 1990's that became the national standard with landmark federal legislation, and creating one of the nation's first beach litter cleanup initiatives, Beach Sweeps, which works to educate citizens about the connection of land-based litter and marine debris. It is now NJ's largest environmental event.

Clean Ocean Action's mission and successful tactics continue to improve the marine water quality of the New Jersey/New York coast by identifying the sources of pollution and attacking each source through research, public education, and citizen action. These efforts have focused on land-based sources of pollution and the lack of strong policies to protect water quality, as well as offshore threats such as oil drilling, LNG ports, and sand mining.

The engaged citizens of the coalition include the small and the tall from diverse interests and backgrounds with a common interest in the marine ecosystem and all that it provides. The constituency also includes the extraordinary aquatic and marine life that are most voiceless in the decisions of public policy. Those who benefit from the work of COA are the millions who enjoy a day at the beach, a seafood dinner, and economic vitality that is a result of the bounty and richness of the marine ecosystem.

For more information, please contact: Clean Ocean Action, 18 Hartshorne Drive, Suite 2, Highlands, 07732
732-872-0111; info@cleanoceanaction.org.

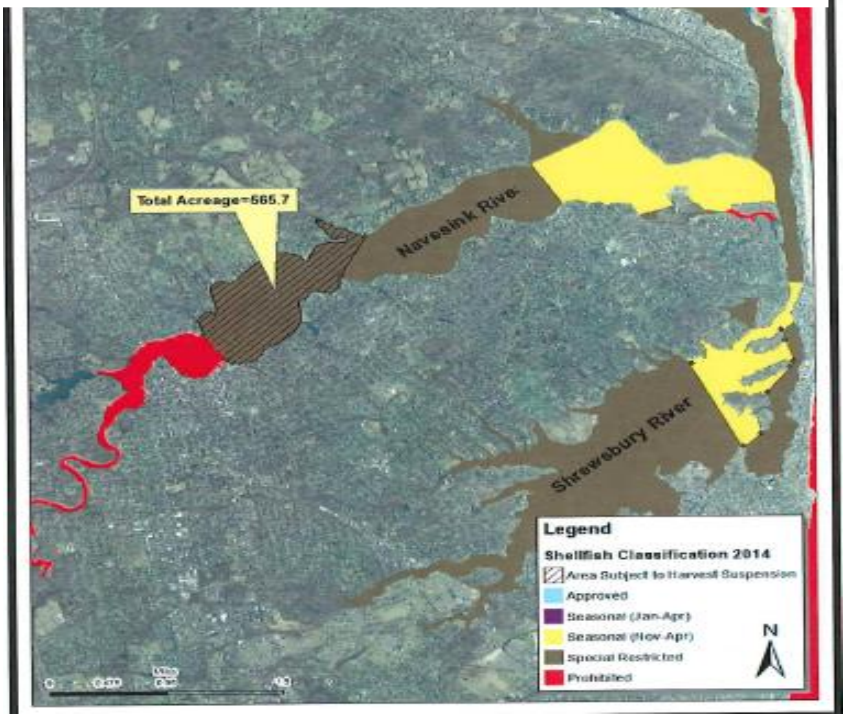
I. Overview

The land and water of the Navesink River Watershed holds immense ecological wealth. The area is a key part of the mid-Atlantic flyway, the convergence of many cold and warm water species' habitats, a nursery for many breeding and wintering species, and supports one of the only commercially harvested soft clam fisheries in the state, as well as substantial, hard clam and blue crab populations and critical fish and animal habitat. The Navesink also supports a robust recreation based economy comprised of paddling sports, boating, crabbing, angling and clamming, sailing, birdwatching, and swimming.

The struggle to improve and maintain the water quality of the Navesink has been a tale that has unfolded in fits and starts throughout the last several decades. The popularization of the Jersey Shore as a vacation destination and expansion of railways to the shore throughout the 19th century led to increases in population and development pressures. These pressures culminated with a post WWII boom in development, habitat loss, industrial and wastewater discharge, spills, and dumping throughout the NY/NJ Harbor Estuary and New York Bight.

By the 1950's, the commercial shellfishing industry and much of the surrounding ecosystem collapsed due to pollution, disease, and habitat loss. Substantial improvements were not made until the mid-1970's following the passage of the Clean Water Act and modern environmental regulations, and investment in improved wastewater treatment technology. For a time, improvements in water quality allowed the reopening of shellfish harvesting in the downstream-most section of the Navesink in the late 1990's, which had been previously closed for over twenty-five years.

Figure 3: NJDEP Bureau of Marine Water Monitoring image showing June 9, 2015 administrative suspension of harvest of 565.7 acres in the Navesink



However, by the early 2000's trouble could be seen in the watershed and the river, and the first of many downgrades in shellfishing habitat due to high levels of fecal contamination occurred in 2005. This deterioration of water quality continues, as most recently indicated by a January 2015 NJDEP administrative order prohibiting harvest in 565 acres of the Navesink, roughly from McClees west to Oyster Point.[4]

The only direct harvesting of shellfish left in the NY/NJ Harbor Estuary, from Jamaica Bay to the Shrewsbury River, is conducted seasonally in the Navesink and Shrewsbury Rivers from November to April. With this most recent downgrade, the last of the direct harvest shellfishing beds in this region are at risk of closure.

This cherished waterway is no longer the site of

[4] *See* Public Notice of the Suspension of Harvest from Shellfishing Beds Dangerous to Health, NJDEP, January 9, 2015, *available at* http://www.nj.gov/dep/bmw/publicnotice/10915.pdf

industrial and municipal wastewater discharges, yet continues to be impacted by high levels of fecal pollution. 40 years of Local, State, and Federal intervention have pointed to a multifaceted and insidious culprit: **aging infrastructure and septic systems**, and **agricultural and urban and suburban runoff, all** mobilized and exacerbated by rainfall.

To meet fishable, swimmable standards, the people of the Navesink Watershed must answer complex questions as to how they will identify and eliminate leaking sanitary infrastructure, reduce the large amounts of runoff from the urban, suburban, and agricultural landscape, and preserve key areas of open space. Past efforts across New Jersey have clearly shown that citizen engagement and action are critical to these efforts.

Clean Ocean Action was prompted to focus on the Navesink River following the most recent downgrade of shellfish harvesting areas for several reasons:

- Any increase in pollution is unacceptable, especially in a waterway protected by one of the most stringent water quality designations in the State – Category One, which stipulates ***no change in existing water quality.***
- NJDEP considers shellfish water classifications to be a primary indicator of the State's coastal waters health.[5]
- The loss of shellfish harvesting area directly impacts those who work on the River, as well as the surrounding economies.
- Human sources of pathogens present an increased risk to human health.[6]
- The environmental impacts of leaking sanitary sewers can impact the productivity of our fisheries, the resiliency of the ecosystem and include hypoxia, harmful algal blooms, habitat degradation, floating debris, and impacts to threatened or endangered species.[7]
- Expansion of parks and open space with public access along the waterfront will facilitate and encourage swimming and water use, potentially increasing the exposure of users to public health risks.
- Pathogens are the most frequent cause of water quality impairment statewide.[8] Efforts to improve the Navesink River could have statewide applications.
- The causes of pathogen impairments stem primarily from nonpoint source pollution, which is also implicated in numerous other pollution impairments including high levels of pesticides, excess nutrients, low levels of dissolved oxygen, sedimentation, etc. Targeting pathogen pollution would improve overall water quality.

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[5] *See* Partnerships for Improving Water Quality in the Upper Navesink River, Leslie McGeorge, NJDEP Water Monitoring and Standards, 2005, *available at* www.**state**.nj.us/dep/wms/.../Navesink%20river%20-%20McGeorge.PPT

[6] *See* Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf, *see also* Water Sanitation and Health, World Health Organization at page 55, *available at* http://www.who.int/water_sanitation_health/bathing/srwe1-chap4.pdf, *see also* Sanitary Sewer Overflows, 1996, EPA Office of Wastewater Management, *available at* https://www3.epa.gov/npdes/pubs/ssodesc.pdf

[7] Why Control SSOs?, USEPA, *available at* https://www3.epa.gov/npdes/pubs/sso_casestudy_control.pdf

[8] 2014 New Jersey Integrated Water Quality Assessment Report, Draft 2015, NJDEP Division of Water Monitoring and Standards, *available at* http://www.state.nj.us/dep/wms/bears/docs/2014_draft_integrated_report_with_appendices.pdf

II. Fecal Contamination in Water and Human Illness

Fecal contamination can be defined simply as the presence of animal or human fecal material in a waterway. More specifically, fecal contamination is pollution due to the presence in water of microorganisms found in the gastrointestinal tract and fecal material of animals and humans.[9] The presence of fecal contamination in water is an indicator that illness-causing pathogens (such as viruses, protozoa, bacteria, parasites) may be present.[10] Depending on the concentration, potential health risks may exist for individuals exposed to this water.

Exposure to these illness-causing waterborne pathogens can occur in a variety of ways. This report will focus on two common activities in the Navesink that expose humans to potential illness from fecal contamination; **Shellfish Consumption**, and **Recreational Contact.**

a. Testing Water for Fecal Contamination

Consistent with the requirements of the Clean Water Act, US Environmental Protection Agency (USEPA) requires state clean water programs to establish numeric water quality criteria for waterborne pathogens based on National Standards.[11] However the methodologies and structure of a water monitoring regime and the process of developing regulations to protect people from illness is complex. A general understanding of these concepts is necessary to understand the past, present, and future of the fecal contamination problems in the Navesink River.

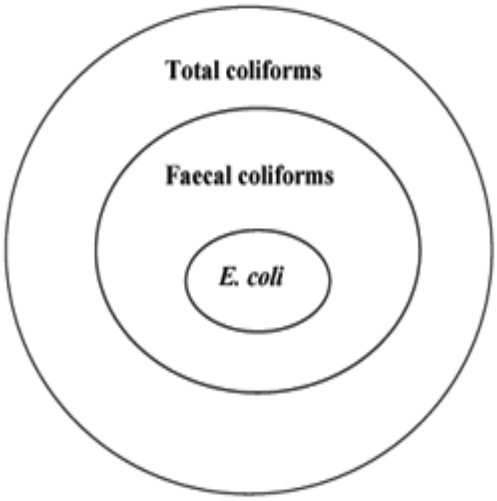

Figure 4: Classification of coliforms; the smaller the subset, the more accurate the microorganism(s) of choice. See FN 13 for source.

It is impractical due to time and resource constraints to test water samples for every single specific pathogen which may be present in contaminated water. Instead, water-monitoring programs employ easy to test for groups of bacteria, which are known to occur in fecal pollution as indicator organisms. These are known as Fecal Indicator Bacteria (FIB).[12] A FIB's presence in a water sample has been scientifically proven to indicate the presence of fecal contamination, and therefore, the presence of the many other dangerous pathogens contained therein.[13]

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[9] *See* Bain R, Cronk R, Wright J, Yang H, Slaymaker T, Bartram J (2014) Fecal Contamination of Drinking-Water in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. PLoS Med 11(5): e1001644. doi:10.1371/journal.pmed.1001644

[10] *See* Safe Waters, Healthy Waters: A guide for citizen groups on Bacteria Monitoring in Local Waterways, April 2016, Center for Watershed Protection at page 4, *available at* http://www.cwp.org/wp-content/uploads/2016/05/SAFE-WATERS-Guide_Final.pdf ("Fecal waste can contain pathogens such as harmful bacteria, viruses and protozoa. Pathogens can cause disease in humans, including minor illnesses such as gastroenteritis or upper respiratory infections, and, occasionally, more serious diseases.")

[11] 33 U.S.C. § 1313(i).

[12] *See* Safe Waters, Healthy Waters: A guide for citizen groups on Bacteria Monitoring in Local Waterways, April 2016, Center for Watershed Protection at page 4, *available at* http://www.cwp.org/wp-content/uploads/2016/05/SAFE-WATERS-Guide_Final.pdf . *See also* Water Sanitation and Health, World Health Organization *available at* *http://www.who.int/water_sanitation_health/bathing/srwe1-chap4.pdf*

[13] *Id*. *see also* WUTOR, VC; TOGO, CA and PLETSCHKE, BI. Suitability of total coliform β-D-galactosidase activity and CFU counts in monitoring faecal contamination of environmental water samples. Water SA [online]. 2009, vol.35, n.1 [cited 2016-06-24], pp. 85-88 . *available at* http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502009000100010&lng=en&nrm=iso. ISSN 0378-4738.

Yet most FIB used for human health standards are non-pathogenic (not illness causing). Furthermore, the actual risk of contracting an illness from fecal contamination depends on a host of factors including the source of the fecal bacteria, the method of exposure, amount of pathogen, and the age and health status of the infected party.[14]

In the past, governmental authorities used a group of related bacteria known as Total Coliforms as the FIB standard to protect against shellfish consumption transmitted diseases. Total Coliform bacteria occur naturally in the environment in soil and decaying organic matter, as well as inside the digestive tracts of animals.[15] The majority of Total Coliforms are harmless to human health.[16] Because of its prevalence throughout the environment, Total Coliform gives only a very general indication of the amount of potentially harmful pathogens present in the water.[17] Therefore, for many uses, most regulatory entities today have transitioned from Total Coliforms, to FIB with more specificity to the presence of human-illness causing fecal contamination.[18]

Fecal Coliform, a subcategory of Total Coliform bacteria, are found only in the digestive track of warm blooded animals.[19] Therefore, Fecal Coliform give a more accurate indication of pathogens that could cause illness. Fecal Coliform was used until 1986 as a recreational water quality indicator, and continues to be used today for shellfish classification criteria.[20]

In 1986, EPA determined that the presence of *E. coli* or *Enterococci* bacteria (specific types of fecal bacteria) are more accurate indicators of human illness causing pathogens **for swimmers** than the fecal coliform indicator used in the past.[21] As a result, most states, including New Jersey, use *E.* Coli and *Enterococci* FIBs over fecal coliform to protect swimmers and boaters, however some states continue to use fecal coliform for recreational contact criteria even today.[22]

Research also seems to indicate that the type of warm-blooded animal the bacteria came from, and how they were raised, may increase or decrease the level of risk to humans.[23] For example, wild Canadian Geese feces, while unsightly

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[14] *Id*.
[15] What Are Coliform Bacteria?, Penn State Extension, *available at* http://extension.psu.edu/natural-resources/water/drinking-water/water-testing/pollutants/coliform-bacteria, *see also* Background on Sausal Creek Water Quality Monitoring, USEPA, *available at* http://www.documents.sausalcreek.org/SausalCreek_WQMonBackground.pdf
[16] *Id*.
[17] *Id*.
[18] *see* Background on Sausal Creek Water Quality Monitoring, EPA, *available at* http://www.documents.sausalcreek.org/SausalCreek_WQMonBackground.pdf ("Thus, the usefulness of total coliforms as an indicator of fecal contamination depends on the extent to which the bacteria species found are fecal and human in origin. For recreational waters, total coliforms are no longer recommended as an indicator. For drinking water, total coliforms are still the standard test because their presence indicates contamination of a water supply by an outside source.")
[19] *Id*., *see also* What Are Coliform Bacteria?, Penn State Extension, *available at* http://extension.psu.edu/natural-resources/water/drinking-water/water-testing/pollutants/coliform-bacteria,
[20] *See* 1986 Recreational Water Quality Criteria, USEPA.
[21] *Id*.
[22] *Id*.
[23] Understanding Concentrated Animal Feeding Operations and Their Impact on Communities, National Association of Local Boards of Health, 2010, *available at* https://www.cdc.gov/nceh/ehs/docs/understanding_cafos_nalboh.pdf, at page 9-10 (due to crowded conditions and use of antibiotics, CAFOS may represent elevated health risk to communities beyond traditional small scale agriculture.) *see also* PATHOGENS IN ANIMAL WASTES AND THE IMPACTS OF WASTE MANAGEMENT PRACTICES ON THEIR SURVIVAL, TRANSPORT AND FATE, National Center for Manure and Animal Waste Management, 2006, *available at* http://fyi.uwex.edu/manureirrigation/files/2014/03/ASABE_2006_Pathogens-in-Animal-Wastes-and-Impacts-of-Waste-Management-Practices.pdf .

and itself a potential pathogen vector, may not carry the same level of risk to human health as say, pig manure from a concentrated feed lot.[24] Importantly, human sources of fecal pollution carry the highest risk of human illness, as human fecal matter contains a host of pathogens that are perfectly adapted to infect humans.[25] For this reason, use of source tracking methods, and the elimination of human sources of pathogens is given priority.

"Since the probability of human pathogens is greater in human waste than in animal waste, pollution sources with a significant human signature are of greater public health significance and should be given priority for remediation." [26]

b. Constraints and Limitations of Fecal Indicator Bacteria

NJDEP's use of specific FIB to protect human health has been approved by the EPA, as a scientifically valid method to guard against disease transmission. However, as testing methods and scientific understanding of FIB evolve, so too does the regulatory and policy choices made to protect human health.[27] Both the type of indicator bacteria chosen, the frequency of sampling, location, and calculation of the standards all play a role in the ability of a water monitoring regime to effectively protect human health. [28]

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[24] *See* Canada Goose Management Website. University of Nebraska-Lincoln, NRES 348 Wildlife Damage Management class, Spring Semester, 2010. Scott Hygnstrom, Instructor; Stephen Vantassel, Webmaster. http://icwdm.org/handbook/Birds/CanadadGeese/Default.aspx ("Transmission of disease or parasites from geese to humans has not been well documented, but the potential exists." This potential is in no small way related to the number of geese and their high mobility (Fallacara et al. 2001). ") *see also* Community-spread MRSA infections Related to Pig Manure, USA Today, September 16, 2013, *available at* http://www.usatoday.com/story/news/nation/2013/09/16/pig-manure-superbugs/2816545/ *("*People with the greatest exposure to hog farms -- because they lived close to a large farm or several smaller ones -- were 25% more likely to develop a MRSA infection, compared to those with the lowest exposure, says lead author Joan Casey, a graduate student at Johns Hopkins.")

[25] *see also* Water Sanitation and Health, World Health Organization at page 55, *available at* *http://www.who.int/water_sanitation_health/bathing/srwe1-chap4.pdf*, *see also* EPA Office of Wastewater Management, https://www3.epa.gov/npdes/pubs/ssodesc.pdf (list of potential diseases caused by Sanitary Sewer leaks) ("In 1990 the sewer system for this city of 5,000 exceeded its capacity, causing overflows and backups at several locations. Breaks in drinking water mains lowered the water pressure, allowing contamination from nearby SSOs to enter the drinking water system. Researchers linked these overflows with a pathogenic strain of Escherichia coli which killed 4 people, hospitalized 32 and caused diarrhea and other problems in 243 people.")

[26] *See* Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, at page 17, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf,

[27] *See* USEPA Review of Coliphages as Possible Indicators of Fecal Contamination for Ambient Water Quality*,* April, 2015. *Available at* *http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2015-0300-0002* (according to a more recent literature reviewed by EPA, it has been suggested that viral pathogens are the leading causative agents of recreational waterborne illnesses. Unfortunately, because bacteria respond to water treatment processes and environmental degradation processes differently than viruses, traditional FIB, such as enterococci may not be the best indicators of viral pathogens associated with fecal contamination after all.) *see also* Burton et al. 1987, (sediments may contain elevated levels of pathogens which live for extended periods following high flow events.)

[28] Water Sanitation and Health, World Health Organization at page 68, *available at* http://www.who.int/water_sanitation_health/bathing/srwe1-chap4.pdf ("The geometric mean is statistically a more stable measure, but this is because the inherent variability in the distribution of the water quality data is not characterized in the geometric mean. However, it is this variability that produces the high values at the top end of the statistical distribution that are of greatest public health concern. The 95% compliance system, on the other hand, does reflect much of the top-end variability in the distribution of water quality data and has the merit of being more easily understood. However, it is affected by greater statistical uncertainty and hence is a less reliable measure of water quality, thus requiring careful application to regulation.") *see also Id*. at 55 (""[i]t may be important to identify human versus animal enterococci, as greater human health risks (primarily enteric viruses) are likely to be associated with human fecal material—hence the emphasis on human sources of pollution in the sanitary inspection

III. Turning Bacteria Into Criteria

The Clean Water Act section 101(a) establishes an objective to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" in order to provide for "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water."[29] This is commonly referred to as the "Swimmable Fishable" standard. To put this objective into motion, each State is required to develop Water Quality Standards to meet these goals.

Figure 5: Water Quality Standards – USEPA

Water Quality Standards (WQS) form the legal basis for controlling pollution in U.S. waters. WQS are composed of three concepts, as shown in the figure to the left. All waters must have designations for how they are used (beneficial use), and numeric and/or narrative criteria that support those uses. Antidegradation policies are also required, to ensure that high quality waterways are not degraded, and that all waters meet their minimum water quality criteria. Finally, ongoing monitoring requirements are enforced by EPA to determine whether WQS are met.[30]

The type and amount of exposure to a waterborne illness depends on how a person is using a waterbody. Therefore regulators choose different FIBs to develop specific protective numeric criteria for that specific "use". As stated above, this report is focusing on **Shellfish Harvest Use** and **Recreational Use (swimming, wading, paddling)** in the Navesink River. The criteria designed to protect human health for these uses differs in the FIB chosen, the allowed limits of the FIB, and sensitivity to water quality changes, yet both sets of criteria are designed to protect humans from the same risk; ***are there bacteria, microorganisms, or viruses in the water in an amount that poses an unacceptable risk to human health?***

It is important to understand the similarities and differences between Recreational Criteria and Shellfish Harvesting Criteria:

- Recreational Contact Criteria (swimming, wading, or splashing) utilizes **Enterococci** in salt water as an indicator of dangerous pathogen levels.
- Shellfish Harvesting Classification Criteria uses **fecal coliform** as an indicator of dangerous pathogen levels.

Both of these criteria seek to ascertain the presence and concentration of waterborne pathogens in the water, and whether swimming, wading or splashing, or eating the shellfish from a given area or waterway is safe.

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categorization of beach classification (see Table 4.12). Grant et al. (2001) presented a good example of this approach. They demonstrated that enterococci from stormwater, impacted by bird feces and wetland sediments and from marine vegetation, confounded the assessment of possible bather impact in the surf zone at southern Californian beaches. There will, however, be cases where animal feces is an important source of pollution in terms of human health risk [emphasis added].")

[29] Clean Water Act § 101(a).

[30] Clean Water Act § 303(d), 305(b).

a. Swimming and Wading, Paddling and Sailing: Primary and Secondary Contact Recreation Criteria

Recreational Contact Criteria is designed to protect humans from exposure to waterborne pathogens during full or partial immersion "where a high degree of bodily contact with the water, immersion and ingestion are likely."[31]

- **"Primary Contact Recreation"** are recreational activities that involve significant ingestion risks and includes, but are not limited to, wading, swimming, diving, surfing, and water skiing.[32] Primary Contact Recreation Criteria refers to water quality necessary to support these activities.
- **"Secondary Contact Recreation"** are recreational activities where the probability of water ingestion is minimal and includes, but not limited to, boating and fishing.[33] Secondary contact is intended to protect incidental contact such as a splash or partial submersion.

It should be noted that the Secondary Contact Recreation standards are less stringent than primary contact criteria, therefore a waterbody that must meet Primary Contact Criteria would meet secondary contact criteria by default. In New Jersey, Secondary Contact Criteria are only applied to lower quality waterways. This criteria is not applicable to the Navesink because it is designated as a higher quality waterbody. However, it is helpful to see the difference between what NJDEP determines to be the "safe" levels of bacteria for primary contact activities versus a secondary contact activity such as paddling.

It is also important to note that NJDEP tests for two specific Fecal Indicator Bacteria (FIB) for Recreational Water Criteria; *Escherichia coli* (*E. coli*) **in fresh water** and Enterococci **in salt water**.[34]

New Jersey's Surface Water Quality Standards (SWQS) states these recreation criteria for saline waters as such:

Primary Contact criteria for saline waters under New Jersey Surface Water Quality Standards states that "Enterococci levels shall not exceed a geometric mean (average) of 35/100 ml, or a single sample maximum of 104/100 ml."[35]
Secondary Contact Criteria: "For SE2 waters, Fecal coliform levels shall not exceed a geometric mean of 770/100 ml. For SE3 waters, Fecal coliform levels shall not exceed a geometric mean of 1500/100ml."

Furthermore, "in the years prior to 2004 the primary contact standard was 200 fecal coliforms per 100 mL of sample."[36]

b. Shellfish Harvesting Criteria

There is a direct relationship between pollution of shellfish growing areas and the transmission of diseases to humans through consumption.[37] Therefore water quality criteria for shellfishing waters classification is, similar to recreational contact criteria, focused on quantifying the amount of pathogens in the water, and intended to protect human health.

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[31] *See* 2012 Recreational Water Quality Criteria Fact Sheet, USEPA, *available at* http://www.ugra.org/pdfs/EPAfactsheet2012.pdf
[32] New Jersey Surface Water Quality Standards, found at N. J. A. C. 7:9B
[33] *Id*.
[34] *See* USEPA *Review of Coliphages as Possible Indicators of Fecal Contamination for Ambient Water Quality,* April, 2015. *Available at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2015-0300-0002*
[35] *See* NJ SWQS 7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters: (Expressed as Maximum concentrations unless otherwise noted)
[36] *See* CCMP Summary Report for 2006 and 2007, NJDEP
[37] *See Partial Sanitary Survey of Shellfish Growing Area NE-2: Navesink River 1999-2003,* NJDEP Water Monitoring and Standards, July 2005, *available at* http://www.nj.gov/dep/bmw/ReportMonmouth.htm

Note that shellfish criteria apply only to bivalves such as clams, oysters, and mussels, and are not applicable to crustaceans such as crabs.

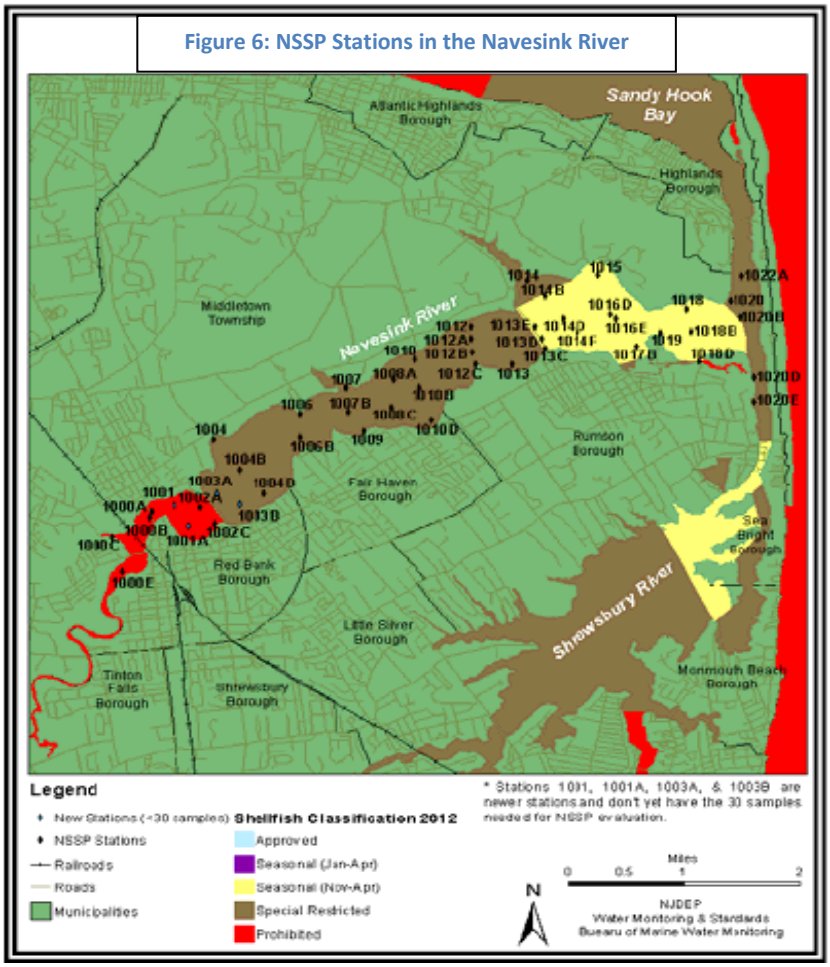

Figure 6: NSSP Stations in the Navesink River

Shellfish Harvesting Waters Criteria are derived from federal guidelines promulgated by the National Shellfish Sanitation Program (NSSP) that are established by the Interstate Shellfish Sanitation Conference (ISSC) and overseen within the Food and Drug Administration (FDA).[38] The NSSP was formed in 1925 due to an outbreak of typhoid fever in the early 1920's from eating raw shellfish that were contaminated by sewage.[39] The NSSP guidelines cover water quality criteria, water sampling program structure and frequency, number of patrols and enforcement, as well as other requirements a state shellfish sanitation program must have in order to legally sell shellfish in interstate commerce.

The NJDEP Bureau of Marine Water Monitoring performs water quality surveys and monitoring for shellfish harvesting areas within the federally approved NSSP Program, collecting approximately 15,000 water samples each year at over 2,500 sampling locations in the state's bays and ocean waters.[40] This data is also used in the Clean Water Act reporting requirements under sections 303(d) and 305(b) of the Clean Water Act.

Shellfish are filter feeders, and are known to accumulate pollutants in their tissues.[41] Shellfish consumption involves ingesting the entire organism, therefore the criteria for "approved" shellfishing areas are very strict, as consuming just one contaminated shellfish could send a person to the hospital or worse. In fact, shellfish harvesting criteria for "approved" waters is more stringent than for primary contact recreation. What this means is that Water Quality Standards in New Jersey allow a person to swim in water that is too polluted to safely harvest shellfish within it, and in fact, this is exactly what is occurring in the Navesink River. Therefore, shellfish harvesting criteria is the most protective standard for water quality.

Some waters can be open to harvest with no restrictions; also known as "direct harvest" waters. These waters are classified as "Approved areas" and reflect very low amounts of coliform bacteria and generally clean waters (for bacteria). As coliform counts increase, waters are classified as "Special Restricted areas"; moderately polluted waters

[38] *See* Growing Area Classifications, NSSP 2015 Guidelines, Chapter IV, page 54, *available at* http://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm
[39] *See* http://www.harborestuary.org/pdf/hepshellfish.pdf , NSSP 1998; NJDEP 1998.
[40] *See* NJDEP Bureau of Marine Water Monitoring website, *available at* http://www.nj.gov/dep/bmw/waterclass.htm
[41] *See* Marine Water Pollution: Shellfish Waters, updated 2014, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.nj.gov/dep/dsr/trends/pdfs/marine5.pdf

that are approved for harvest only if followed by post harvesting processing such as depuration or relay process that remove harmful bacteria from the shellfish. Finally, when water quality reaches a point where shellfish cannot be safely harvested for consumption at any time of year, even considering post-harvest processing, the waters are classified as Prohibited.[42] Prohibited means "a classification used to identify a growing area where the harvest of shellfish for consumption is not permitted."[43] Note also that seasonal restrictions can also be applied to waters. Seasonal status can be applied to both approved and restricted waters and would thus be classified as "seasonal approved" depending on the results of water sampling at certain times of year.[44]

The standards for both fecal and total coliform in approved and restricted waters are below. Note that if a waterbody does not meet restricted criteria, the water is classified as prohibited:

- **FECAL COLIFORM**
  - **Standard for the Approved Classification of Growing Areas Affected by Nonpoint Sources:** The fecal coliform median (or geometric mean MPN or MF (mTEC)) of the water sample results *shall not exceed fourteen (14) per 100 ml*.[45]
  - **Standard for the Restricted Classification of Growing Areas Affected by Nonpoint Sources and Used as a Shellstock Source for Shellstock Depuration:** The fecal coliform median or geometric mean MPN or MF (mTEC) of the water sample results *shall not exceed 88 per 100 ml*.[46]
- **TOTAL COLIFORM**
  - **Standard for the Approved Classification of Growing Areas Affected by Nonpoint Source Pollution**: The total coliform geometric mean of the water sample results for each sampling station *shall not exceed 70 MPN per 100 ml*.
  - **Standard for the Restricted Classification of Growing Areas Affected by Nonpoint Sources and Used as a Shellfish Source for Shellfish Depuration:** The total coliform geometric mean MPN of the water sample results for each sample *shall not exceed 700 per 100 ml*.

Table 1: Criteria for Systematic Random Sampling Strategy

CRITERIA FOR SYSTEMATIC RANDOM SAMPLING STRATEGY				
Classification	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric Mean (MPN/100 mL)	Max. 90th Percentile (MPN/100 mL)	Geometric Mean (MPN/100 mL)	Max. 90th Percentile (MPN/100 mL)
Approved	70	330	14	49
Special Restricted	700	3300	88	300

From the NSSP Guidelines

And here are the standards for Shellfish compared side by side to surface water quality standards:

[42] *See* Growing Area Classifications, NSSP 2015 Guidelines, Chapter IV, page 54, *available at* http://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm
[43] *See* N.J.A.C. 7:12 Shellfish Growing Water Classification
[44] Subchapter 5. Seasonal Special Restricted Shellfish Growing Waters, *See* N.J.A.C. 7:12 Shellfish Growing Water Classification
[45] *See* Growing Area Classifications, NSSP 2015 Guidelines, Chapter IV, page 54, *available at* http://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm
[46] *Id*.

Table 2: Water Quality criteria expressed in CFU/100 mL[47]

Bacterial Indicator	NJ Surface Water Quality Standards (SWQS)		National Shellfish Sanitation Program (NSSP)
	Within 1500 ft. of shoreline	1500 ft. to 3 mi. from shoreline	
Total Coliform	N/A	N/A	• Geometric Mean (Geomean) shall not exceed 70 • No more than 10% of samples shall exceed 330 for APC monitoring • Estimated 90th percentile shall not exceed 330 for SRS monitoring
Fecal Coliform	• Geomean shall not exceed 50	• Geomean shall not exceed 200 • No more than 10% in any 30-day period to exceed 400	• Median or geomean shall not exceed 14 • No more than 10% shall exceed 49 for APC monitoring • Estimated 90th percentile shall not exceed 49 for SRS monitoring
Enterococcus	• Geomean shall not exceed 35 • Single sample shall not exceed 104	N/A	N/A

c. Other Water Quality Criteria

There are many other Surface Water Quality Criteria parameters relevant to the Navesink River. These criteria are all linked to the "fishable, swimmable, aquatic life" objectives under the Clean Water Act and include criteria for dissolved oxygen levels, toxics, chemicals, heavy metals, pesticides, and the presence of aquatic macroinvertebrates. These will be the subject of future review and evaluation by Clean Ocean Action.

IV. The Navesink River Today

a. Current Designations

As detailed below, the Navesink River is an SE1 (C1) waterbody – this classification reflects the current designated uses of the Navesink River, as well as the antidegradation category the river falls under.[48] The "SE1 (C1)" designation reflects that the Navesink is an **exceptional waterbody**, and has several designated uses that depend upon some of the highest standards of water quality and water quality protection in the State:

- **SE1** refers to the type and uses of the waterbody. The Navesink is a **Saline Estuary** with the highest designated use categorization for saline waterways (the 1 in SE1) which include:
  - Shellfish harvesting
  - Maintenance, migration and propagation of the natural and established biota;
  - Primary contact recreation; and
  - Any other reasonable uses.[49]
- **C1** is an abbreviation for "Category 1" – an "exceptional" waterbody subject to additional protections from ***any measurable change*** in water quality due to their exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources. This designation relates to the concept of "**antidegradation**" standards for C1 streams of "***no change in existing water quality"*** –

[47] Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12 Atlantic Coastal Water Region, 2006, at 10, *available at* http://www.nj.gov/dep/wms/bear/coastal_pathogen_tmdls_wma12%20for%20adoption.pdf

[48] *See* NJ SWQS at 7:9B-1.15 Surface water classifications for the waters of the State of New Jersey

[49] New Jersey Surface Water Quality Standards at NJAC 7:9B-1.12(d)

importantly, "***including calculable or predicted changes***" and "***without adverse impacts on organisms, communities, or ecosystems of concern."***[50]

- **Shellfish Harvesting Classification Criteria** for Fecal Coliform:
  - Fecal Coliform should not exceed a geometric mean of *fourteen (14) per 100 ml* in approved waters and *88 per 100 ml* in restricted waters.[51]
- For ***Primary Contact Criteria***:
  - Enterococci levels shall not exceed a geometric mean of 35/100 ml, or a single sample maximum of 104/100 ml."[52]
  - Note that prior to adopting enterococci criteria, NJDEP and many other states used Fecal Coliform as the FIB for primary contact criteria, with a single sample maximum of 200/100ml.[53]

Earlier in this report, it was stated that designated uses assigned to a waterbody do not have to reflect the actual condition of the waterbody – they can be aspirational. When a waterbody does not meet a designated use i.e., when the measurements of a given parameter do not meet the criteria reflecting the designated uses, the waterbody is said to "not attain" the designated use, and is considered **"impaired"**.[54] This triggers a federally mandated listing of the impaired waterbody, reporting to EPA, and the prioritization of impaired waters for cleanup plans (called TMDLs or Total Maximum Daily Loads).[55] These requirements will be discussed later in the report.

b. Swimming in the Navesink

Support for primary contact recreation is one of the key purposes of the Clean Water Act.[56] Furthermore, as noted above, the Navesink is designated as an SE1 (C1) waterbody – an exceptional waterway whose water quality must support shellfish harvesting, maintenance, migration and propagation of the natural and established biota, primary contact recreation; and any other reasonable uses.[57] However, the Navesink River does not meet swimmable water quality standards.[58] According to NJDEP, "the river remains safe for boating."[59] However, this is a much lower water quality bar to meet compared to the standards for safe swimming and immersion activities.

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[50] *See* New Jersey Surface Water Quality Standards at NJAC 7:9B-1.5(d)2.iii.

[51] *See* Growing Area Classifications, NSSP 2015 Guidelines, Chapter IV, page 54, *available at* http://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm

[52] *See* NJ SWQS 7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters: (Expressed as Maximum concentrations unless otherwise noted)

[53] *see* N.J.A.C. 8:26-8.8 Closure of Bathing Beaches, *see also* 2005 New Jerse SWQS.

[54] *See* Clean Water Act §303(d) (mandates that states submit to USEPA, on a biennial basis, a list of waters that do not support their designated uses because they are not meeting surface water quality standards despite the implementation of technology-based effluent limits. All such waters must be identified on the 303(d) List of Water Quality Limited Waters ("303(d) List")). *See also* Clean Water Act § 305(b) (mandates that states submit to USEPA on a biennial basis, a Statewide Water Quality Inventory Report or "305(b) Report" that describes the status of principal waters in terms of overall water quality and support of designated uses, as well as strategies to maintain and improve water quality.)

[55] *Id*.

[56] Clean Water Act § 101(a).

[57] New Jersey Surface Water Quality Standards at NJAC 7:9B-1.12(d)

[58] *See* Waterbody Quality Assessment Report, USEPA, *available at* https://iaspub.epa.gov/waters10/attains_waterbody.control?p_au_id=NJ02030104070110-01&p_cycle=2012&p_state=NJ&p_report_type, *see also* Draft 2014 New Jersey Integrated Water Quality Assessment Report, Draft 2015, NJDEP Division of Water Monitoring and Standards, Appendix A at page 19, *available at* http://www.state.nj.us/dep/wms/bears/docs/2014_draft_integrated_report_with_appendices.pdf

NJDEP oversees the Cooperative Coastal Monitoring Program (CCMP), which utilizes 215 monitoring locations -- including 185 along the ocean and 30 in the bay -- where water samples are taken every Monday during the swimming season by local and county health agencies to ensure that water quality remains safe for swimming.[60]

Figure 7: Swimming near stormwater outfall, Navesink River, NJ

Currently, New Jersey's CCMP provides weekly water quality monitoring only at "bathing beaches", a regulatory term that refers ONLY to beaches that are lifeguarded.[61] While there are many other water quality monitoring programs in the Navesink, including NJDEP's Ambient Monitoring Program, NSSP Program, and USGS Water Sampling, none of these programs sample as frequently and consistently as the CCMP. **It is only through the CCMP program that swimming areas are sampled weekly during the swimming season, and "swimming advisories" or "closures" due to pathogen levels are issued.**[62] Currently, there are no lifeguarded beaches in the Navesink, therefore, **no weekly testing requirement for swimming areas and beaches in the Navesink**, no matter how heavily and regularly used.

Yet it is undeniable that people partially or totally immerse themselves in the river frequently during the warmer months, whether through swimming, paddling, or wading. As the population swells each summer with paddlers, water skiers, swimmers, and other total and partial immersion activities, pathogen pollution, and the potential for illness, becomes an increasingly pressing concern. Furthermore, as Monmouth County continues to expand access points to the Navesink and encourages people to use the river, it becomes increasingly clear that the Navesink must be monitored and made safe for these types of uses.[63] ***Today, water monitoring specifically for recreational use in the Navesink is not occurring, nor are areas of high use being posted to indicate potentially unsafe water quality conditions.***

In fact, in 2009, Monmouth County issued what appears to be a public health advisory titled "Stormwater Runoff Advisory", which states "Stormwater runoff can cause health standards to be exceeded for recreational uses in streams, estuaries, and the ocean."[64] "The Health Department recommends that you avoid contact with water near flowing stormwater outfall pipes, streams, and wetlands; and when water becomes muddy from resuspended sediments."[65]

NJDEP Bureau of Marine Water Monitoring, Monmouth County Health Department, and United States Geological Survey have undertaken water sampling operations of differing scopes and scales in the Navesink River. The data is publicly available online and a subset has been included as Appendix C and D of this report.[66] As a review of this data indicates, there are repeated single sample maximum exceedances of the enterococci standard for Primary Contact Recreation, as

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[59] *See* DEP Launches Study of Water Quality in the Navesink River, NJDEP Press Release June 24, 2016, *available at* http://www.nj.gov/dep/newsrel/2016/16_0063.htm

[60] *See* NJBEACHES.org, *see also* NJ SWQS 7:9B. NOTE: there are no CCMP stations in the Navesink currently, because there are no lifeguarded beach.

[61] *See* N.J.A.C. *8:26-5.10* Bathing Beach Supervision, N.J.A.C. 8:26-7.16 Sample Collection at Bathing Beaches, N.J.A.C. 8:26-8.8 Closure of Bathing Beaches. *See also* http://www.nj.gov/dep/wms/Loftin%20-%20Coastal%20Coop%20Monitoring.pdf

[62] *Id*.

[63] *See* Claypit Creek Expansion proposal, and Swimming River Park proposal

[64] *See* Stormwater Runoff Advisory, 2009, Monmouth County Health Department Website, *available at* http://co.monmouth.nj.us/documents/118%5CmchdStormwaterRunoffAdvisory.pdf

[65] *Id*.

[66] *See* EPA STORET Database, USGS database, Monmouth County Health Department website FIND WEBSITES detail MCHD lab closures and monitorning

well as the older Fecal Coliform Primary Contact single sample maximum.[67] As seen in this data set, the Navesink River's presence on USEPA's 303(d) list for numerous pollutants including pathogen impairments, and the 2014 Integrated Report, overall water quality in the Navesink River does not currently support swimming.

While the exact nature of this impairment must be further studied, it appears that swimming conditions in the Navesink are subject to high variance.[68] As NJDEP's 2008 MST study and Monmouth County Health Department Stormwater Runoff Advisory indicate, this variance is most likely correlated with rain events, and a strong seasonal influence.[69] This essentially means that water quality conditions are most likely at their worst, during and soon after a rain event, and underscores how important a recreational water quality monitoring program, utilizing frequent routine and storm event sampling, is to public health and safety.

Unfortunately, between 2007 and 2009, funding for recreational water quality monitoring was reduced at the Federal and State levels.[70] To accommodate these cuts, NJDEP no longer tests at what were once called "environmental monitoring stations" – these included areas that were known to be heavily used by the public such as bay and river beaches, but with no formal lifeguard and "bathing beach" designation.[71] Furthermore, at the County level, 2009 marked the start of funding cuts to the Monmouth County Health Department laboratory. Today, most county lab work is outsourced. While MCHD, and the Monmouth County Regional Health Commission continue to sample bathing beaches under the CCMP, the expertise and ability to perform microbial analysis has been lost.

c. Shellfish Harvesting in the Navesink

The New York/ New Jersey Harbor estuary was once one of world's largest and most well-known shellfish harvesting areas.[72] The Navesink River alone holds over 2,600 acres of potential shellfish harvesting area.[73] Yet multiple downgrades of shellfish harvesting areas in the Navesink have occurred since 2005 totaling over 700 acres prohibited to shellfish harvesting.[74] USEPA lists the Navesink as impaired for shellfish harvesting.

Today the last direct harvest beds reside at the mouths of Shrewsbury and Navesink Rivers. The map below (Figure 9) is taken from the NJDEP Bureau of Marine Water Quality Monitoring NSSP Interactive Map, and shows shellfish waters classifications for the Navesink River – Red is Prohibited, Light Tan is Suspended by Administrative Order, Brown is

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[67] *See* N.J.A.C. 8:26-7.18 Microbiological Water Quality Standards for Bathing Beaches ("The estimated fecal coliform concentrations shall not exceed 200 fecal coliform per 100 milliliters.")

[68] *See* Appendix C and D for NSSP and Monmouth County Health Department data showing fluctuations in fecal coliform levels, with spikes well above the recreational use standard of 200 fecal coliform/ 100ml.

[69] *see*

[70] What's At Stake: Beach Protection Act of 2007, Surfrider Foundation, http://webcache.googleusercontent.com/search?q=cache:Ic8cSmLrNMUJ:actionnetwork.org/campaign/beachact_2007/explanation&cd=1&hl=en&ct=clnk&gl=us (Google cache)

[71] *See* CCMP Summary Report for 2006 and 2007, NJDEP, at page 3 ("In 2007 the Cape May County Health Department removed all environmental bay monitoring stations from the program in order to focus limited sampling resources on recreational bathing sites."

[72] *see History on the Half-Shell: The Story of New York City and its Oysters,* New York Public Library, *available at* http://www.nypl.org/blog/2011/06/01/history-half-shell-intertwined-story-new-york-city-and-its-oysters#2, *see also* Locust, Middletown Borough, *available at* http://www.middletownnj.org/244/Locust ("In the early 19th century, the "Shrewsbury" or Navesink River oyster was considered a great delicacy. Clay Pit Creek became an active center of shellfishing, as well as an ideal harbor for the boat men who sailed to New York with clams and oysters for the restaurant trade.").

[73] Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP, 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/

[74] NJDEP 2005 Administrative Closure of 152 acres + 2015 administrative closure of 565 acres = 717 acres now prohibited. *See* NJDEP Bureau of Marine Water Monitoring News, *available at* http://www.nj.gov/dep/bmw/news.html

Special Restricted, and the Light Greenish Color overlaying the Brown is Seasonally Approved Waters open only from November through April. The gold dots reflect NJDEP Bureau of Marine Water Monitoring NSSP sampling stations.

NOTE: 2016 maps are not yet available. The "light tan" area of the Navesink River, reflecting a "Suspended by Administrative Order" classification will soon be turned RED for "prohibited" when NJDEP finalizes its' 2016 Shellfish Classification Rules.

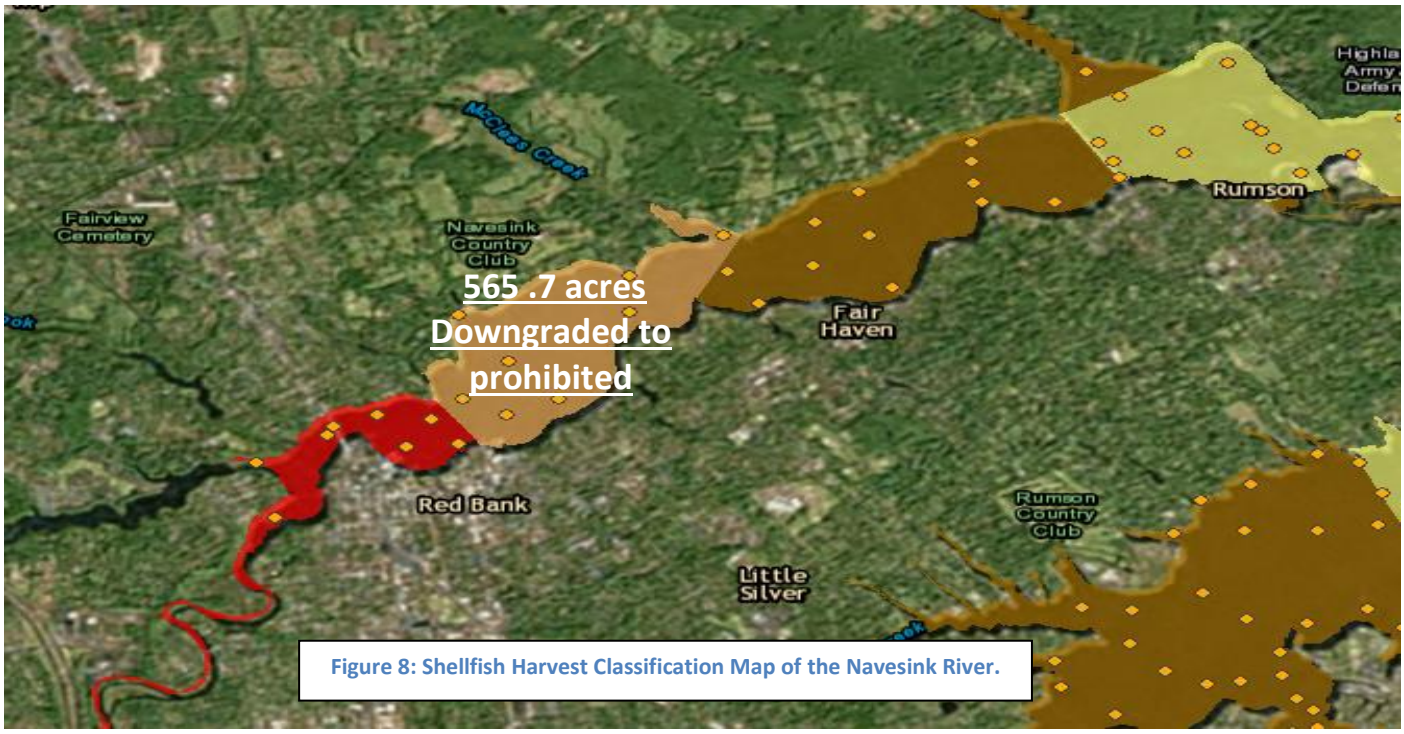

Figure 8: Shellfish Harvest Classification Map of the Navesink River.

The current trends in deteriorating water quality indicate that the seasonally open shellfish beds on the east side of the Oceanic Bridge are at a heightened risk of closure.[75]

d. EPA's 303(d) List –A Waterway Report Card

Section 305(b) of the Clean Water Act requires states to assess and report on the water quality status of waters within the states. NJDEP uses the data collected from the NSSP, and other ambient stations monitored by NJDEP, USGS, and approved entities to fulfill this assessment and reporting requirement. Section 303(d) requires states to "list" waters that are not attaining water quality standards and submit these lists of impaired waters to EPA. EPA manages a nationwide database containing these reports and water quality data.

[75] DEP Launches Study of Water Quality in the Navesink River, NJDEP Press Release, June 24, 2016, *available at* http://www.nj.gov/dep/newsrel/2016/16_0063.htm ("The downgrades have been incrementally moving downstream to the mouth of the river.").

Table 3: 2012 Waterbody Report for Navesink River (below Rt. 35)/Lower Shrewsbury[76]

Designated Use	Designated Use Group	Status
Agricultural Water Supply	Agricultural	Good
Aquatic Life	Fish, Shellfish, And Wildlife Protection And Propagation	Impaired
Fish Consumption	Aquatic Life Harvesting	Impaired
Industrial Water Supply	Industrial	Good
Primary Contact Recreation	Recreation	Impaired
Public Water Supply	Public Water Supply	Not Assessed
Shellfish Harvesting	Aquatic Life Harvesting	Impaired

As seen in the chart, the Navesink River is listed as not supporting the designated uses of Aquatic Life, Recreation, Shellfish, and Fish Consumption due to numerous pollutants including pathogens.[77] In 2015, NJDEP released its most recent report to EPA detailing water quality in the State. This report also lists the Navesink as impaired for chemicals such as PCBs and DDT, low amounts of Dissolved Oxygen due to excess nutrient loading, as well as high levels of pathogens such as Total Coliform, Fecal Coliform, Enterococcus, and *E.Coli*.[78] It is clear that efforts to date have not been successful at achieving and maintaining fishable, swimmable standards in the Navesink. See Appendix B for a chronology detailing these past efforts.

e. The Navesink River in a Statewide Context

The Navesink River is not immune to the water quality issues that have impacted coastal waterways up and down the roughly 120 miles of coastline in New Jersey. In fact, the Navesink exhibits many of the characteristics seen statewide; high population densities, large areas of impervious surface cover from sprawling commercial, residential, and

[76] *See* Waterbody Quality Assessment Report, USEPA, *available at* https://iaspub.epa.gov/waters10/attains_waterbody.control?p_au_id=NJ02030104070110-01&p_cycle=2012&p_state=NJ&p_report_type

[77] Id. *see also* Draft 2014 New Jersey Integrated Water Quality Assessment Report, Draft 2015, NJDEP Division of Water Monitoring and Standards, Appendix A at page 19, *available at* http://www.state.nj.us/dep/wms/bears/docs/2014_draft_integrated_report_with_appendices.pdf.

[78] *Id*.

waterfront development, aging infrastructure, and an underlying legacy of industrial and residential pollution.[79] As a result, problems such as anoxic conditions (low Dissolved Oxygen levels), phytoplankton blooms, public health risks such as high pathogen levels and Harmful Algal Blooms (HABs) and changes in abundance of commercially valuable fish and shellfish have frequently been documented in New Jersey coastal waters.[80]

The NJDEP Integrated Report is a biannual requirement under the Clean Water Act, and provides for a "snapshot" of water quality conditions over a relatively short period of time, as well as an overview of water quality conditions on a statewide basis.[81] The 2014 Integrated Report, was released on February 1, 2016, and relies on water quality data generated from January 1, 2008 through December 31, 2012.

The report shows a statewide negative trend toward impaired conditions. In particular, analysis contained in the report "shows median concentrations of [total dissolved solids], chlorides, dissolved nitrate plus nitrite and total nitrogen increased statewide during the assessment period."[82] Likewise, statewide sampling showed "a slight negative trend toward impaired conditions," with one of the strongest trends being "the decline of non-impaired ('Excellent' and 'Good') sites."[83]

The 2014 Integrated Report confirms that, while great progress has been made in addressing the discreet industrial sources of water pollution from the 70's and 80's, continued development and population pressures have impacted New Jersey waters in a negative way. These are systemic and statewide problems that have been decades in the making:

- **2008:** Designated uses were fully attained in 37 out of 480 *(7.7%)* fully assessed subwatersheds.
- **2010**: Statewide, 355 miles of rivers and streams, and 1,465 acres of lakes located within 27 subwatersheds *(3%)* fully support all designated uses (except for fish consumption).
- **2012:** Statewide, 400 miles of rivers and streams, and 1,560 acres of lakes located within 23 of New Jersey's 952 *(2.1%)* subwatersheds fully support all designated uses (except for fish consumption).
- **2014**: Statewide, 205 miles of rivers and streams, and 2,197 acres of lakes located within 14 of New Jersey's 958 *(1.5%)* subwatersheds fully support all designated uses (except for fish consumption).

[79] *See* Beach, D. 2002. Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States. Pew Oceans Commission, Arlington, Virginia. *See also* 2014 New Jersey Integrated Water Quality Assessment Report, Draft 2015, NJDEP Division of Water Monitoring and Standards, at page vii-viii, *available at* http://www.state.nj.us/dep/wms/bears/docs/2014_draft_integrated_report_with_appendices.pdf

[80] *See* NJDEP Ambient Monitoring Program, Report on Marine and Coastal Water Quality, 1993-1997, prepared by Bonnie J. Zimmer, Ph. D, and Sandra Groppenbacher.

[81] *See* Draft NJDEP 2014 Integrated Report, *see also* Clean Water Act § 305(b) (mandates that states submit to USEPA on a biennial basis, a Statewide Water Quality Inventory Report or "305(b) Report" that describes the status of principal waters in terms of overall water quality and support of designated uses, as well as strategies to maintain and improve water quality.)

[82] 2014 New Jersey Integrated Water Quality Assessment Report, Draft 2015, NJDEP Division of Water Monitoring and Standards, Appendix A at page 52, *available at* http://www.state.nj.us/dep/wms/bears/docs/2014_draft_integrated_report_with_appendices.pdf.

[83] *Id.*

EPA lists stormwater related pollution issues as a source of impairment for more New Jersey waters than any other source.[84] According to that assessment, urban stormwater is causing impairments in 13,093.9 miles of rivers, 26,865.9 acres of lakes, reservoirs, and ponds, 193.7 square miles of bays and estuaries, and 371.9 square miles of ocean and near coastal waters.[85] This rain event driven pollution problem puts human and ecosystem health at risk in the Navesink, and state wide.

V. Land Use and Water Quality

The term "land use" describes the footprint left by human activity upon the landscape. [86] According to one source, Water Quality declined in 35% of NJ watersheds during the 1990s and these declines were linked to changes in land use.[87] Development of forested and agricultural areas into residential and commercial areas, and the attendant construction of wastewater, road, and other infrastructure is a primary cause of water quality impacts throughout the Navesink watershed.[88] Therefore, it is critically important to understand how the Navesink Watershed has been developed in the past 40 years, and how this correlates to water quality issues

a. Land Use Trends in Monmouth County

Following World War II, rapid population growth and the development of road infrastructure and suburban development changed the landscape of the State. "From 1950 to 1980, the suburbs were king in New Jersey. Suburban Sprawl marched across the state's suburban and rural counties while the urban core declined, laying the foundation for the state's densely packed population that we still see today."[89]

According to the New Jersey Department of Workforce and Labor, Monmouth County's population exploded by over 36 percent from the period 1970 to 2012."[90] According to a 1982 NJDEP report, "[p]opulation growth between 1970 and 1980 occurred throughout the basin, with the largest suburban centers located at Middletown Township and Red Bank."[91]

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[84] New Jersey Water Quality Assessment Report, USEPA, (2012), *available at* https://ofmpub.epa.gov/waters10/attains_state.control?p_state=NJ.
[85] *Id.*
[86] *see* Barnegat Bay Partnership website at http://bbp.ocean.edu/pages/147.asp *see also* Impacts of Impervious Cover on Aquatic Systems, Watershed Protection Research Monogrpah No. 1, *available at* http://clear.uconn.edu/projects/tmdl/library/papers/Schueler_2003.pdf
[87] Rivers in Danger: The Impact of Development on Water Quality In New Jersey, New Jersey Interest Research Group, Law and Policy Center, April 2003, *available at* http://research.policyarchive.org/5180.pdf
[88] *See* NJDEP 2005 Navesink Sanitary Survey
[89] Growth in New Jersey is Changing, Steven Stirling, NJ Advanced Media, *available at* *http://www.nj.com/news/index.ssf/2016/03/njs_fastest_growing_towns.html#1*
[90] Monmouth County Community fact Book, New Jersey Department of Labor and Workforce Development, June 2014, *available at* http://lwd.dol.state.nj.us/labor/lpa/pub/factbook/monfct.pdf
[91] Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP, 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/

The Monmouth County Water Quality Management Plan, cited in that 1982 NJDEP Bacterial Contamination report, estimated at that time that land use in the Navesink River Basin was constituted as "32% forested, **29%** residential, commercial and industrial; 23% cleared land; 11% wetlands, 4% surface water; and 1% vacant land."[92]

The 1982 Monmouth County Growth Management Guide states that "**developed land** had grown from 97,416 acres, representing **31.9% of all land in the county in 1966**, to 132,587 acres (**43.5%) in 1974** and 156,549 acres (**51.3%) of all land by 1980**."[93]

A 1985 report by the Monmouth County Panning Board, titled "Land Use in the Swimming and Manasquan River Reservoir Watersheds" states succinctly, "As part of the New York Metropolitan Region, Monmouth County is directly affected by the economic and population trends of the Region as a whole. One of these trends is the deconcentration of the larger economic and population centers, which has led to the increased development of the Region's suburban areas, including Monmouth County. In 1966 Monmouth County was 68% undeveloped. ***By 1980, the amount of undeveloped land had dropped to 48%.***"[94]

However, the predominant land use patterns - agriculture and open spaces turned into residential, suburban infrastructure, and urban development, continue. The Draft 2016 Monmouth County Master Plan Update developed helpful visual comparisons of land use data between 1986 and 2012, shown below a figures 9 and 10, which indicate that "the largest change can be attributed to residential uses (+6.7%) which now accounts for 32.5% of all land use in the county."[95] Note the changes in land use surrounding the Navesink, as well as the areas to the west of the Navesink from which the primary headwaters of the Swimming River flow. As figure 12 on page 29 illustrates, once a watershed reaches 10% impervious cover (pavement, roads, compacted soil), water quality within the watershed begins to decline.

Importantly, Monmouth County Parks System's and Monmouth Conservation Foundation's work to identify and preserve open space and farmland have been essential in helping to preserve the rural character and ecological function of the county. Monmouth Conservation Foundation has preserved over 22,500 acres of open space and farmlands over its 38 years of existence.[96] Monmouth County Freeholders and Recreation Commissioners have supported the preservation of over 16,500 acres of open space and an additional 2,792 acres of easements as part of the Monmouth County Park System.[97] Both organizations are working to preserve waterfront across Monmouth County.

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[92] *Id.*
[93] Land Use Element, Monmouth County Planning Board 2015 Draft Master Plan Update.
[94] 1985 report by the Monmouth County Panning Board, titled "Land Use in the Swimming and Manasquan River Reservoir Watersheds"
[95] Land Use Element, Monmouth County Planning Board 2015 Draft Master Plan Update.
[96] *See* About Us, Monmouth Conservation Foundation Website, *available at* www.monmouthconservation.org.
[97] *See* County Open Space Program, Monmouth County Parks System, *available at* https://www.monmouthcountyparks.com/page.aspx?ID=2588

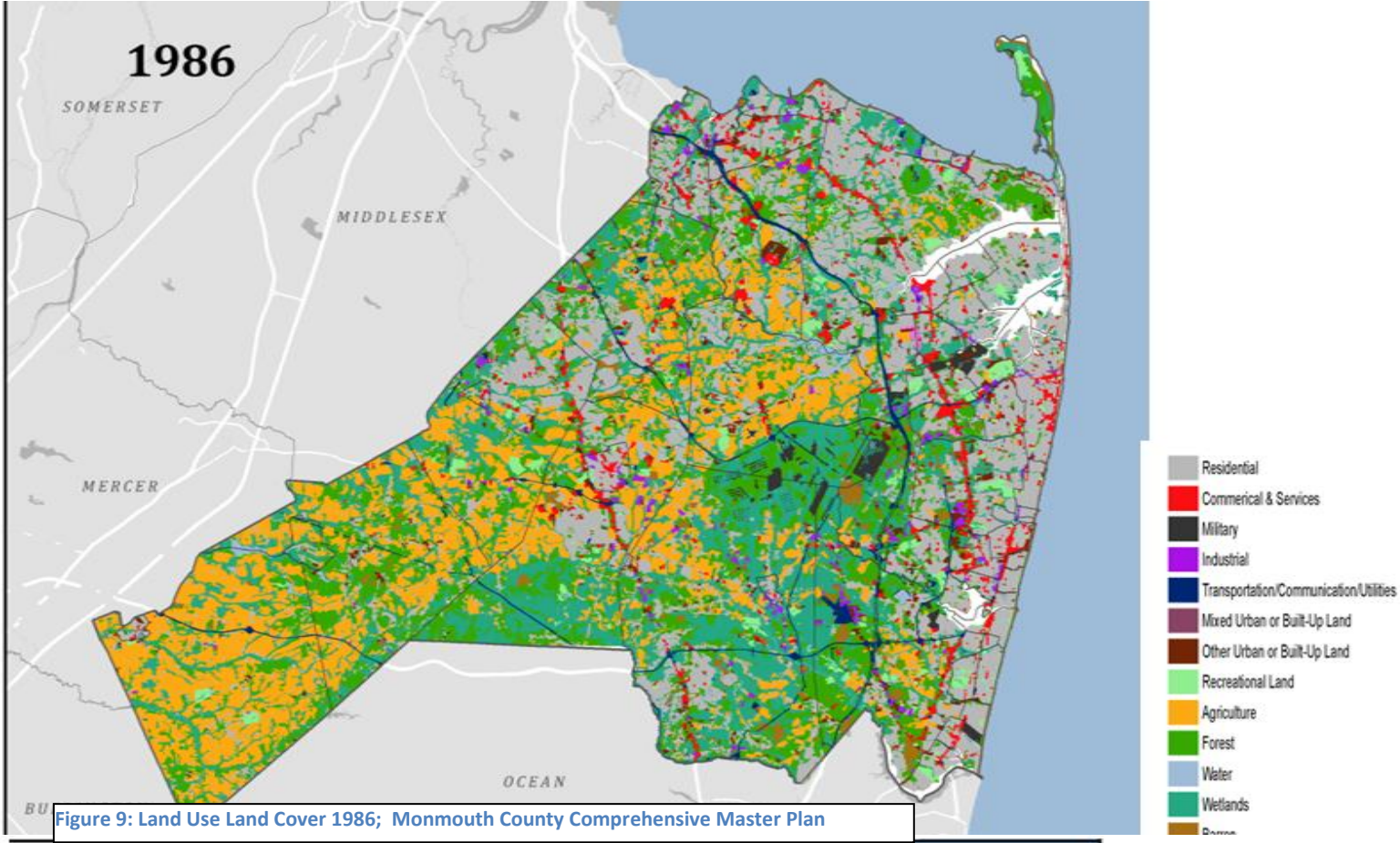


Figure 9: Land Use Land Cover 1986; Monmouth County Comprehensive Master Plan

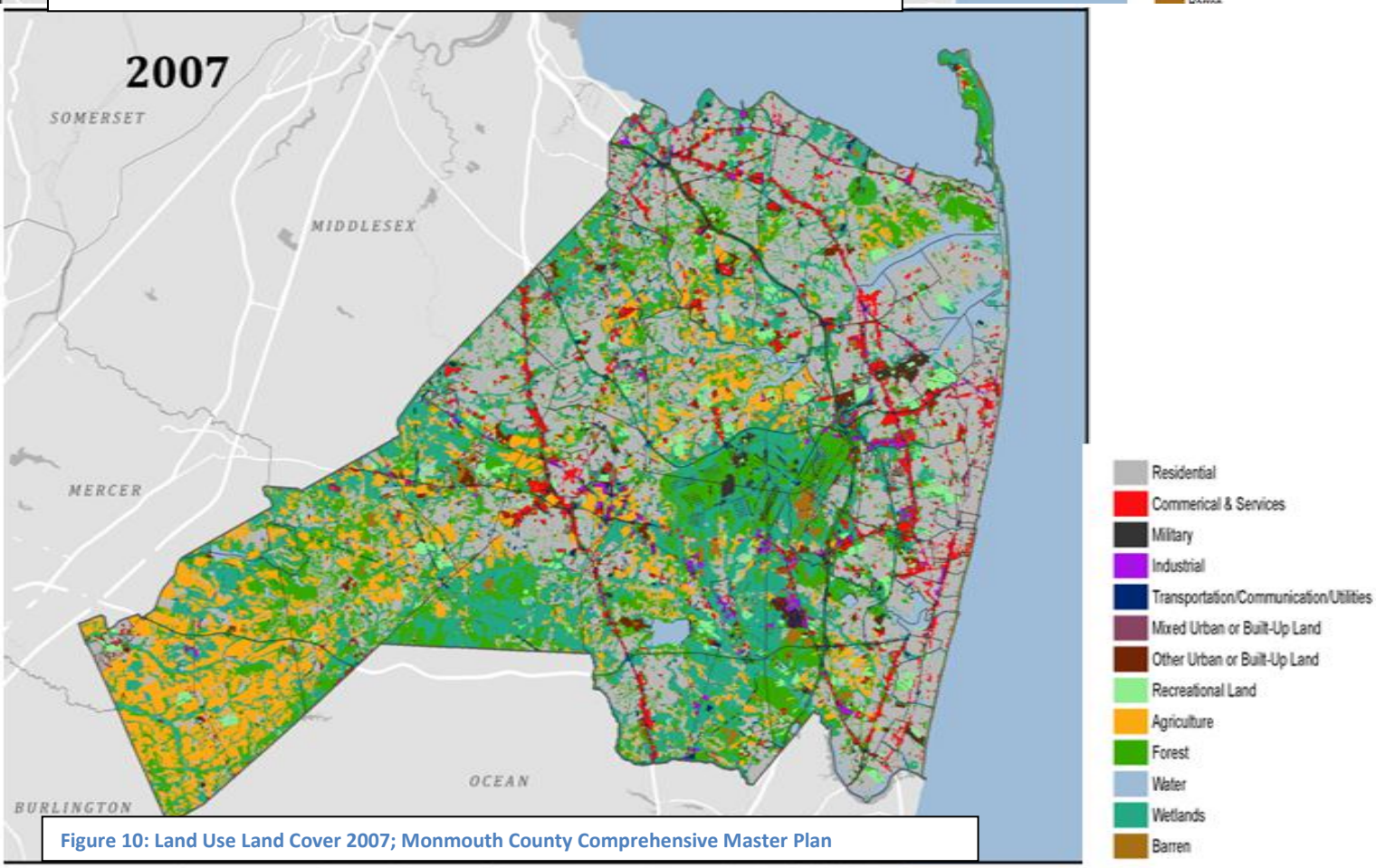


Figure 10: Land Use Land Cover 2007; Monmouth County Comprehensive Master Plan

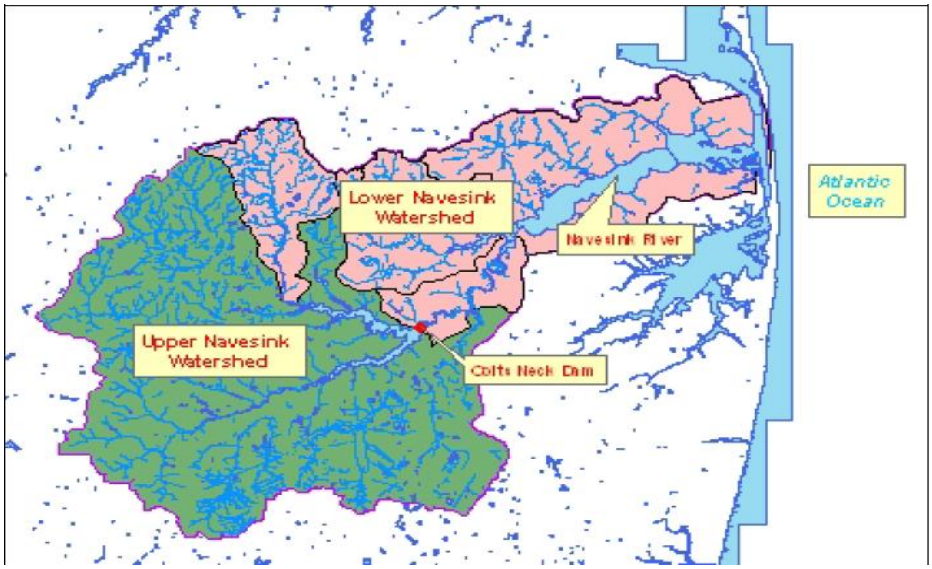


Figure 11: The Upper and Lower Navesink Watersheds, from Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed

b. The Upper Watershed

The Upper Navesink Watershed is defined as the land area located above the Colts Neck Swimming River Dam.[98] According to a 1982 report by NJDEP, "The headwaters of the Navesink generally flow through moderately sloping, *sparsely* developed rural/agricultural lands, whereas the mainstem of the river traverses densely populated areas as it approaches the coast."[99] In 2011, Rutgers Equine Science Center funded study found that open space and agricultural land comprise 44.2% of the total upper watershed, followed by wetland and open waters at 26.5% and then developed residential and commercial properties at 29.3%.[100]

Table 4: Percentage of Land Use Cover and Groundwater Recharge Rate of the Upper Navesink Watershed – taken from Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed, 2011.

Upper Navesink River Regional Watershed (Above Dam) Ground-Water Recharge Rankings					
Total Land Area	**Land Use**	**% of Sub-Watershed**	**Rainfall Volume Recharged**	**Avg. Recharge Rate**	**GWR**
(Acres)	**Description**		**(Gallons/Yr)**	**(In./Yr.)**	**Rank**
1,466	Landscaped Open Space	4.23	545,403,949	15	B : 11-15 in/yr
7,205	Agricultural	20.78	2,476,891,212	13	B : 11-15 in/yr
936	Brush - shrubs, weeds and grass	2.70	319,402,253	16	A : 16-23 in/yr
5,715	Woods, orchards, and tree nurseries	16.48	1,950,172,341	15	B : 11-15 in/yr
1,724	Residential 1/2 to 1 acre lots	4.97	508,472,509	11	B : 11-15 in/yr
5,973	Residential 1 to 2 acre lots	17.23	1,928,242,784	13	B : 11-15 in/yr
249	Unvegetated	0.72	71,699,928	12	B : 11-15 in/yr
14	Residential 1/8 acre lots	0.04	1,867,584	5	D : 1-7 in/yr
1,236	Landscaped Commercial	3.56	36,667,371	2	D : 1-7 in/yr
10,153	Wetland and Open Water	29.28			
Total					
34,671			7,838,819,934		

[98] Bill Sciarappa, PI, Brian Hulme and Kevin Soldo, Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed, 2011. Rutgers Equine Science Center, at page 11.
[99] Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP, 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/, at page 1.
[100] Bill Sciarappa, PI, Brian Hulme and Kevin Soldo, Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed, 2011. Rutgers Equine Science Center, at page 12.

The study found that the overall health of the upper watershed was "relatively good", and that the preservation of agricultural areas and open space was immensely valuable both economically, as well as ecologically in the critical roles these open spaces play in the health of both the upper and lower watersheds.[101]

"Basically, the overall health and natural resource wealth of the Upper Navesink Watershed is relatively good. Residential communities are amply spaced and their lawns do not appear to be excessively fertilized. Equine operations are largely in compliance with best management practices with few exceptions, although pasture management can always be improved everywhere. It remains difficult to manage the ever-growing deer and goose populations, but several programs are in progress."[102]

However, the authors of the study also acknowledge the impacts of increased development in the watershed, and increased sedimentation and absence of macroinvertebrates as a result:

"The largest threat to this watershed is that of increased development creating increased impervious surfaces, atop an elevated, sloping watershed; leading to more Storm-water run-off, increased stream velocity, more erosion and concentration of non-point source pollutants. As this report indicates, an increase of impervious surfaces leads to a decrease of groundwater recharge along with the well-known increase in soil movement through erosion. Some evidence of this problem is already occurring as noted in the lack of macroinvertebrates in these highly sedimented rivers. While this has not yet led to increased nutrient loading that is the next probable step to occur in the process of environmental degradation. In addition, if the environmental integrity of the upper watershed region is not protected, the more significant issues facing the lower watershed region will be exacerbated."[103]

It remains true that the Upper and Lower watersheds are distinct in their land use patterns, zoning and septic density regulations, large parcels of privately and publicly managed open space, and surviving small agriculture operations. Yet subdivision of previously agricultural lands, increase in impervious surface, and the related expansion of sanitary infrastructure has increased throughout the upper watershed. In the lower watershed, suburban, residential, and urbanized development has continued to expand.

As the Rutgers Agricultural study succinctly states, "The extensive conversion of land-use from open space, forest, fields and farms to suburban sprawl and urban development that has characterized New Jersey's historic growth creates a continuing threat to the further contamination of this extraordinarily rich and beautiful eco-system."[104]

c. <u>The Lower Watershed</u>

The Lower Navesink Watershed has historically been a more heavily developed and urbanized population center when compared with the Upper Watershed. NJDEP, as early as 1982, characterized the Lower Navesink Watershed as "typically suburban development, with high population densities in the communities which border the Navesink River

[101] *Id*. at 46
[102] *Id*. at 46
[103] *Id*. at 48
[104] *Id*. at 46

(i.e, Red Bank, Middletown, Fair Haven and Rumson). The Lower watershed has storm drainage systems throughout the developed residential areas. . . "[105]

The NJDEP 2005 Sanitary Survey for the Navesink characterizes the areas surrounding the Navesink as "heavily developed with urban areas Middletown, Highlands, Sea Bright, Rumson, Fair Haven, Red Bank, and Tinton Fall are very urbanized and almost all of these communities are on public sewer, with the exception of the rural areas in Middletown and about sixteen homes in Rumson. . . On the northern side of the Navesink River (Middletown Twp) development consisted of many single-family homes, built on large lots. Some are not connected to the public sewer system. The Middletown Township Health Department has performed many dye-tests in the area and found no major problem associated with the septic tanks (Zimmer, 2000). "[106]

The NJDEP 2005 sanitary survey for the shellfish harvest areas in the Navesink noted several new developments built since 1996, adjacent to the shellfish growing area. "The construction of big single family homes on both sides of the Navesink River, were sighted in Middletown and the construction of new condos and townhouses adjacent to the river in Red Bank."[107] The 2012 reappraisal states "Since this region is already highly developed there has not been much residential growth in recent years. The surrounding landscape had not changed significantly since the last shoreline survey."[108] Land use patterns over the last 40 years suggest a trend of residential, suburban and urban land cover replacing agricultural and open space in both the upper and lower Navesink watersheds.

d. Land Use and Water Quality Impacts

Impervious surfaces are areas covered by material that impedes the infiltration of water into the soil. Examples of impervious surfaces are buildings, pavement, concrete, and severely compacted soils (including lawns).[109]

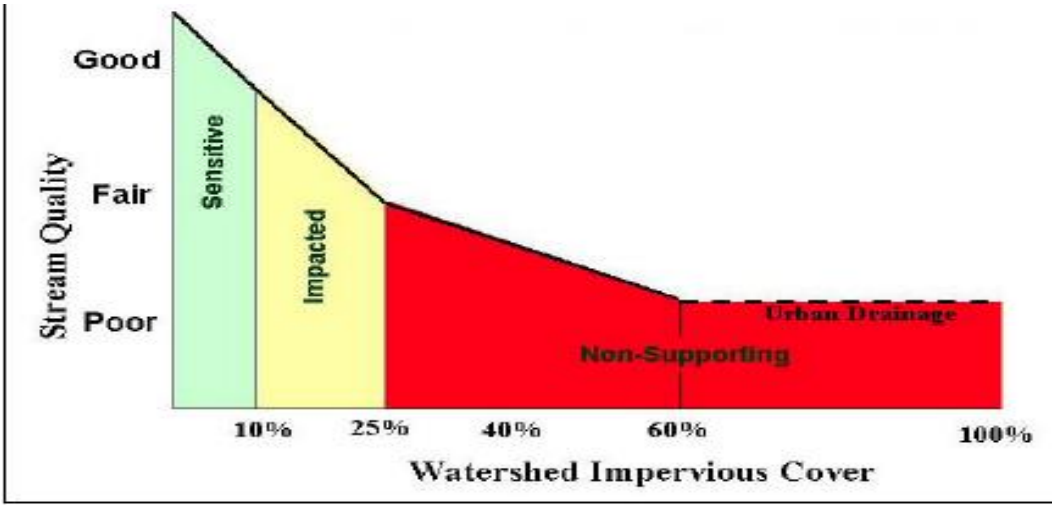


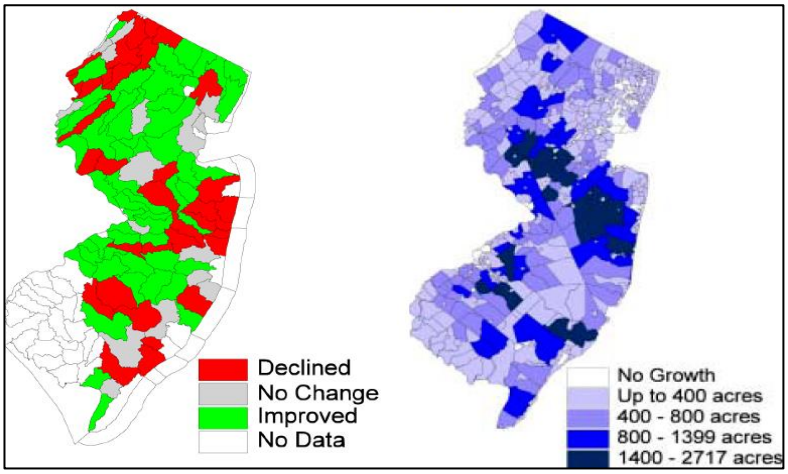
Figure 12: Impervious Cover Model – taken from Impacts of Impervious Cover on Aquatic Systems

[105] Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/, at page 9.
[106] *Partial Sanitary Survey of Shellfish Growing Area NE-2: Navesink River 1999-2003,* NJDEP Water Monitoring and Standards, July 2005, *available at* http://www.nj.gov/dep/bmw/ReportMonmouth.htm, at page 15,
[107] *Id at* 13.
[108] Reappraisal Report of Shellfish Growing Area NE-2 Navesink River, 2012, NJDEP (Tracy Fay, Principal Biologist), at page 4.
[109] The Impacts of Impervious Surfaces on Water Resources, New Hampshire Estuaries Project, *available at* http://www.prep.unh.edu/resources/pdf/theimpactsof-nhep-04.pdf

There is a direct correlation between the percentage of impervious surface in a watershed, and the quality of the water.[110] The Navesink clearly shows this correlation – many of the headwater streams that feed the river are impaired due to high levels of bacteria from agricultural and urban stormwater runoff, among other impairments.[111] Furthermore, areas of the river in close proximity to the densest development have recorded the highest spikes in bacteria levels, low levels of dissolved oxygen, and readily apparent poor water quality, especially after rain events.[112]

In the **Navesink River Watershed,** 6% of total land was developed in watersheds feeding the Navesink River between 1986 and 1995.[113] Specifically, 2,576 acres of land were developed, calculated by New Jersey Public Interest Research Group (NJPIRG) as "equivalent to over 1,900 football fields", and as of 1995, "these watersheds contained 5,998 acres of pavement, rooftops, and other impervious surfaces."[114] That represents 10% of the watershed. In the late 1990s, 12 of 15 sites tested in this basin showed moderate impairment and 3 of 15 showed severe impairment, representing a 3% water quality decline.[115] The large amount of impervious surface in the Navesink generates large volumes of stormwater which mobilize a host of excess nutrients and fertilizers, pesticides and other chemicals, trash and debris, oils and grease, and animal and human fecal sources.

Figure 13: (left) Change in water quality early to late 1990s; (right) acres of new development, 1986-1995



[116]

[110] Impacts of Impervious Cover on Aquatic Systems, Watershed Protection Research Monogrpah No. 1, *available at* http://clear.uconn.edu/projects/tmdl/library/papers/Schueler_2003.pdf

[111] Total Maximum Daily Loads for Fecal Coliform to Address 31 Streams in the Atlantic Water Region, 2003, *available at* http://www.nj.gov/dep/wms/bear/Atlantic%20FC.pdf , *see also* 2012 Waterbody Assessment Report for Pine Brook/Hockhockson Brook, Yellow Brook, etc.

[112] *See* Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf (indicating that the areas of highest bacterial loading occurs in close proximity and from the areas of highest urban density).

[113] Rivers in Danger: The Impact of Development on Water Quality In New Jersey, New Jersey Interest Research Group, Law and Policy Center, April 2003, at page 14, *available at* http://research.policyarchive.org/5180.pdf

[114] *Id*.

[115] *Id*.

[116] *Id.* at 13

VI. Pollution Sources and Source Tracking

This section will identify categories of pollution sources, and some of the source tracking methods that NJDEP and Environmental Canine Services LLC (in partnership with COA) have used to identify the type and source of bacteria impacting the river.

a. Urban Stormwater Runoff

As the above analysis of land use trends and the link between land use and water quality makes clear, a primary cause of bacterial pollution in the Navesink River stems from toxic runoff entering the tributaries and river from the thousands of acres of impervious surface within the watershed. There are numerous direct and indirect stormwater inputs into the Navesink River and its tributaries.[117] According to NJDEP in 2005, "these numerous storm water inputs have the potential to negatively impact the water quality within this growing area."[118]

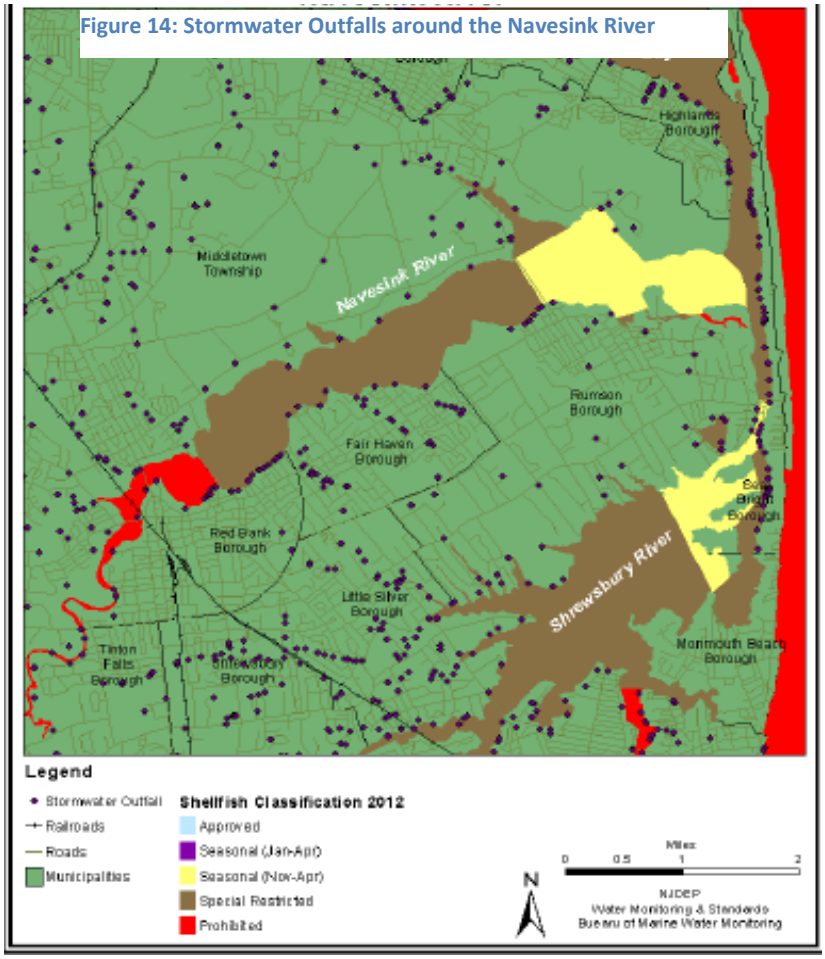


Figure 14: Stormwater Outfalls around the Navesink River

NJDEP's 2012 Navesink Sanitary Survey Reappraisal states that "the first flush after a rain event often carries the most pollutants" and impacts ***the entire river.*** [119] The 2012 Reappraisal concludes that "[r]ainfall appears to be a significant factor for the stations located in this growing area; especially within 24 hours of a rain event. This is expected since this area is urban and is abundant in impervious surfaces."[120]

A Total Maximum Daily Load (TMDL) is an EPA approved "pollution diet" plan, designed to address specific sources of pollution in a waterbody. In 2006, a shellfish harvest impairment TMDL was developed for the Navesink. The TMDL estimated the amount of bacterial loading coming from "regulated" stormwater outfalls such as those covered by the State's municipal stormwater permitting program, and those not directly regulated. This distinction gives a clearer idea of the percentage of bacteria coming only urbanized areas. The 2006 TMDL expressed this distinction by labeling regulated sources as "Waste Load Allocations (WLAs)" and non-regulated stormwater sources estimated as "Load Allocations (LAs)".[121] According to this estimation, regulated "WLAs" representing urbanized sources of

[117] Reappraisal Report of Shellfish Growing Area NE-2 Navesink River, 2012, NJDEP (Tracy Fay, Principal Biologist), at page 6.
[118] *Partial Sanitary Survey of Shellfish Growing Area NE-2: Navesink River 1999-2003,* NJDEP Water Monitoring and Standards, July 2005, at page 26, *available at* http://www.nj.gov/dep/bmw/ReportMonmouth.htm,
[119] Reappraisal Report of Shellfish Growing Area NE-2 Navesink River, 2012, NJDEP (Tracy Fay, Principal Biologist), at 9.
[120] *Id*.

stormwater accounts for **66%** of the TMDL reduction plan, while "LAs" representing non-urbanized sources of pollution account for **29%** of the reduction plan.[122]

Table 5: Assignment of WLAs and LAs for stormwater point sources and nonpoint sources[123]

Land Use Source Category	Municipal Tier	TMDL Allocation Type
High density residential	A	WLA
Medium density residential (incl. mixed residential, mixed urban, other urban, military reservations, and no longer military)	A	WLA
Low density residential (incl. rural residential, recreational land, and athletic fields)	A	WLA
Commercial	A	WLA
Industrial	A	WLA
Roadways	A	WLA
High density residential	B	LA
Medium density residential (incl. mixed residential, mixed urban, other urban, military reservations, and no longer military)	B	LA
Low density residential (incl. rural residential, recreational land, and athletic fields)	B	LA
Commercial	B	LA
Industrial	B	LA
Roadways	B	LA
Agricultural	N/A	LA
Forest	N/A	LA
Barren land	N/A	LA

Notes: - Wetland areas were not included in load estimates based on model assumptions.
- There are no Tier B municipalities located in the affected drainage areas.

According to the 2006 Navesink TMDL, "bacteria concentrations were typically higher during summer months. The influx of summer vacationers and the resulting increase in septic and potential leaking sewer volumes, increased marina and boat use, and other factors contribute to this seasonal trend."[124] Many of the factors cited to explain this seasonal variance can be connected to the total volume of urban runoff increasing during the summer months.

In 2008 NJDEP analyzed historical coliform data collected from 1993 to 2002, and determined, as the 2005 Sanitary Survey, and 2012 Reappraisal confirmed, that there is a direct correlation between rainfall and bacteria levels.[125] According to the 2008 Study "rainfall more than one inch over 24 hours prior to sampling showed some hot spots of higher coliform values", and "more than one inch over 24 hours prior to sampling during the summer months (May-October) impacted much of the upper Navesink River."[126]

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[121] Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12 Atlantic Coastal Water Region, 2006, at 25-26, *available at* http://www.nj.gov/dep/wms/bear/coastal_pathogen_tmdls_wma12%20for%20adoption.pdf
[122] *Id*.
[123] *Id*.
[124] *Id*. at 22
[125] *See* Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf
[126] *Id*. at 8.

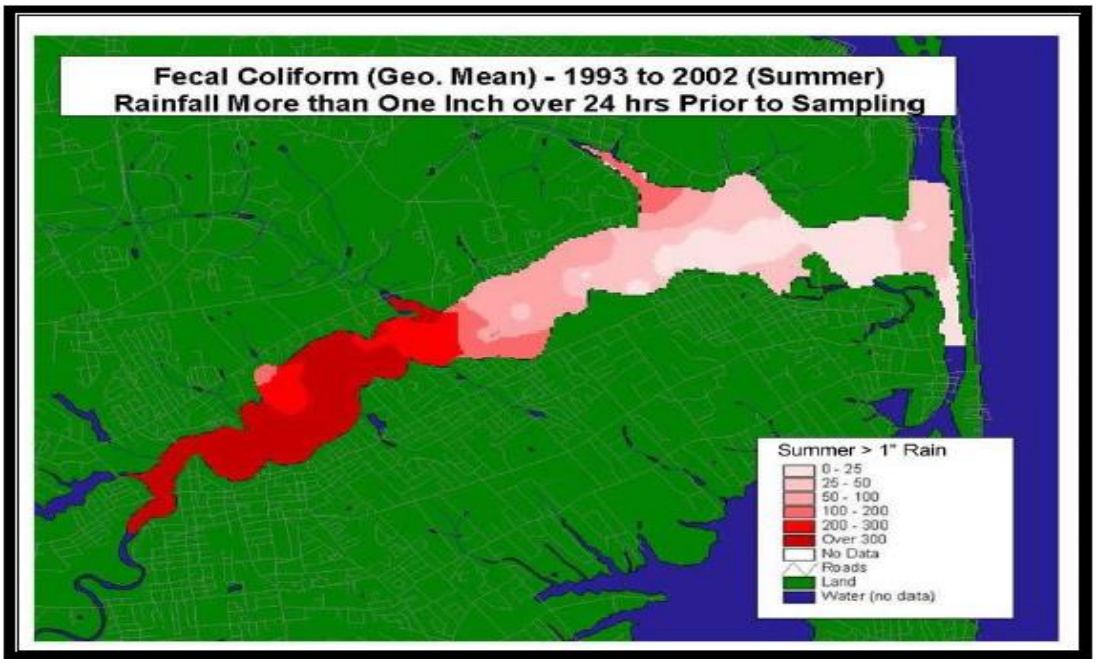

Figure 15: Long term analysis – fecal coliform 1993-2002 rainfall more than one inch over 24 hours prior to sampling

The conclusion NJDEP reached from this analysis is this: "These rainfall impacts are the reason that routine sampling results for shellfish sanitation fail to meet the criteria for safe shellfish harvest in the lower Navesink River during the summer months and in the upper Navesink River (above the Oceanic Bridge) on a year-round basis."[127]

The 2006 TMDL also identified 2 worst case monitoring stations in the Navesink. Station 1000C, located in close proximity to the heavily developed areas of Red Bank and Middletown where Shadow Lake empties into the Navesink, was unsurprisingly identified as one of these stations. [128] However, Station 1014, located at the mouth of Claypit Creek, adjacent to the seasonal direct harvest beds, was also identified as a worst case station. Claypit Creek and its drainage area are relatively undeveloped, indicating a potential wildlife and environmental source. These "worst case stations" illustrate the diversity of potential sources, and the need for further source tracking studies in many areas of the river, including the urbanized and rural areas of the watershed.

Based upon land use analysis, and the conclusions within the 2006 Navesink TMDL, and the 2008 Microbial Source Tracking Study, as well as continued spikes in bacteria levels after rain events, we can conclude that the bacterial pollution in the Navesink is driven by storm events, and furthermore, that urban stormwater runoff is one of the primary drivers of bacterial pollution into the Navesink.

[127] *Id*.
[128] Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12 Atlantic Coastal Water Region, 2006, at 22*, available at* http://www.nj.gov/dep/wms/bear/coastal_pathogen_tmdls_wma12%20for%20adoption.pdf

b. Human Sources and Source Tracking

ii. Source Tracking Generally

As described earlier in the report, the use of more traditional pathogen and fecal indicator bacteria has limitations in predicting sources and level of health risks. Microbial Source Tracking (MST) techniques have been used to refine the identification of type and source of bacteria that are occurring within the toxic stormwater plume impacting the Navesink. In 2008 this type of analysis identified human sources – mobilized by rainfall - that leached, leaked, spilled, or otherwise entered the flow of stormwater into the river.

MST is a rapidly evolving field that seeks to identify the source of microbial contamination in the environment. It is based on the assumption that, given the appropriate method and fecal source identifier, the source of fecal pollution can be detected (US EPA 2005). MST methods can indicate if contamination is from humans or other animals, and can sometimes even identify specific animal sources.[129]

There are numerous MST methods, each with its own strengths, weaknesses, and limitations. NJDEP has used Multiple Antibiotic Resistance (MAR) profiling, F+ RNA Coliphage, the use of optical brighteners (found in detergents), and dye testing to identify human sources of bacteria.[130] Clean Ocean Action is partnering with Environmental Canine Services LLC, which works with scent trained canines to identify human wastewater indicators. There is rapid development in this field, and numerous tools with advantages and disadvantages to each that must be considered before making definitive conclusions. What we can say about MST in general is that "there is no single method that is capable of identifying specific sources of fecal pollution in the environment with absolute certainty. Research is continuing at a rapid pace, and new techniques are sure to be developed."[131]

iii. 2008 NJDEP Microbial Source Tracking Study

In 2006, NJDEP, in conjunction with the Monmouth County Health Department and Red Bank Division of Public Works, undertook an MST analysis of the Upper Navesink River, based around the lower Swimming River and Red Bank area. In 2008, the preliminary results of this study were released, titled "UPPER NAVESINK RIVER STORMWATER STUDY: MICROBIAL SOURCE TRACKING".

The microbial source tracking component of NJDEP's 2008 efforts used several methods of MST including MAR profiling, Optical Brightener, and F+ RNA Coliphage, over multiple storm events to determine the presence of ***both human and wildlife sources of pollution*** with problems noted from stormwater discharges.[132] At the time of writing this report, this study is the preeminent and most recent intensive study of the pollution issues affecting the Navesink. The study determined that:

1) The urban areas in the Navesink River are impacted by rainfall accumulations ***above 0.3*** inch, particularly following a rain event.

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[129] *See* Microbial Source Tracking: Current Methodology and Future Directions, American Society for Microbiology, *available at http://aem.asm.org/content/68/12/5796.full*, *see also* Microbial Source Tracking, Rutgers Presentation http://salem.njaes.rutgers.edu/nre/ppt/2012_mangiafico_fecal_water_contamination.pdf

[130] Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf

[131] *Id*.

[132] *Id*.

2) Using historical fecal coliform data (1993-2002) two conclusions were reached: rainfall was correlated with the coliform values in the upper Navesink River, and there was a correlation with summer being a more problematic time of the season for bacteria pollution, which is no surprise given the population of tourists and heavy use of marinas, and warmer months conducive to bacteria growth.

3) Potential sources impacting the upper Navesink River suggests ***that stormwater discharges and failing infrastructure are the most likely sources***."[133]

4) Several sites in the vicinity of Red Bank were identified with highly elevated bacterial levels; including five stations for which Microbial Source Tracking (MST) indicators revealed that humans were a probable source of fecal contamination after rainfall." [134]

Table 5: Stormwater Study and Microbial Source Tracking Results

Station	Location	Identified as Potential Pollution site from the Stormwater Study	Identified as Potential Pollution site from the Microbial Source Indicators
13	Swimming River at Locust Ave.	X	X
14	Navesink River at Front Street	X	X
16	Navesink River at the mixing zone of the Maple Ave. storm water discharge	X	X
18	Navesink River in the vicinity of the Riverview Hospital	X	X
34	Navesink River – "end of pipe" storm water discharge at Maple Ave.		X

The 2008 study concludes that "[i]n order to improve the sanitary quality of the upper Navesink estuary, these locations should be given priority for further investigation and remediation. Reducing the bacterial loads from these stormwater discharges will likely result in significant water quality improvement. NJDEP will continue routine monitoring of the Navesink River and will follow-up with intensive stormwater monitoring when stormwater infrastructure improvement projects are complete so that the effectiveness of these efforts can be measured."[135]

In conjunction with these findings, NJDEP, MCHD, and the City of Red Bank undertook further source trackdown and elimination work between 2006 and 2009, which resulted in:

a. The identification and elimination of an overflowing and improperly maintained septic tank that discharged into an outfall that drained east of Riverview hospital;
b. The identification and elimination of an overflowing and improperly maintained septic tank that was located in a marina adjacent to Hubbard's Bridge and that discharged into the river via leaching and overflow (owner also owned a septic tank pump –out service);

[133] *See* Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, at page 1, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf
[134] *Id.* at 18.
[135] *Id.*

c. The elimination of three (3) other septic systems on Locust Avenue;
d. The identification and elimination of improper cross connections between sanitary and storm sewer piping in the YMCA that led to whiteners and detergent discharge at the foot of Maple Avenue,
e. The identification of an overflowing French drain oil water separator in the area of Riverview hospital loading dock and establishment of on-going cleaning and maintenance procedures;
f. The identification and elimination of contamination from leaking garbage dumpsters from commercial properties along Riverside Avenue and Bodman Place.
g. The study also prompted other follow up tracking efforts by Red Bank in the area of their outfalls as well as targeted sampling being conducted on the Middletown side of the River including McClees Creek, etc. ***COA has been unable to find any conclusions or results obtained as a result of these additional efforts.***
h. Furthermore, the town of Red Bank has repeatedly stated that they continue to invest large amounts of money in infrastructure monitoring and improvements, including inspection of storm water infrastructure, and videotaping and replacing aging sanitary lines.[136]

However, no follow up report detailing these actions was released by NJDEP, Monmouth County Health Department, or Red Bank, nor has COA been able to verify that any follow up sampling was conducted following this source tracking and elimination work.

In the years that have elapsed since 2008, NJDEP has continued to monitor the Navesink River in compliance with NSSP (shellfish) classification requirements, as well as ambient water monitoring under Clean Water Act program requirements. However, no intensive MST work and storm event sampling work has been undertaken since the completion of the initial 2008 report, until now.

While the bulleted elimination work detailed above are positive steps in addressing human sources of pollution in the Navesink, post-elimination monitoring would have been the only way to determine whether the sources eliminated by Red Bank were effective in reducing *all* human signatures in the River or only partially, and what the overall impact of this source elimination work was on water quality.

c. Animal Sources

i. Horses and Livestock

Efforts to reduce the amount of animal manure deposited in the tributaries of the Navesink began as early as 1982.[137] NJDEP identified the horse and cow farms along Pine and Hockhockson Brooks to be a major source of fecal pollution in a 1982 study, estimating up to 75 tons of manure produced *per day* by the more than 3000 horses in the area.[138] "Aerial photographs, together with field reconnaissance, reveal a concentration of livestock and farming operations, of which horse breeding farms predominate. According to the Monmouth County Soil Conservation Service, approximately 25

[136] Meeting with Administrator Stan Sickles of Red Bank, NJDEP Bureau of Marine Water Monitoring Acting Chief Bob Schuster, and interested members of the public, on May 16, 2016, Red Bank Municipal Building.
[137] Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/ at page 10, 14.
[138] *Id*.

horse farms are located in the Pine Brook watershed. Some dairy cattle farms are located in the Pine Brook watershed. Crop acreage in the Lower Navesink watershed is also devoted primarily to tree and shrub farming."[139]

Manure and fertilizer management BMPs began to be implemented soon after the 1982, and by 1996, NJDEP concluded in a Navesink River Sanitary Survey Reappraisal that "[t]hese efforts resulted in a recommendation by the Department in August 1996 to upgrade the Marine Water Shellfish Classification in the lower Navisink to "*Seasonally Approved*."[140]

In 1998 and 1999 Rutgers University's Agricultural Extension and Department of Environmental Services were awarded Federal "319 grants" for the implementation of Best Management Practices (BMPs) and development of nontraditional organic manure in the Upper Navesink Watershed.[141] This work produced several status reports and assessments of agricultural sources of bacterial loading into waterbodies. As part of the 2006 TMDL for the Navesink, more 319 grants were disbursed to address the agricultural inputs into the upper watershed.[142]

A Rutgers Equine Science Center Report titled "Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed" was released in 2011. This report focused on the agricultural inputs into the Upper Navesink Watershed and quantified the amount of horses in the upper watershed at "approximately 14,000 horses and several other types of farms animals yet only 11,999 residents."[143] The 2011 Rutgers Study states that "[i]n terms of soil and water quality, this upper watershed is in reasonable health but there are some indications of deterioration, especially stream sedimentation from erosion and other nonpoint source pollutants related to storm-water run-off."[144]

Rutgers Environmental Extension Newsletter, the "Green Knight", announced the release of this report, stating that "[t]he coastal waterways of the Navesink River are plagued with excessive concentrations of nitrogen, phosphorus and bacteria that close beaches to swimmers, close clam beds to harvest, reduce fish populations and cause human health problems. The rural waterway of the west were measured to have very few of these environmental problems and of the three critical water quality parameters, there were no exceedances for nitrate, dissolved oxygen or stream turbidity. This finding indicates that organic manures and synthetic fertilizers are not being applied at an excessive rate and that the agricultural watershed had several major unforeseen economic benefits."[145]

The 2011 Rutgers Study, "Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed", concluded that interaction between the upper watershed and the lower watershed appears to be minimal.[146] However, the analysis of agricultural inputs in the upper watershed, and interaction between the upper and lower watersheds raises several questions that must be answered:

- What is the status of agricultural BMP implementation in the Upper Watershed?

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[139] *Id.*
[140] NJDEP 1996 Navesink Sanitary Survey Reappraisal, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/36419/PDF/1/
[141] Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12 Atlantic Coastal Water Region, 2006, at 25*, available at* ttp://www.nj.gov/dep/wms/bear/coastal_pathogen_tmdls_wma12%20for%20adoption.pdf, Table 11.
[142] *Id*.
[143] *Id*. at 2.
[144] Bill Sciarappa, PI, Brian Hulme and Kevin Soldo, Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed, 2011. Rutgers Equine Science Center, at page 2.
[145] Green Knight Newsletter, August 2011, *available at http://salem.njaes.rutgers.edu/greenknight/documents/green-knight-2011-08-01.pdf*
[146] Bill Sciarappa, PI, Brian Hulme and Kevin Soldo, Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed, 2011. Rutgers Equine Science Center

- Has aging septic or sewer infrastructure deteriorated to the point that there are potential human sources loading the upper watershed?
- Will follow up work utilizing "station 31" indicate that there is an interaction of bacterial sources between the upper and lower watershed?

COA recommends that the Rutgers Cooperative Extension, and the Freehold Soil Conservation District, once again bring their expertise to help answer these questions.

ii. Wildlife and other Domestic Animal Sources of Contamination

Animal sources of bacterial pollution can come from both wild and domesticated animals. Birds, rodents, and other critters both large and small, as well as more routine source such as improperly disposed of dog and cat waste or cow and horse manure can all contribute to bacterial loading in a waterbody and represent a potential risk to human health.[147]

According to the Center for Watershed Protection, "[d]ogs in particular appear to be a major source of coliform bacteria and other microbes, which is not surprising given their population density, daily defecation rate, and pathogen infection rates. According to van der Wel (1995), a single gram of dog feces contains 23 million fecal coliform bacteria. Bacteria from wild and domestic animals may indicate the presence of the parasites Giardia or Cryptosporidium."[148]

Regardless of the type of animal, fecal material is transmitted into waterways through the flow of stormwater over the land. The more impervious surface, the more volume of stormwater there is to mobilize this fecal material.

There are numerous regulations and management practices designed to address these issues, including agricultural BMPs , pooper scooper laws, and geese management plans, the fact is that these types of pollution sources can only be fully addressed by proper management, enforcement of laws, and reducing the total volume of stormwater entering a waterbody. It is clear that municipalities must emphasize enforcement of these ordinances.

d. Marinas and Boat Discharges

Marinas have long been identified as potential sources of bacterial contamination.[149] For this reason, waters within marinas are categorically excluded from shellfish harvesting areas, and a buffer area is required to be calculated between open shellfish beds and marinas to prevent contamination.[150] Due to discharges and spills from boats and ideal growing conditions for bacteria (stagnant water), marinas have been identified by the sanitary surveys as well as source tracking studies as potential sources of bacterial contamination. The NJDEP 2012 Navesink Reappraisal states that there are 21 marinas in the Navesink River.[151]

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[147] *See* Safe Waters, Healthy Waters: A guide for Citizen Groups on Bacteria Monitoring in Local Waterways, April 2016, Center for Watershed Protection at page 8, *available at* http://www.cwp.org/wp-content/uploads/2016/05/SAFE-WATERS-Guide_Final.pdf
[148] *Id.*
[149] *See Partial Sanitary Survey of Shellfish Growing Area NE-2: Navesink River 1999-2003,* NJDEP Water Monitoring and Standards, July 2005, *available at* http://www.nj.gov/dep/bmw/ReportMonmouth.htm,
[150] *See* NSSP Guide for the Control of Molluscan Shellfish 2013
[151] Reappraisal Report of Shellfish Growing Area NE-2 Navesink River, 2012, NJDEP (Tracy Fay, Principal Biologist)

Larger boats on the Navesink have a marine head and holding tank to hold the waste. Most of these tanks are designed to be pumped out when full. While discharge of holding tanks is actually allowed outside US territorial waters (3 miles or more offshore), this practice is illegal in the Navesink River.[152] Unfortunately, some people may be discharging their holding tanks overboard in the Navesink and Shrewsbury River area, resulting in untreated sewage directly entering the water.

Today, the Navesink River is a "No Discharge Zone" which means no waste may be discharged, even if treated. No excuses or exceptions. There are a number of pump out stations throughout the river. The Navesink River Municipalities Committee has taken the issue of pump out stations as its first order of business and will be encouraging signage, awareness, increased enforcement, and other ways to ensure that the Navesink remains a "no discharge" zone.

Mobile Pump Out Boats are also an excellent way to encourage proper holding tank management. The NY/NJ Baykeeper is currently operating the "Royal Flush" for the Monmouth County Health Department; a pump out boat servicing the two rivers area for the season. The Royal Flush will operate on Fridays and Saturdays from July 1 to October 1, 2016 and is free of charge.[153]

e. Interaction Between the Upper and Lower Watersheds

Both the Rutgers agricultural analysis completed in 2011, and the 2008 NJDEP Microbial Study did not find any strong relationship between bacterial pollution in the Upper Watershed migrating into the Lower Watershed.

The 2011 Rutgers agricultural analysis of the Upper Watershed states that "the lower portion (of the Navesink Watershed) below the dam has had severe and chronic environmental issues. *Interaction between the upper and lower regions appears limited*. Some of those significant local issues downstream, below the dividing dam, include flooding and very high bacterial counts."[154]

NJDEP's 2008 Microbial Source Tracking study states that "[t]he long term analysis of monitoring data from the Swimming River Reservoir ***discounted the reservoir as a significant source of bacterial contamination***."[155]

However, NJDEP's 2008 study did find that Station 31 (located in Colts Neck nearby the Reservoir) reported at least one extremely high spike of *E. coli* bacteria with indications of a human, domestic and wild animal signature.[156] Unfortunately, no follow up work at this area was performed. This test result indicates that more sampling must be done to determine if bacteria loading in the Upper Watershed is impacting the Lower watershed.

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[152] EPA Region 2 News Release, http://yosemite.epa.gov/opa/admpress.nsf/d10ed0d99d826b068525735900400c2a/e49dc8502d3f32998525724800632e1b!opendocument

[153] *See* MCHD "Royal Flush"Pump Out Boat, Monmouth County Health Department Website, *available at* https://co.monmouth.nj.us/page.aspx?ID=4686

[154] *Id*. at 5.

[155] NJDEP 2008 Microbial Source Tracking Study in the Navesink at 10 ("Based on routine fecal coliform monitoring by WM&S from 1997 to 2000, the Swimming River Reservoir was discounted as a significant source of bacterial contamination. Monitoring data (fecal coliform geometric means) from NJ American Water Company revealed very low bacterial levels at the spillway and further confirmed NJDEP's findings. Figure 8 shows the fecal coliform geometric means from NJDEP's routine monitoring program.")

[156] NJDEP 2008 Microbial Source Tracking Study in the Navesink at 13

VII. TMDLs and Stormwater Regulations

a. The 2006 Total Maximum Daily Load (TMDL)

A TMDL is a legally binding cleanup plan for waters that do not meet the Clean Water Act's water quality standards.[157] A TMDL establishes a science based and enforceable cap on total pollution, and a "diet" or reduction plan necessary to meet the designated uses of the waterbody (swimming and fishing).[158] A TMDL requires enforceable reductions in current pollutant loadings necessary to achieve water quality standards. Reductions are set for point source dischargers, like sewage treatment plants and municipally operated stormwater infrastructure (called "waste load allocations"), and for nonpoint sources, like runoff from development, houses, and roads ("load allocations").[159] Additionally, a TMDL must include an implementation plan with enforceable requirements to assure that the TMDL pollutant reduction loadings are actually met.[160] These requirements are known as "reasonable assurance".

In 2006, EPA approved TMDLs for shellfishing impairments due to high total coliform levels for the Navesink and Shrewsbury Rivers and the larger Watershed Management Area 12.[161] This TMDL, and similar TMDLs throughout the State, were designed to address nonpoint source loading of bacteria into waterways. Unfortunately, these types of TMDLs, while a step forward in identifying and reducing sources, have thus far been ineffective in improving water quality.

The 2006 TMDL developed for the Navesink lists numerous potential sources for the bacterial loading in the Navesink and states that "[o]ptions available to control nonpoint sources of bacteria typically include measures such as sewage infrastructure improvements, goose management strategies, pet waste ordinances, agricultural conservation management plans, and septic system replacement and maintenance. *The effectiveness of these control measures is not easily measured relative to observed ambient concentrations*."[162]

The 2006 Total Coliform TMDL for the Navesink suggests several management efforts and describes various government programs to reduce pollution loads including:

- Municipal Stormwater Permits (called MS4 permits) and Regulations (see figure 16).
- Inspection, repair, and replacement of Sewage conveyance facilities (also linked to MS4 requirements)
- Geese management plans
- Agricultural activity management
- Pet waste management (MS4 permit requirement)
- Waste and litter management at municipal level

However, several structural deficiencies exist within the 2006 TMDL which have become readily apparent over the last 10 years, especially as water quality has continued to deteriorate:

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[157] *see* 33 USC §1313, Water quality standards and implementation plans, 40 CFR § 130.7 Total maximum daily loads (TMDL) and individual water quality-based effluent limitations.
[158] *Id*.
[159] *Id.*
[160] *Id*.
[161] Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12 Atlantic Coastal Water Region, 2006, at 25*, available at* ttp://www.nj.gov/dep/wms/bear/coastal_pathogen_tmdls_wma12%20for%20adoption.pdf,
[162] 2006 Navesink TMDL at page 20.

- There is no schedule for implementation or for achieving reductions in fecal pollution, and at best, it would take decades to see any measurable improvements, if at all.
- There are no additional monitoring requirements provided for in the TMDL.
- The 2006 TMDL uses a computer model to estimate the amount of stormwater runoff entering the Navesink based on estimating the bacterial load of differing land use areas in the area.[163] There are potential flaws in the assumptions made in bacterial loading – the model does not appear to fully or sufficiently account for leaking sanitary infrastructure and septic systems, potential for contaminated sediment, and input from wild and domestic animals. [164]
- The TMDL relies on the narrative based "statewide basic requirements" in the MS4 permitting program to achieve the majority of the pollution reductions. These are narrative actions designed by NJDEP to reduce stormwater pollution (such as "implement a pet waste ordinance", see Figure 16). These narrative criteria make it very difficult to monitor and quantify the effectiveness of implementation and the measures themselves.
- Shoreline survey data and some data sets used to estimate bacteria loading date from 1992-1995.
- Some Land Use data dates from 1995-1997.
- Due to the difficulty in distinguishing regulated stormwater inputs from unregulated inputs, the reduction plan may be inaccurate, and difficult to measure reductions.

Because of the many difficulties in quantifying nonpoint source loading, and the effectiveness of narrative reduction requirements, NJDEP has recently stated that "Control of land based non-point sources may be best accomplished through reducing the impacts through Best Management Practices (BMPs) and broader initiatives like the statewide fertilizer law. There are also a host of stressors beyond water quality that can affect the success of an ecosystem. TMDLs can only address water quality stressors."[165] While COA does not necessarily agree with this statement, it serves to illustrate the difficulties of using a TMDL framework to address nonpoint bacterial pollution.[166] Furthermore, these difficulties clearly show a need for a new paradigm that is watershed specific and driven by grassroots energy.

b. Stormwater Regulations In New Jersey

A Municipal Separate Storm Sewer System (MS4) is a municipally owned stormwater collection system that discharges untreated stormwater directly to a waterbody. Starting in 1990 USEPA began to issue permits to large municipalities. By 2004, the MS4 permit program and related Municipal Stormwater Management Rules had been implemented throughout New Jersey, requiring municipalities to perform maintenance, supervise construction sites, and undertake other actions designed to reduce the flooding and pollution impacts of stormwater discharges into waterbodies.

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[163] 2006 Total Coliform TMDL.

[164] 2006 Total Coliform TMDL at pages 18 and 19 ("Direct contributions from illicit discharges, livestock, pets, and wildlife (e.g. seagulls, geese, and other waterfowl in particular) were not estimated based on the lack of site-specific information needed to represent these sources . . . Bacteria may also be present in the sediment in some areas, as a result of contamination from stormwater, failing septic systems, malfunctioning sewer systems, agricultural runoff, and other sources. For these TMDLs, the loads contributed by wildlife, sediment, and the other sources were assumed to be included in the land use loading coefficients.")

[165] Letter from NJDEP Deputy Chief of Staff John Gray to Senator Bob Smith RE S765: a bill to implement a TMDL for the Barnegat Bay.

[166] *See* Changes Needed If Key EPA Program Is to Help Fulfill the Nation's Water Quality Goals, Government Accountability Office, *available at* http://www.gao.gov/assets/660/659496.pdf ("landowner participation and adequate funding—factors they viewed as among the most helpful in implementing TMDLs—were not present in the implementation activities of at least two-thirds of long-established TMDLs, particularly those of nonpoint source TMDLs.").

The 2004 Phase II MS4 permits implemented in New Jersey included the required creation of a Municipal Stormwater Management Plan, maintenance of stormwater infrastructure, monitoring for dry weather flow and illicit connections, and the adoption of Statewide Basic Requirements (SBRs) that are designed to substantially reduce nutrient and bacterial loadings in impaired watersheds.[167] These control measures include post construction and redevelopment runoff requirements, adoption and enforcement of a pet waste disposal ordinance, prohibiting the feeding of unconfined wildlife on public property, cleaning catch basins, performing good housekeeping at maintenance yards, and providing related public education and employee training. According to NJDEP, "These basic requirements will provide for a measure of load reduction from existing development."[168] Unfortunately, the MS4 program, even after proposed updates in 2016, has been beset by a lack of monitoring, oversight, and enforcement, and continued development in already impaired watersheds.[169]

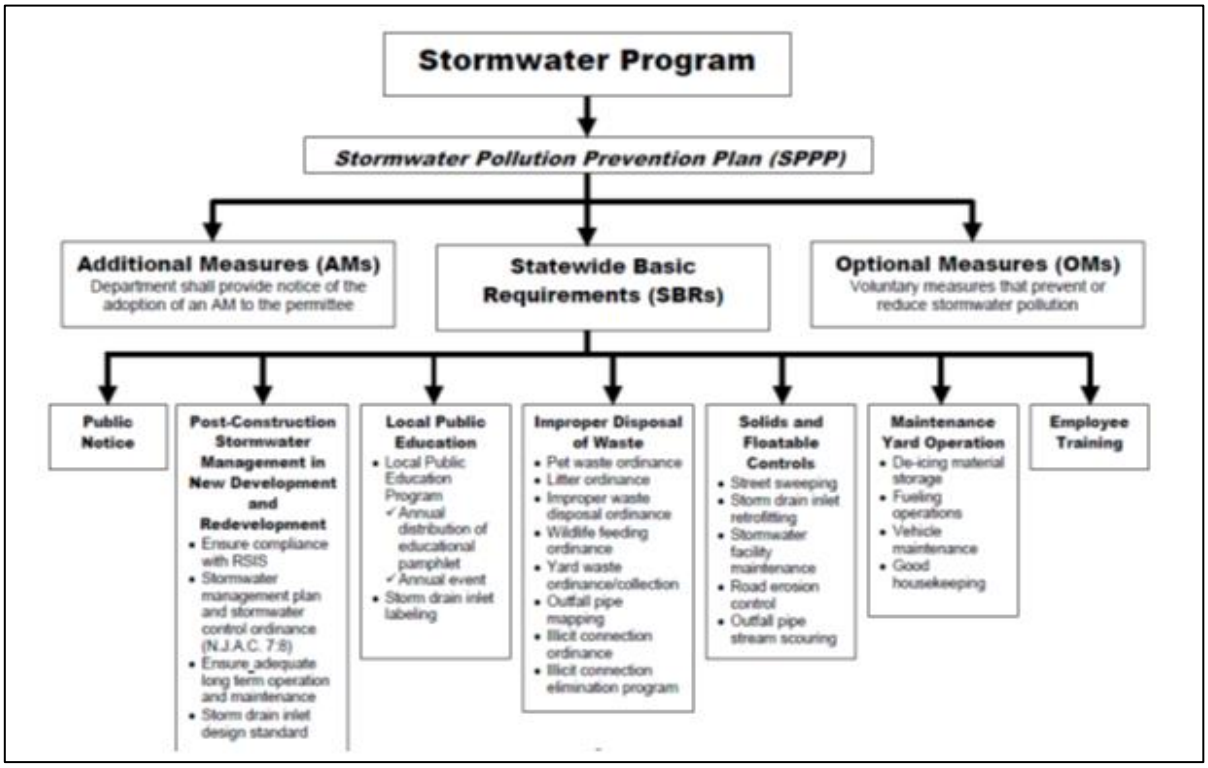

Figure 16: Municipal Separate Storm Sewer System (MS4) and Stormwater Regulations.

The Navesink TMDL relies on the NJDEP Municipal Stormwater Program to achieve the majority of the reductions in bacteria pollution.[170] NJDEP recently released a preliminary draft of the revamped MS4 permits, yet, while clearer and more organized, the permits continue to use narrative criteria, making it difficult to monitor and quantify the

[167] Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Rules, N.J.A.C. 7:14A

[168] NJDEP 2005 proposed Phase I Passaic River Study Total Maximum Daily Load for Phosphorus in Wanaque Reservoir Northeast Water Region.

[169] *See* Petition Dated February 4, 2014, Requesting the Modification (or Revocation and Reissuance) of Tier A Municipalities, Tier B Municipalities, Highway Agency, and Public Complex General Stormwater Permits *available at* http://switchboard.nrdc.org/blogs/llevine/NJ%20MS4%20Permit%20Petition%202-4-14%20(with%20exhibits).pdf, *see also* Environmental Coalition Comments on the Preliminary Draft Renewal of Master General Permits No. NJ0141852 for Tier A Municipal Separate Storm Sewer Systems & No. NJ0141861 for Tier B Municipal Separate Storm Sewer Systems, Submitted April 15, 2016, *available on* COA Navesink River Google Doc Page.

[170] *Id*.

effectiveness of implementation and the measures themselves.[171] The MS4 updates also once again fail to require that owners of stormwater outfalls post advisory signs on outfalls that discharge by lifeguarded bathing beaches.[172] Furthermore, the MS4 permits fail to incorporate any concrete action or planning requirements beyond a mandate to "identify and develop opportunities" to address impairment-causing pollutants, without any associated measurable standards, requirement to develop a TMDL implementation plan and obligation to implement some portion of that plan during the permit term, or discharge monitoring requirements.[173] These are systemic flaws.

Furthermore, the 2006 TMDL for the Navesink should have also triggered the drafting of additional measures" (AMs) and "optional measures" (OMs) provided for in the 2004 Phase II MS4 regulations. AMs and OMs are NJDEP or municipally required stormwater control strategies that go above and beyond the existing Statewide Basic Requirements. These measures would have been specifically designed to achieve the reductions contained in the TMDL.[174] None were ever drafted or implemented by either NJDEP or the municipalities.

Municipal Stormwater Regulations also provide for the creation of a Regional Stormwater Management Plan (RSWMP); "a technical planning procedure and regulatory process meant to address watershed wide stormwater impacts."[175] According to NJDEP's guidance, an RSWMP "creates a combination of regulations and actions tailored to the specific needs of a drainage area, but it does not reduce environmental protection. Rather, it allows regulations more flexibility to match the concerns, conditions, and features of regions that are connected by a common drainage area."[176] The first step to creating an RSWMP is the creation of a much needed and broadly representative regional planning committee.[177] Monmouth County Planning Board led efforts to create a Navesink/Swimming River Regional Stormwater Management Plan Committee (RSWMP) through the NJDEP Division of Watershed Management framework as early as 2005. NJDEP stated that "support of the municipalities in the planning area is critical to the development of a RSWMP."[178] Any one municipality's opposition to the plan can halt implementation, even after years of development. By 2007, it was clear that there would be no consensus among the municipalities. A March of 2007 letter by the Township of Colts Neck affirmed their "unanimous continued opposition to the creation of a Regional Stormwater Management Plan."[179] While a draft RSWMP for the Swimming and Navesink River exists, no official document was finalized and efforts to create a plan have been abandoned.

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[171] *Id*.

[172] Authorized under NJAC 7:14A-25.6(b)3iv4: "Public education on stormwater impacts: The permittee shall implement a public education program about the impacts of stormwater discharges on surface water and groundwater, and about the steps that the public can take to reduce pollutants in stormwater runoff. "

[173] *See* Petition Dated February 4, 2014, Requesting the Modification (or Revocation and Reissuance) of Tier A Municipalities, Tier B Municipalities, Highway Agency, and Public Complex General Stormwater Permits *available at* http://switchboard.nrdc.org/blogs/llevine/NJ%20MS4%20Permit%20Petition%202-4-14%20(with%20exhibits).pdf, *see also* Environmental Coalition Comments on the Preliminary Draft Renewal of Master General Permits No. NJ0141852 for Tier A Municipal Separate Storm Sewer Systems & No. NJ0141861 for Tier B Municipal Separate Storm Sewer Systems, Submitted April 15, 2016, *available on* COA Navesink River Google Doc Page.

[174] *See* NJAC 7:14A-25.6(e), NJAC 7:14A-25.6(i)

[175] *See* NJAC 7:8-3

[176] New Jersey Stormwater Best Management Practices, NJDEP 2004, *available at* http://www.njstormwater.org/bmp_manual/NJ_SWBMP_3%20print.pdf

[177] *See* NJAC 7:8-3

[178] *Id. see also* Letter from Pat Rector, Coordinator RSMP NJDEP to Turner Shell, Monmouth County Planning Board, Dated March 2, 2007.

[179] Letter from Colts Neck Township Administrator Robert Bowden to Monmouth County Planning Board, March 27, 2007.

The 2008 NJDEP Microbial Source Tracking (MST) Study states that, since some of the impacts "appear to be related to municipal wastewater sewer leakages, there should be continued efforts by the municipalities to identify subsequent conditions of their sewer systems to discover any sewer line leakages or possible illicit connections", and that the NJDEP will monitor the stormwater mitigation efforts of the appropriate municipalities through the respective New Jersey Pollutant Discharge System Municipal Stormwater Permits.[180] It is important to note that illicit connection trackdown, litter and pet waste pick up ordinances, and stormwater infrastructure inspection and maintenance ***are required measures within the*** MS4 permitting program and 2006 TMDL.[181] However, several recent audits of the program by NJDEP and released to the public indicate that a renewed emphasis on implementation of MS4 requirements throughout the Navesink Watershed is necessary.[182]

NJDEP's stormwater management regulations delegate most responsibilities to the municipality. Labeling storm drains, illicit connection trackdown, inspection and maintenance of stormwater facilities, ensuring post construction hydrology, and enforcement of litter, pet waste, goose, and other stormwater related control measures including optional measures such as posting stormwater outfalls that discharge to recreationally used waters, are left to the municipalities to fund and implement.

Sublists 4 and 5 of New Jersey's Draft 2014 Integrated List of Waters identify the sources of New Jersey's water quality impairments.[183] Of particular concern, "Urban Runoff/Storm Sewers" is listed as a source of impairment for 942 of the total 2,560 assessment unit/pollutant combinations identified on that list.[184] (117 of these assessment unit/pollutant combinations were added to the list *after* the 2009 MS4 permits were issued.[185]) MS4 Permits and the Municipal Stormwater Regulations provide a framework for ensuring actions specifically designed to achieve TMDL reductions are taken by municipalities. However, as of yet, no Additional Measures or Optional Measures have been adopted, and the energy, commitment, and specificity necessary to make the MS4 system effective has thus far been absent.

In summary, implementation of stormwater management controls at the Federal, State, and Local level, has been ineffective and underfunded.

VIII. Next Steps and the Future of the Navesink

The Navesink watershed is 95 square miles. It encompasses a multitude of land use patterns, population demographics, and ecological resources. In order to see meaningful improvements in water quality, a new paradigm is needed. Local support from engaged individual citizens and water users, community and environmental groups, and municipal governments is crucial. Tying in County, State, and Federal resources will also be critical, and will depend in large part

[180] 2008 Microbial Study
[181] *See* Tier A MS4 Permits list of Statewide Basic Requirements including requirements for Post Construction, Local Public Education, Ordinance Requirements, Illicit Connection & MS4 Outfall Pipe Mapping, Solids and Floatables Control, and Employee Training. Found at Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Rules, N.J.A.C. 7:14A
[182] *See* NJDEP MS4 audits for the Towns of Hopewell and South Toms River.
[183] 2014 New Jersey Integrated Water Quality Assessment Report, Draft 2015, NJDEP Division of Water Monitoring and Standards, at page vii-viii, *available at* http://www.state.nj.us/dep/wms/bears/docs/2014_draft_integrated_report_with_appendices.pdf, Appendix B: Sources of Parameters Causing Use Impairment (Sublists 4 and 5), http://www.state.nj.us/dep/wms/bears/docs/2014_draft_sources_and_causes_of_impairment-sublists_4_and_5.pdf.
[184] *Id.*
[185] *Id.* (tally of entries attributed to urban runoff/storm sewers that were added to the list in 2010, 2012, and 2014).

upon the coordination and cooperation demonstrated by local entities. This network of private and public, Local, Municipal, County, State, and Federal entities, represent all of the knowledge, skills, support, and resources necessary to accomplish our goals.

a. Source Tracking and Water Monitoring

The first step in addressing the fecal pollution impairment in the Navesink is to gather as much water quality data as possible, using both innovative source tracking methods and traditional water monitoring. Storm event and source trackdown sampling has already begun by NJDEP, Environmental Canine Services in partnership with COA, and others. This work will seek to identify the sources of pollution, whether human or animal, and track them back to discrete areas that can be targeted for pollution elimination work.

USEPA now recognizes that source tracking is an invaluable tool in addressing impairments: "MST can support bacteria TMDL development and implementation during the assessment process, the allocation analysis, and/or development of an implementation plan. Specifically, MST can help to identify the sources that contribute to the observed impairment, determine which sources are likely the most dominant in the watershed of interest, and focus management actions through targeting implementation and identifying controls that are appropriate and relevant to the identified sources."[186]

Both COA and NJDEP Bureau of Marine Water Monitoring have learned valuable lessons from reviewing the successes and disappointments of past source tracking work. Source tracking activities provide a basis for frequent in person meetings and engagement between key stakeholders, governmental, and elected officials, and provides the public with a visible and exciting demonstration of the type of efforts needed to improve water quality. Frequent in-person meetings while source tracking is ongoing engender a collaborative and action oriented focus, and will focus on sharing source tracking updates, progress reports, and information, as well as the status of stormwater reduction efforts throughout the watershed.

Another critical step in gathering data is the implementation of a recreational water quality monitoring program, either through a reestablishment of NJDEP's "environmental monitoring station" sampling under the CCMP, or a independent program using student, citizen, and eNGO resources. Such a program could be run throughout the watershed on a routine and storm event basis, with results posted publicly and broadcasted as loud and as far as possible. Many watersheds and communities have had great success implementing citizen water sampling programs in order to gain valuable data, spread awareness, engage the community, and take the necessary first step towards making our waters swimmable.[187] As an example, NY/NJ Baykeeper is enlisting the help of volunteers to collect water samples and test for pathogen indicators at several pre-selected heavily used and under-monitored sites along the entire New Jersey Bayshore. [188] A water-sampling program in the Navesink can be a first step for citizens interested in working on these issues.

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[186] Using Microbial Source Tracking to Support TMDL Development and Implementation, USEPA Region 10, 2011, *available at* https://www3.epa.gov/region10/pdf/tmdl/mst_for_tmdls_guide_04_22_11.pdf
[187] *See* New York Water Trail Association Website, http://www.nycwatertrail.org/
[188] http://nynjbaykeeper.org/raritan-bay-waters-to-be-monitored-for-pathogens/

b. Stormwater Volume Reduction

Any next steps must acknowledge that stormwater runoff is inherently polluted with bacteria from non-human nonpoint sources, and that this is a significant volumetric source of fecal indicator bacteria in the Navesink. Therefore, source tracking efforts must focus on identifying human and non-human sources of pollution in infrastructure, as well as environmental sources, yet also support a broader effort to reduce total volume of stormwater runoff. Source tracking can help to identify sources, and the siting of elimination and green infrastructure implementation work in these areas.

Concurrent to source tracking efforts, an aggressive and coordinated stormwater reduction and water quality improvement campaign must be implemented throughout the watershed. These efforts must combine a focus on grassroots networking and cooperation, education and awareness outreach, and individual and community voluntary efforts. Furthermore, a renewed emphasis must be placed on the existing stormwater regulatory framework at the municipal, county, and State level.

The Rally for the Navesink coalition is excited to work with stakeholders and municipalities to develop a plan to reduce total stormwater volume in the Watershed using current regulations, education and awareness, and community initiatives. COA has already reached out to Rutgers Water Resources Program to help work toward the completion of an Impervious Cover Assessment and Reduction Action Plan for every municipality in the Navesink.[189]

VI. Conclusion

As the most recent shellfish classification downgrade of over 565 acres of the Navesink makes clear, ***water quality is deteriorating.*** Numerous efforts, studies, and thousands of water samples over the last 30 years point to a complex source of fecal pollution from **aging sanitary infrastructure**, and **agricultural and urban runoff,** all of which is triggered**,** mobilized, and exacerbated by rainfall.

The Navesink River is emblematic of the stormwater driven water quality issues plaguing coastal waters statewide, as well as the ineffectiveness of regulatory measures to address these problems. The shellfish downgrade must serve as a call to unite, and begin a rapid and holistic effort to improve water quality.

The Navesink Watershed, filled with incredible beauty and resources, and populated by thousands of citizens, business leaders, and environmental organizations that work on, enjoy, and live near the river, has the ability to take action now. With the knowledge gained from past efforts, and a vision for the future, these efforts can also establish a model for water quality improvement that will stand over time and inspire others. If water quality improvements cannot be made in the Navesink, it is hard to imagine that they can be achieved anywhere in the country.

[189] Impervious Cover Assessment (ICA) and Impervious Cover Reduction Action Plans (RAPs), presentation by Dr. Chris Obrupta, Rutgers Water Resources Program, January 2016, *available at* http://water.rutgers.edu/Recent_Presentations/Obropta_MonmouthCoCRSGroup1-21-2016.pdf. Note that Reduction Action Plans for the Towns of Fair Haven and Tinton Falls have either been or are soon to be completed.

Appendix A: List of Commonly Used Acronyms

BMPs – Best Management Practices

C1 – Category One

CAFRA – Coastal Area

CCMP – Cooperative Coastal Monitoring Program

CSO – Combined Sewer Overflow

CWA – Clean Water Act

DDT - Dichlorodiphenyltrichloroethane

DO – dissolved oxygen

E. coli – *Enterococcus coli*

FDA – Food and Drug Administration

FHACA – Flood Hazard Area Control Act

FIB – Fecal Indicator Bacteria

HABs – Harmful Algal Blooms

HEP – The New York-New Jersey Harbor & Estuary Program

ISSC – Interstate Shellfish Sanitation Conference

LAs – Load Allocations

MAR – Multiple Antibiotic Resistance

MS4 – Municipal Stormwater Management Plan

MST – Microbial Source Tracking

NJDEP – New Jersey Department of Environmental Protection

NJPIRG – New Jersey Public Interest Research Group

NJWSA – New Jersey Water Supply Authority

NPS – non-point source

NSSP – National Shellfish Sanitation Program

PCB - Polychlorinated Biphenyl

PIB – Pathogen Indicator Bacteria

RSWMP – Regional Stormwater Management Plan Committee

SE1 – Saline Estuary

SBR – Statewide Basic Requirement

SWQS - Surface Water Quality Standards

SWRPA – Special water resource protection area

TMDLs – Total Maximum Daily Loads

USEPA – United Stated Environmental Protection Agency

WLAs – Waste Load Allocations

WQS – Water Quality Standards

Appendix B: Water Quality Chronology of the Navesink Watershed

There have been numerous efforts in the past several decades to identify and eliminate sources of pollution affecting the recreation and shellfishing opportunities in the Navesink. This section puts these events in chronological order and summarizes these attempts in an effort to clarify the legal and policy tools already implemented in the Navesink River Watershed.

- **1971** - water quality had deteriorated to the point that restrictions on harvesting shellfish in the Navesink were put in place "classifying all shellfish growing waters" condemned for direct harvest and marketing of clams, mussels and oysters.""[190]
- **Mid-1970s** - Major improvements to the Navesink River began. Following the elimination of 14 small and outdated wastewater treatment plants discharging to the river, the sewage was conveyed to a larger, secondary treatment facility for discharge offshore. The next step was to control runoff from the area's numerous horse farms through the steady implementation of "best management practices," including improved handling of organic wastes and modification of pastures to protect local surface waters.[191]
- **1981 -** A multi-agency government effort to address non-point source pollution in the Navesink was initiated.[192] This effort was apparently called "The Navesink Watershed Management Project", and according to one of the only sources of information on this group, was comprised of "a partnership among conservation organizations and several governmental agencies, initiated in 1981 to reduce nonpoint source pollution in the Navesink estuary. Progress includes identification of the extent of recreational boating, the infrastructure required to reduce sewage and the need for education to encourage change. In partnership with the Natural Resource Conservation Service, a project involving 19 long term contracts was implemented on state, county and local lands along the Navesink River to reduce runoff and sedimentation entering the estuary. This project employed grassed waterways, a composting facility and animal waste storage facilities to protect the estuary."[193] The status of this partnership effort is unknown.
- **1982** - NJDEP report states that "As a result of high bacterial levels for shellfish growing waters in New Jersey, all 2,622 acres of shellfish harvesting areas in the Navesink River (Monmouth County) have been closed for more than 20 years." The report also identifies "animal, rather than human, feces, and emanates from horse farm operations proximal to upstream tributaries of the Navesink River." Finally, the report linked bacteria loading to storm events and noted that the numbers of Total Coliform increased 23-fold, Fecal Coliform and Fecal Streptococci increased 7-fold.[194] This report sought to identify best management practices to be implemented within the watershed "for controlling stormwaer, abating water quality effects of agriculture and other soil-disturbing activities and minimizing the water quality effects of waste disposal."[195]

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[190] A Report to the Deputy Administrator: Pollution Control in the US – Some Examples of Recent Accomplishments, 1976, *available at* http://nepis.epa.gov/Exe/ZyPDF.cgi/9101JSRA.PDF?Dockey=9101JSRA.PDF
[191] NOAA, State of the Coastal Environment, *available at* http://oceanservice.noaa.gov/websites/retiredsites/sotc_pdf/SGW.PDF
[192] Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12 Atlantic Coastal Water Region, 2006, at 10, *available at* http://www.nj.gov/dep/wms/bear/coastal_pathogen_tmdls_wma12%20for%20adoption.pdf
[193] *See* New Jersey Audubon website for the Navesink and Shrewsbury Rivers, *available at* http://www.njaudubon.org/SectionIBBA/IBBASiteGuide.aspx?sk=3124
[194] Bacterial Contamination of Shellfish Harvest Areas in the Navesink River, NJDEP, 1982, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/29476/
[195] *Id*.

- **1986** - sampling and storm drain studies prompted the drafting of a Memorandum of Understanding between NJDEP, USEPA, and US and NJ Department of Agriculture, as well as 12 municipal, county, private and public institutions to: *"formalize our commitment to the Navesink River Water Pollution Control Shellfish Protection Program and its primary goal of improving water quality in the Navesink Watershed to a point at which the river's full shellfishery and recreational potential may be attained."*[196]
- **1980s** - NJDEP's Environment Planning Program initiated the Navesink nonpoint source study, which included "intensive watershed/land-use analysis, inventory and compliance assessment of point source permits, evaluation of potential nonpoint sources and monitoring of the estuary and its tributaries. Sources of contamination were subsequently attributed to a combination of stormwater runoff associated with residential development, agricultural waste, and marina/boat associated pollutants."[197]
- **1985** - A portion of the Navesink River was designated as Category One (C1) based on shellfish waters.
- **1986** - NJ Department of Agriculture started work to reduce fecal pollution in the watershed and in the river and noted the "multiple benefits for agriculture, fish and shellfish, and any of us who use the watershed for water supply or recreation."[198]
- **1988** – A report conducted by NOAA states that "All 1,662 acres of shellfish harvesting areas in the Navesink River have been closed to direct harvest and marketing of clams, ovsters and mussels for more than twenty years. This is a result of high bacterial levels in excess of the standard limits set for shellfish growing waters in New Jersey. Since no significant point sources of bacterial pollution exist in the Navesink River watershed, the present study was initiated to identify and isolate probable NPS (non-point source) contamination to the estuary. The findings of this study indicate that the primary bacterial loading originates from animal, rather than human, feces that emanate from horse farm operations proximal to upstream tributaries of the Navesink River, as well as from urban/suburban stormwater runoff."[199]
- **1992 to 1995** – Data showed that water quality in the Navesink had improved since 1993 due to a decrease in nonpoint source loadings from coastal development, agricultural waste, and marina and boating related contamination into the Navesink watershed.[200]
- **1995** - EPA headline proclaims "*Partnership Successfully Reduces Nonpoint Source Pollution in the Navesink River",* stating "The partnership has learned important lessons: we have learned that nonpoint source programs need to be flexible, innovative, and developed on a site-specific basis. To gain institutional and financial support, the program must be created by the very parties that will play an integral role in resource management. The Navesink River Program is an exemplary partnership."[201]
- **1996** - New Jersey upgraded 624 acres of some of the most productive shellfish growing waters in the state to "conditionally approved" after more than 20 years of harvest restrictions (Zimmer, 1997).[202]

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[196] Memorandum of Understanding, dated August 21, 1986.

[197] Section 319 Success Stories: Volume II: Highlights of State and Tribal Nonpoint Source Programs, 1997, at page 113, *available through* National Service Center for Environmental Publications (NSCEP). *See also* USEPA Nonpoint Source News-Notes, Issue 40, 1995

[198] NJ Department of Agriculture Secretary Brown as quoted in NJDEP, 1986. Navesink River Project Kicked Off Water Resources News Fall 1986, Vol. 2, No. 4.

[199] NOAA, State of New Jersey Non Point Source Assessment and Management Program, December 1988, *available at* https://www.gpo.gov/fdsys/pkg/CZIC-td424-35-n5-n66-1988/html/CZIC-td424-35-n5-n66-1988.htm

[200] *See* http://www.harborestuary.org/pdf/hepshellfish.pdf, siting to NJDEP 1986, 1996 Shellfish Sanitation Surveys/

[201] USEPA Nonpoint Source News-Notes, Issue 40, 1995

[202] NJDEP 1996 Navesink Sanitary Survey Reappraisal, *available at* https://rucore.libraries.rutgers.edu/rutgers-lib/36419/PDF/1/

- **1997** – A section of the Navesink River was upgraded from *Special Restricted* to *Seasonally Approved (November to April* for the first time in 25 years. This was the result of reducing non-point source contamination to the river through an effort made by the Navesink River Watershed, Monmouth County and many state agencies, as well as the private sector. This achievement was touted by many entities as a textbook example of what innovative pollution control measures. [203] NJDEP stated in the 1997 Shellfish Growing Classification Report that "Water quality is adversely affected by nonpoint sources of pollutants, including storm runoff from agricultural, suburban, and urban areas. Over the last ten years significant progress has been made, particularly in the Navesink River area, to reduce the quantity of pollutants entering the water from nonpoint sources."
- **1998** - USEPA Published a book titled Clean Water Action Plan, which contained a short section on the Navesink: "The Navesink River in New Jersey was closed to shellfishing in the early 1970s because of extensive pollution from industrial, marina, and agricultural sources. A Memorandum of Understanding was signed by the New Jersey Departments of Environmental Protection and Agriculture, EPA, Natural Resources Conservation Service, and 12 county, municipal, academic, and private organizations to restore recreational and commercial shellfish harvesting to the Navesink by reducing the amount of bacteria that enters the river. After years of implementing innovative pollution control measures the Navesink was re-opened to shellfishing in 1997 and now generates an estimated 10 million annually for the local economy."[204]
- **1998 -** The Navesink River was listed as impaired under the EPA 303(d) list for Total Coliform Bacteria.[205]
- **1999** - EPA approved the NJDEP's plan to prohibit boats from discharging treated or untreated sewage into the Navesink River in Monmouth County, determining that there are a sufficient number of pump-out facilities located in the area to receive the sewage from vessels.[206] Today, the Navesink River is a "No Discharge Zone" with a number of pump out stations throughout the river, and the NY/NJ Baykeeper currently operating the "Royal Flush" a pump out boat servicing the two rivers area.
- **2003** - EPA approved Total Maximum Daily Loads (TMDLs) for Fecal Coliform to address 31 Streams in the Atlantic Water Region. Three streams draining into the Navesink were included in this TMDL package. The TMDL identifies specific strategies for each stream segment, and included funding for Rutgers University to addresses manure management of small horse farms in the Navesink River Watershed. Some progress seemed to have been made in reducing agricultural sources of fecal coliform bacteria, however no streams have been improved enough to remove them from the 303(d) impaired list, no follow up seems to have been performed after 2011, and currently, the status of BMP implementation in the upper watershed is unknown.
- **2004** - New Jersey approves the Phase II process of the MS4 permit program and related Municipal Stormwater Management Rules. The MS4 permits include the required creation of a Municipal Stormwater Management Plan, and various control measures that were designed to substantially reduce nutrient and bacterial loadings in impaired watersheds.[207] These control measures include adoption and enforcement of a pet waste disposal ordinance, prohibiting the feeding of unconfined wildlife on public property, cleaning catch basins, performing

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[203] Section 319 Success Stories: Volume II: Highlights of State and Tribal Nonpoint Source Programs, 1997, at page 113, *available through* National Service Center for Environmental Publications (NSCEP). *See also* USEPA Nonpoint Source News-Notes, Issue 40, 1995

[204] USEPA Clean Water Action Plan, 1998

[205] Waterbody Assessment Report for the Navesink Estuary, *available at* http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=NJ_0101&p_cycle=1998#causes

[206] EPA Region 2 News Release, http://yosemite.epa.gov/opa/admpress.nsf/d10ed0d99d826b068525735900400c2a/e49dc8502d3f32998525724800632e1b!opendocument

[207] Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Rules, N.J.A.C. 7:14A

good housekeeping at maintenance yards, and providing related public education and employee training. According to NJDEP, "These basic requirements will provide for a measure of load reduction from existing development."[208] The New Jersey Stormwater Management Rules also established additional water quality protections including a 300- foot special water resource protection area (SWRPA) around Category One (C1) waterbodies and their intermittent and perennial tributaries.[209] Unfortunately, the MS4 program, even after proposed updates in 2016, has been beset by a lack of monitoring, oversight, and enforcement, among many other issues.[210]

- **2005** - NJDEP Sanitary Survey for the Navesink reviewes approximately 1,340 water samples collected for total and fecal coliform bacteria between 1999 and 2003 at over 40 stations, and recommends that 152 acres of waters in the upper portion of the Navesink River be downgraded from *Special Restricted* to *Prohibited*. The proposed area encompassed all waters located west of Highway 35 Bridge (Cooper's Bridge) in Red Bank, including Swimming River and Shadow Lake.[211] The 2006 Shellfish classification rules formally downgraded the 152 acres to prohibited.[212] According to NJDEP at this time, "the closure of productive shellfish waters was a clear indicator of the worsening water quality in the upper Navesink River."[213]
- **2005** - The Monmouth County Planning Board led efforts to create a Navesink/Swimming River Regional Stormwater Management Plan Committee (RSWMP) through a NJDEP Division of Watershed Management framework. NJDEP stated that "support of the municipalities in the planning area is critical to the development of a RSWMP." All municipalities in a watershed are required to support the plan.
- **2006** - EPA approved Total Maximum Daily Loads (TMDLs) prepared by NJDEP, for shellfishing impairments due to high total coliform levels for the Navesink and Shrewsbury Rivers and the larger Watershed Management Area 12 which encompasses the rivers.
- **2006** - In response to the downgrade of shellfishing waters, NJDEP, undertook a microbial source tracking study of the upper Navesink River in cooperation with Monmouth County Health Department, and the town of Red Bank. The study included a long term analysis of coliform data in the Navesink and in the Swimming River Reservoir as well as storm event testing using Microbial Source Tracking methods, optical brightener tracking, and multiple antibiotic resistance testing.
- **2007** - The Township of Colts Neck affirmed its "unanimous continued opposition to the creation of a Regional Stormwater Management Plan", effectively ending efforts to establish a regional stormwater plan.[214]
- **2008** – The results of the study, titled "Upper Navesink River Stormwater Study: Microbial Source Tracking" are released providing several relevant data points to consider:[215]
    - The long term analysis of Navesink coliform data confirmed a rainfall correlation with water quality, especially during the summer months.
    - The long term analysis of monitoring data from the Swimming River Reservoir discounted the reservoir as a significant source of bacterial contamination. HOWEVER, the study does state that Station 31

[208] NJDEP 2005 proposed Phase I Passaic River Study Total Maximum Daily Load for Phosphorus in Wanaque Reservoir Northeast Water Region.
[209] Stormwater Management Rules, N.J.A.C. 7:8
[210] *See* 2014 Environmental Coalition Comments on MS4 Program, and 2016 Environmental Coalition Comments on MS4 updates
[211] NJDEP 2005 Navesink Sanitary Survey
[212] *Id*. *See also* N.J.A.C., 2006.
[213] *Id*.
[214] Letter from Colts Neck Township Administrator Robert Bowden to Monmouth County Planning Board, March 27, 2007.
[215] Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf

(located in Colts Neck nearby the Reservoir) reported extremely high spikes of bacteria.[216] Unfortunately, no follow up work at this area was performed. NJ American Water, water utility and owner of the Swimming River Reservoir does acknowledge that NJDEP believes that surface water sources of drinking water, including the Swimming River, are highly susceptible for pathogen contamination.[217]

- The report ultimately suggests that stormwater discharges and failing infrastructure in the area are the most likely sources and identified several areas of concern.[218]
- The Study also included and prompted continued source tracking work with NJDEP, the Town of Red Bank, and the Monmouth County Health Department including:
  - the identification and elimination of an overflowing and improperly maintained septic tank that discharged into an outfall that drained east of Riverview hospital;
  - the identification and elimination of an overflowing and improperly maintained septic tank that was located in a marina adjacent to Hubbard's Bridge and that discharged into the river via leaching and overflow (owner also owned a septic tank pump –out service);
  - the elimination of three (3) other septic systems on Locust Avenue;
  - the identification and elimination of improper cross connections between sanitary and storm sewer piping in the YMCA that led to whiteners and detergent discharge at the foot of Maple Avenue,
  - the identification of an overflowing French drain oil water separator in the area of Riverview hospital loading dock and establishment of on-going cleaning and maintenance procedures;
  - the identification and elimination of contamination from leaking garbage dumpsters from commercial properties along Riverside Avenue and Bodman Place.
  - The study also prompted other follow up tracking efforts by the Red Bank in the area of their outfalls as well as targeted sampling being conducted on the Middletown side of the River including McClees creek, etc.

- **2008** – Soon after NJDEP's Microbial Source Tracking study was released, a non-profit organization representing the interests of clammers, fishermen and river users, called the Watermen's Alliance, filed suit against the towns of Red Bank and Colt's Neck as well as the Monmouth Parks Race Track alleging Clean Water Act violations. The suit was ultimately dismissed.
- **2009** - NJDEP Bureau of Marine Water Monitoring halted MST efforts in the Navesink due to reprioritization of resources.
- **2009** - Approximately 120 acres of the Navesink were suspended to harvest before being reopened again, and then re-suspended.[219] This suspension and reopening occurred several times through 2009 and 2010. The initial suspension notice stated: "The downgrades are based on the most recent three years of monitoring data and show declining water quality in these areas, primarily due to nonpoint source impacts related to rainfall. The impacted waters of the upper Navesink River may benefit in subsequent years from actions taken at the

[216] *Id*.
[217] 2015 Annual Drinking Water Report, NJ American Water, *available at* http://www.amwater.com/ccr/coastalnorth.pdf
[218] Upper Navesink River Stormwater Study: Microbial Source Tracking, 2008, NJDEP Bureau of Marine Water Monitoring, *available at* http://www.state.nj.us/dep/bmw/Reports/RevisedNavesinkStormFeb.pdf
[219] *See* NJDEP Bureau of Marine Water Monitoring website at http://www.nj.gov/dep/bmw/archive.html#Sus040809

municipal level in 2008 to locate and address pollution sources. There is currently not sufficient data to assess the impact of these recent corrective actions."[220]

- **2010** - the NJDEP banned the cultivation of research related shellfish reefs in contaminated waters as part of a response to the Federal Drug Administration's concerns that the State was not thoroughly monitoring shellfish beds statewide. As part of this ban, the NY/NJ Baykeeper was forced to halt its oyster gardening program in the Navesink River. The ban also impacted Baykeeper's oyster restoration projects statewide, and currently, the only active research related oyster reef in NJ waters resides within the confines of Naval Weapons Station Earle.
- **2011 -** NJDEP adopted amendments to the shellfish classification rules officially listing the 120 acres previously suspended to harvest as prohibited.[221]
- **2011 -** Rutgers Equine Science Center releases annual report stating "The largest threat to this watershed is that of increased development creating more impervious surfaces, atop an elevated, sloping watershed leading to more storm-water run-off, increased stream velocity, more erosion and concentration of non-point source pollutants."[222]
- **2011** - Report by Rutgers Equine Science Center, titled "Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed " states that "[i]n terms of soil and water quality, this upper watershed is in reasonable health but there are some indications of deterioration, especially stream sedimentation from erosion and other nonpoint source pollutants related to Storm-water run-off."[223] The report also states that "the lower portion (of the Navesink Watershed) below the dam has had severe and chronic environmental issues. Interaction between the upper and lower regions appears limited. Some of those significant local issues downstream, below the dividing dam, include flooding and very high bacterial counts."[224]
- **2011** - the TMDL for the Navesink was finally adopted in the Monmouth County Water Quality Management plan, 5 years after the approval of the document by EPA.
- **2011** - The Watermen's Alliance filed another Clean Water Act citizen suit, this time in federal court, against the Monmouth Park Racetrack for failure to comply with the terms of the consent order it entered into with NJDEP. This suit was also dismissed.
- **2011 -** New Jersey passes one of the most stringent Fertilizer Laws in the Country, limiting the type of fertilizer that can be sold in New Jersey, who can commercially apply these fertilziers, and when application of fertilizer is allowed.
- **2012** - NJDEP Bureau of Marine Water Monitoring released a Sanitary Survey Reappraisal, which concluded that the higher levels of bacteria in the upper portion of the river (prohibited area) result from potential sources of pollution including high urban land use, marinas, and old infrastructure. The 2012 reappraisal states that the classifications in place since 2005 were accurate after examining the 2008-2011 water sampling data.
- **January 9, 2015 -** NJDEP issues administrative suspension of shellfishing activities for 565.7 acres of the Navesink River west of the Oceanic Bridge (as identified in the NJDEP Bureau of Marine Water Monitoring map provided above).

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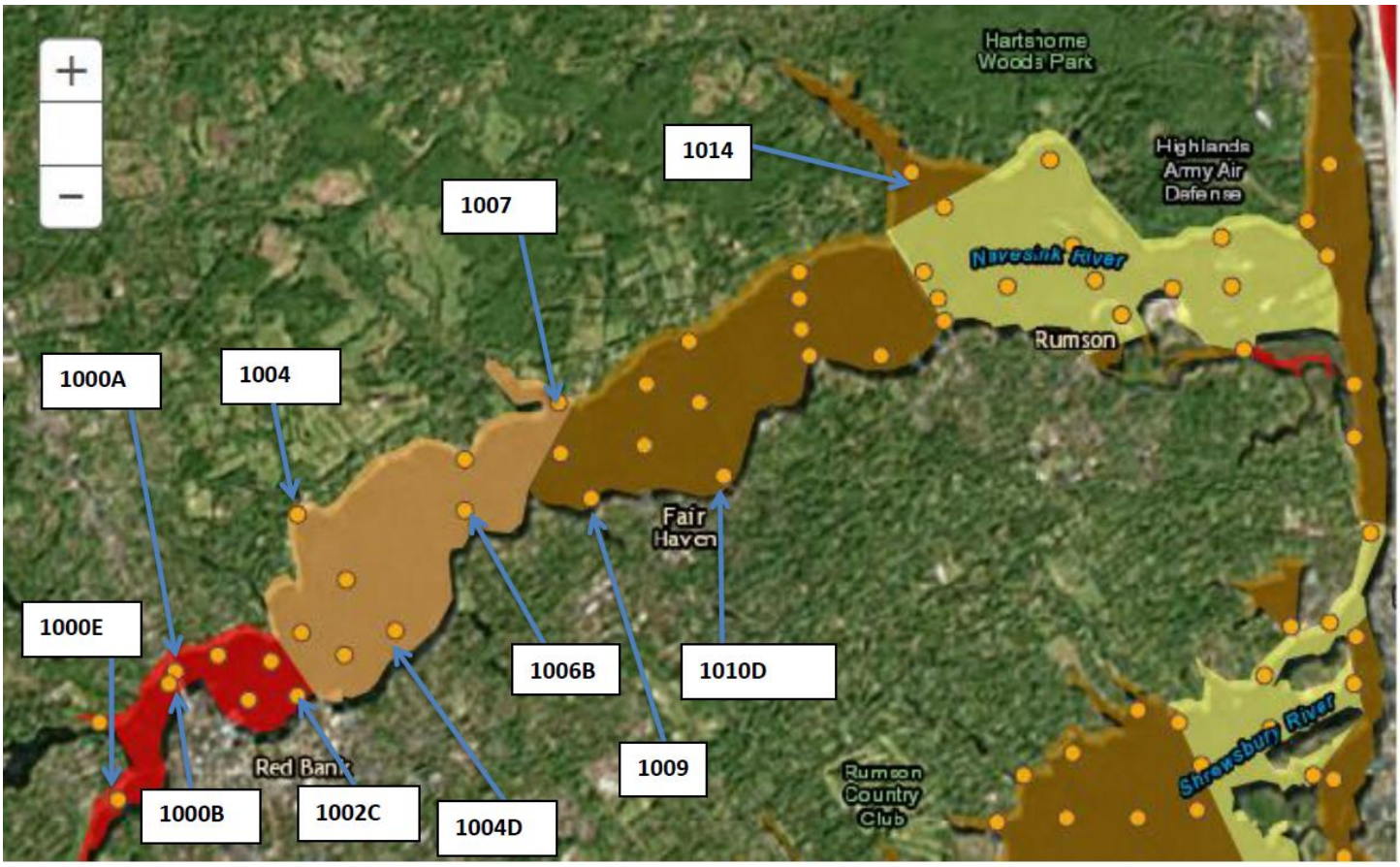
[220] *Id*.
[221] *Id.*
[222] Rutgers Equine Science Center, Annual Report 2011, *available at* http://esc.rutgers.edu/wp-content/uploads/2014/11/2009-2010-Annual-Report.pdf
[223] Bill Sciarappa, PI, Brian Hulme and Kevin Soldo, Agro-Environmental Assessment of Equine Pasture in the Colts Neck Watershed, 2011. Rutgers Equine Science Center.
[224] *Id*.

- **November 16, 2015** - NJDEP releases its updates to the Shellfish Classification Rules, which among other actions, formally changed the status of the "suspended" waters designation to "Prohibited".
- **February 2016 -** A law was enacted in early 2016 that will hopefully work to allow these critically important types of shellfish restoration programs to return to New Jersey waters, including the Navesink. According the NY/NJ Baykeeper, "While the law doesn't lift the ban on shellfish research, restoration, and education activities, it provides a path forward to ensure equal opportunities for all communities that wish to pursue shellfish projects."[225]

[225] http://nynjbaykeeper.org/wp-content/uploads/2016/03/February-2016-Newsletter-HTML-Content.pdf

Appendix C: NJDEP's NSSP 2011-2014 Fecal Coliform Sampling Data For Select Sites in the Navesink River

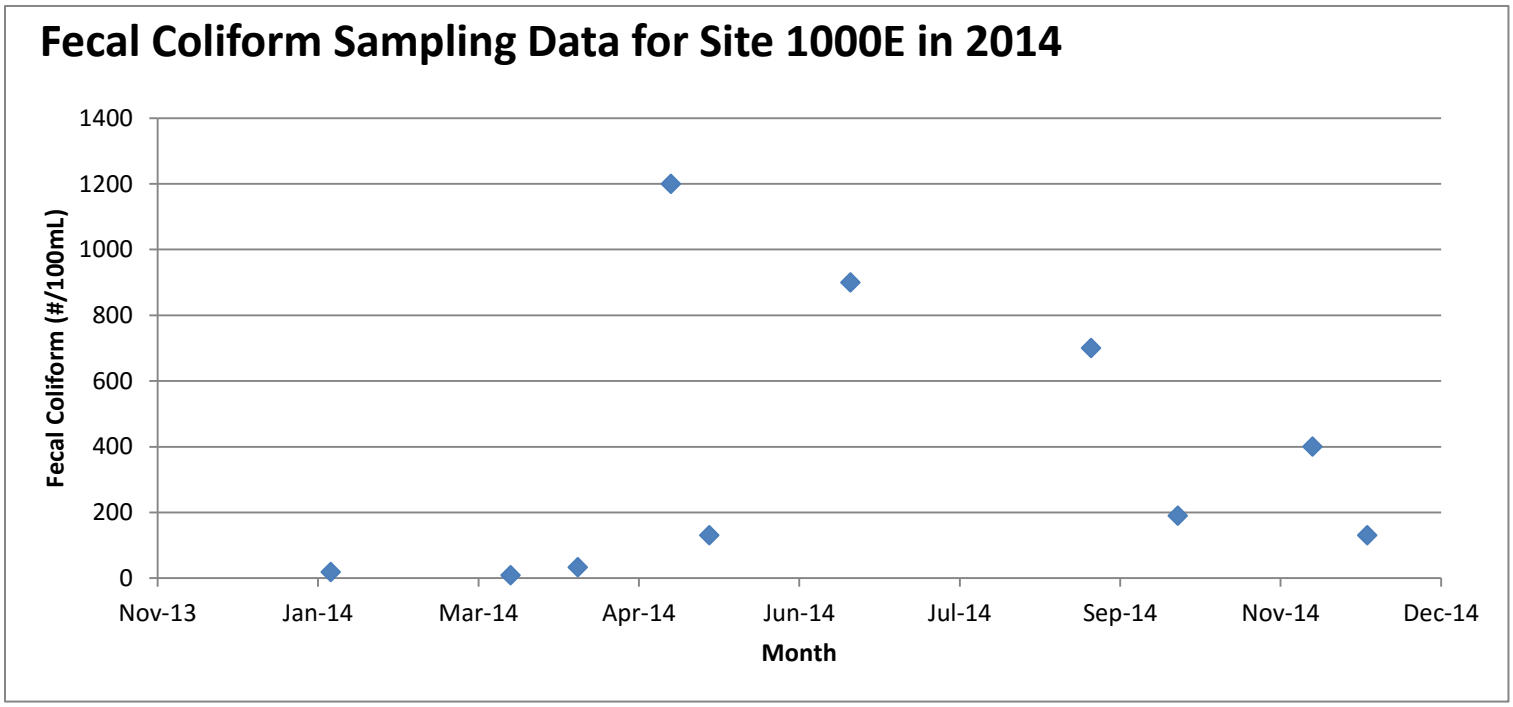


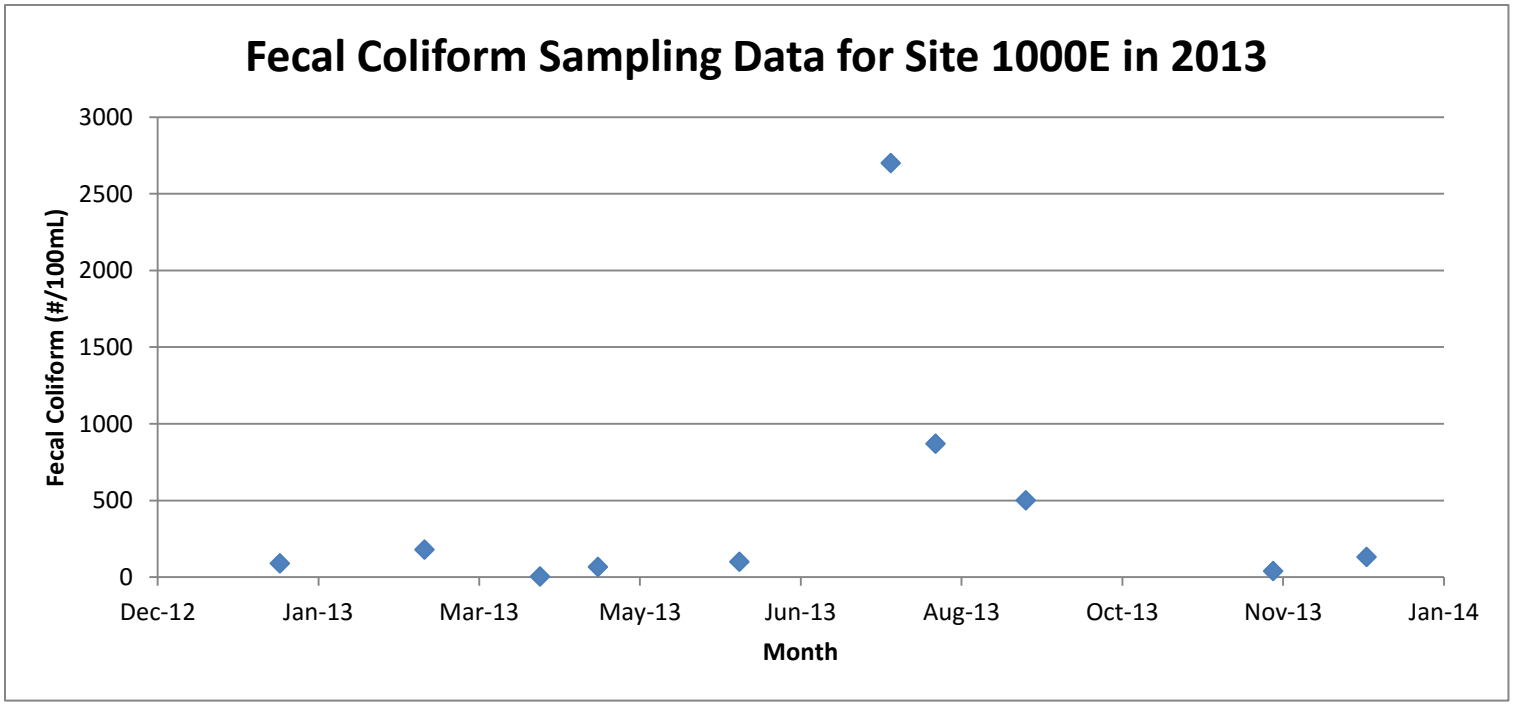
NOTE: These sampling results were accessed through NDJEP Bureau of Marine Water Monitoring website and EPA Storet Database. These are the underlying data points which necessitated NJDEP's downgrade of over 565 acres of shellfish harvesting area. Shellfish Harvesting criteria utilizes a geometric mean (average) or Max 90th percentile calculation as seen below. COA has not undertaken these calculations and will be awaiting NJDEP's statistical summary underlying the 2015 downgrade.

CRITERIA FOR SYSTEMATIC RANDOM SAMPLING STRATEGY				
Classification	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric Mean (MPN/100 mL)	Max. 90th Percentile (MPN/100 mL)	Geometric Mean (MPN/100 mL)	Max. 90th Percentile (MPN/100 mL)
Approved	70	330	14	49
Special Restricted	700	3300	88	300

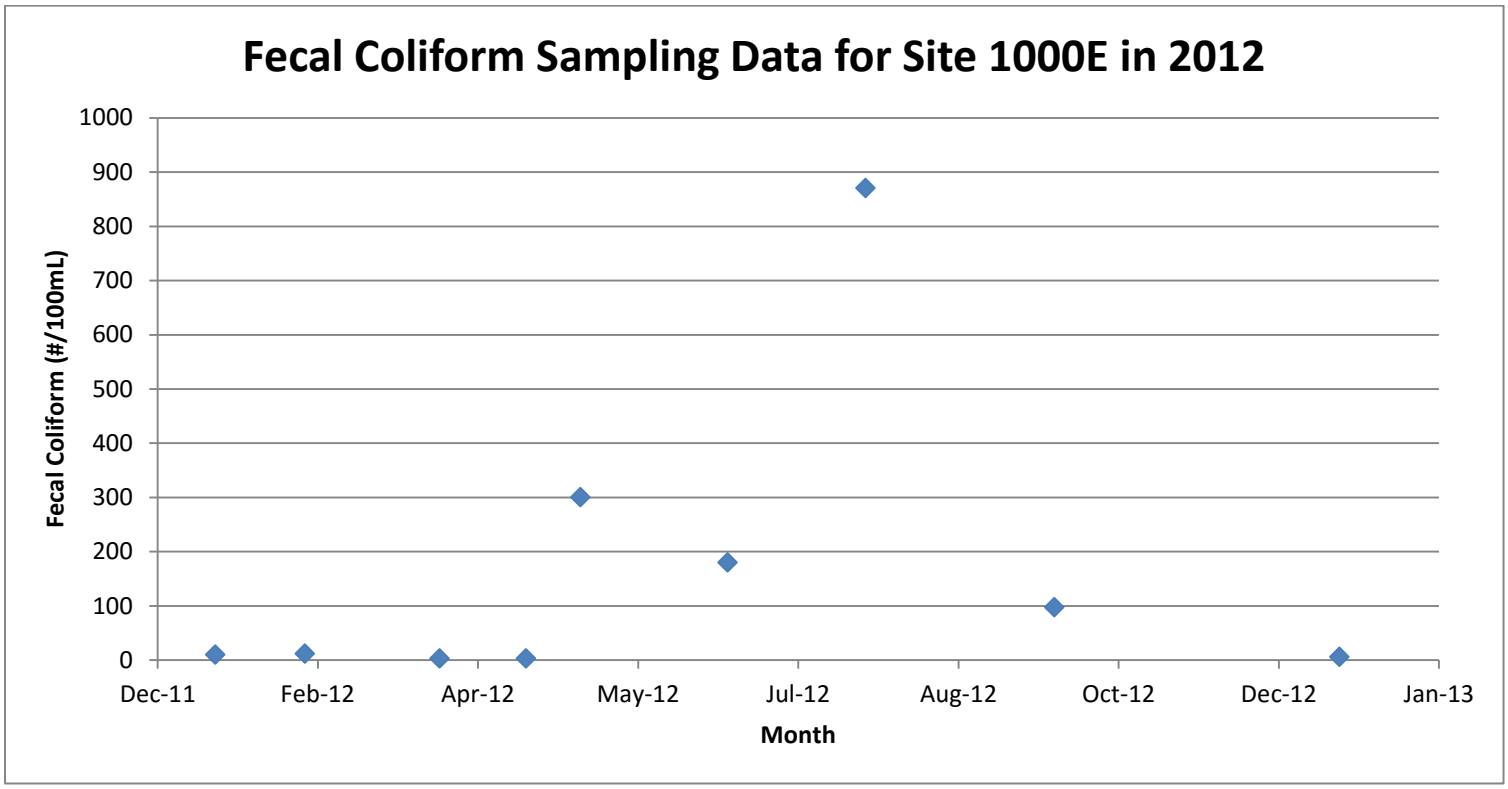
COA has provided visualizations of select stations below only to illustrate exceedances of 200 fecal coliform units / 100ml which until 2004 was the standard for a single sample maximum for recreational contact in New Jersey, and is still

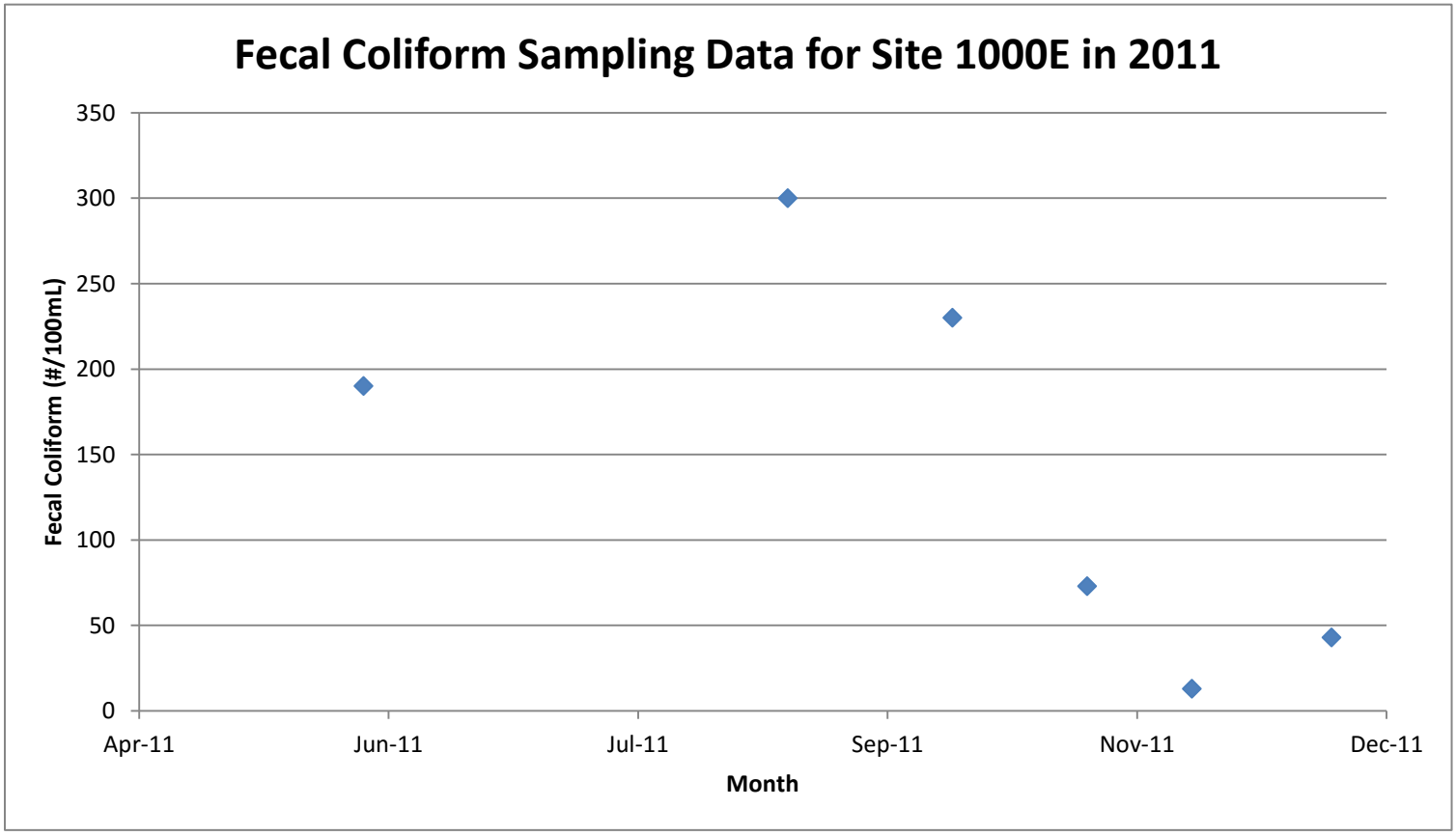
found in the New Jersey Sanitary Code today.[226] **Any result over 200 Fecal Coliform /100 ml would indicate unsafe swimming conditions.**

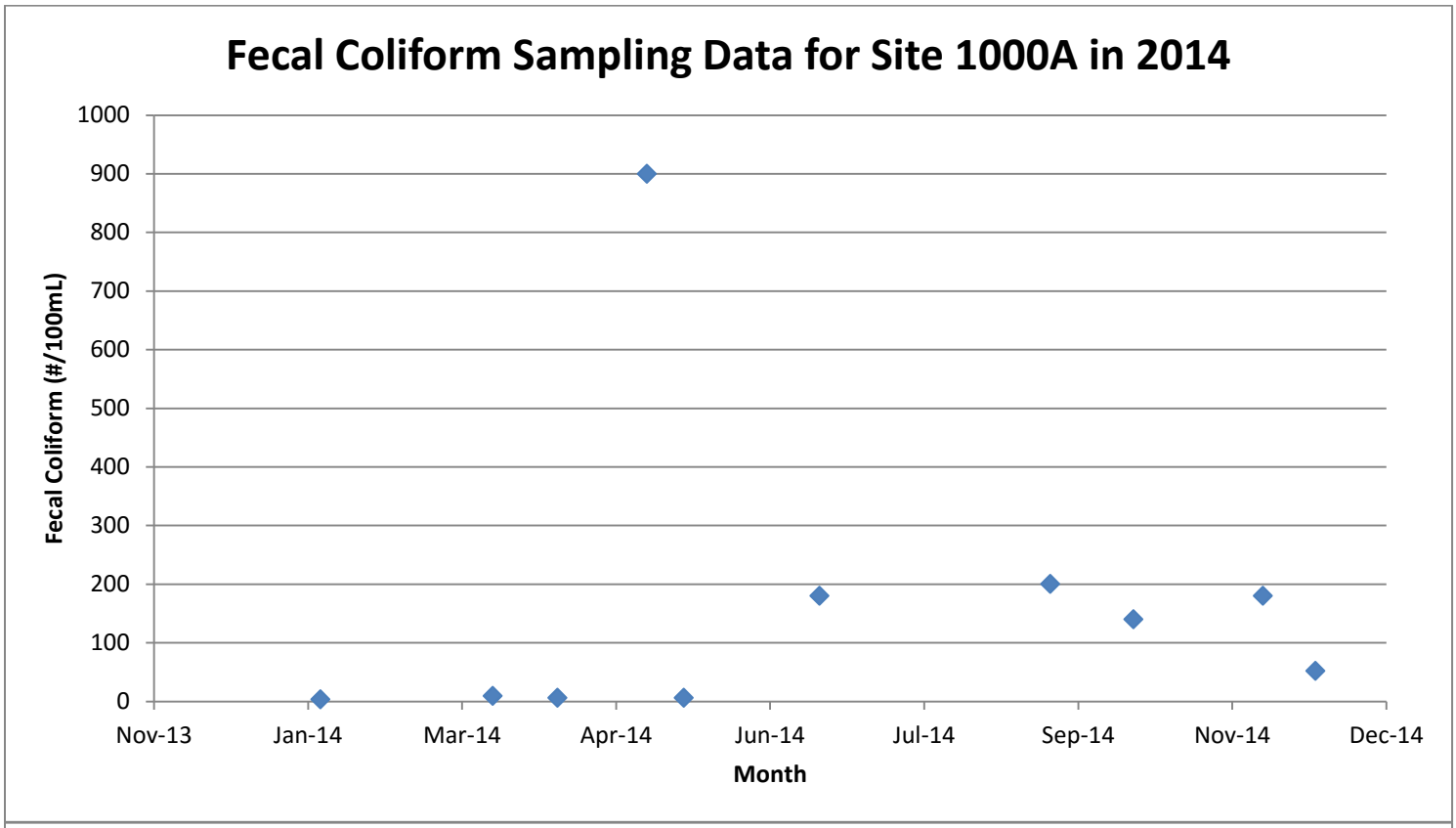


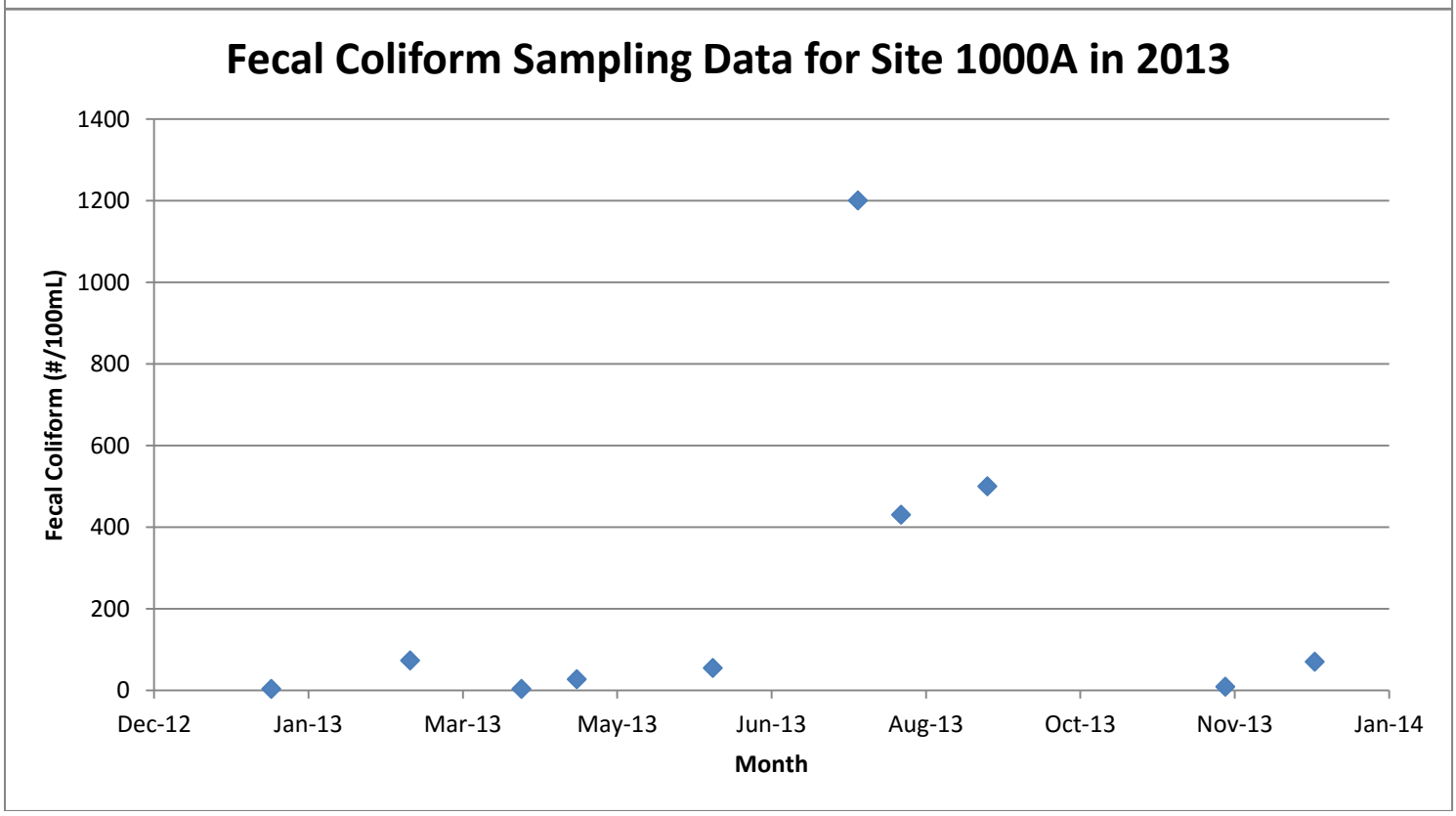


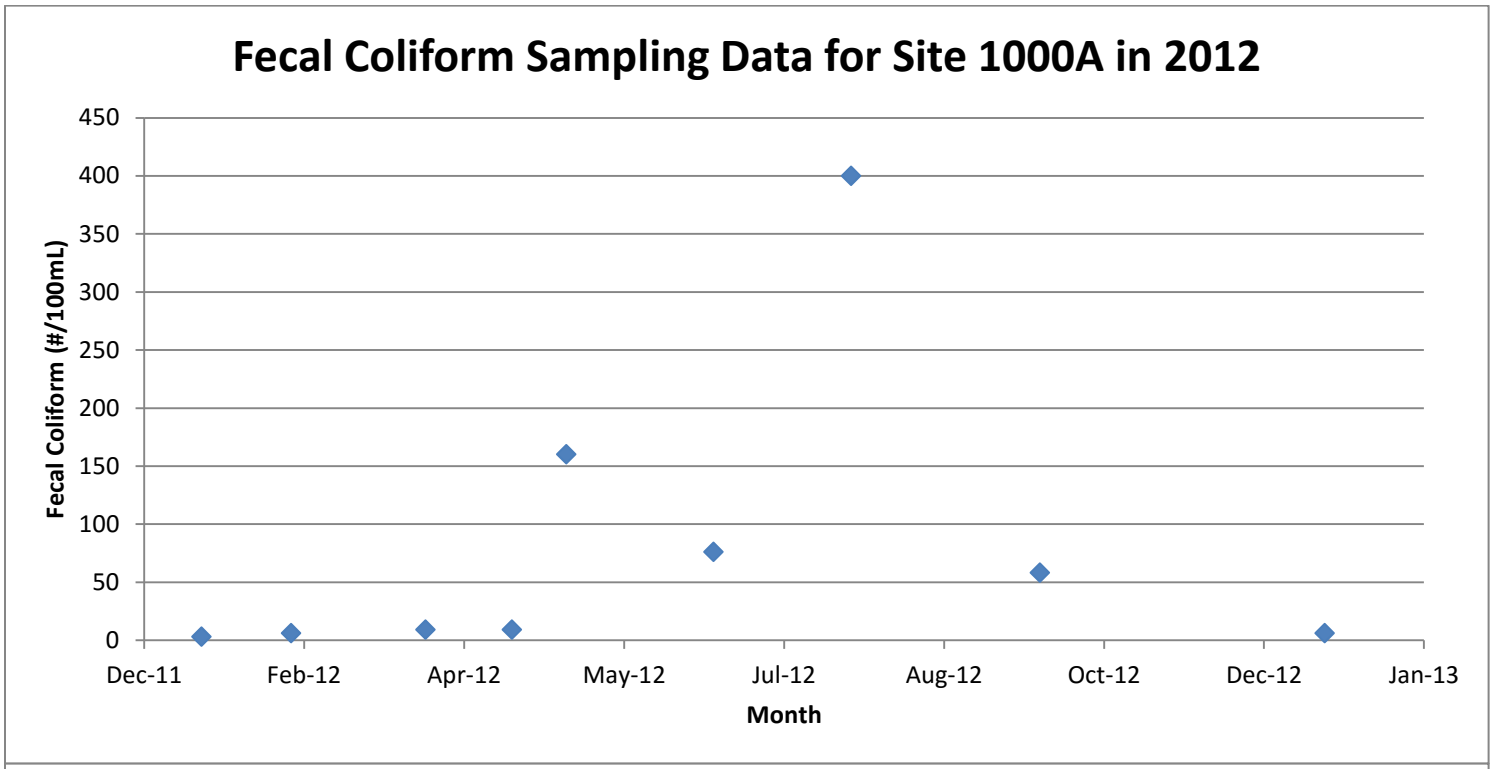
[226] *See* N.J.A.C. *8:26-5.10* Bathing Beach Supervision, N.J.A.C. 8:26-7.16 Sample Collection at Bathing Beaches, N.J.A.C. 8:26-8.8 Closure of Bathing Beaches. *See also* 1986 Recreational Water Quality Criteria, USEPA.

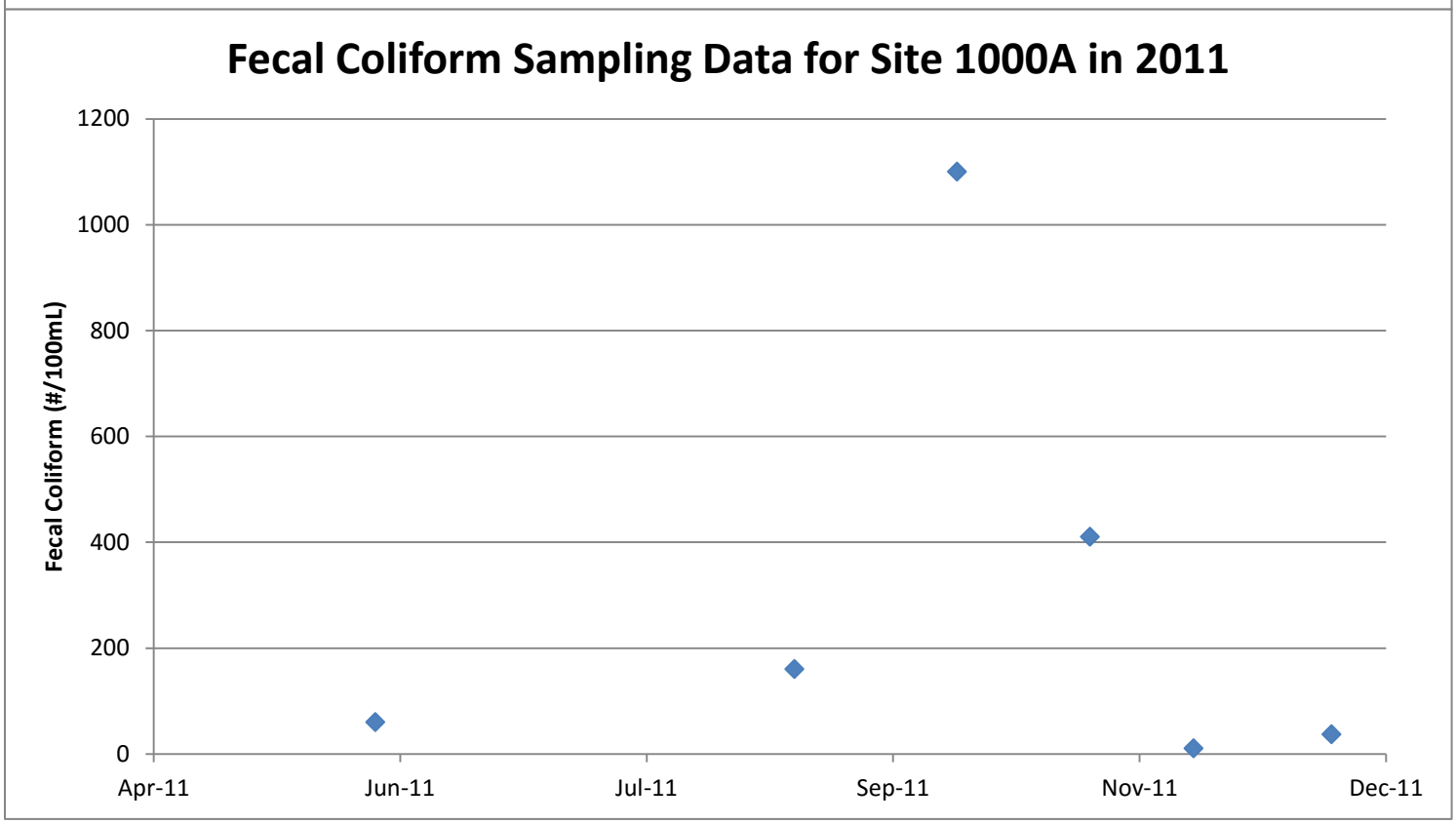

Fecal Coliform Sampling Data for Site 1000E in 2012
Fecal Coliform (#/100mL)
1000
900
800
700
600
500
400
300
200
100
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

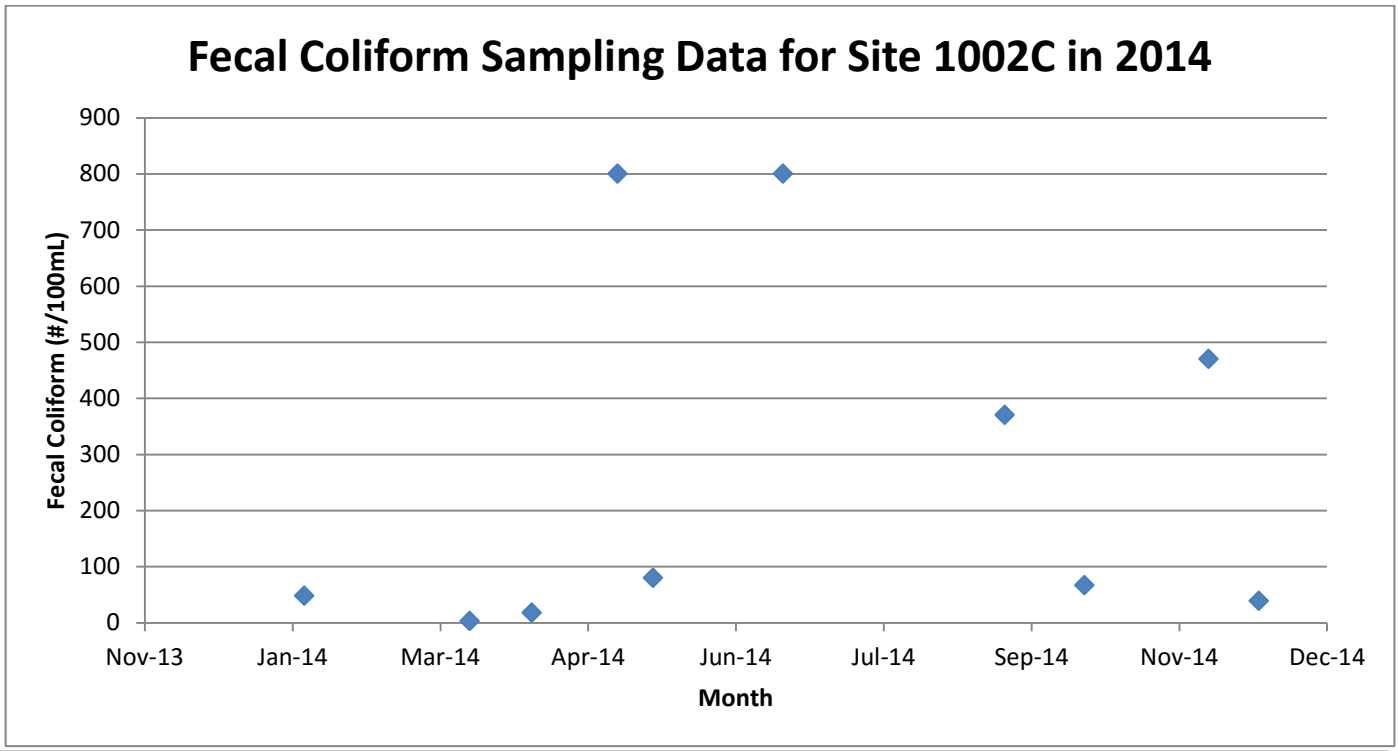

Fecal Coliform Sampling Data for Site 1000E in 2011
Fecal Coliform (#/100mL)
350
300
250
200
150
100
50
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

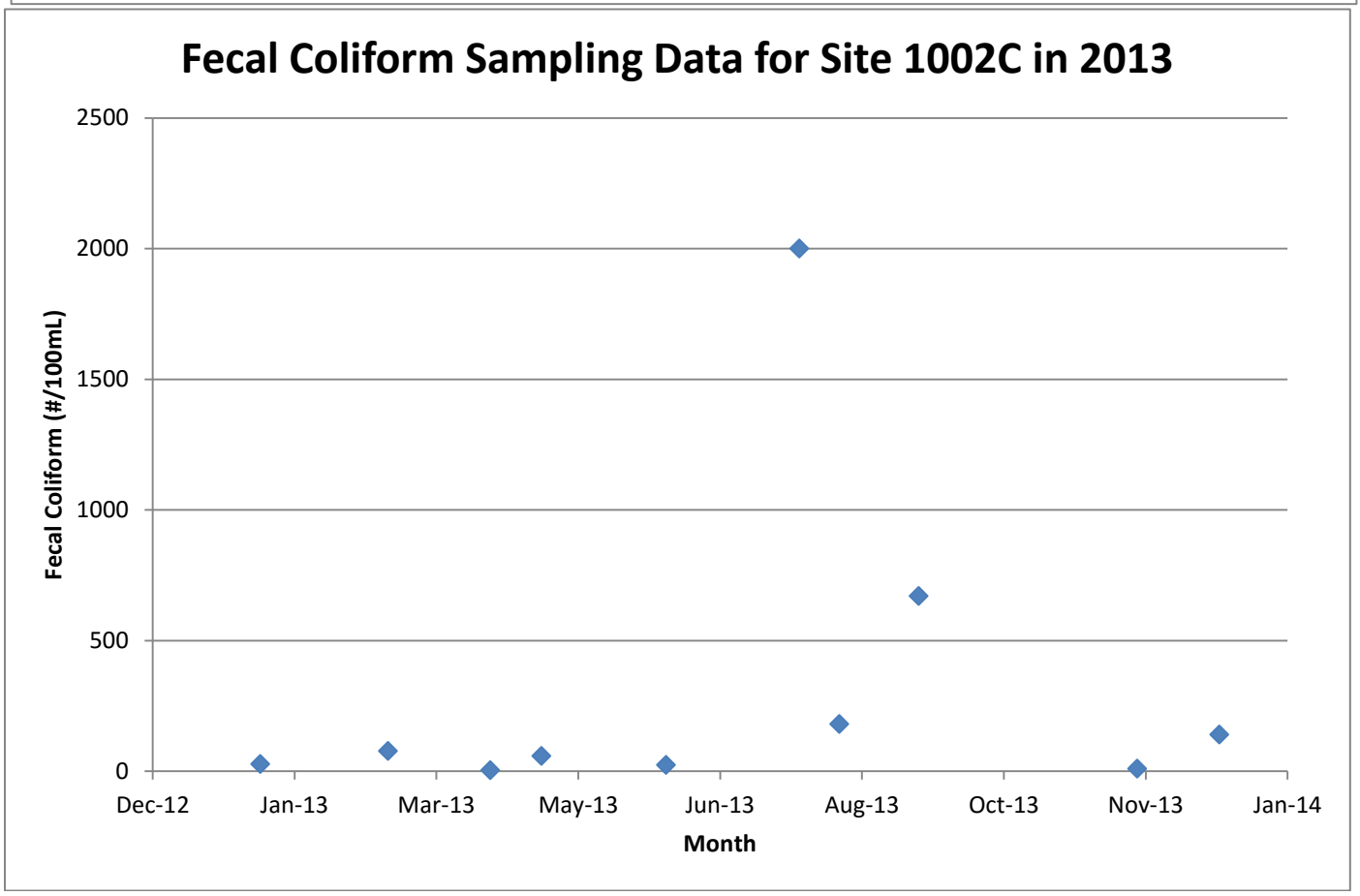

Fecal Coliform Sampling Data for Site 1000A in 2014
Fecal Coliform (#/100mL)
1000
900
800
700
600
500
400
300
200
100
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

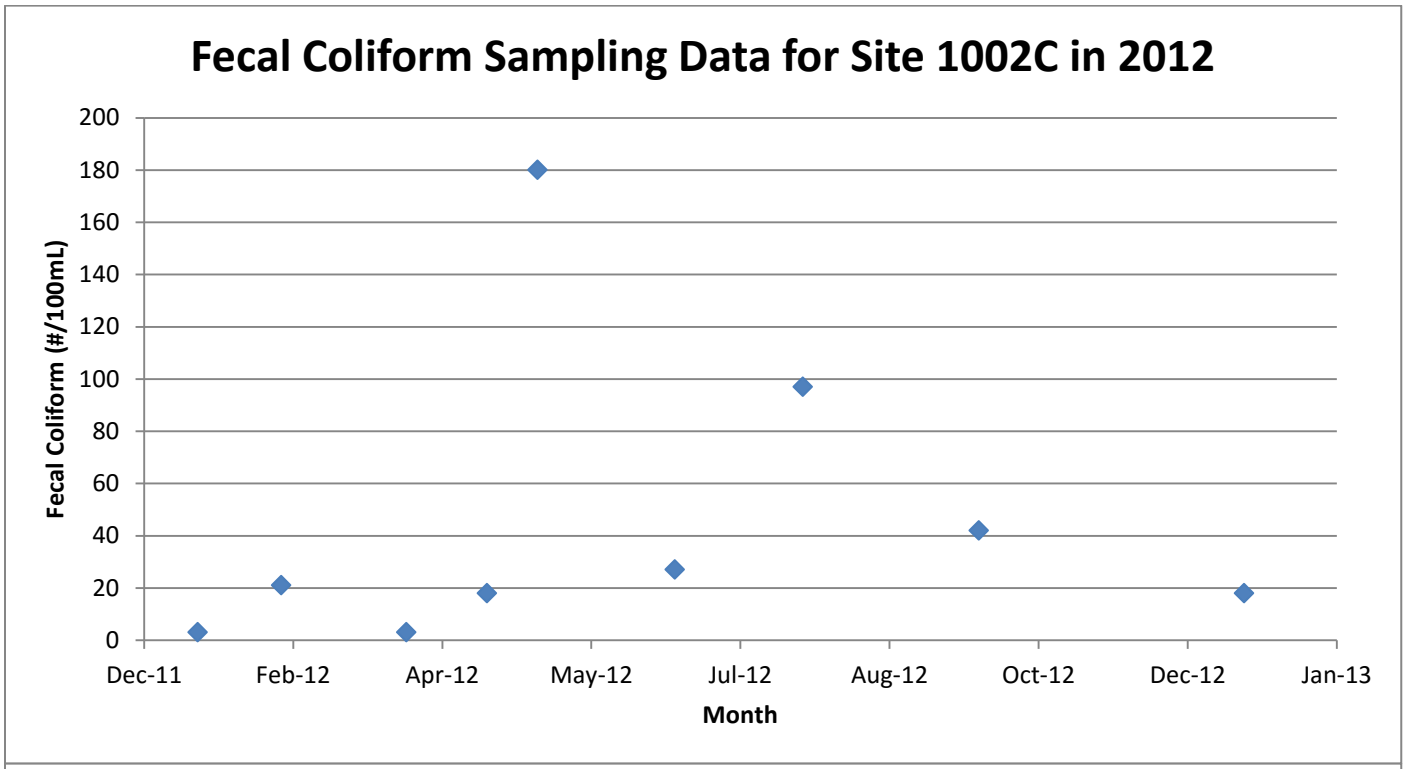

Fecal Coliform Sampling Data for Site 1000A in 2013
Fecal Coliform (#/100mL)
1400
1200
1000
800
600
400
200
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

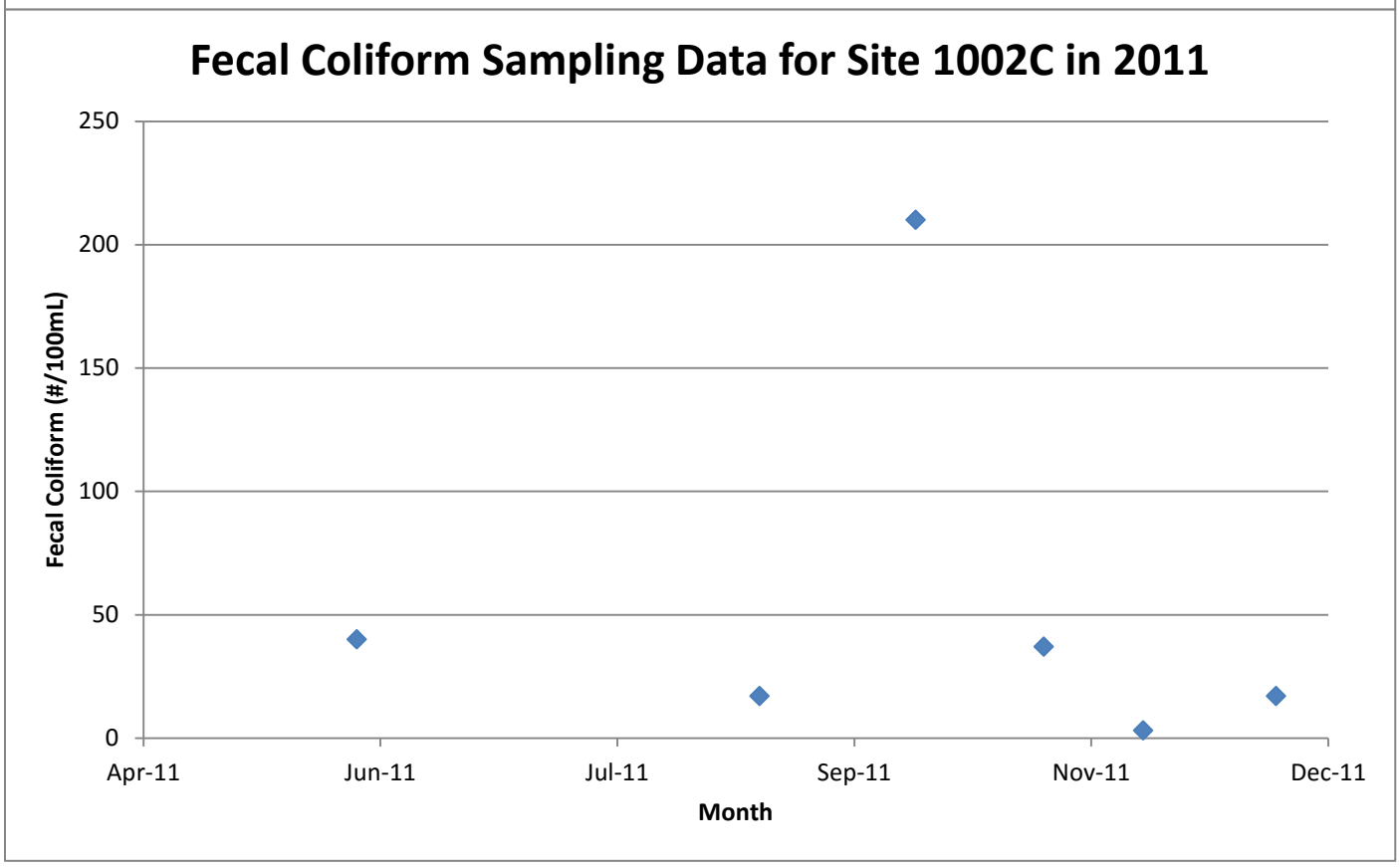

Fecal Coliform Sampling Data for Site 1000A in 2012
Fecal Coliform (#/100mL)
450
400
350
300
250
200
150
100
50
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

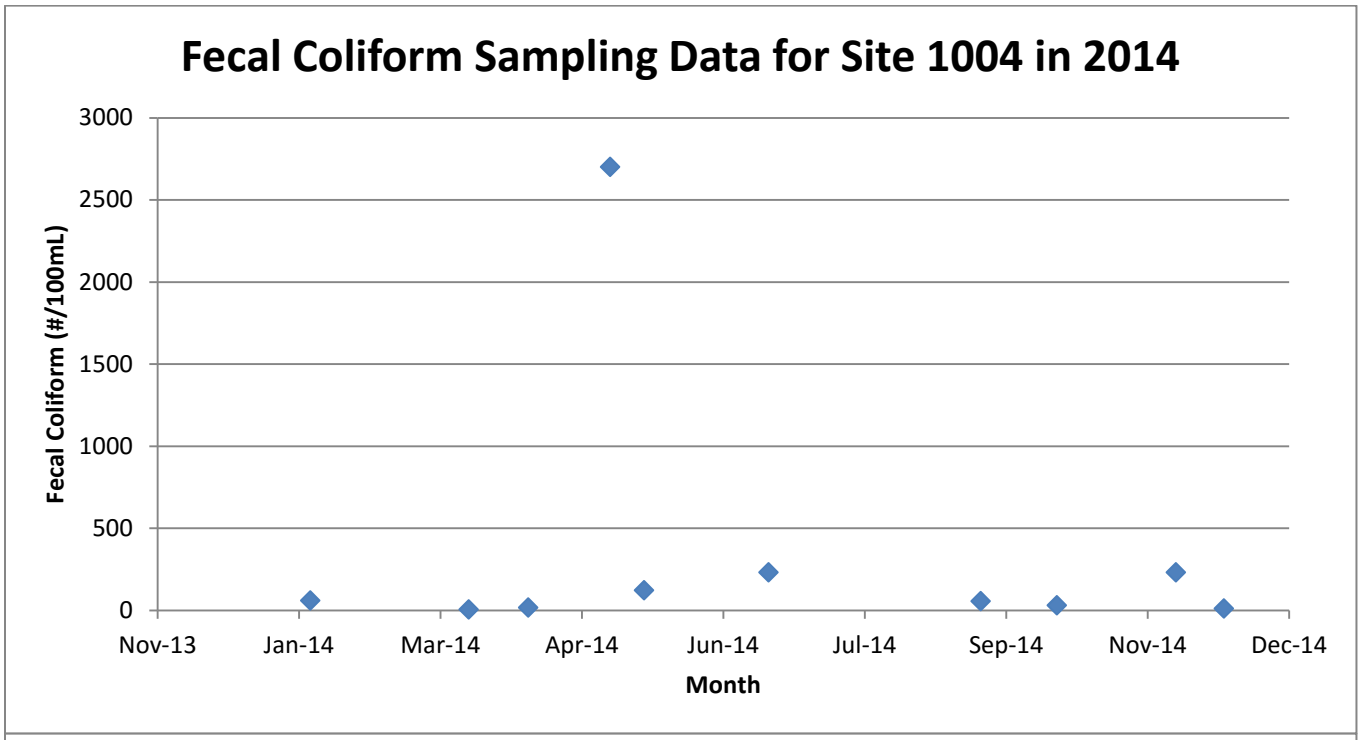

Fecal Coliform Sampling Data for Site 1000A in 2011
Fecal Coliform (#/100mL)
1200
1000
800
600
400
200
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11

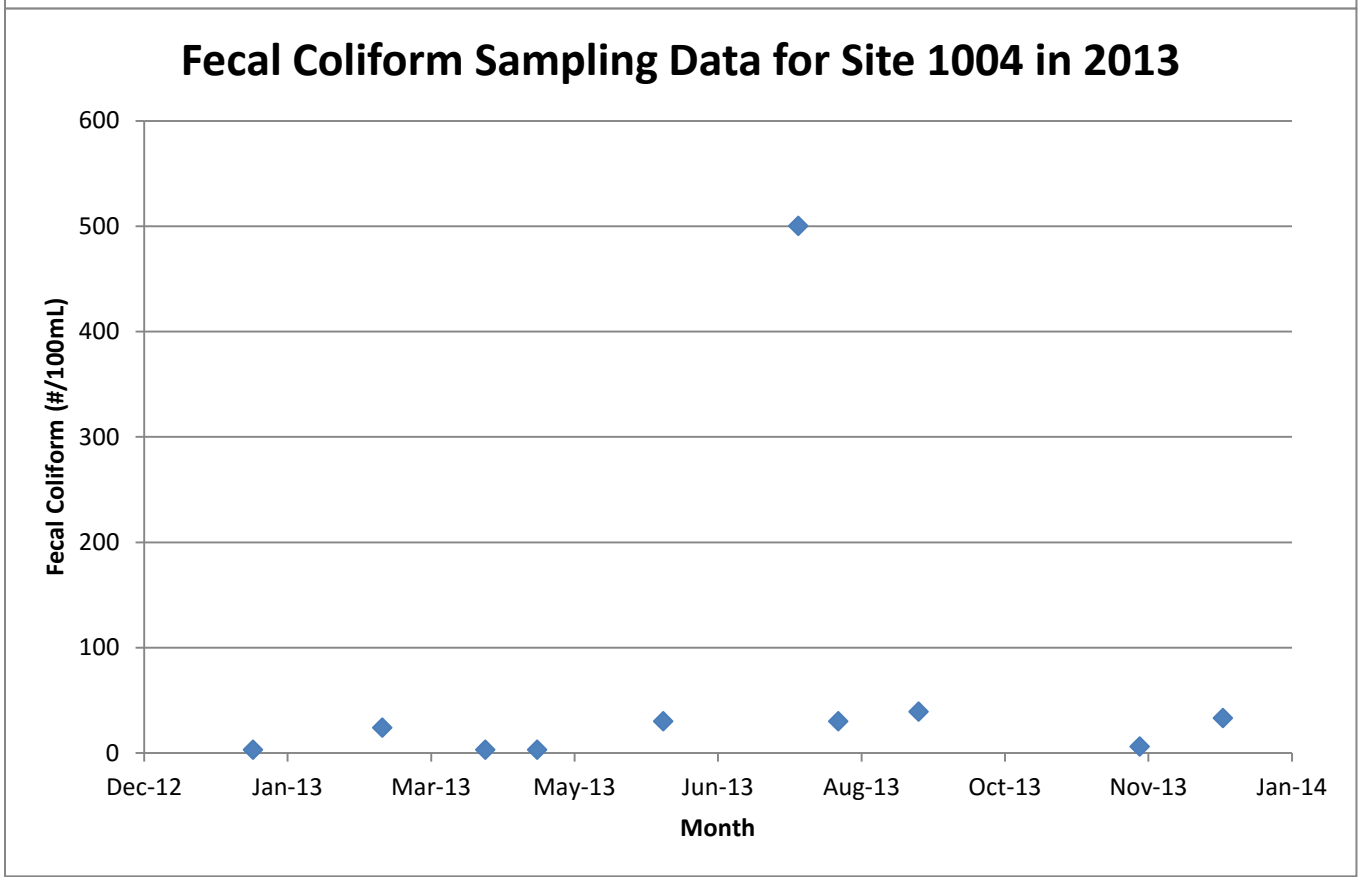

Fecal Coliform Sampling Data for Site 1002C in 2014
Fecal Coliform (#/100mL)
900
800
700
600
500
400
300
200
100
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

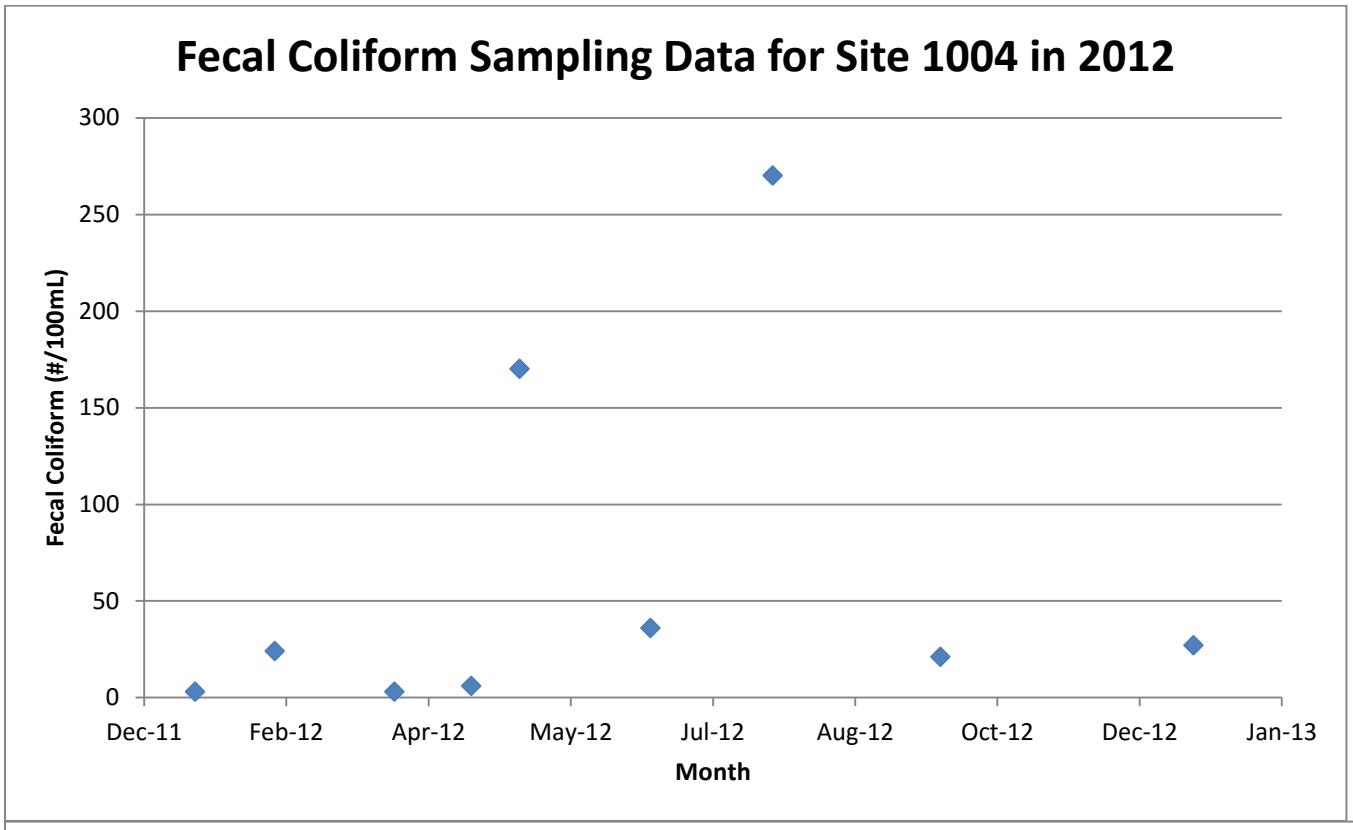

Fecal Coliform Sampling Data for Site 1002C in 2013
Fecal Coliform (#/100mL)
2500
2000
1500
1000
500
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

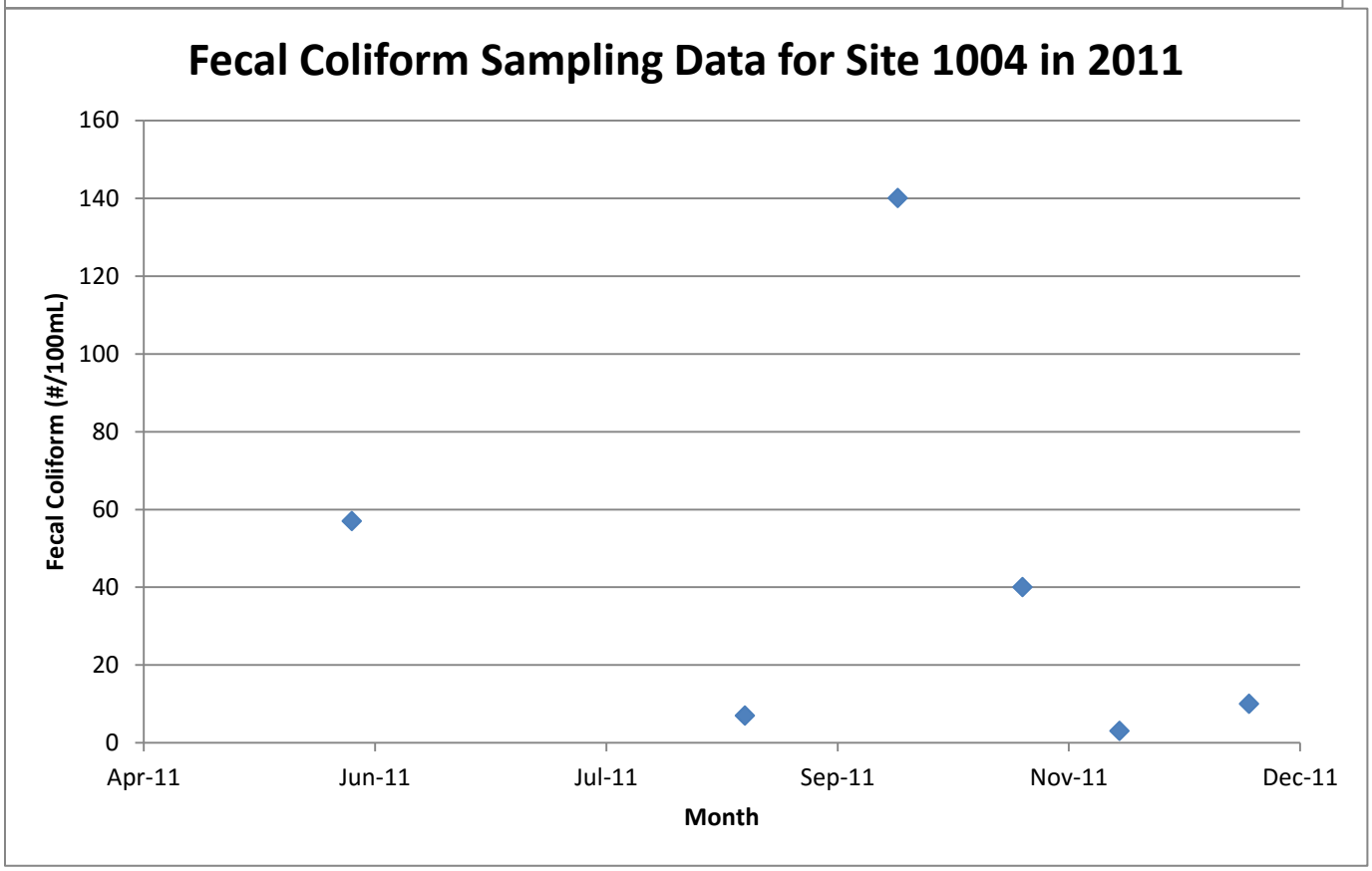

Fecal Coliform Sampling Data for Site 1002C in 2012
Fecal Coliform (#/100mL)
200
180
160
140
120
100
80
60
40
20
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

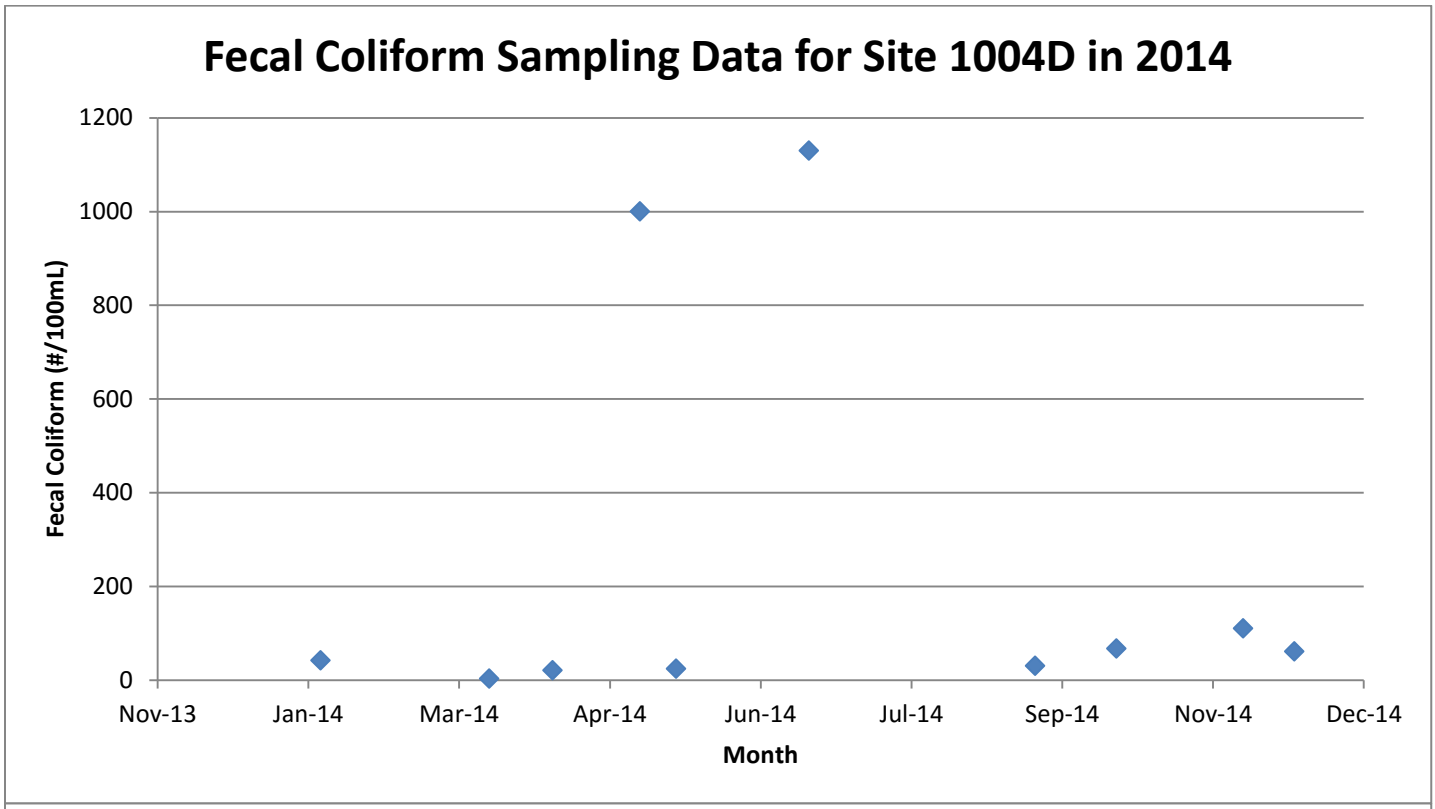

Fecal Coliform Sampling Data for Site 1002C in 2011
Fecal Coliform (#/100mL)
250
200
150
100
50
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

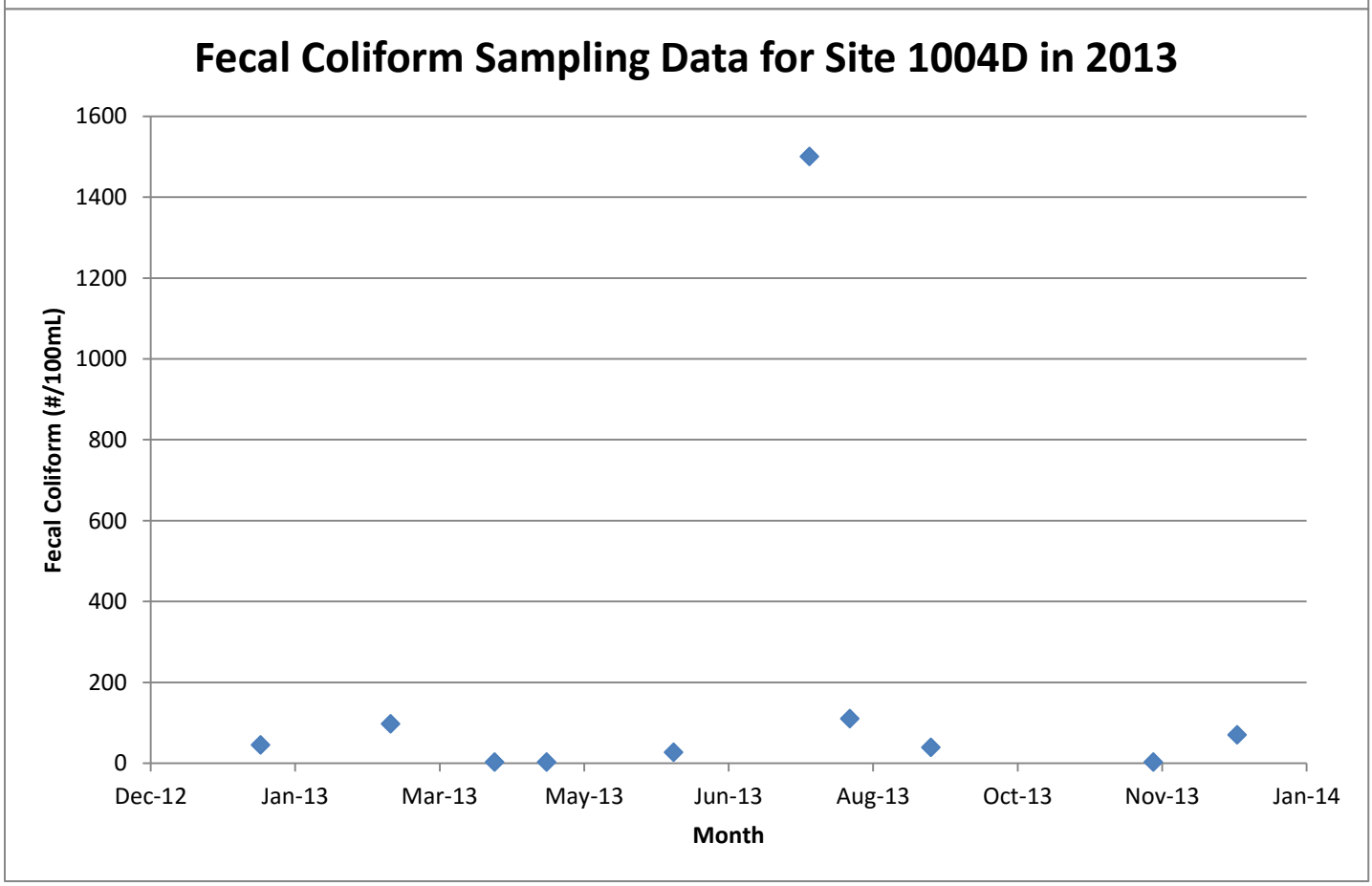

Fecal Coliform Sampling Data for Site 1004 in 2014
Fecal Coliform (#/100mL)
3000
2500
2000
1500
1000
500
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

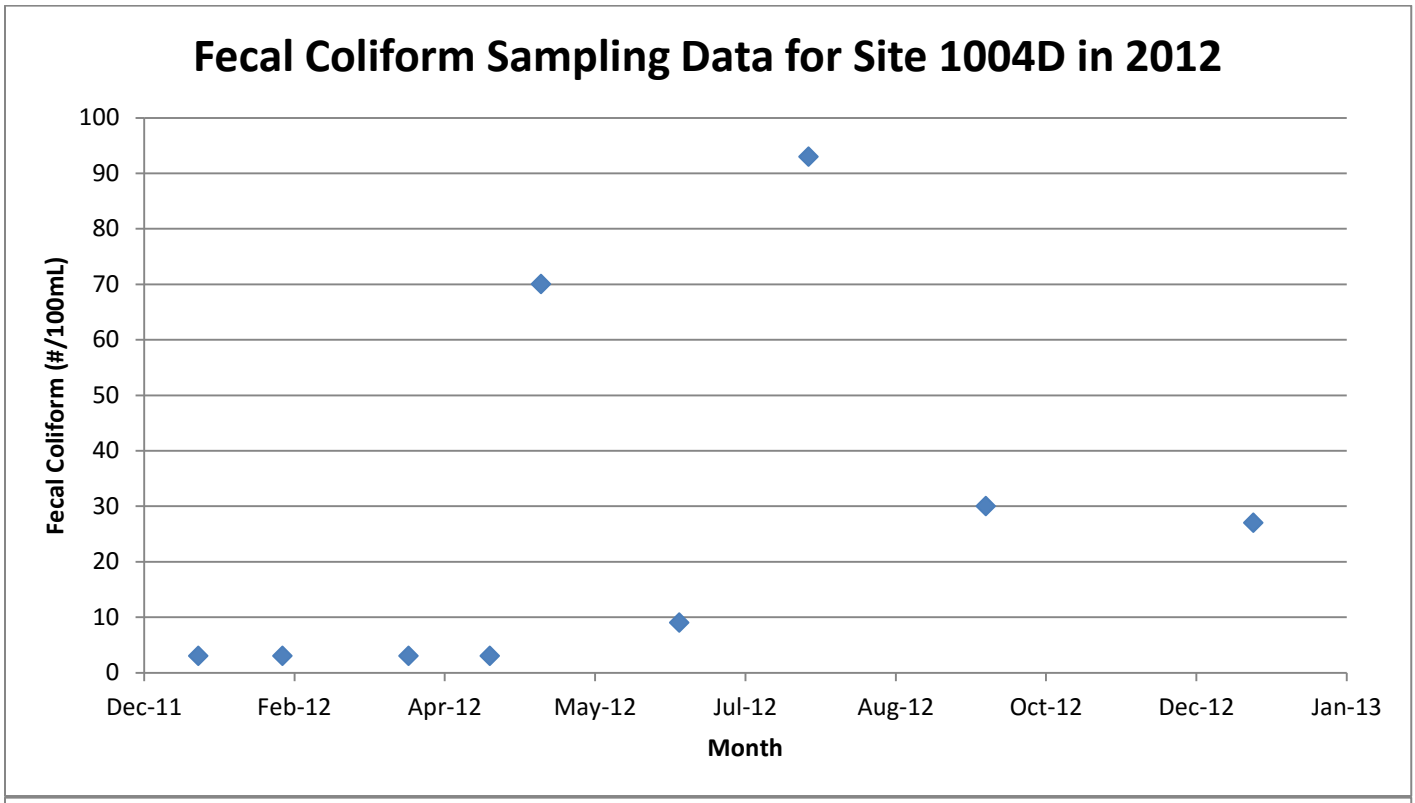

Fecal Coliform Sampling Data for Site 1004 in 2013
Fecal Coliform (#/100mL)
600
500
400
300
200
100
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

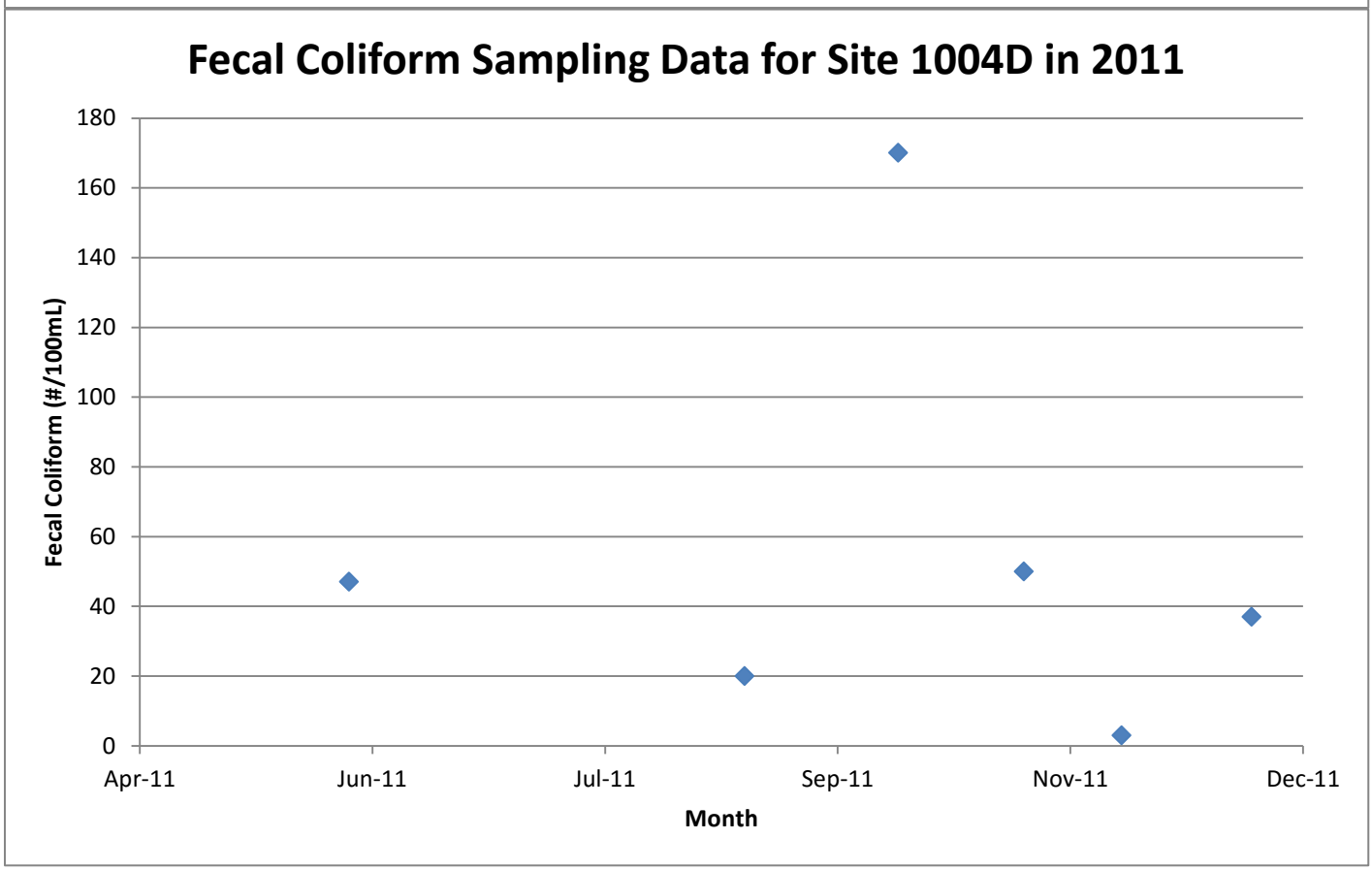

Fecal Coliform Sampling Data for Site 1004 in 2012
Fecal Coliform (#/100mL)
300
250
200
150
100
50
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

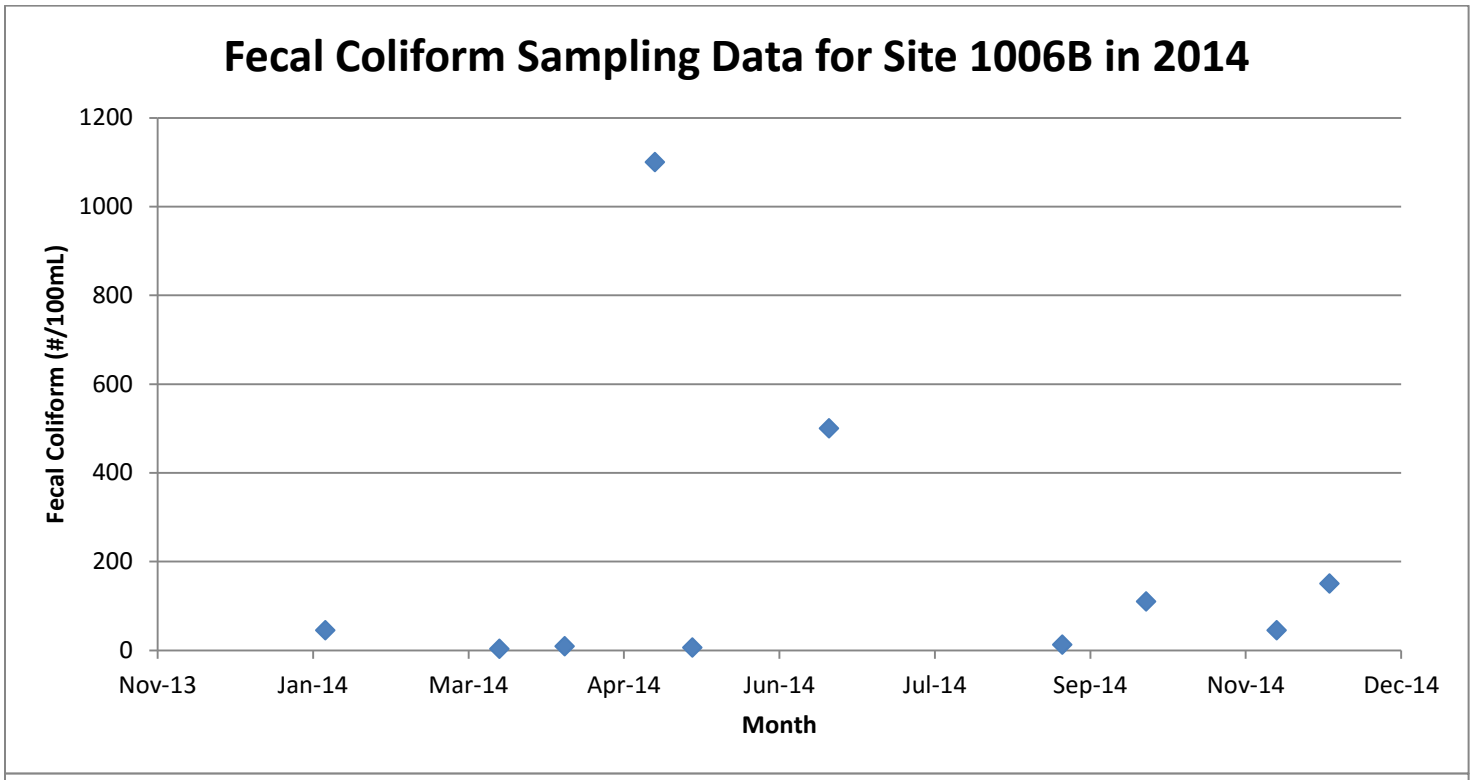

Fecal Coliform Sampling Data for Site 1004 in 2011
Fecal Coliform (#/100mL)
160
140
120
100
80
60
40
20
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

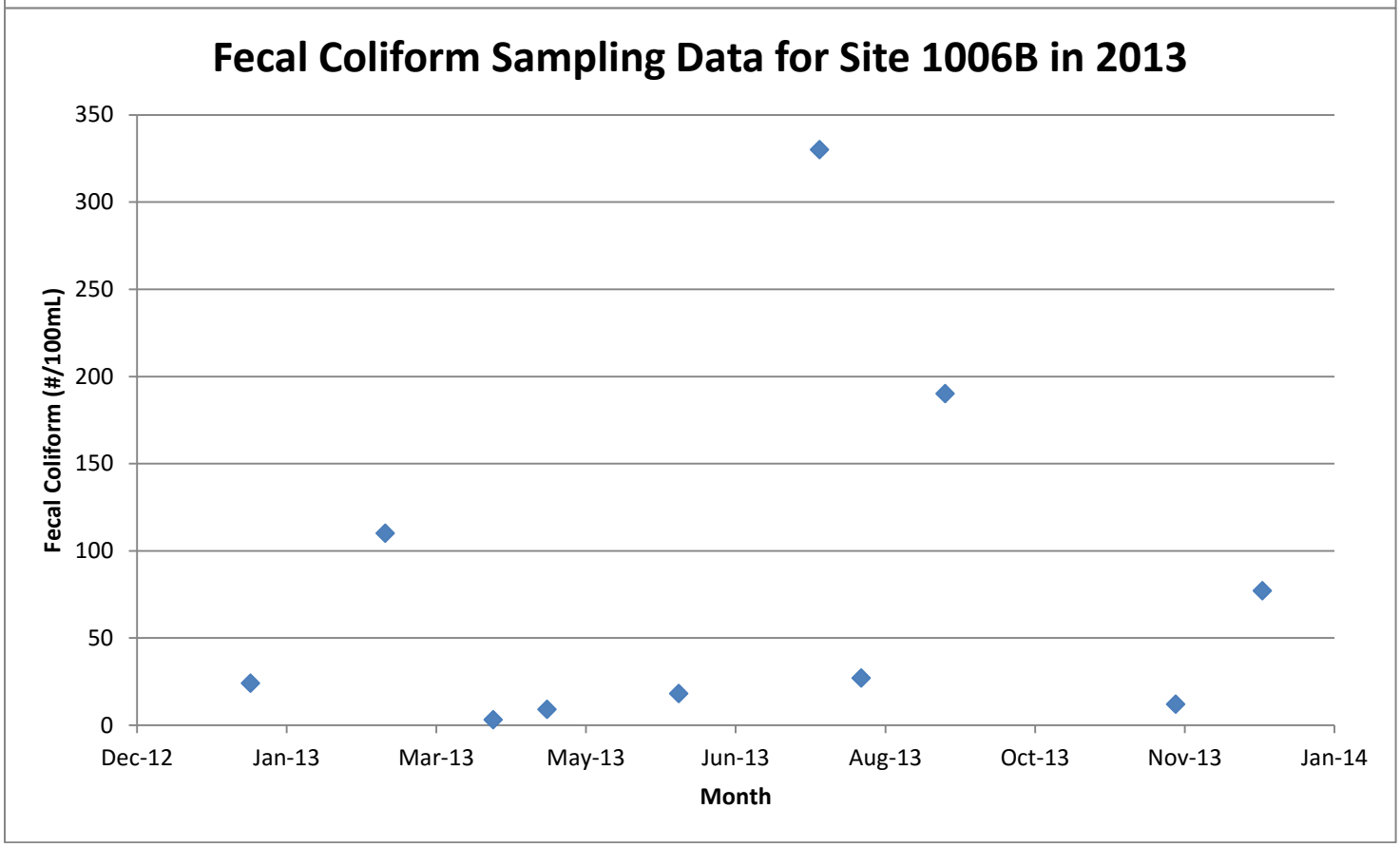

Fecal Coliform Sampling Data for Site 1004D in 2014
Fecal Coliform (#/100mL)
1200
1000
800
600
400
200
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

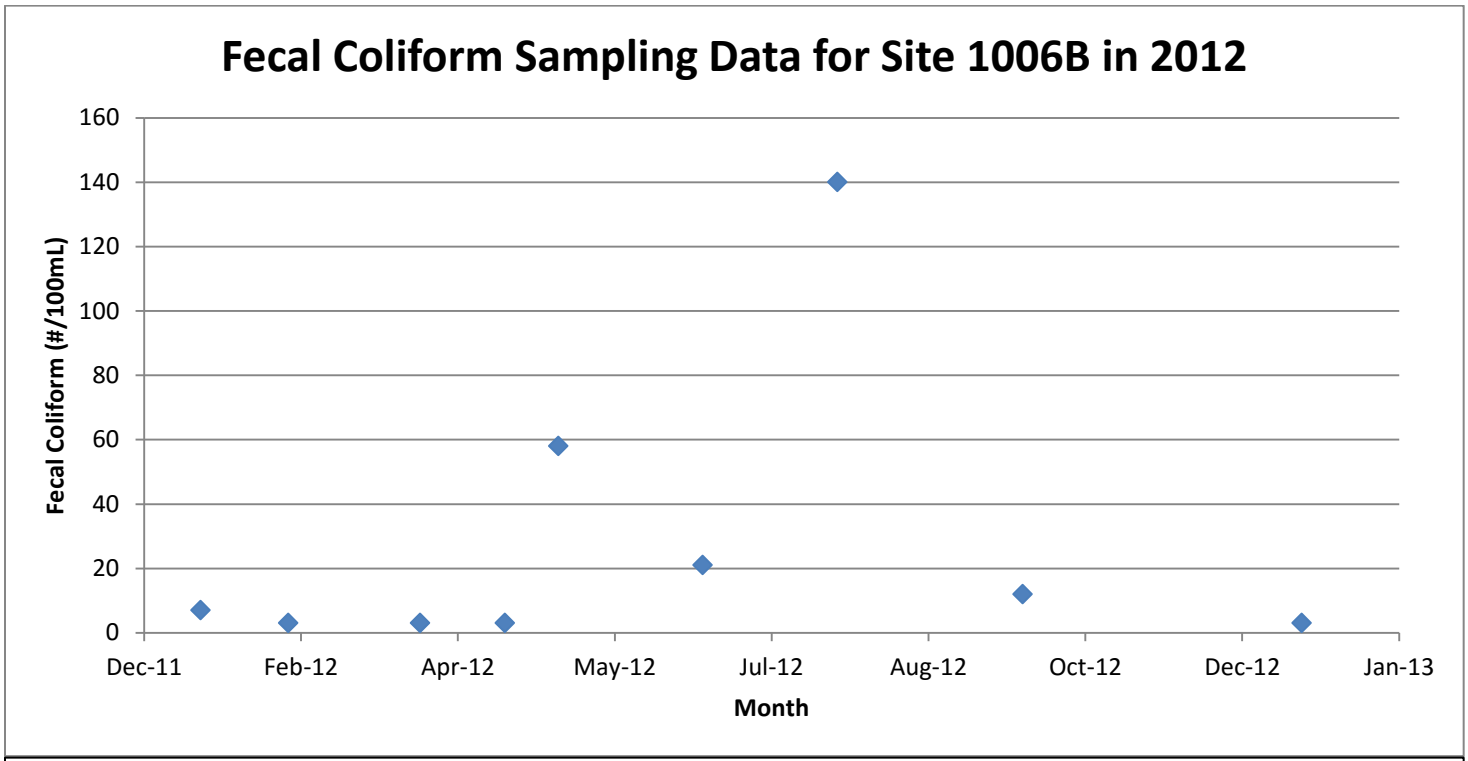

Fecal Coliform Sampling Data for Site 1004D in 2013
Fecal Coliform (#/100mL)
1600
1400
1200
1000
800
600
400
200
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

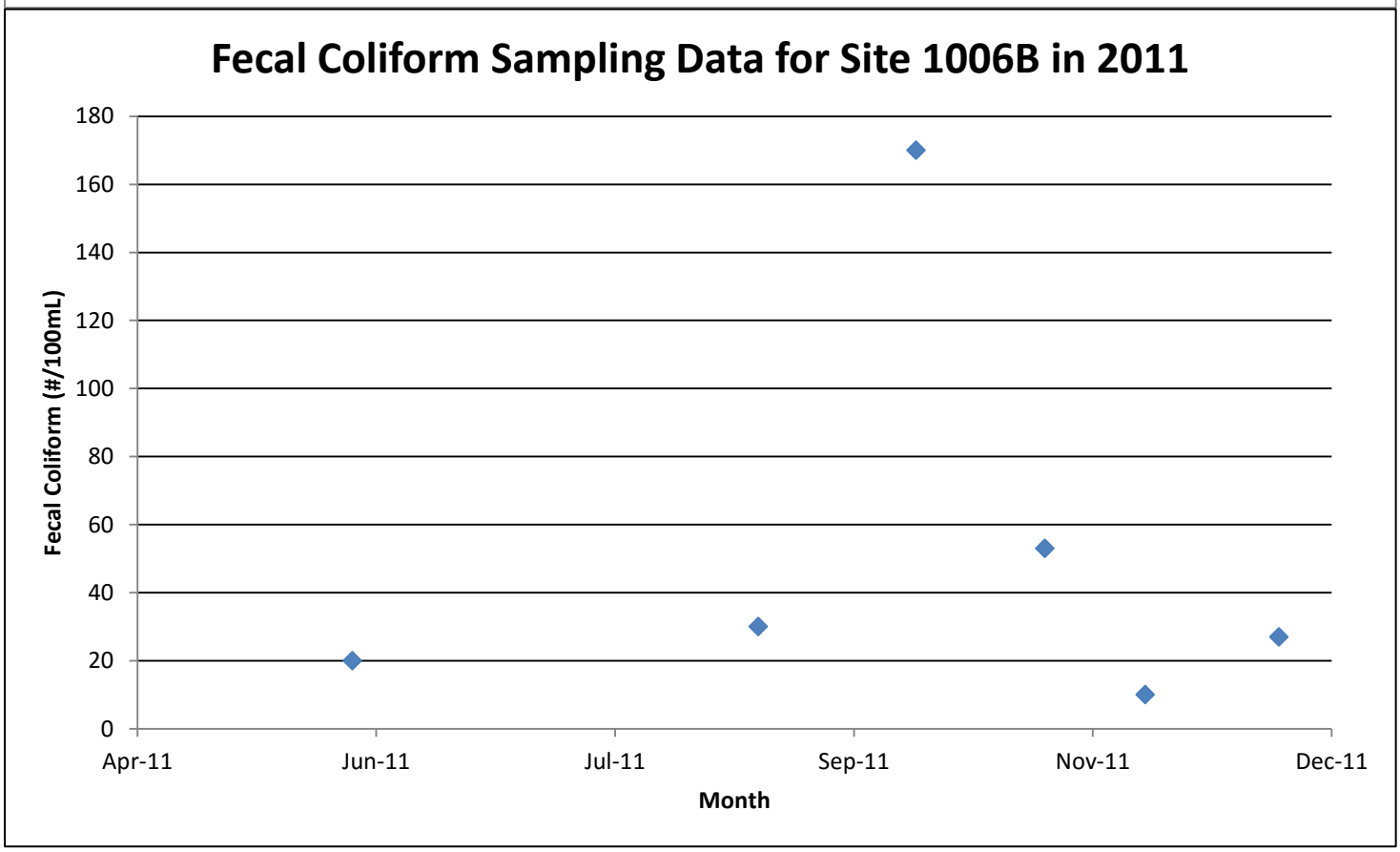

Fecal Coliform Sampling Data for Site 1004D in 2012
Fecal Coliform (#/100mL)
100
90
80
70
60
50
40
30
20
10
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

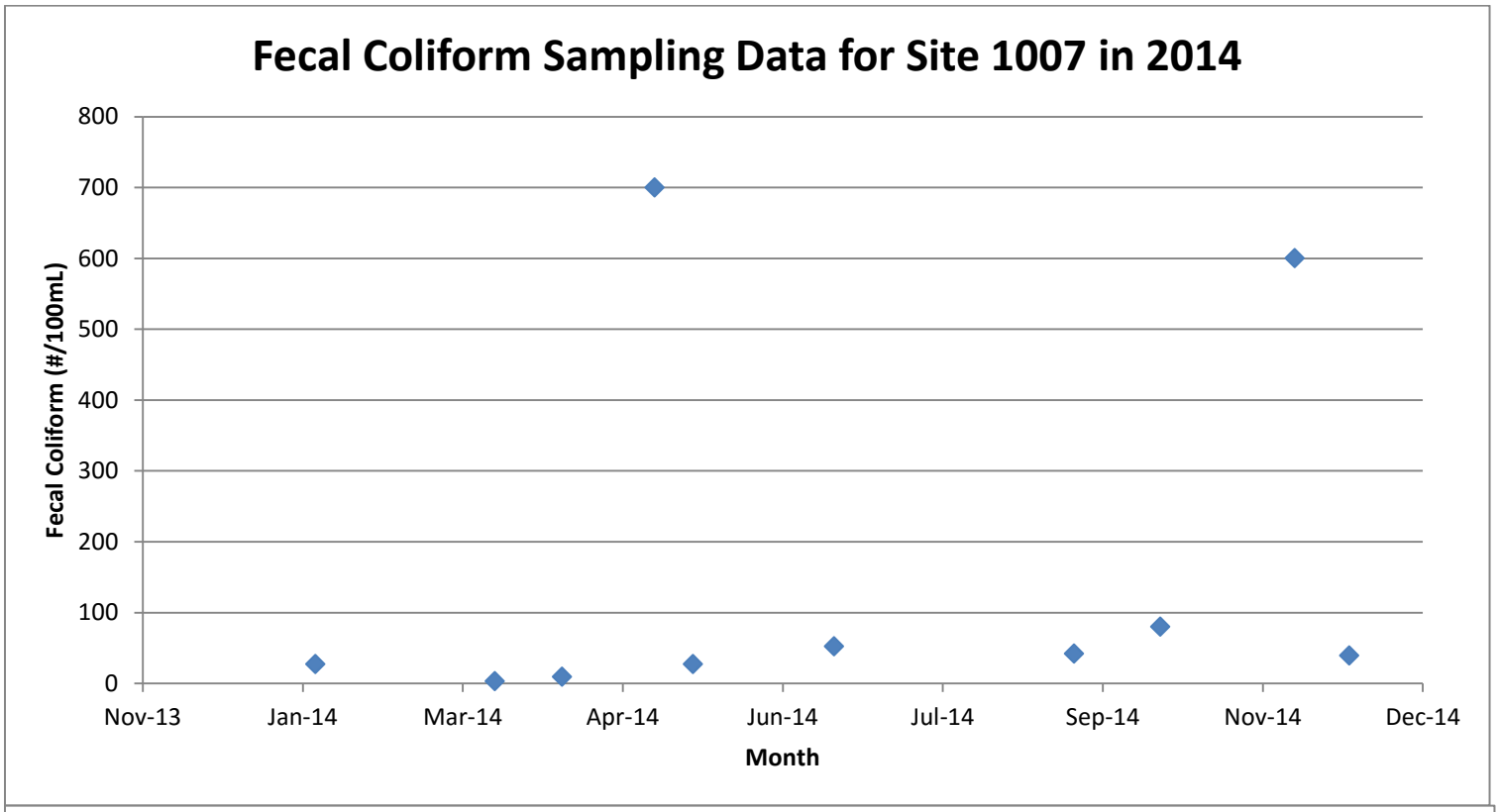

Fecal Coliform Sampling Data for Site 1004D in 2011
Fecal Coliform (#/100mL)
180
160
140
120
100
80
60
40
20
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

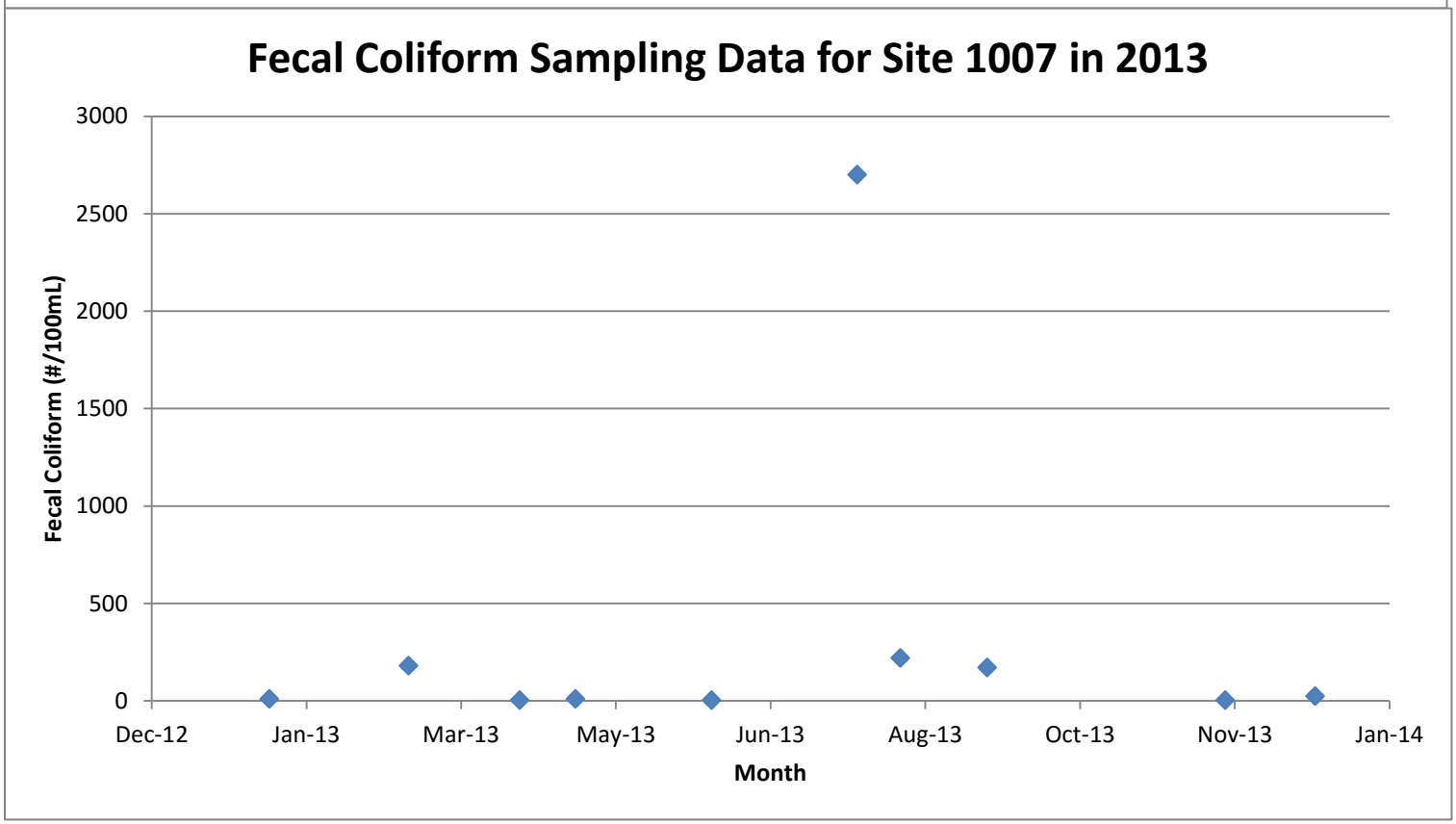

Fecal Coliform Sampling Data for Site 1006B in 2014
Fecal Coliform (#/100mL)
1200
1000
800
600
400
200
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

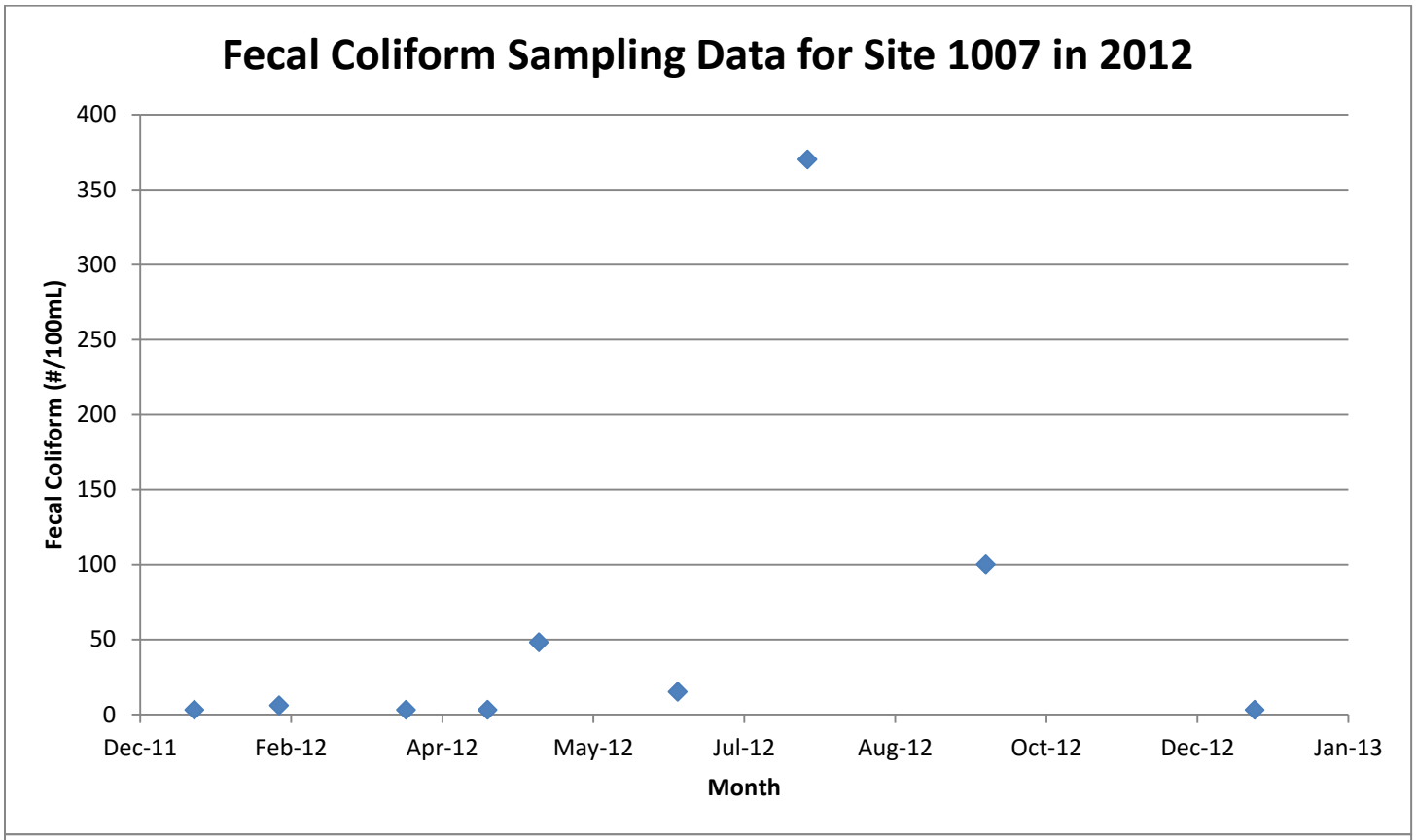

Fecal Coliform Sampling Data for Site 1006B in 2013
Fecal Coliform (#/100mL)
350
300
250
200
150
100
50
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

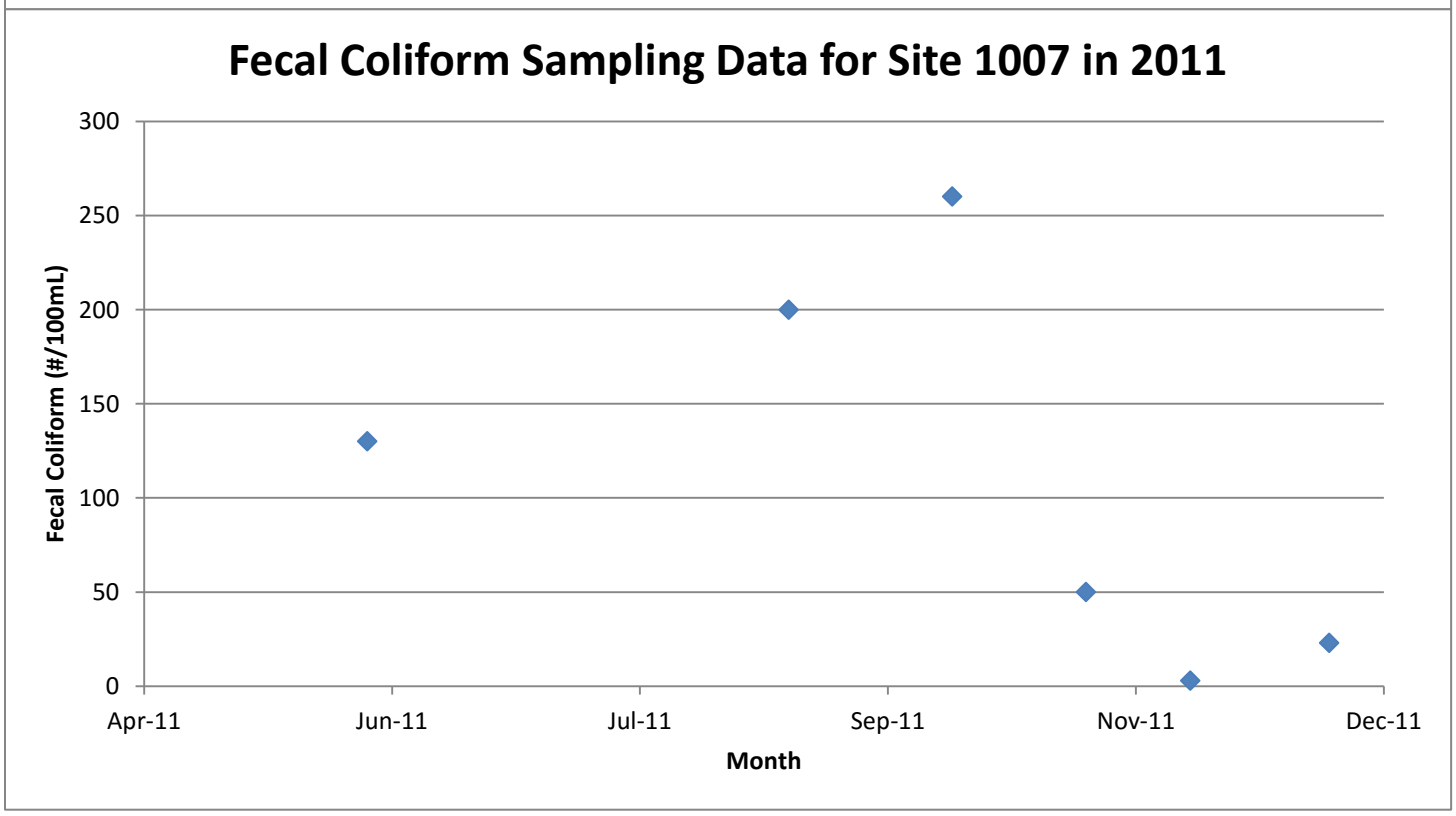

Fecal Coliform Sampling Data for Site 1006B in 2012
Fecal Coliform (#/100mL)
160
140
120
100
80
60
40
20
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

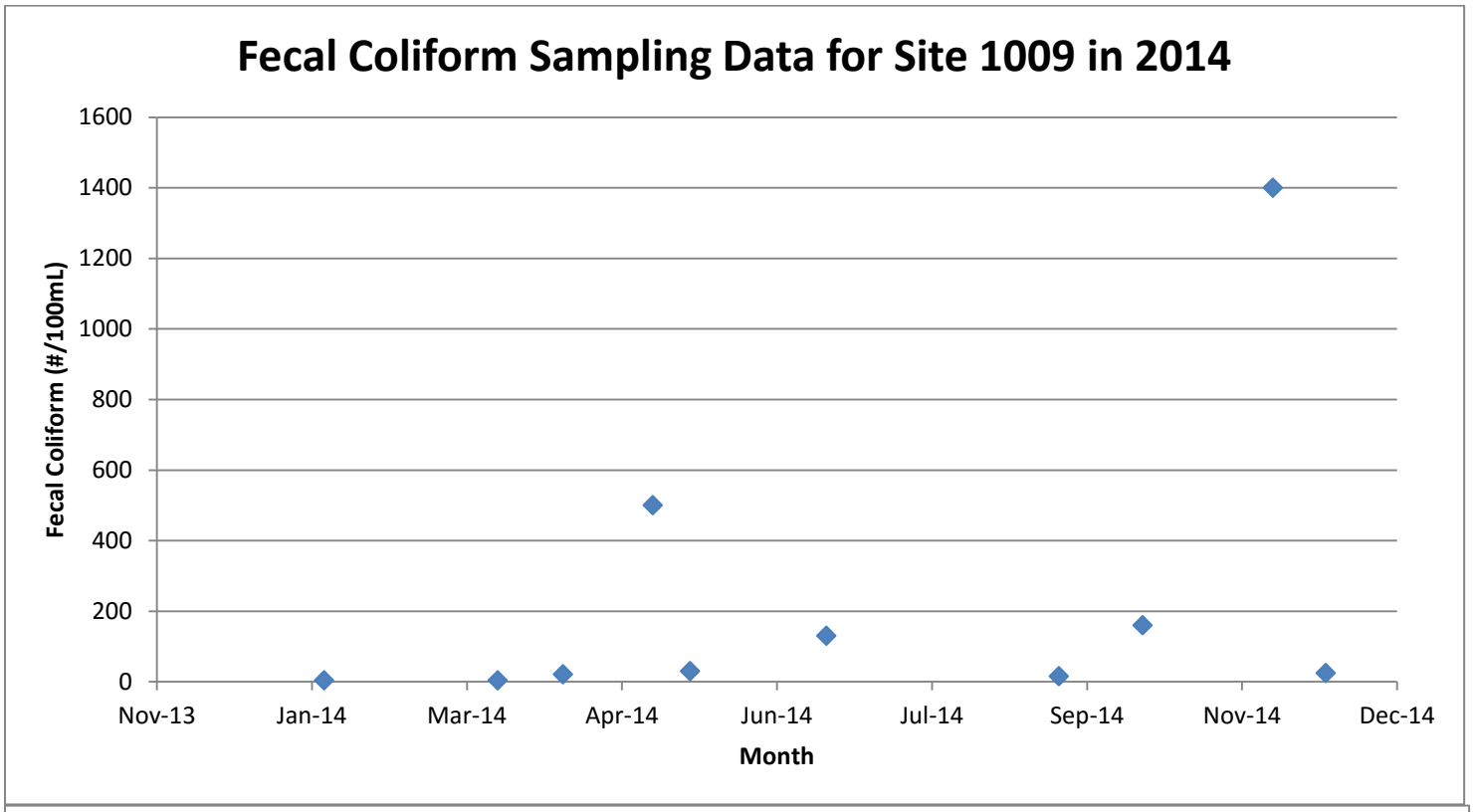

Fecal Coliform Sampling Data for Site 1006B in 2011
Fecal Coliform (#/100mL)
180
160
140
120
100
80
60
40
20
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

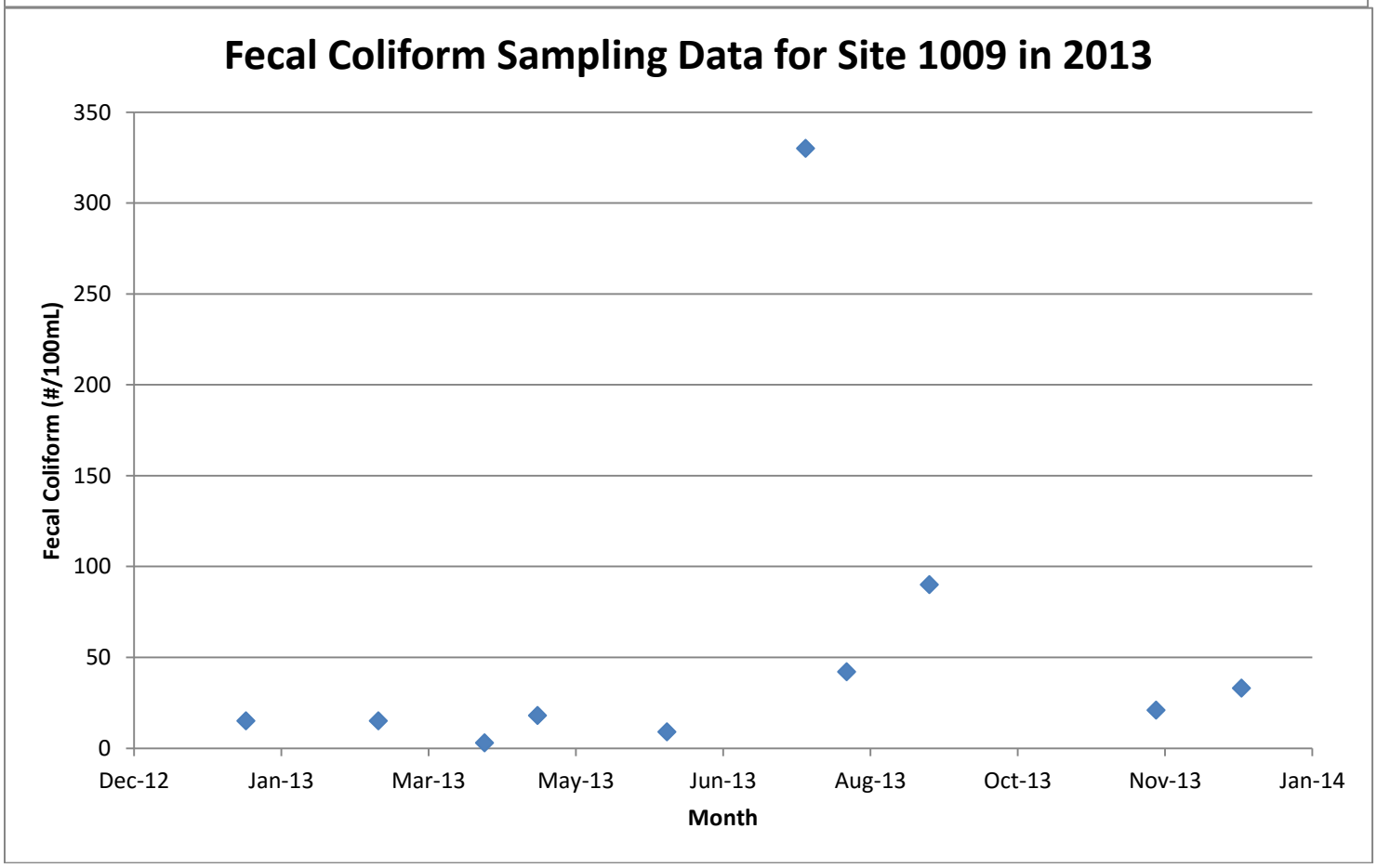

Fecal Coliform Sampling Data for Site 1007 in 2014
Fecal Coliform (#/100mL)
800
700
600
500
400
300
200
100
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

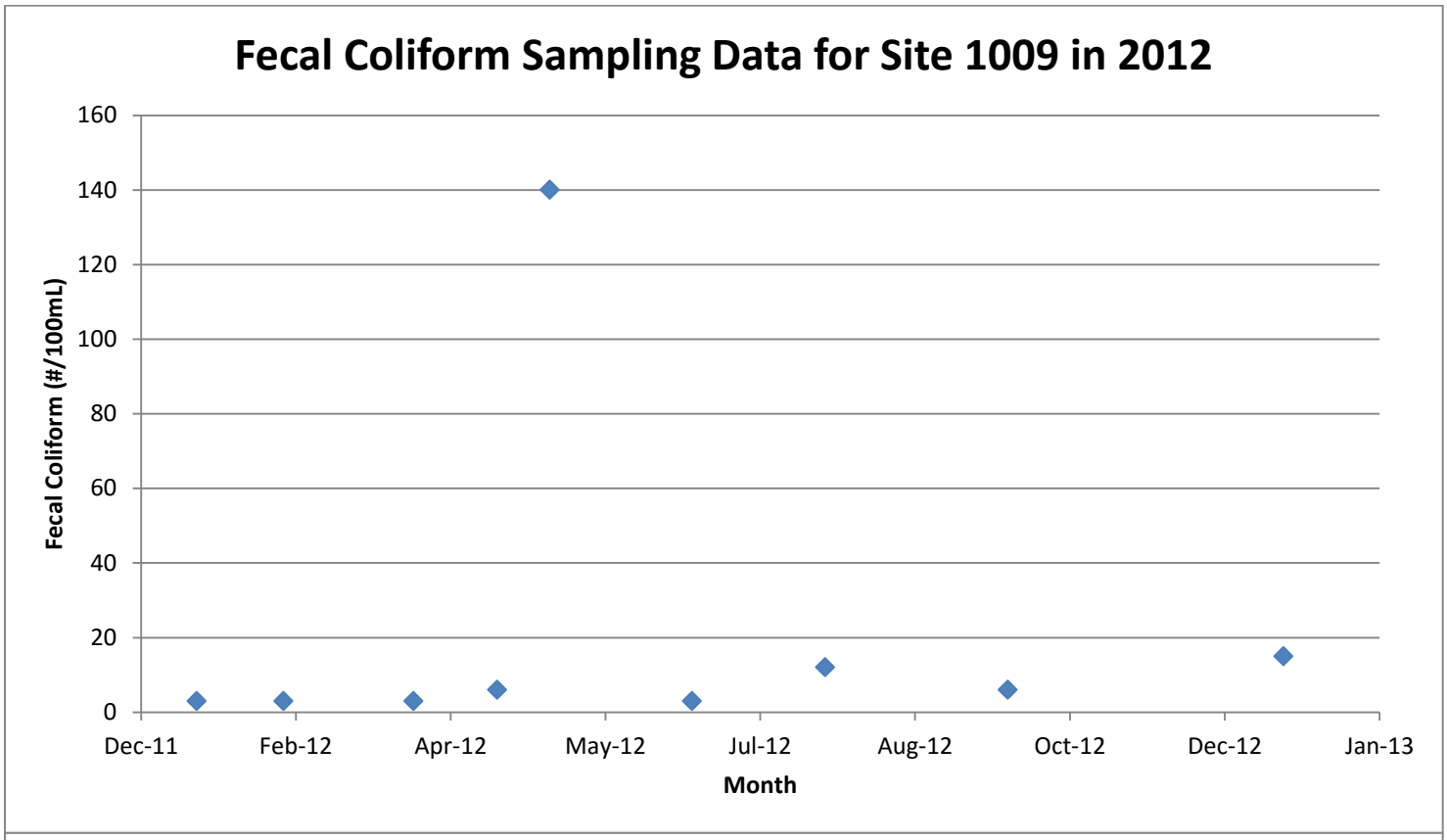

Fecal Coliform Sampling Data for Site 1007 in 2013
Fecal Coliform (#/100mL)
3000
2500
2000
1500
1000
500
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

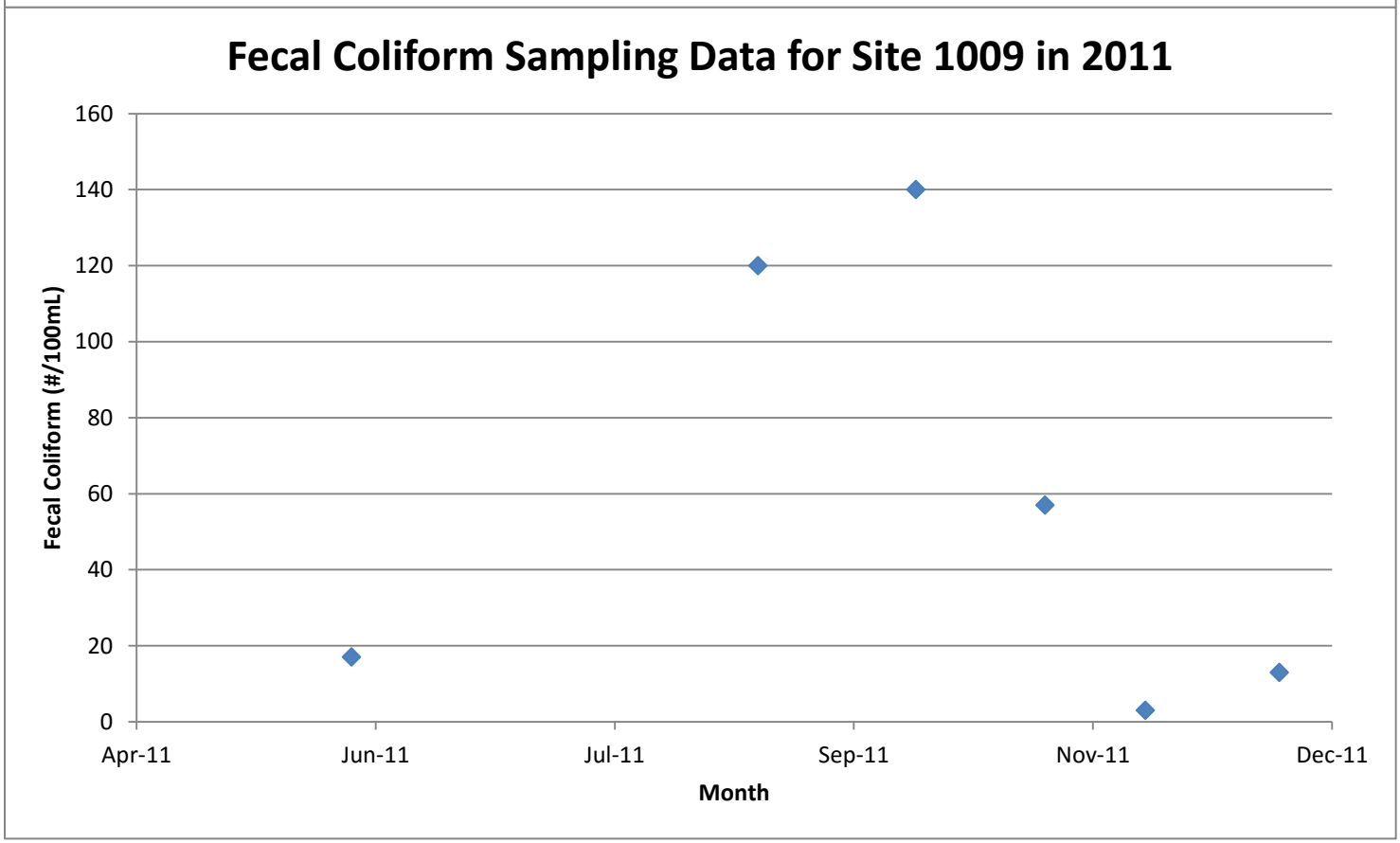

Fecal Coliform Sampling Data for Site 1007 in 2012
Fecal Coliform (#/100mL)
400
350
300
250
200
150
100
50
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

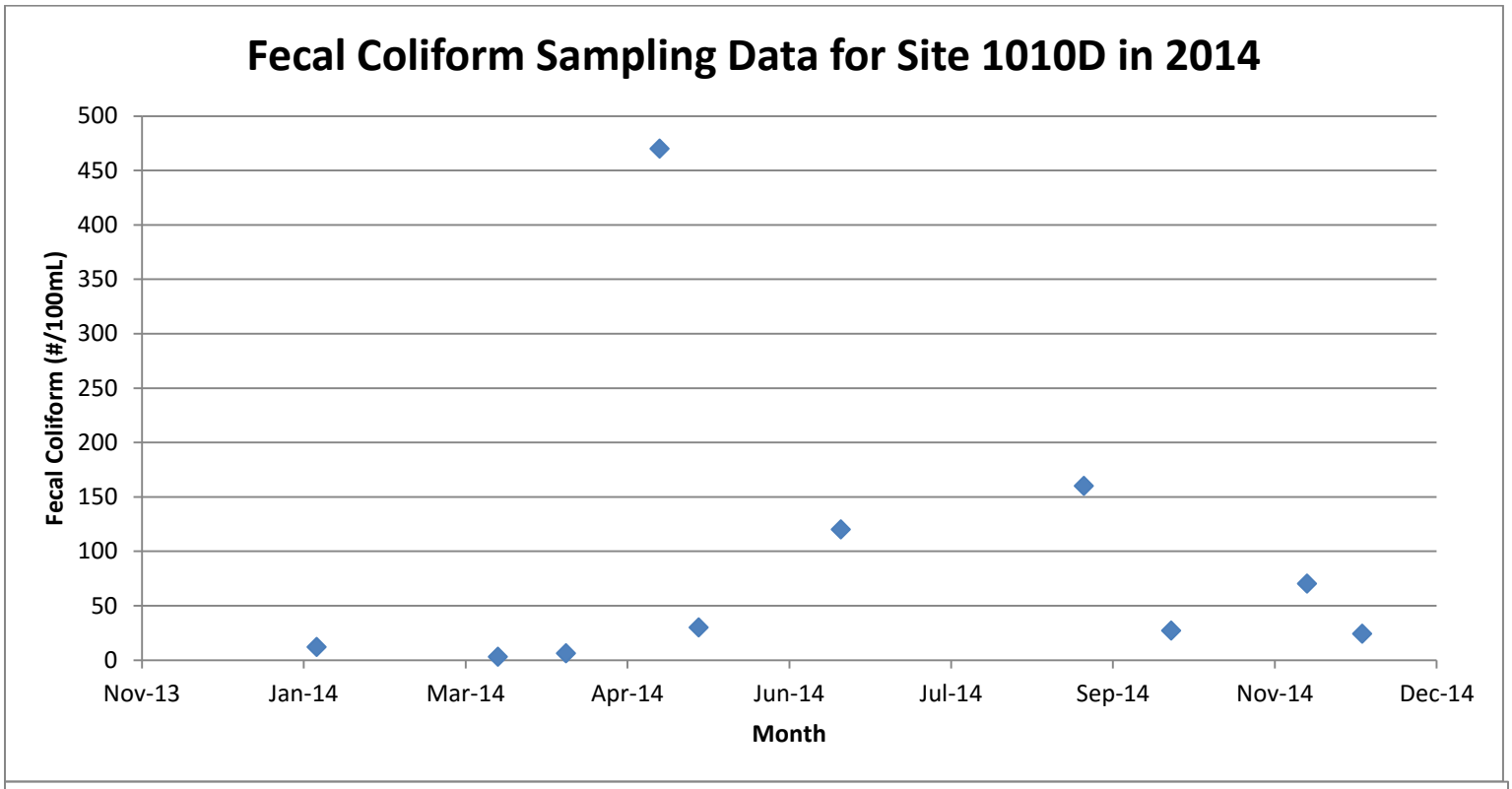

Fecal Coliform Sampling Data for Site 1007 in 2011
Fecal Coliform (#/100mL)
300
250
200
150
100
50
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

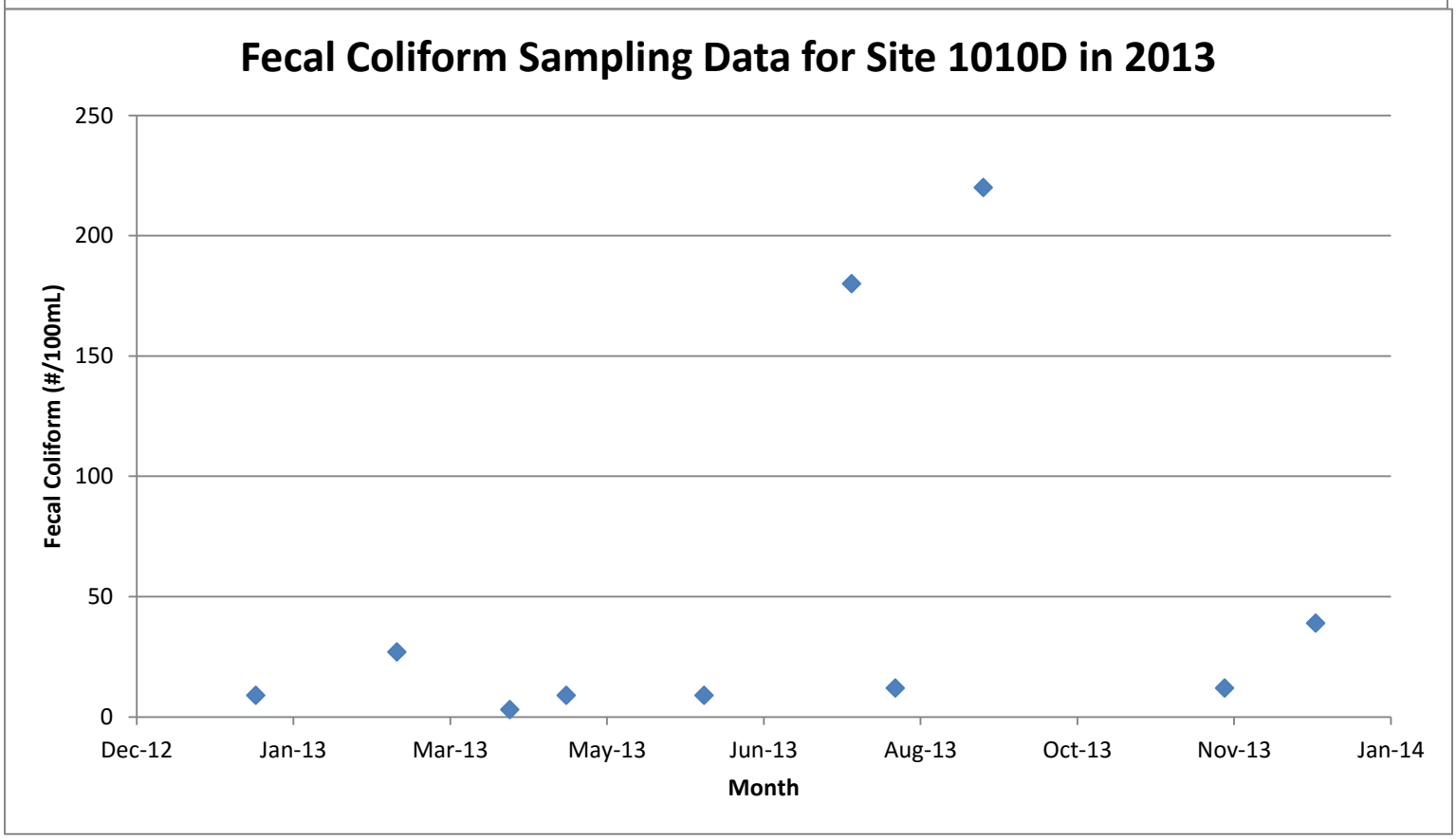

Fecal Coliform Sampling Data for Site 1009 in 2014
Fecal Coliform (#/100mL)
1600
1400
1200
1000
800
600
400
200
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

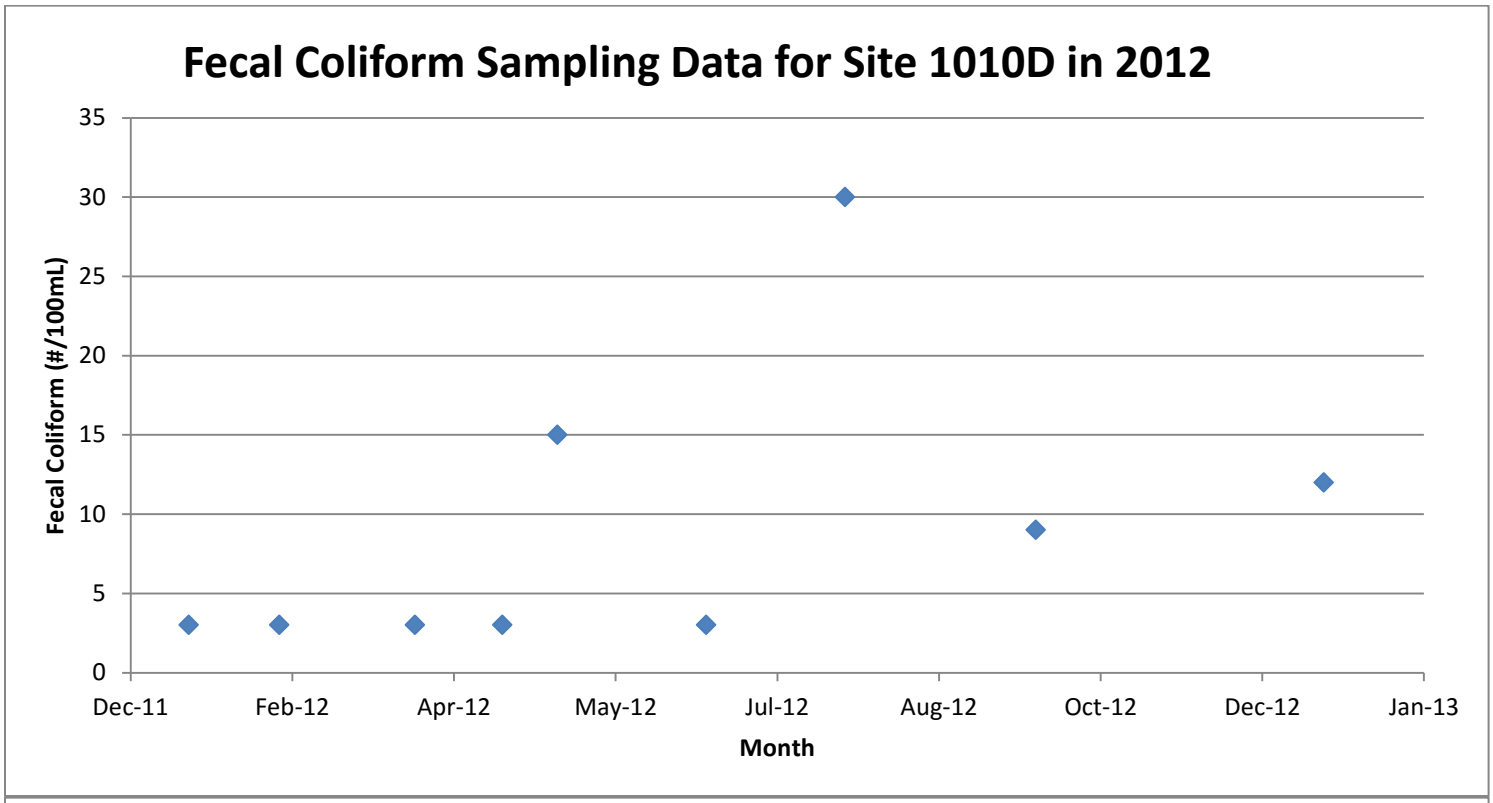

Fecal Coliform Sampling Data for Site 1009 in 2013
Fecal Coliform (#/100mL)
350
300
250
200
150
100
50
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

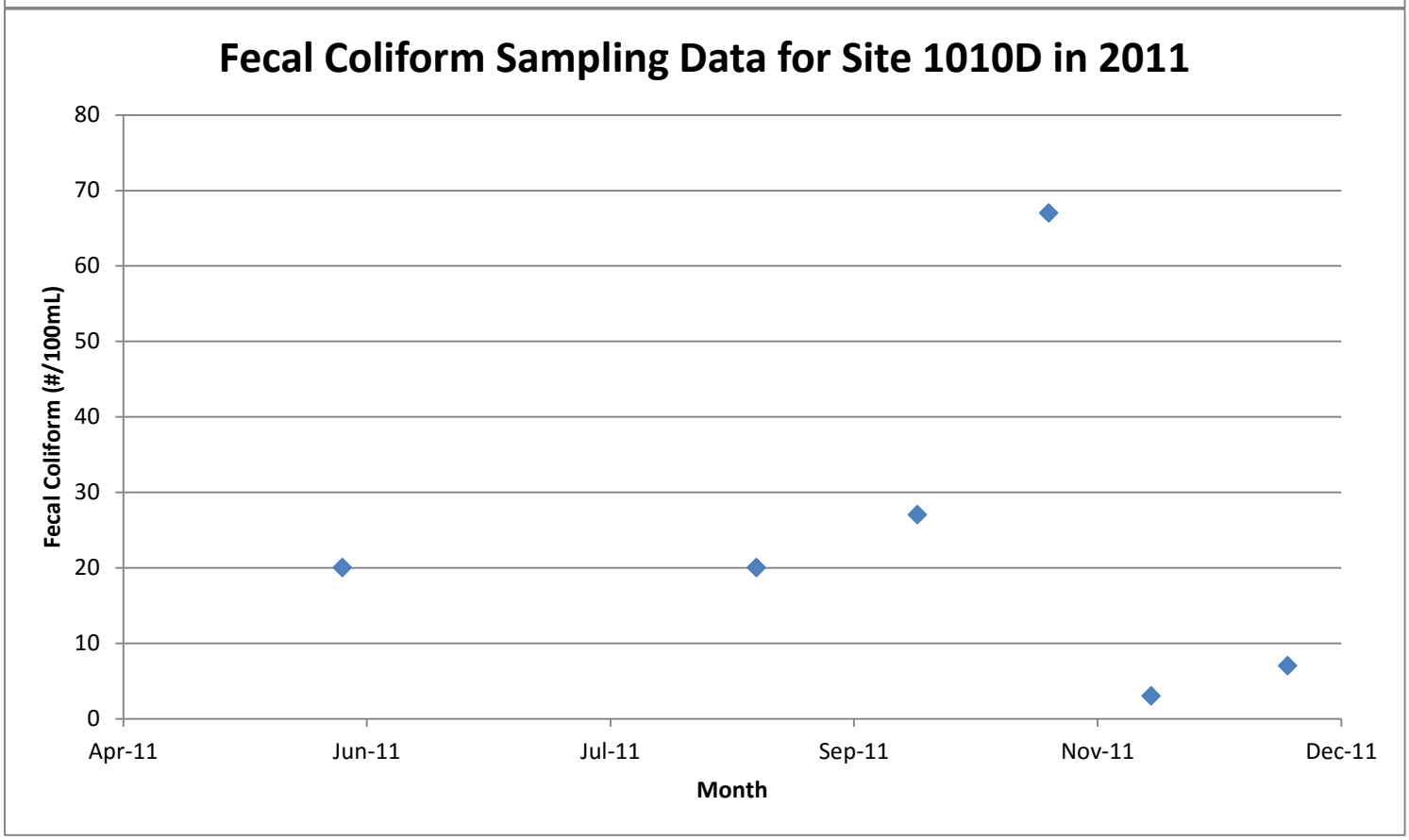

Fecal Coliform Sampling Data for Site 1009 in 2012
Fecal Coliform (#/100mL)
160
140
120
100
80
60
40
20
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month

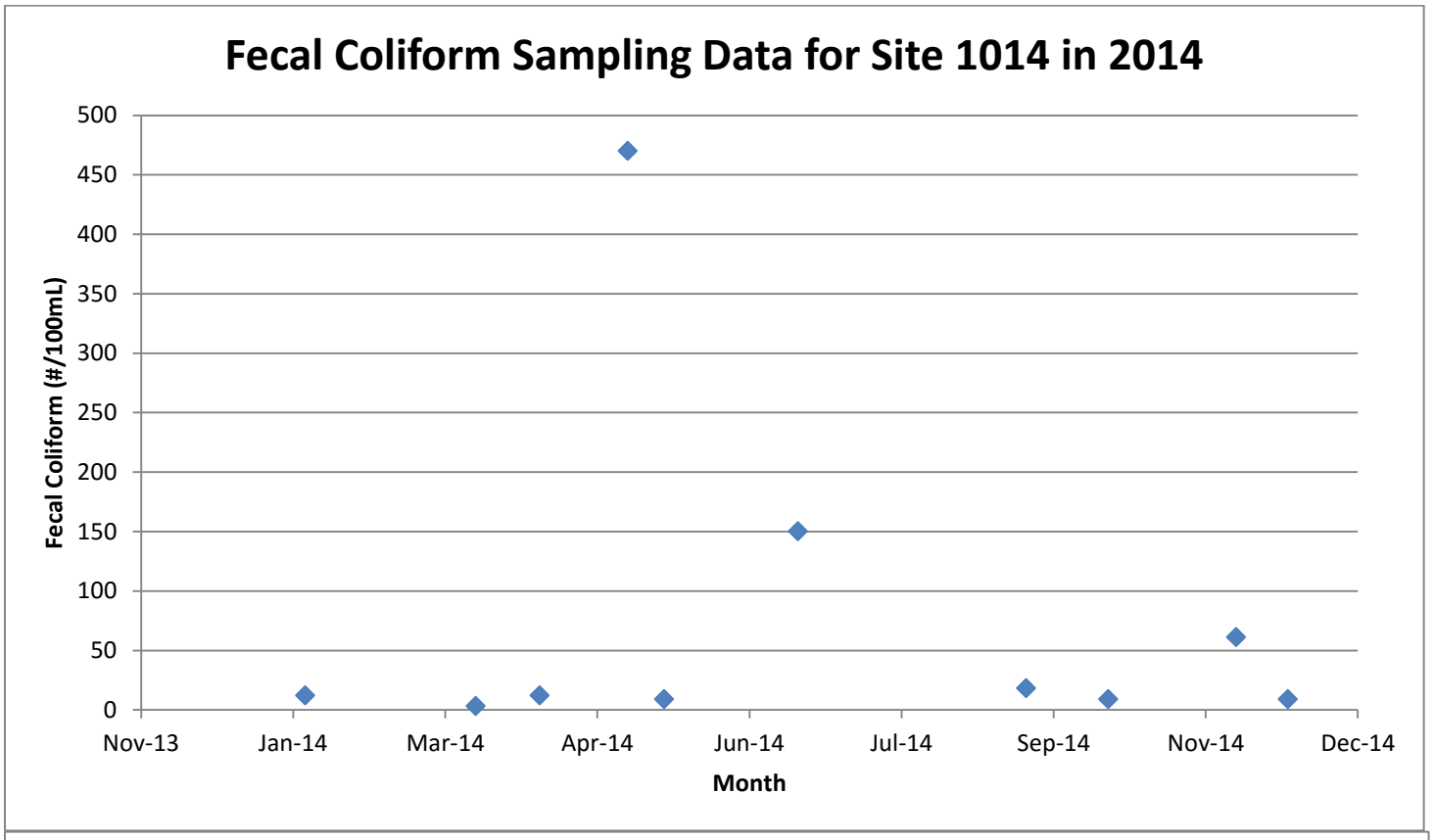

Fecal Coliform Sampling Data for Site 1009 in 2011
Fecal Coliform (#/100mL)
160
140
120
100
80
60
40
20
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

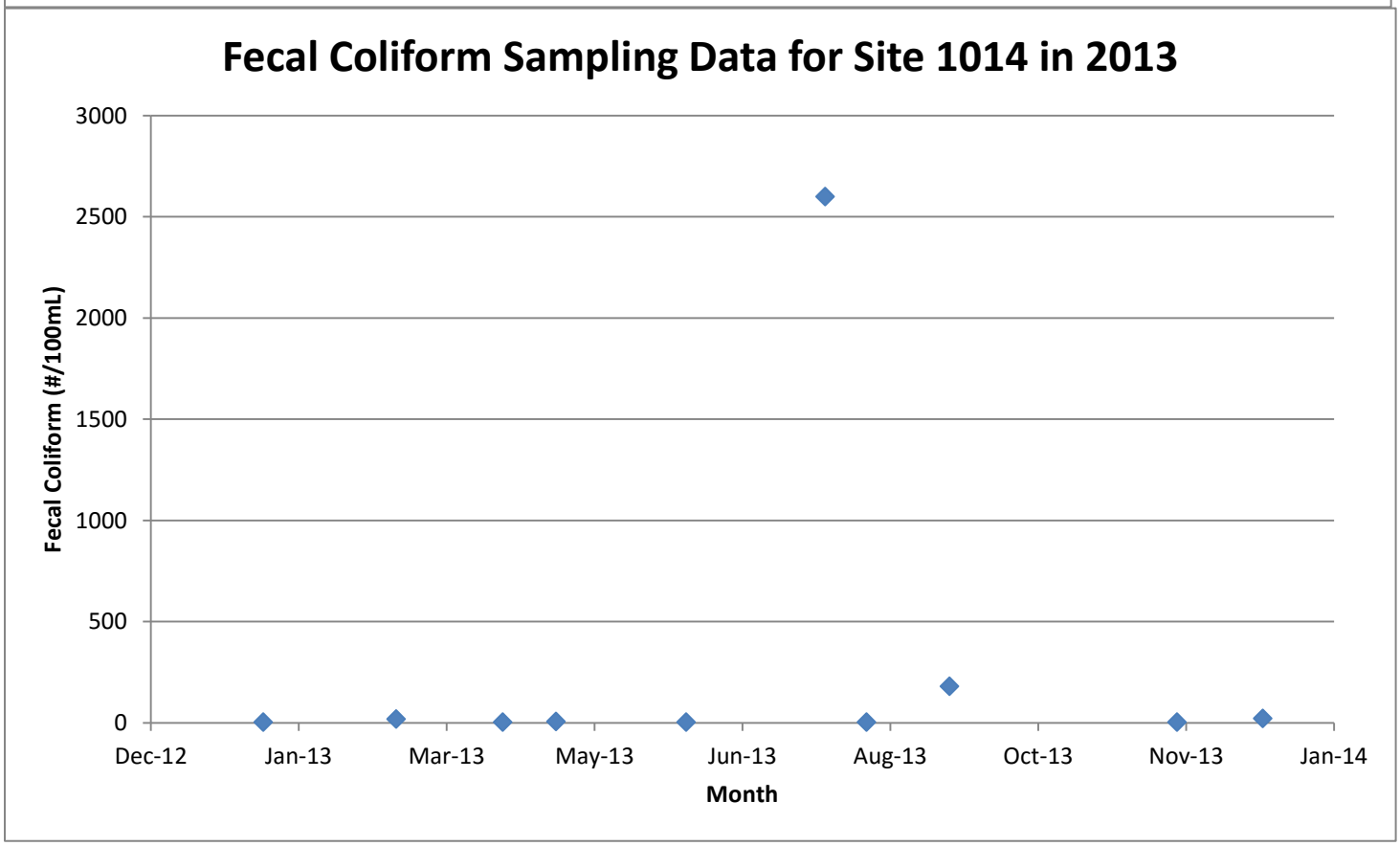

Fecal Coliform Sampling Data for Site 1010D in 2014
Fecal Coliform (#/100mL)
500
450
400
350
300
250
200
150
100
50
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month

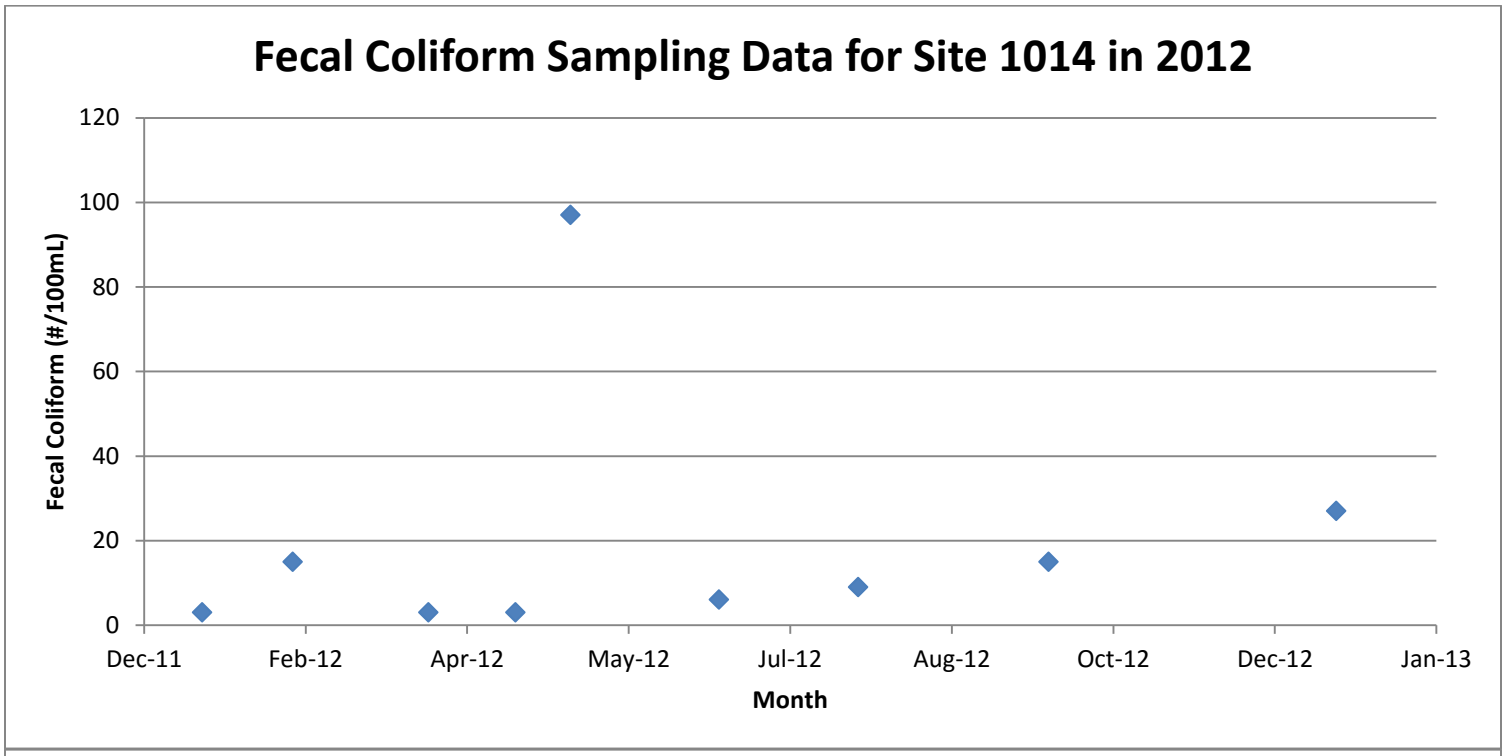

Fecal Coliform Sampling Data for Site 1010D in 2013
Fecal Coliform (#/100mL)
250
200
150
100
50
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month

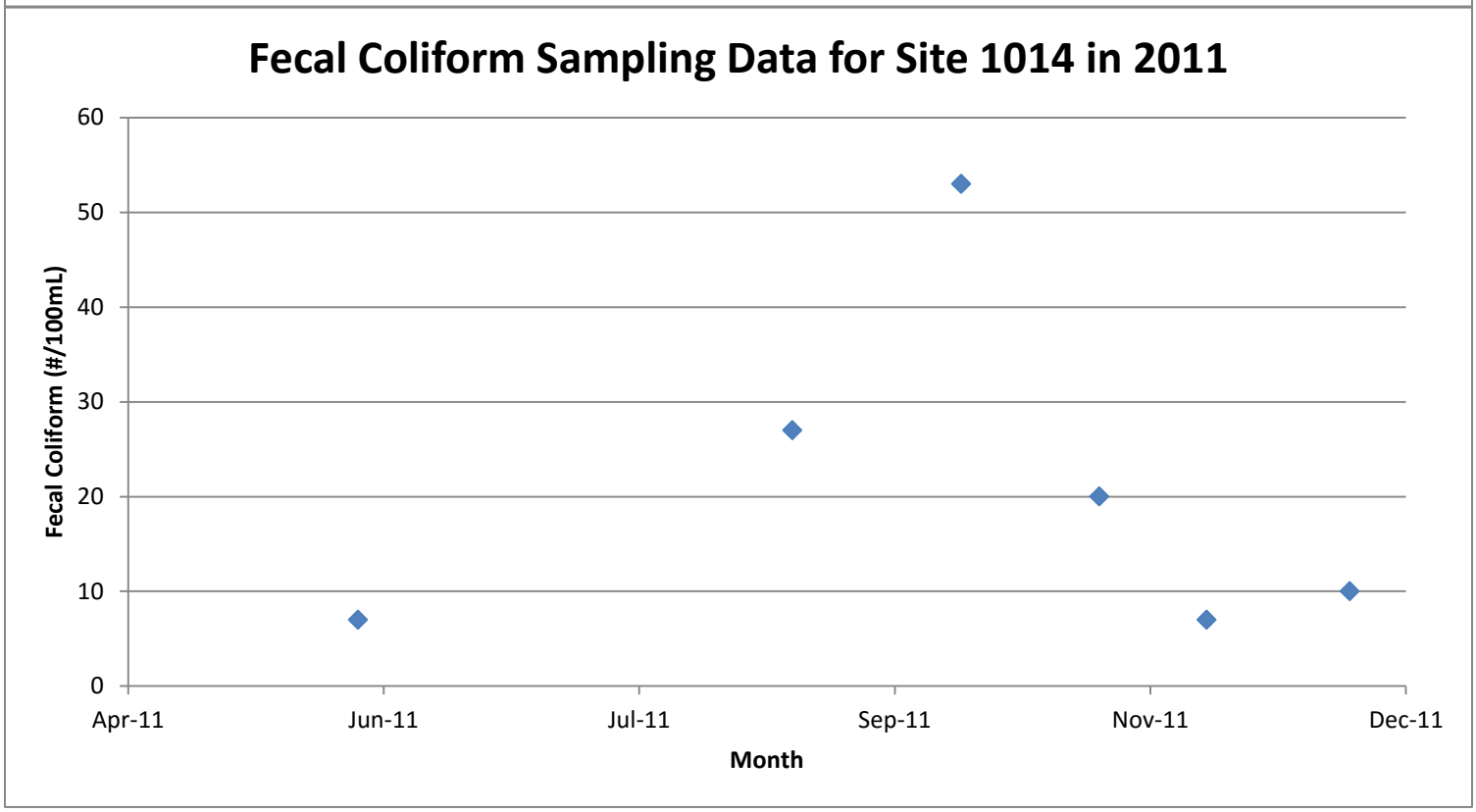

Fecal Coliform Sampling Data for Site 1010D in 2012
Fecal Coliform (#/100mL)
35
30
25
20
15
10
5
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month


Fecal Coliform Sampling Data for Site 1010D in 2011
Fecal Coliform (#/100mL)
80
70
60
50
40
30
20
10
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month


Fecal Coliform Sampling Data for Site 1014 in 2014
Fecal Coliform (#/100mL)
500
450
400
350
300
250
200
150
100
50
0
Nov-13
Jan-14
Mar-14
Apr-14
Jun-14
Jul-14
Sep-14
Nov-14
Dec-14
Month


Fecal Coliform Sampling Data for Site 1014 in 2013
Fecal Coliform (#/100mL)
3000
2500
2000
1500
1000
500
0
Dec-12
Jan-13
Mar-13
May-13
Jun-13
Aug-13
Oct-13
Nov-13
Jan-14
Month


Fecal Coliform Sampling Data for Site 1014 in 2012
Fecal Coliform (#/100mL)
120
100
80
60
40
20
0
Dec-11
Feb-12
Apr-12
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Month


Fecal Coliform Sampling Data for Site 1014 in 2011
Fecal Coliform (#/100mL)
60
50
40
30
20
10
0
Apr-11
Jun-11
Jul-11
Sep-11
Nov-11
Dec-11
Month

Appendix D: Monmouth County Health Department Navesink River Sampling Data

NAVESINK RIVER, RED BANK	MONMOUTH COUNTY HEALTH DEPARTMENT			
Site	**Collection Date**	**Fecal**	**Enterococci**	**SWQS**
41	11/29/2011		0	SE1
41	8/4/2011		970	SE1
41	7/28/2011		280	SE1
41	7/21/2011		210	SE1
41	7/14/2011		390	SE1
41	7/7/2011		750	SE1
41	6/29/2011		0	SE1
41	10/14/2010		0	SE1
41	9/16/2010		0	SE1
41	9/9/2010		250	SE1
41	9/2/2010		330	SE1
41	8/26/2010		690	SE1
41	8/18/2010		240	SE1
41	8/12/2010		400	SE1
41	6/16/2010		0	SE1
41	3/25/2010		0	SE1
41	9/4/2009		480	SE1
41	6/25/2009		240	SE1
41	3/27/2009		120	SE1
41	11/24/2008	120	50	SE1
41	8/27/2008	1500	170	SE1
41	6/3/2008	180	20	SE1
41	3/26/2008	50	60	SE1
41	11/14/2007	40	30	SE1
41	9/26/2007	30	10	SE1
41	9/25/2007	320	240	SE1
41	6/28/2007	800		SE1
41	3/27/2007	10	10	SE1

NAVESINK RIVER, FAIR HAVEN	MONMOUTH COUNTY HEALTH DEPARTMENT			
Site	**Collection Date**	**Fecal**	**Enterococci**	**SWQS**
42	11/6/2013		0	SE1
42	8/15/2013		0	SE1
42	7/3/2013		110	SE1
42	6/27/2013		20	SE1
42	6/20/2013		10	SE1
42	6/13/2013		10	SE1
42	6/6/2013		10	SE1
42	3/22/2013		0	SE1
42	12/4/2012		0	SE1
42	9/21/2012		0	SE1
42	7/12/2012		10	SE1
42	7/5/2012		210	SE1
42	6/28/2012		30	SE1
42	6/21/2012		130	SE1
42	6/14/2012		10	SE1
42	3/14/2012		0	SE1
42	9/28/2009		20	SE1
42	6/10/2009		60	SE1
42	3/18/2009		10	SE1
42	11/24/2008	10	10	SE1
42	8/27/2008	10	10	SE1
42	6/3/2008	40		SE1
42	3/25/2008	10	10	SE1
42	11/14/2007	50	60	SE1
42	9/25/2007	30	10	SE1
42	5/24/2007	10	10	SE1
42	3/27/2007	10	10	SE1