Baltimore Watershed Agreement Phase 1 Action Plan

Mapping Environmental Justice + Water Quality in Baltimore County

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Table of Contents

Executive Summary 01

01 Introduction 02

02 Data Selection, Ranking, Weighting and Analysis 04

03 Conclusions 18

References 20

Appendix A - Raw Data Layers A-1

Executive Summary

Environmental justice (EJ) is defined as the equal distribution of environmental benefits and harms regardless of race, income, or socioeconomic status. EJ arose as a cross-cutting theme in the Baltimore Watershed Agreement Phase 1 Action Plan (BWAAP). Action 2.5 of the BWAAP requires Baltimore County and City to integrate EJ into watershed planning and restoration efforts.

A white paper and memo of findings on water quality issues and EJ indicators was produced for Baltimore County in 2010. Informed by that research, a GIS mapping model was developed to identify priority at-risk environmental justice communities in the County. After collecting available GIS data layers, relevant indicators were grouped into social and demographic indicators, major human health indicators, major watershed health indicators, and minor watershed health indicators.

Poverty and minority data layers were selected as social and demographic indicators. Poverty and minority were weighted highest in the model because they are defining factors of environmental justice. These layers account for 50% of the final composite map weighting.

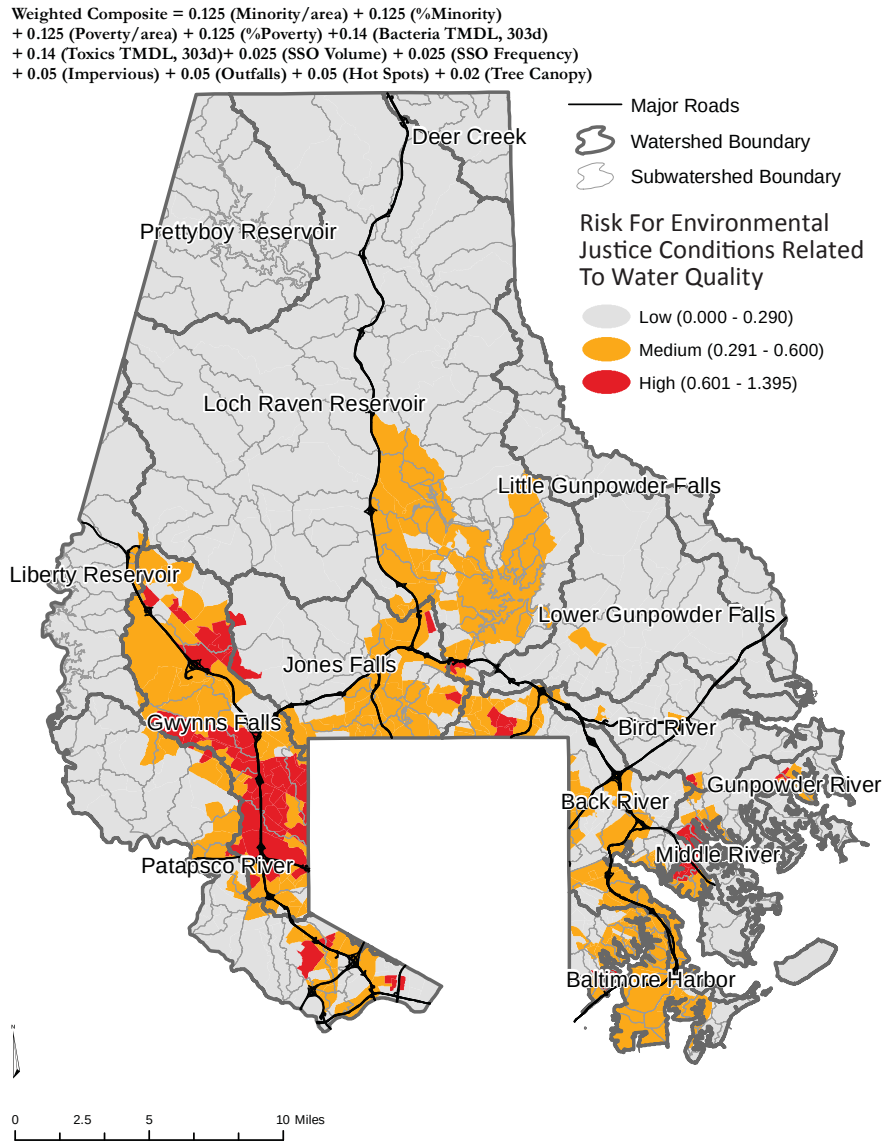
Data layers selected as major human health indicators related to water quality were stream and water bodies with bacteria and toxics Total Maximum Daily Load (TMDL) and 303d impairments. These layers were weighted at a combined total of 28% of the composite map.

Selected major indicators of watershed health included sanitary sewer overflows, storm drain outfalls, hot spots (areas where contamination is highly concentrated), and percent impervious cover. These layers were weighted at a combined total of 20% of the composite map.

The data layer selected as a minor indicator of watershed health was tree canopy, weighted as 2% of the total composite map.

Each of the data layers was combined with US census block groups and ranked into three categories (low, medium, and high) using the Jenks Natural Breaks Classification system. The final weighted composite map of indicator data layers of communities at risk of environmental justice and poor water quality is shown in Figure E1. The Gwynns Falls watershed has the largest area of communities at risk for environmental justice conditions related to water quality.

Figure E1. Communities at risk for environmental justice conditions related to water quality.



01 Introduction

THE BALTIMORE WATERSHED AGREEMENT

The Baltimore Watershed Agreement (BWA) was executed in 2002 to formalize the joint commitments and vision of Baltimore County and Baltimore City to address pollution problems in the region's watersheds. Baltimore County and Baltimore City agreed to improve cooperative, inter-agency management of environmental resources (www.baltimorecountymd.gov/Agencies/environment/watershedagreement/index.html). In December 2006, leaders from Baltimore County and Baltimore City signed the second regional watershed agreement, emphasizing the value and importance of cooperation in addressing water quality and regional watershed issues while highlighting progress. The Phase 1 Action Plan reflects agreed upon goals and high-priority, short-term actions for Baltimore County and Baltimore City to pursue. The plan is organized by the categories of Implementation; Policy & Regulation; Planning & Collaboration; Education; and Outreach & Awareness which cross the five topic areas of Development and Redevelopment; Community Greening; Stormwater; Public Health and Trash. The Committee of Principals and the topic committees identified two areas of concern, sustainable communities and environmental justice, that are woven into the Plan actions. Each action specifies a lead agency and measure of success within the 2009-2012 Phase 1 time frame.

Environmental Justice (EJ) arose as a cross-cutting theme for all watershed planning and water quality related actions during the development of the Baltimore Watershed Action Agreement Phase 1 Action Plan (BWAAP). Action 2.5 of the BWAAP requires the BWA workgroup and the Committee of Principals to "develop policies which ensure environmental justice indicators are taken into consideration during major planning efforts." This was to be done through the development of a white paper on environmental justice indicators and assessment methods well-suited for watershed planning, assessment and prioritization.

The "Environmental Justice Analysis White Paper," prepared for Baltimore County in February of 2010, presented research on environmental justice indicators and assessment methods based on interviews, peer reviews, and EJ indicator document research (Biohabitats, 2010a). A follow-up memo, "Watershed Planning and Environmental Justice: An Assessment Methodology," distilled that research and presented an assessment methodology to integrate environmental justice principles and elements into watershed planning using GIS mapping (Biohabitats, 2010b).

DEFINING ENVIRONMENTAL JUSTICE

Environmental justice efforts focus on the equal distribution of environmental harms and environmental benefits, regardless of race, income or socio-economic status. Furthermore, environmental justice is defined as the "fair treatment and meaningful involvement of all people" in environmental decision-making (EPA, 2011).

Addressing environmental justice concerns helps minimize and prevent populations vulnerable to environmental injustice from being disproportionately burdened by environmental hazards, pollution, and unhealthy land uses. EJ initiatives aim to improve health in communities that tend to have a lack of health-promoting environmental amenities in addition to excessive environmental harms.

The EJ movement began in 1982, yet environmental justice problems are far from resolved (Bullard et al., 2007). While still concerned with exposure to pollutants, the EJ vision has evolved to include sustainability, climate change, wilderness and wetland management, indoor environmental quality, and urban ecology. Given these continued concerns and expanded areas of interest, incorporating environmental justice into watershed planning is both timely and innovative.

BALTIMORE COUNTY EJ + WATERSHED PLANNING MAPPING

In order to implement BWAAP Action 2.5, an ArcView GIS model was developed to map areas in the County with the highest risk of EJ violations combined with poor watershed health. The resulting map will help to guide County watershed planning and implementation efforts, such as Small Watershed Action Plans (SWAPs), to prioritize efforts that will promote environmental justice as a stacked benefit with improving water quality.

Attention to process, internal leadership, accountability, and advancing complementary policies is essential if long-term EJ improvements are to be realized. A systems approach is required in order to restore functionality to our streams and rivers, which eventually empty into the Baltimore Harbor and the Chesapeake Bay. Efforts and actions within a watershed are interdependent, so overall change will only occur if those decisions are working toward the improvement of the whole system.

INDICATORS

Identifying relevant EJ populations within the context of watershed planning is a unique exercise compared to previous environmental justice efforts. As such, it requires new methods to systematically and easily identify potential communities experiencing environmental injustices stemming from water quality issues.

Few sources use explicit indicators to track environmental justice in the context of watershed planning and water quality. However, many implicitly utilize a combination of indicators that begin to address the interrelationships between environmental health and social equity, listed below.

- Social and Demographic Indicators
- Human Health Indicators
- Watershed Health Indicators
- Community Involvement Indicators

02 Data Selection, Ranking, Weighting & Analysis

DATA INPUT

Geographical Information System (GIS) software is a powerful mapping and spatial analysis tool. Using ArcGIS software to overlay and analyze spatial data and output serves as the best method for identifying viable locations for priority EJ and water quality projects.

From the broad indicator categories developed during the research of existing indicators, data layers were selected for this analysis based on availability for Baltimore County. The data layers used within this model can be expanded or simplified based on availability in a given municipality. Data selection is somewhat subjective based on knowledge of relevant local EJ issues. Future assessments may benefit from the inclusion of other data layers or newer data as it becomes available.

The following steps were developed to explore the relationships and patterns that begin to appear when we start to examine indicators relevant to environmental justice and watershed health.

Step 1 in creating a GIS EJ indicator model for any locale is collecting raw data needed for analysis and subsequent processing including municipal boundaries, census data, watershed and sewershed boundaries, waterway locations, and land use.

Step 2 is to identify the most relevant demographic indicators of environmental justice such as poverty, minority, language proficiency, education, and job statistics. For this model poverty and minority status were chosen as demographic indicators for environmental justice.

Step 3 is to identify indicators of major human health impacts related to water quality. These could include waters with high levels of bacteria, chemicals, and metals, violations of recreational water standards, fish consumption advisories, and illnesses attributable to water pollutants. Data availability led to the choice of using Bacteria TMDL & 303d stream impairments and Toxics TMDL & 303d impairments data for these indicators. Bacteria, noted as an indicator of potential disease pathogens, and toxics, noted because as they accumulate in fish and other aquatic species they can provide a public health risk to those who might consume those species.

Step 4 is to identify indicator layers for major watershed health indicators data related to water pollution and stormwater issues. These include sanitary sewer overflows, stormwater outfall locations, hot spot pollutant point sources, and impervious surfaces.

Step 5 is to identify minor watershed health indicators such as the lack of tree canopy and the presence of trash or dumping sites. Tree canopy is known to help slow the speed of stormwater runoff, slowing it down and providing for infiltration around tree roots. In this case percent tree canopy was the data selected for availability.

BASE DATA

Initially, two units of analysis were considered to scale the data layers - census block groups and subwatershed boundaries (shown in Figures 2.2 and 2.3). While the resulting EJ map will be applied to small watershed action plans by the County, the census block group boundaries divide smaller area blocks within the more urban portions of the County, offering a finer-grained understanding of areas that have a higher population density. The subwatershed boundaries are added onto the final composite map in order to rank the model results by subwatershed. Subwatershed, stream, and hydrologic data used in this model are from the County's 2005 stream layer (Figure 2.3).

1a. Municipal Boundaries
1b. Census Data
1c. Watershed and Subwatershed Boundaries
1d. Hydrologic Features
1e. Land Use

SELECTED INDICATOR DATA LAYERS

The following data layers were selected from an initial list of potential indicators of environmental justice and water quality based on availability and refinement of the model (See Appendix A for the raw data that was used to develop these layers):

2a. % Poverty
2b. Poverty Density
2c. % Minority
2d. Minority Density
3a. Bacteria TMDL & 303d Stream Impairments
3b. Toxics TMDL & 303d Stream Impairments
4a. Sanitary Sewer Overflow Volume
4b. Sanitary Sewer Overflows Frequency
4c. Storm Drain Outfalls
4d. Hot Spots
4e. % Impervious Cover
5a. % Tree Canopy

Figure 2.1 shows the described assessment method with the selected indicators grouped into steps within the model.

Figure 2.1. Selected EJ Indicators and Assessment Method for Watershed Planning

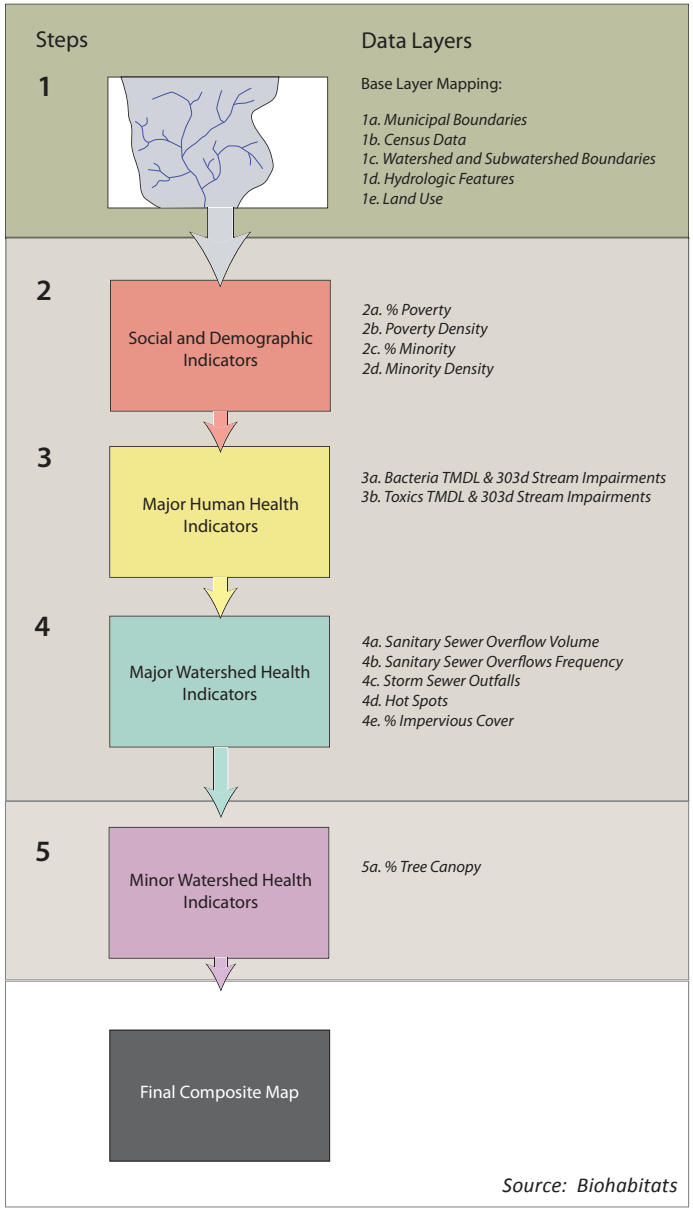


Figure 2.2. Baltimore County Census Block Group Map With Major Highways.
Data Source: 2000 US Census.

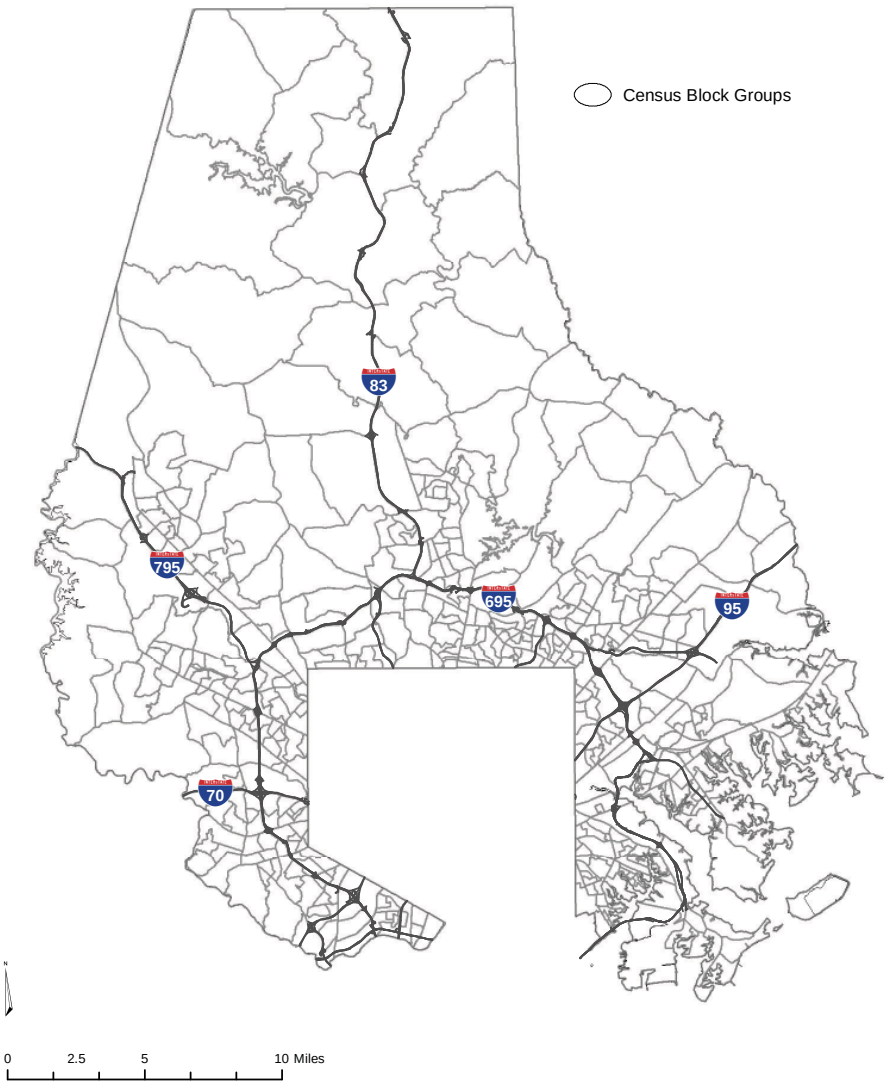
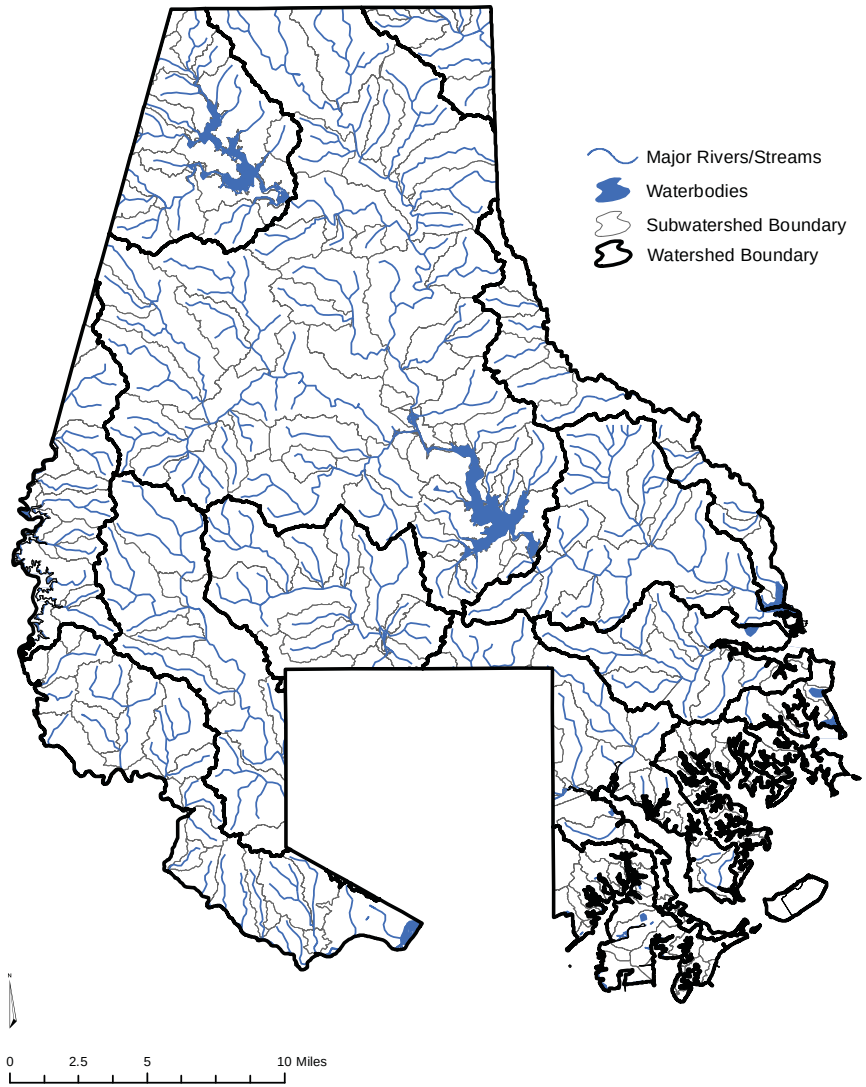


Figure 2.3. Baltimore County River, Streams, Waterbodies, and Sub-Watersheds Map.



Data Source: Baltimore County 2005 stream layer.

DATA LAYER RANKING & WEIGHTING

Each data layer was ranked into categories using the Jenks Natural Breaks Classification system. The Jenks method statistically clusters sets of data into categories based on breaks in the data. In this model, each data set was split into three categories (low, medium, and high). The metrics were normalized to develop the composite analysis being assigned values of 0, 1, and 2 for the low, medium, and high categories, respectively. In all maps, 0 is represented as gray, 1 as orange, and 2 as red. See Figures 2.5 through 2.16 for ranked data layers.

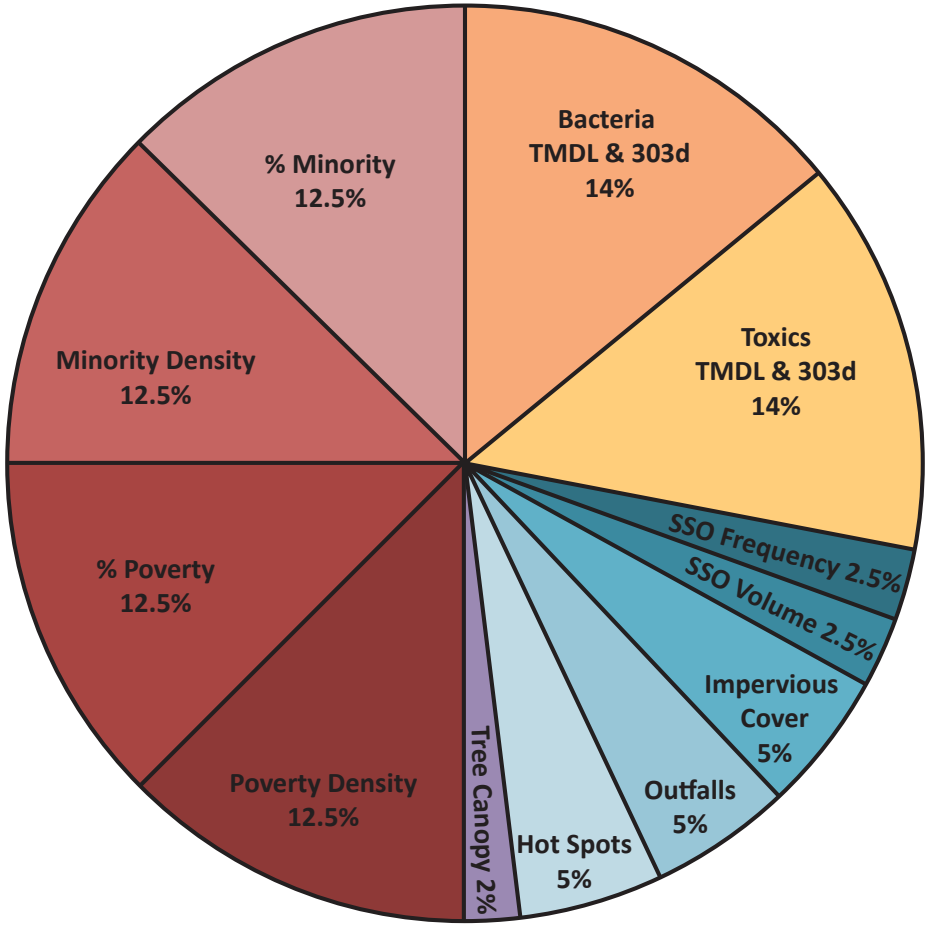
The twelve layers in the model are weighted based on the indicator assessment model (Figure 2.1). The social and demographic layers (in red) of poverty and minority define environmental justice and are therefore ranked to a total of 50% of the weighted composite (divided into 4 layers). Major human health indicator layers (in yellow) including bacteria and toxics TMDL and 303d stream impairments are weighted second highest at a combined total of 28% due to their direct impact on public health, another key component in EJ. Major watershed health layers (in blue) including SSOs, impervious cover, storm drain outfalls, and hot spots are ranked in the third level of indicators as a total of 20% of the composite. Tree canopy (in purple) is weighted as a minor watershed health indicator at 2% of the total composite.

In summary, the final composite map consists of the following weighting:

50%	Social and Demographic Indicators
28%	Major Human Health Impact Indicators
20%	Major Watershed Health Indicators
2%	Minor Watershed Health Indicators

Figure 2.4 shows the weighting percent each data layer was multiplied by before adding all of the layers together to form the final composite map.

Figure 2.4. Weighting Pie Chart



INDICATOR DATA LAYER ANALYSIS

SOCIAL AND DEMOGRAPHIC INDICATORS (Layers 2a-2d)

Poverty & Minority Data

Poverty is an important indicator defining environmental justice. Impoverished communities are the most susceptible to EJ issues and the least able to relocate to a healthier environment. These communities are also more likely to experience cumulative health risk from other stresses related to income, limited access to health care, and other environmental factors.

Potentially separate from poverty, minority populations are also at higher risk of EJ issues, or environmental racism. Historically, environmental racism has led to placement of harmful land uses, such as polluting industry or noxious infrastructure in minority neighborhoods of various economic status. One such example is the placement of the first sewage treatment plant in Manhattan in a middle class African American community in Harlem in 1985.

Poverty and minority data for Baltimore County were acquired from the 2000 US Census data. Ideally this data set will be replaced with 2010 US Census data as GIS layers become available. The raw census data lists numbers of impoverished families per block group and number of minority individuals by block group. Block groups vary in area greatly as they are divided into smaller blocks in more densely populated urban areas and larger block groups in more rural, less densely populated areas. To balance out this discrepancy of block group area versus population density while still recognizing relative poverty and minority per block group area, the model layers both percent of families in poverty and minority individuals per block group and number of families and individuals by block group divided by block group area. Therefore, metrics for these four data layers are:

2a. % poverty = # of impoverished families per block group / total # of families per block group
2b. Poverty density = # of impoverished families per block group / area of block group
2c. % minority = # of minority individuals per block group / total # of individuals per block group
2d. Minority density = # of minority individuals per block group / area of block group

See Figures 2.5 - 2.8.

Figure 2.5. Percentage of Minority Individuals in Census Block Groups

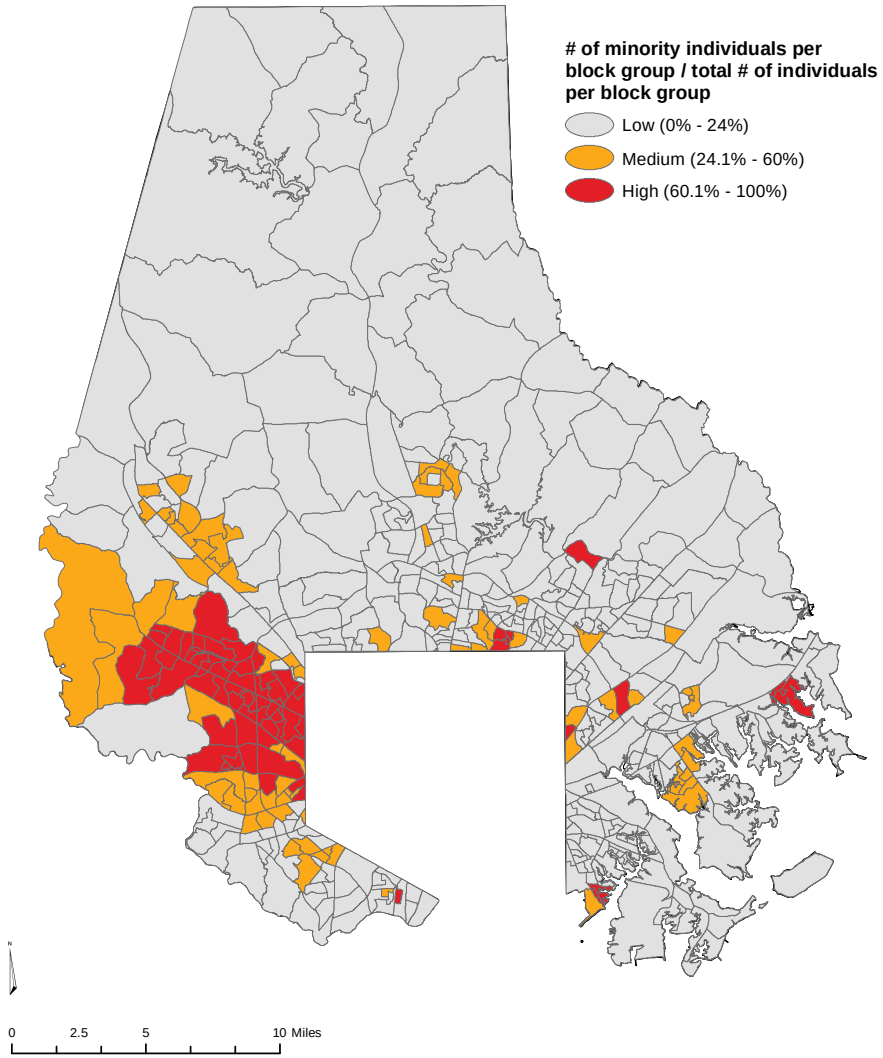


Figure 2.6. Density of Minority Individuals Per Block Group

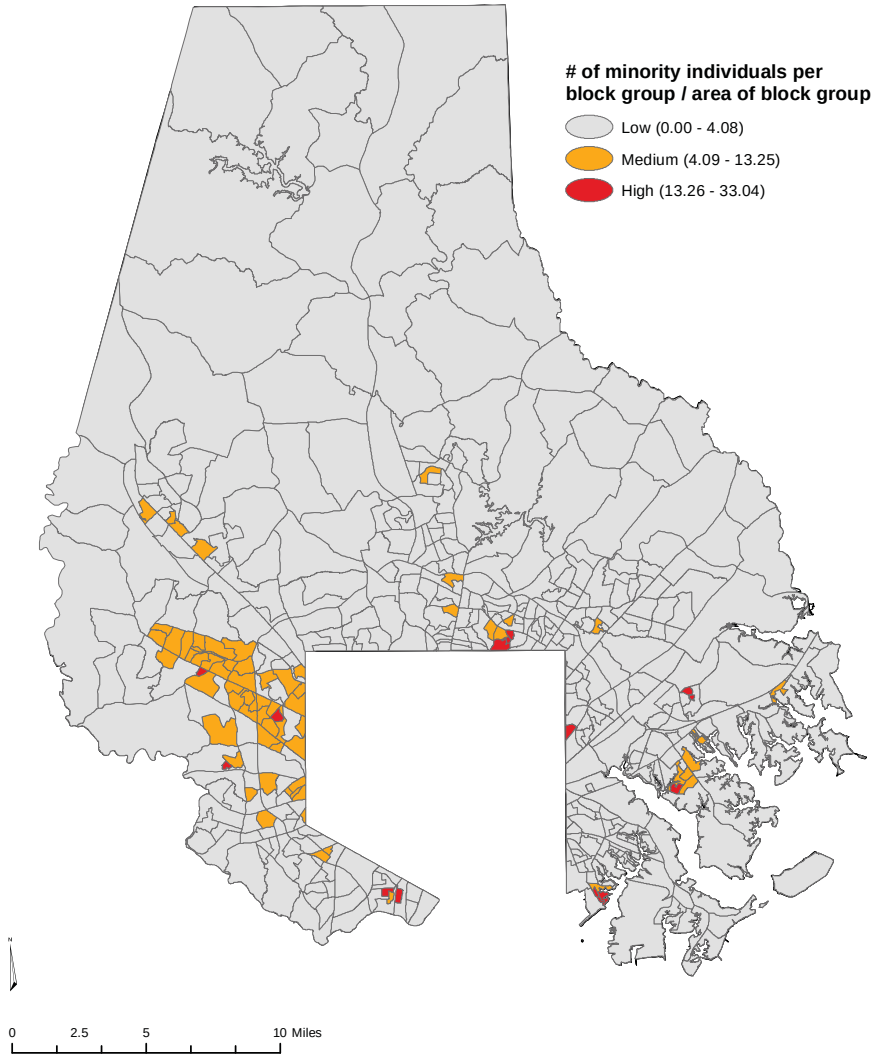


Figure 2.7. Percentage of Families in Census Block Groups Below Poverty

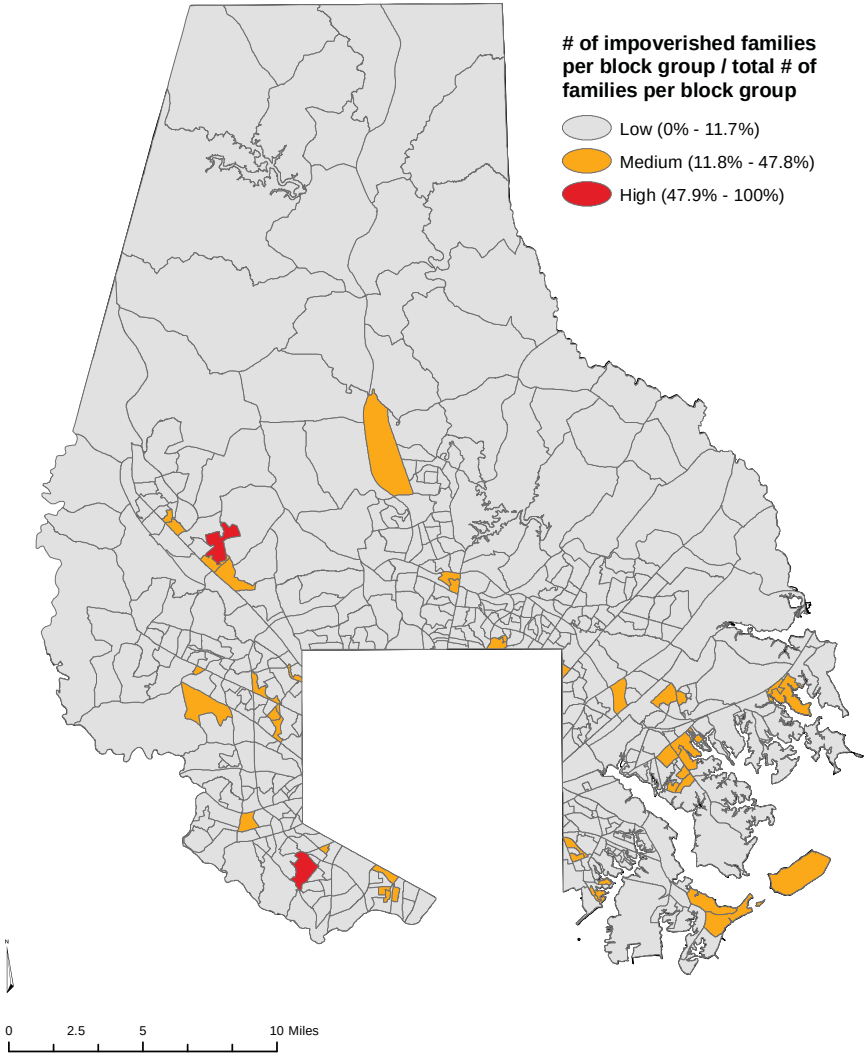
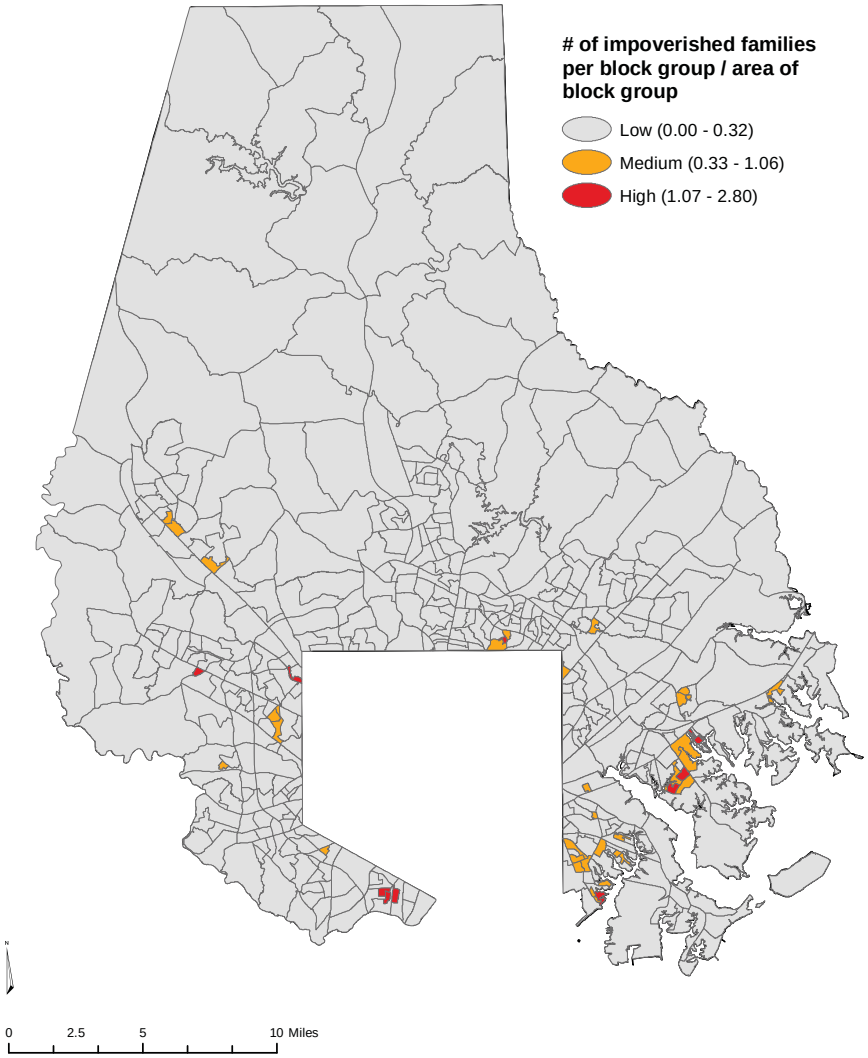


Figure 2.8. Density of Families Below Poverty



MAJOR HUMAN HEALTH INDICATORS (Layers 3a and 3b)

TMDL & 303(d)

Section 303(d) of the Clean Water Act requires municipalities to monitor and list waterbodies impaired by pollutants. If monitoring determines that pollutant levels are in excess of safe water quality standards, then Maryland Department of Environment (MDE) will develop the TMDL, for subsequent EPA approval, for the specific pollutant reductions for that waterbody. Waterbodies determined to be impaired with pending TMDLs are categorized as 303(d) waters. TMDLs and 303(d) impairment status are issued for various pollutants including bacteria, toxics (chemicals and metals), nutrients (nitrogen and phosphorus), sediment, and trash. Of these possible pollutants, only bacteria and toxics pose a direct public health risk and are therefore used in the EJ model.

Baltimore County Department of Environmental Protection and Sustainability supplied TMDL and 303d data sets of impaired streams and water bodies for bacteria and toxics.

Bacteria (measured by presence of fecal coliform) based on EPA standards is an indicator of pathogens in water. Waters with high bacteria counts pose a public health risk for recreational body contact and violate safe swimming standards. Sources of fecal coliform bacteria include human sewage, domestic animals, livestock, and wildlife. Human sources can be the result of leaking or overflowing sanitary sewer infrastructure, combined sewer overflow, or failing septic systems, which create the highest risk of pathogen transfer. TMDL regulations require reducing amounts of bacteria in the water by set percentages for each water body impairment.

The toxics impairments found in Baltimore County streams and water bodies are mercury, clordane (a chemical used as a pesticide), and Polychlorinated biphenyls (PCBs). In waterbodies used for fishing, these toxics can accumulate in fish tissue, violating safe fish consumption standards. When body contact with sediment is likely during recreation, toxics can also lead to long term health effects which are difficult to measure.

The raw TMDL & 303(d) bacteria and toxics data consists of georeferenced line data, for impaired streams, and georeferenced polygon data for lakes, reservoirs and tidal waters. These layers were interpreted by adding a one quarter mile buffer to estimate the likely distance users would walk to recreate, then ranking each block group by the % of block group area containing buffer area. For the bacteria layer, the concentration of the human source bacteria monitored in impaired waters was multiplied by the required percent reduction to rank the priority block groups. In the toxics data layer, areas were multiplied by the number of toxic impairments (mercury, chlordane, and PCBs) present (1,2, or 3). The area of buffer area within each block group was then area weighted by dividing by the total area of the block group. Therefore, the metrics for these two data layers are:

> **3a. Bacteria TMDL & 303(d) Stream Impairments** = [(% human source x % required reduction per water body) x (buffer zone area per block group)] / area of block group
>
> **3b. Toxics TMDL & 303(d) Stream Impairments** = (# of pollutant types per water body x buffer zone area per block group) / area of block group

See Figures 2.9 and 2.10.

Figure 2.9. Bacteria TMDL & 303d Stream Impairments

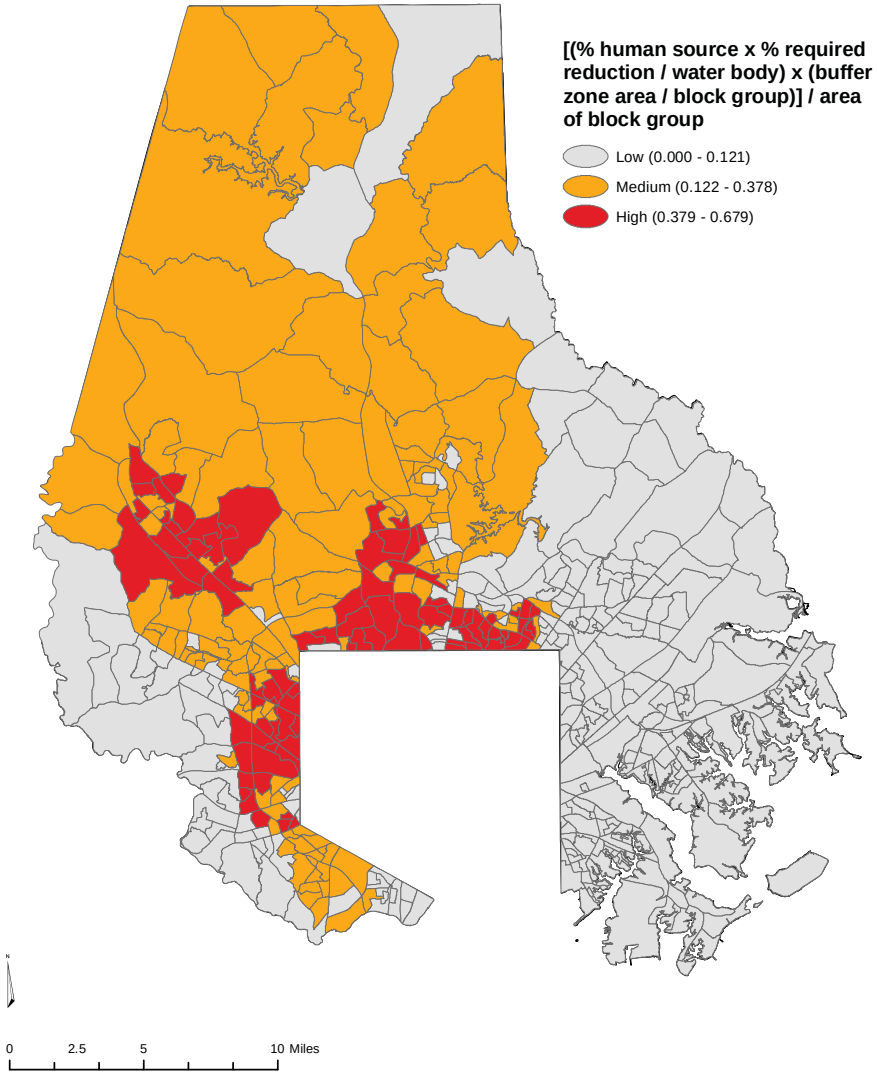
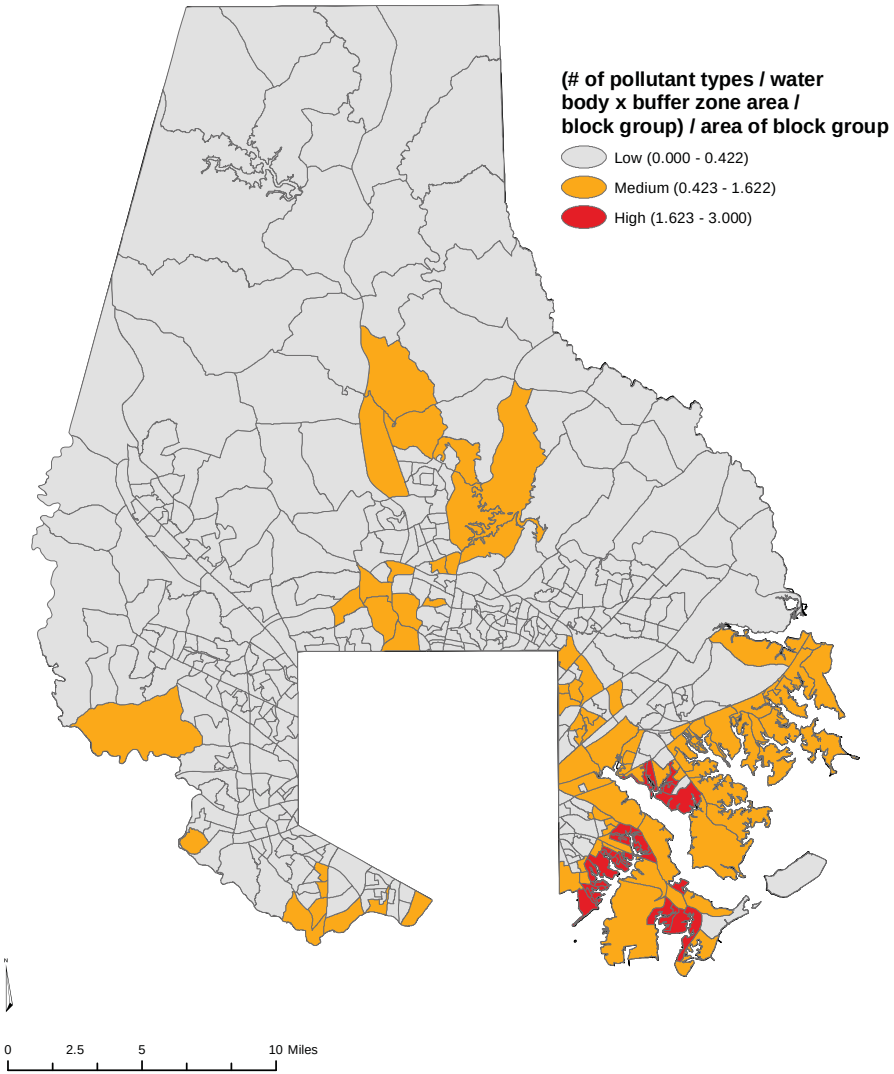


Figure 2.10. Toxics TMDL & 303d Stream Impairments



MAJOR WATERSHED HEALTH INDICATORS (Layers 4a-4e)

Sanitary Sewer Overflows and Storm Drain Outfalls

Baltimore County Department of Public Works and Department of Environmental Protection and Sustainability provided point data for sanitary sewer overflows (SSOs) and storm drain outfalls.

Failures of sanitary sewer infrastructure such as high flows, blockages, and line breaks can cause overflows of raw sewage to enter streams and water bodies. These SSOs are a major source of pollutants such as bacteria and nutrients in streams. Many SSOs go undetected or are difficult to identify, but those which are detected through public complaint or pollutant source tracking are recorded through County monitoring efforts. Only SSO data from 2000 through 2006 was used in the EJ model because these overflows were monitored prior to the issuance of the County's consent decree. Each point in the SSO data set represents a single occurrence. To determine not only SSO occurrence, but severity of SSO points, the data was split into one layer with the total volume of SSO events within a census block group divided by number of years and a second layer with the frequency of SSO events per census block group divided by total years. The metrics for these layers are:

> **4a. SSO volume** = total volume of SSO events from 2000-2006 per block group / 6 years / area of block group
> **4b. SSO frequency** = total number of SSO events from 2000-2006 per block group / 6 years / area of block group

Underground, piped storm drain infrastructure typically outlets directly into streams and other water bodies without filtration. Presence of storm drain outfalls creates a higher risk of pollutants from stormwater runoff entering a water body and increases the potential for human body contact with these pollutants. Outfall sites often degrade streams with pollutants as well as channel erosion from high flow velocities. At the point that the consent decree was issued the County initiated an extensive effort to make major improvements to the sewer infrastructure. Outfall point data was ranked by the number of outfalls per block group:

> **4c. Storm drain outfall density** = # of outfalls / area of block group

See Figures 2.11 - 2.13.

Figure 2.11. SSO Volume

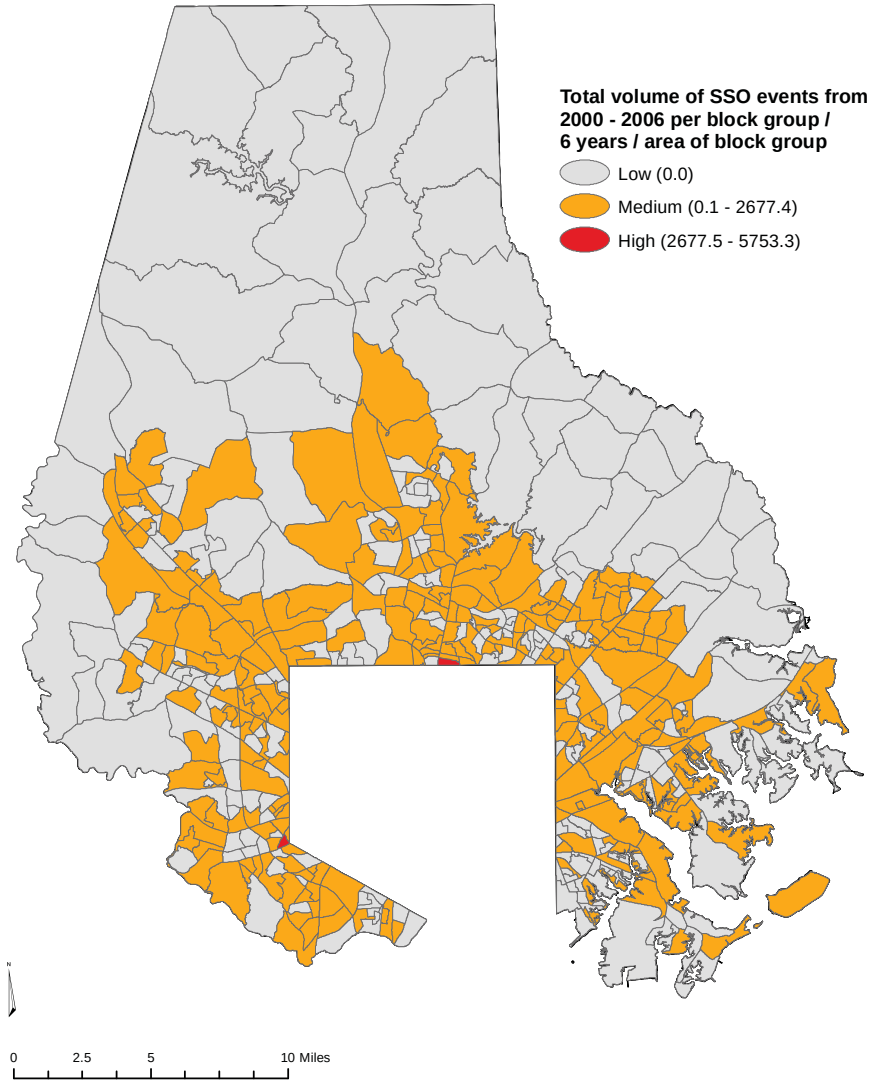


Figure 2.12. SSO Frequency

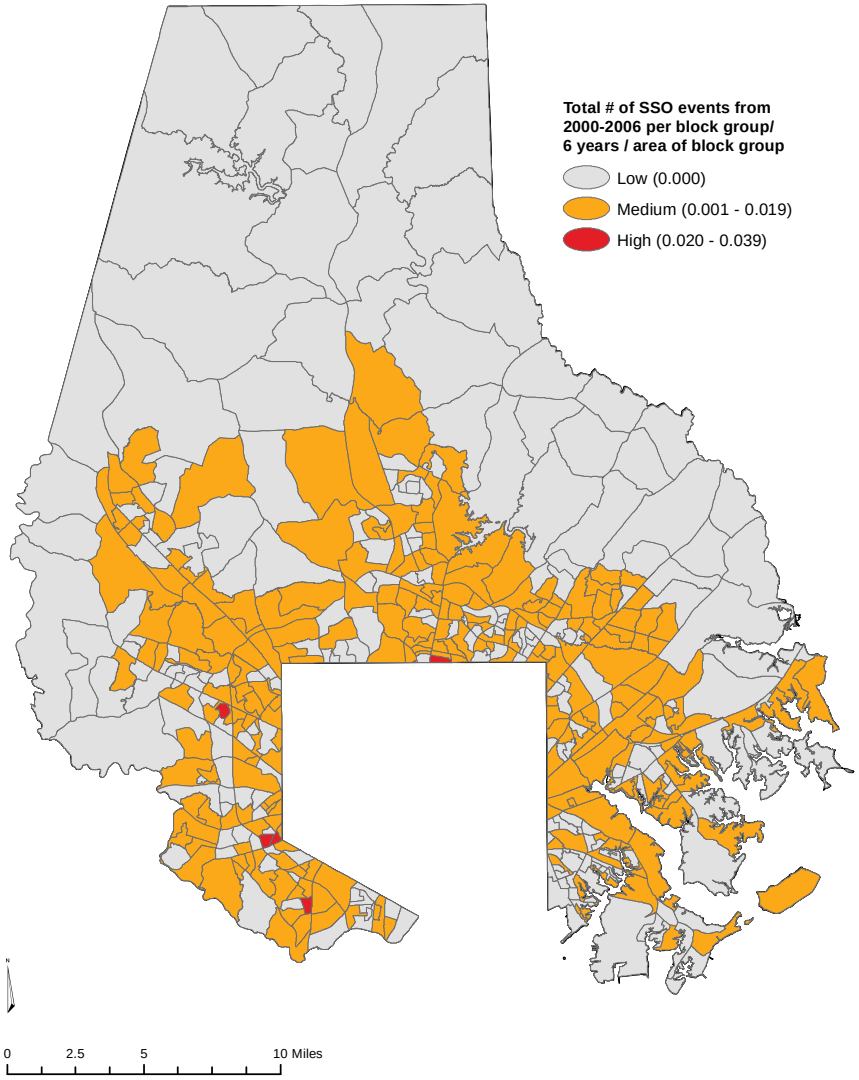
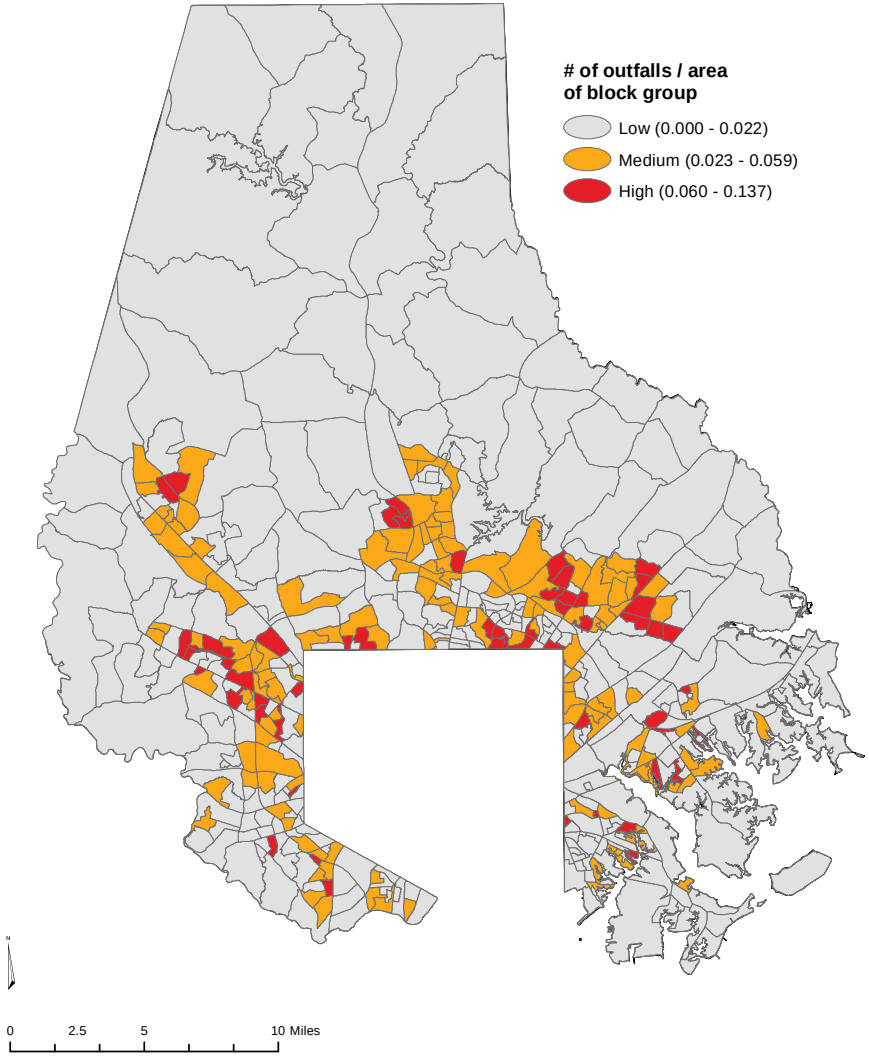


Figure 2.13. Storm Drain Outfalls



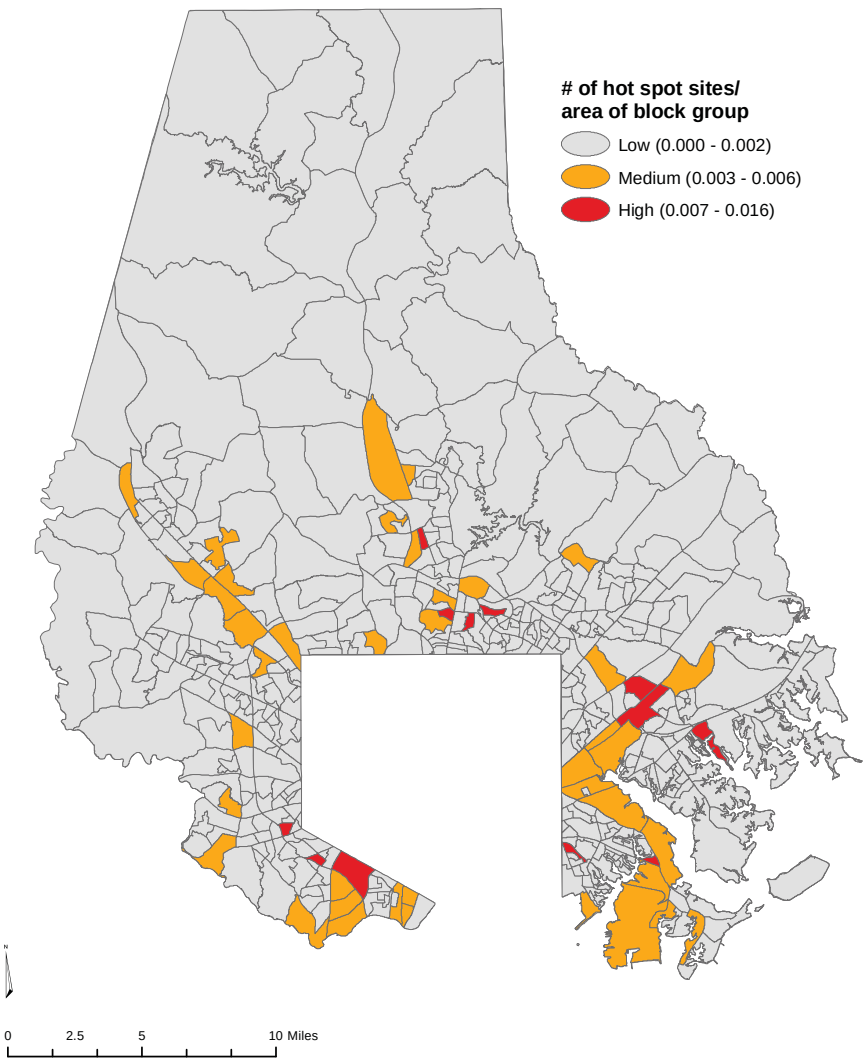
Hot Spots

Hot spots are potential point sources of industrial and commercial pollutants. These pollutants (often toxic metals and chemicals) may seep into groundwater or flow directly into streams and water bodies as point source pollutants. Hot spot point data from EPA used in this model includes Toxic Release Inventory (TRI); Resource Conservation and Recovery Act - Treatment, Storage Disposal (RCRA); Risk Management Program (RMP); Permit Compliance System; Major NPDES (PCS); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and Section Seven Tracking System for pesticide producing establishments (SSTS). The block groups were ranked based on density of hot spots per block group area:

4d. Hot spot density = # of hot spot points / area of block group

See Figure 2.14.

Figure 2.14. Potential Hot Spots



Impervious Cover

Impervious cover, such as roofs, parking lots, and other hard surfaces in the landscape increase stormwater runoff which carries pollutants into streams and waterbodies. Conversely, tree canopies slow stormwater. Extensive tree canopy areas typically indicate pervious surfaces such as forest which help to slow and filter stormwater.

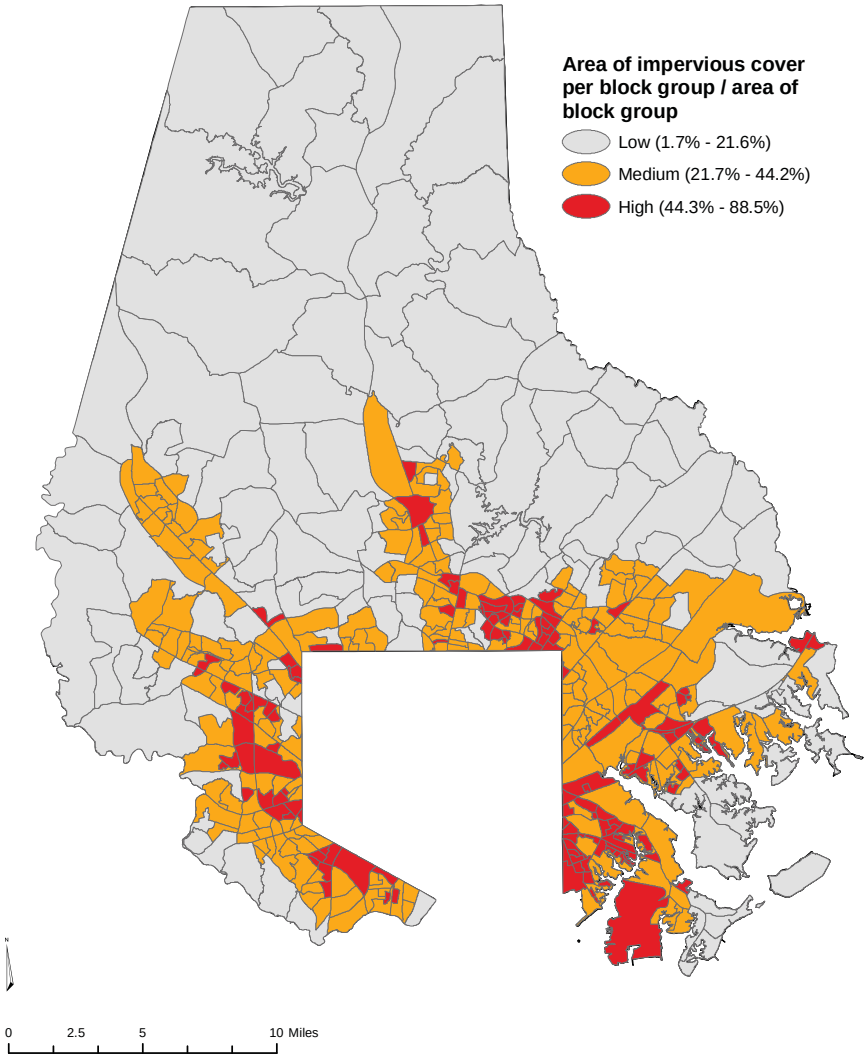
Impervious cover is an indicator of stream health, as typically the higher the percent of impervious cover is in a watershed, the lower the health of streams and waterbodies. By conveying more pollutants into streams and water bodies, impervious cover is an indirect indicator of public health and environmental justice. Similar to impervious cover, lack of tree canopy can also indicate poor stream health more indirectly.

Impervious cover was derived from Baltimore County planimetric data (roads and buildings) and the University of Vermont's Urban Tree Cover data set provided tree cover data for this EJ model. The raw impervious cover data, including buildings, roads, and other pavement, was ranked by percent impervious cover area by block group:

> **4e. % Impervious Cover** = area of impervious cover per block group / area of block group

See Figure 2.15.

Figure 2.15. Percent Impervious Cover



MINOR WATERSHED HEALTH INDICATORS (Layer 5a)

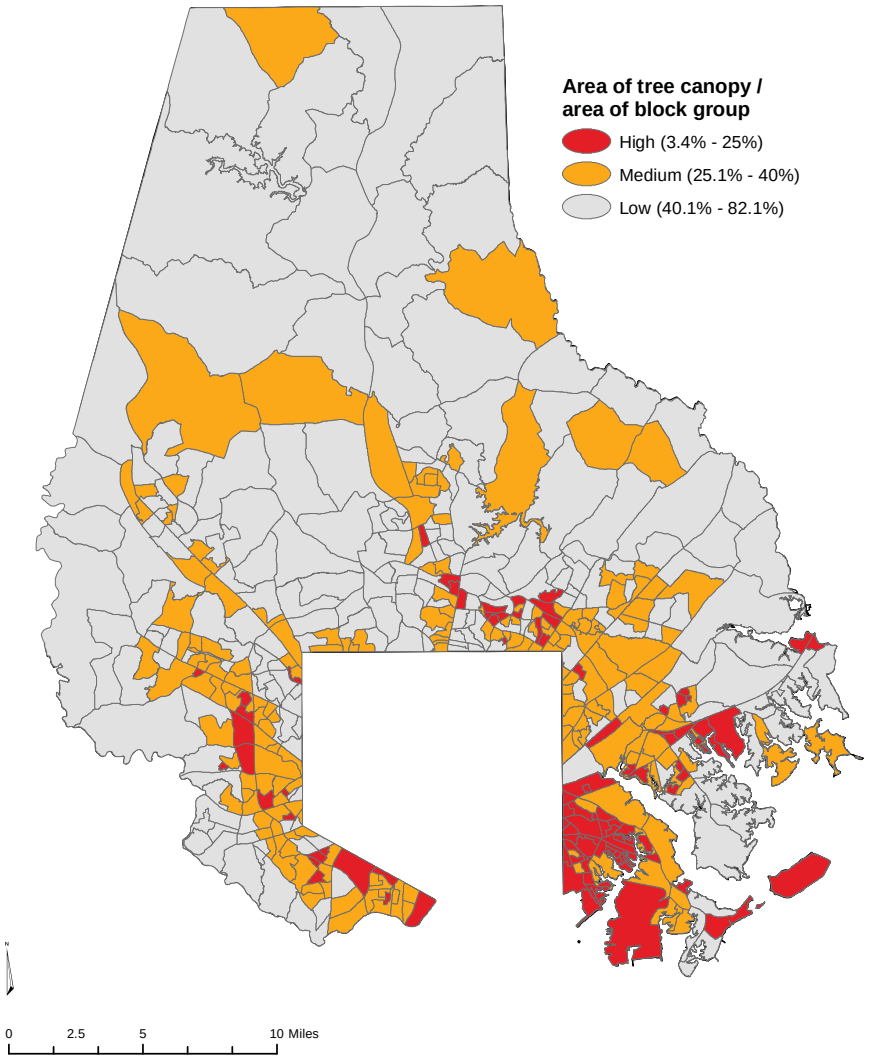
Tree Canopy

The tree canopy raw data was also ranked based on percent of area with tree canopy cover in each block group but was split into three categories based on recommendations by American Forests of a 25% tree canopy goal for urban residential areas and a 40% tree canopy goal for entire metro areas across all land use types. Therefore, the ranked categories are 0-25%, 25-40%, and >40%, with 0-25% ranked as highest EJ risk, 25.1% - 40% as medium risk, and 40.1% - 82.1% as low risk:

5a. % Tree canopy = area of tree canopy / area of block group

See Figure 2.16.

Figure 2.16. Tree Canopy



CONCLUSION

Figure 3.1 shows the top 5 locations by subwatershed of high EJ risk. Figures 3.2 and 3.3 show the resulting final composite map and the final composite map with the watershed and subwatershed boundaries overlaid.

Figure 3.1 shows a concentration of at-risk communities in the Gwynns Falls watershed but the highest percentage of high EJ risk is in the very south of the Baltimore Harbor watershed in the Clement Cove subwatershed. Another notable area of high risk is in the Middle River watershed, in Hopkins Creek. The weighted composite map shows that the Gwynns Falls watershed has the highest risk of environmental justice issues related to water quality by area.

In order to take the most up to date data into account within the assessment method, the data layers used in this model should be updated as new data becomes available, such as the 2010 Census Data. New data sets related to public health and community engagements may also strengthen the model in the future.

Baltimore County plans to utilize this composite map in their Small Watershed Action Plans (SWAPs) in order to prioritize watershed restoration work in locations where those actions may also promote environmental justice.

While this model focuses on EJ as it relates to water quality, ideally this mapping will feed broader efforts to ensure environmental justice in Baltimore County and City.

Figure 3.1. Top 5 Watersheds with High Percentage of EJ Risk

RANK	WATERSHED	SUBWATERSHED	% HIGH EJ RISK
1	Baltimore Harbor	Clements Cove	86.39
2	Gwynns Falls	Powder Mill Run	72.94
3	Gwynns Falls	Scotts Level	70.23
4	Middle River	Hopkins Creek	69.59
5	Gwynns Falls	Dead Run	62.38

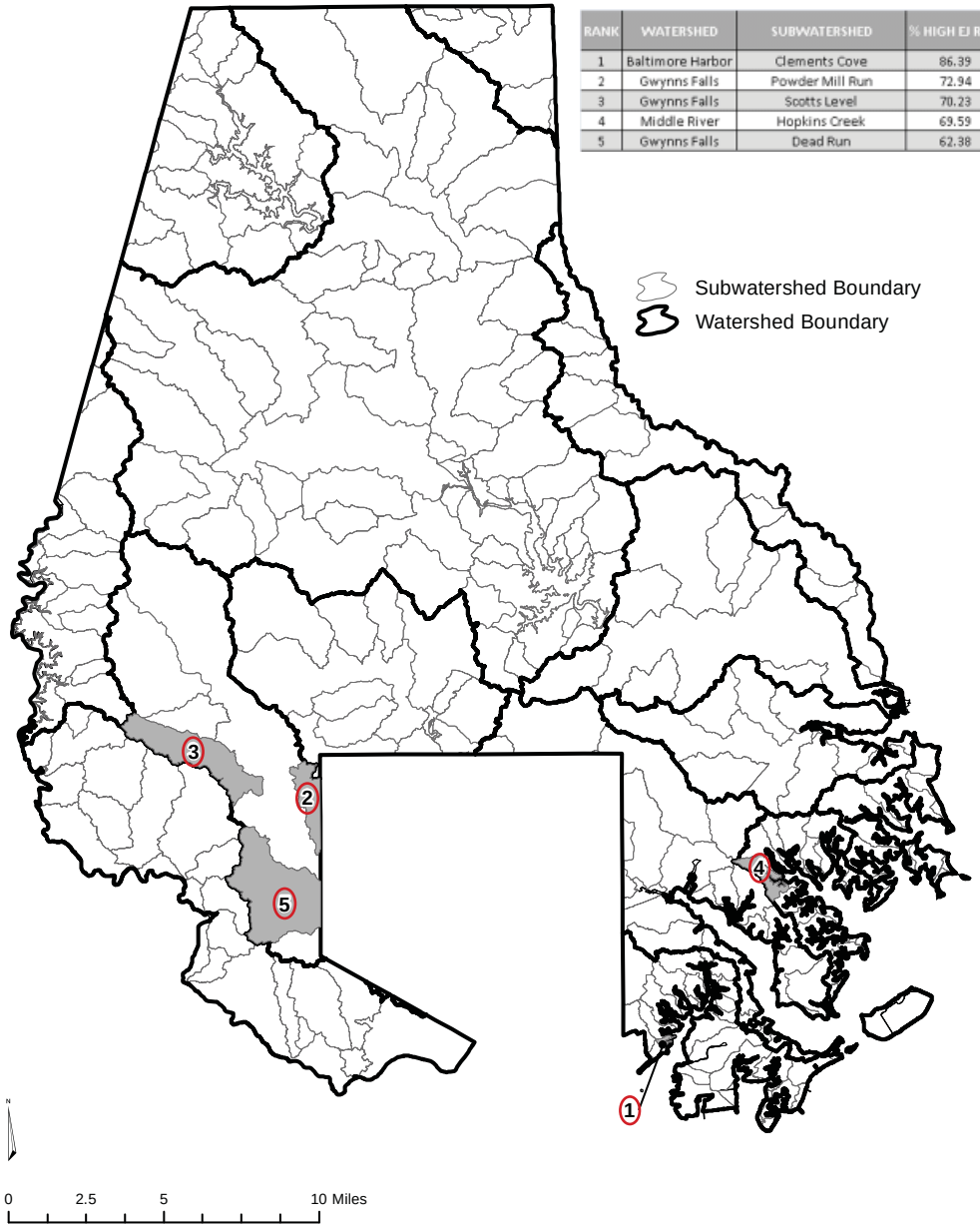


Figure 3.2. Weighted Composite Map

Weighted Composite = 0.125 (Minority/area) + 0.125 (%Minority) + 0.125 (Poverty/area) + 0.125 (%Poverty) +0.14 (Bacteria TMDL, 303d) + 0.14 (Toxics TMDL, 303d)+ 0.025 (SSO Volume) + 0.025 (SSO Frequency) + 0.05 (Impervious) + 0.05 (Outfalls) + 0.05 (Hot Spots) + 0.02 (Tree Canopy)

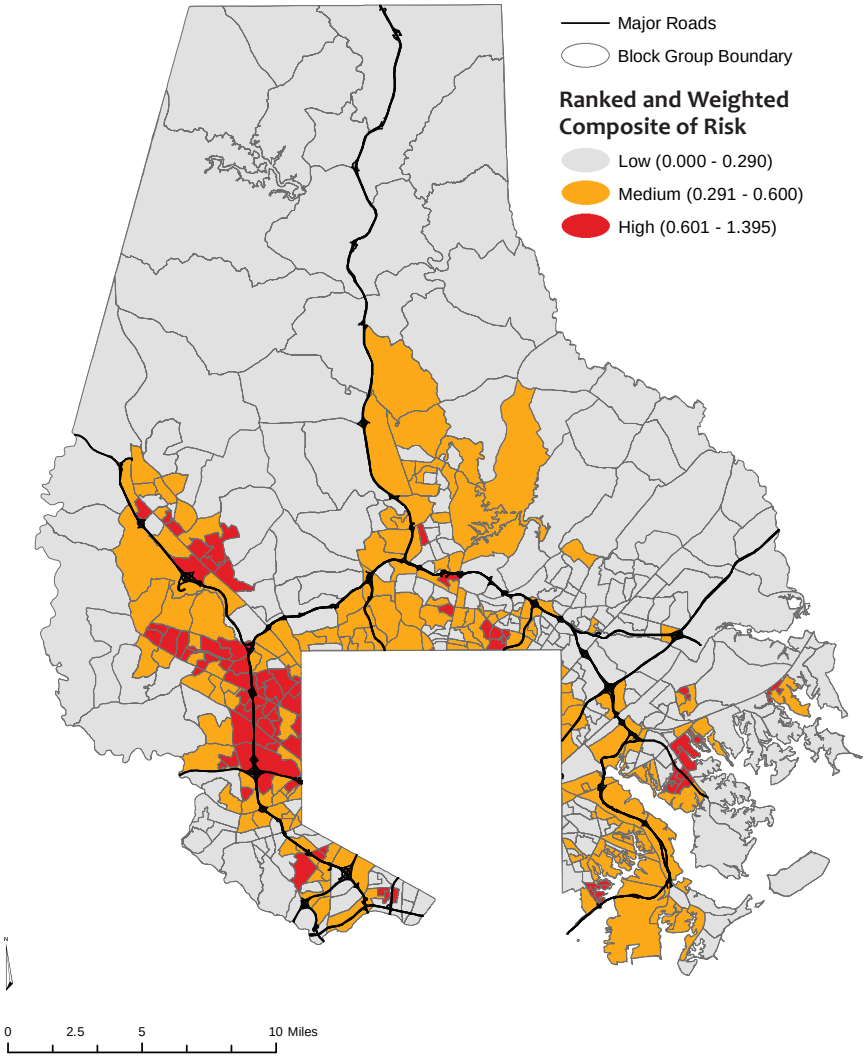
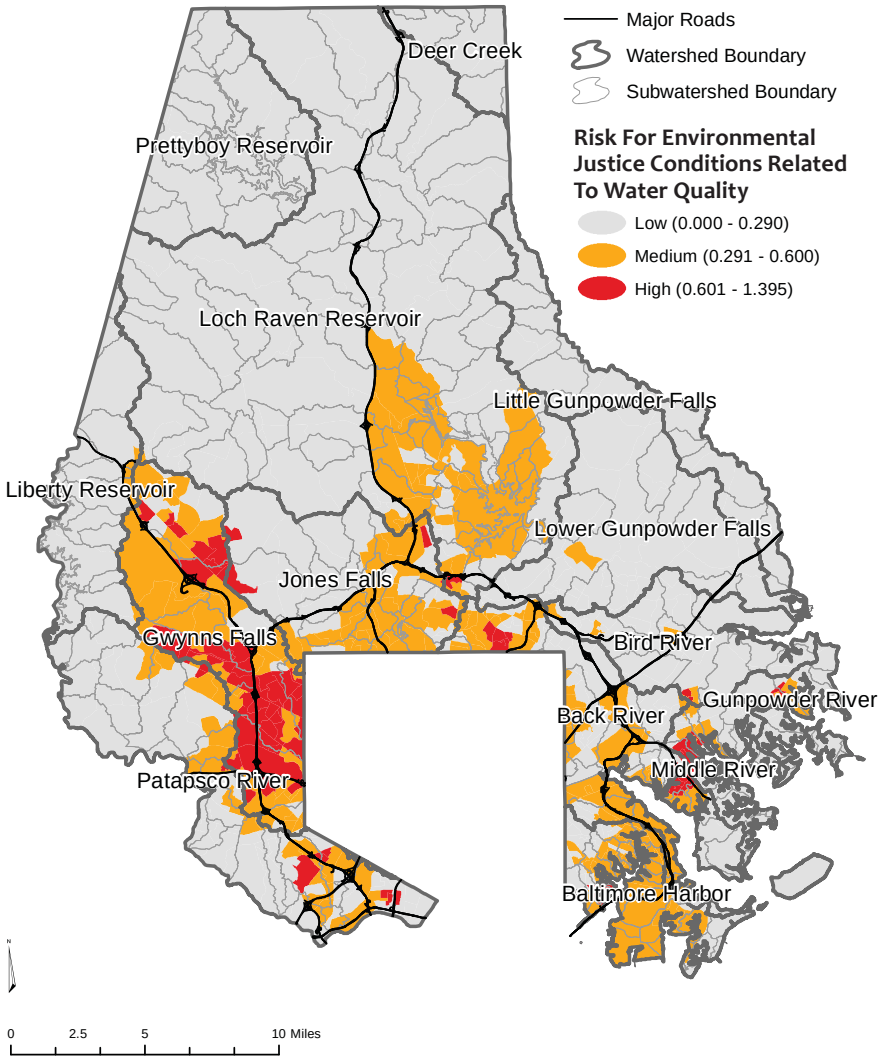


Figure 3.3. Weighted Composite Map, with watersheds and subwatersheds. Map shows communities at risk for environmental justice conditions related to water quality.

Weighted Composite = 0.125 (Minority/area) + 0.125 (%Minority) + 0.125 (Poverty/area) + 0.125 (%Poverty) +0.14 (Bacteria TMDL, 303d) + 0.14 (Toxics TMDL, 303d)+ 0.025 (SSO Volume) + 0.025 (SSO Frequency) + 0.05 (Impervious) + 0.05 (Outfalls) + 0.05 (Hot Spots) + 0.02 (Tree Canopy)



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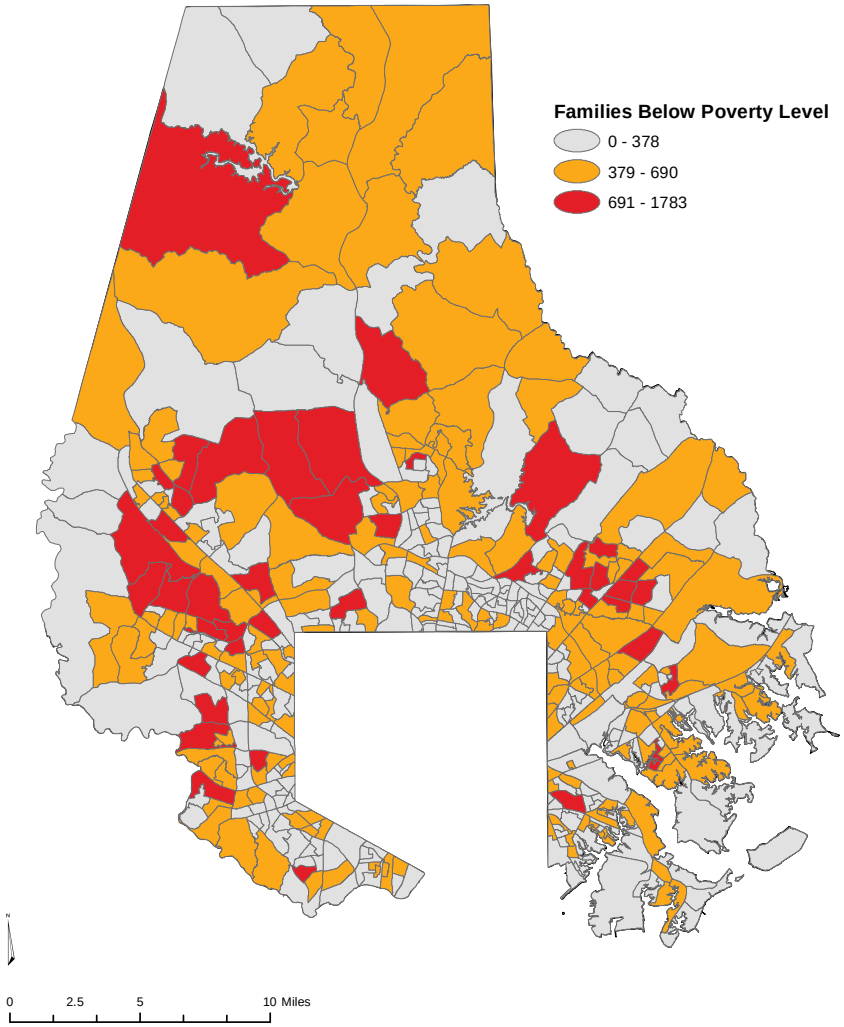
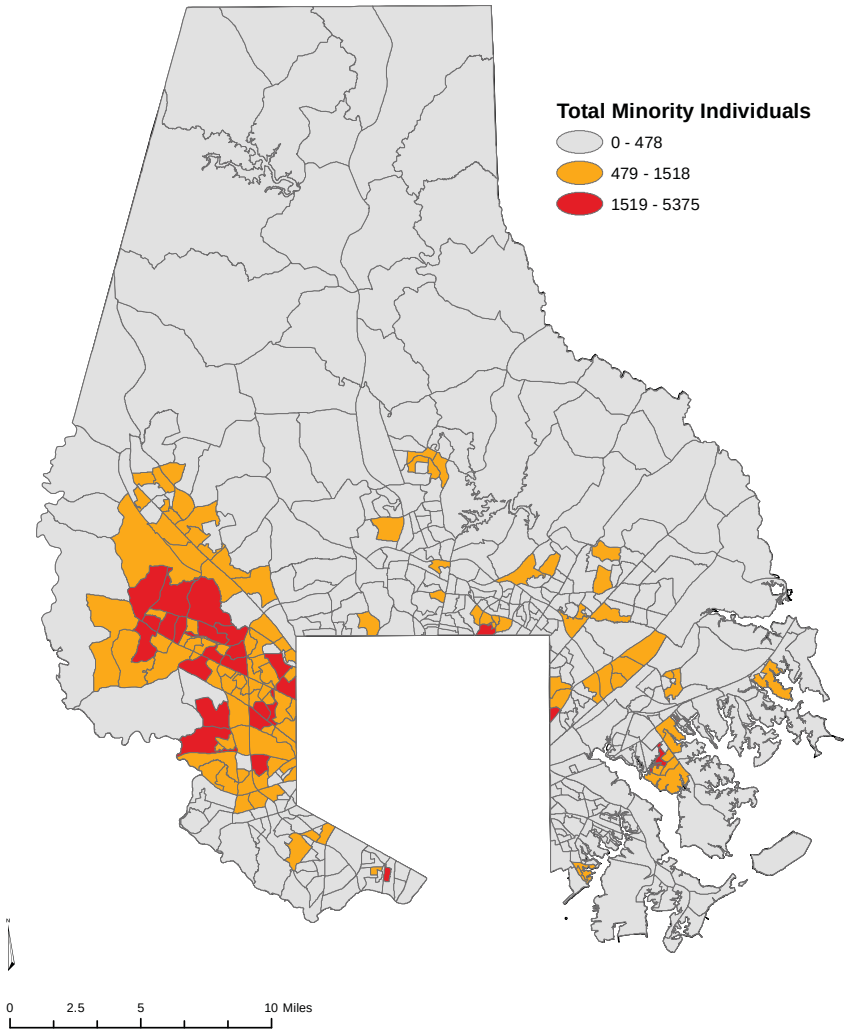
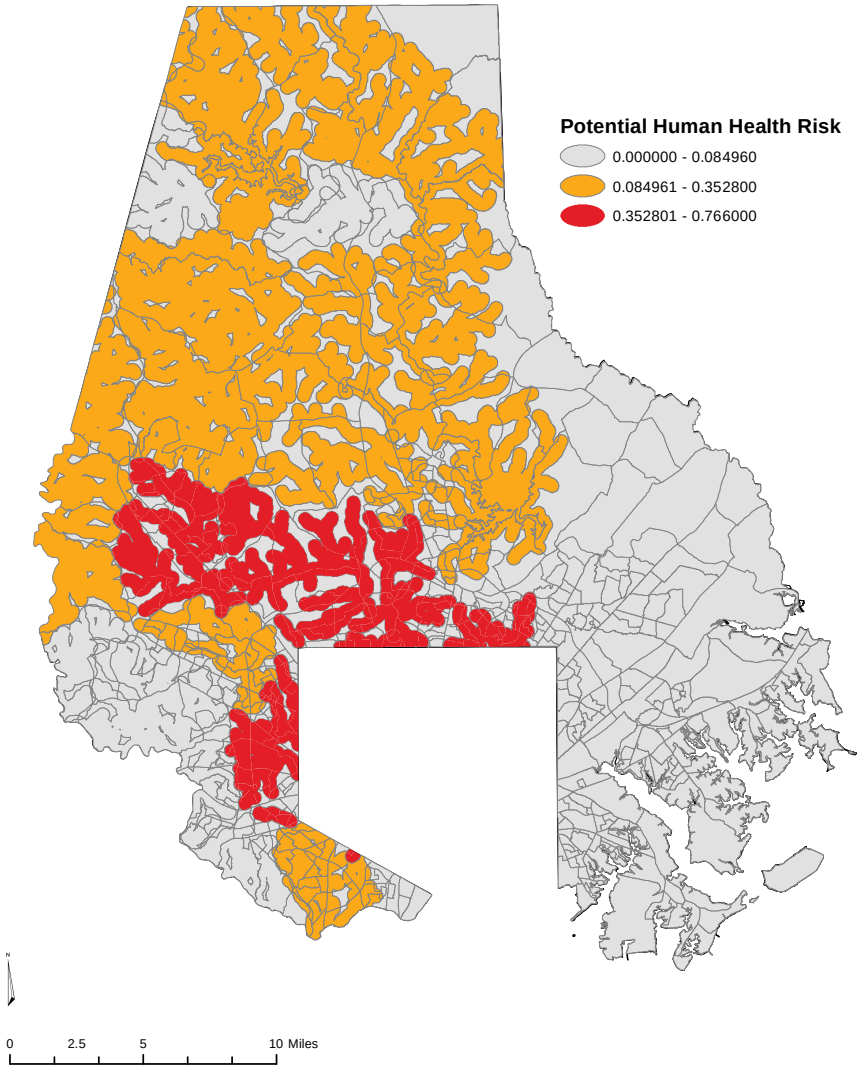
Total Families with Income Below Poverty Level



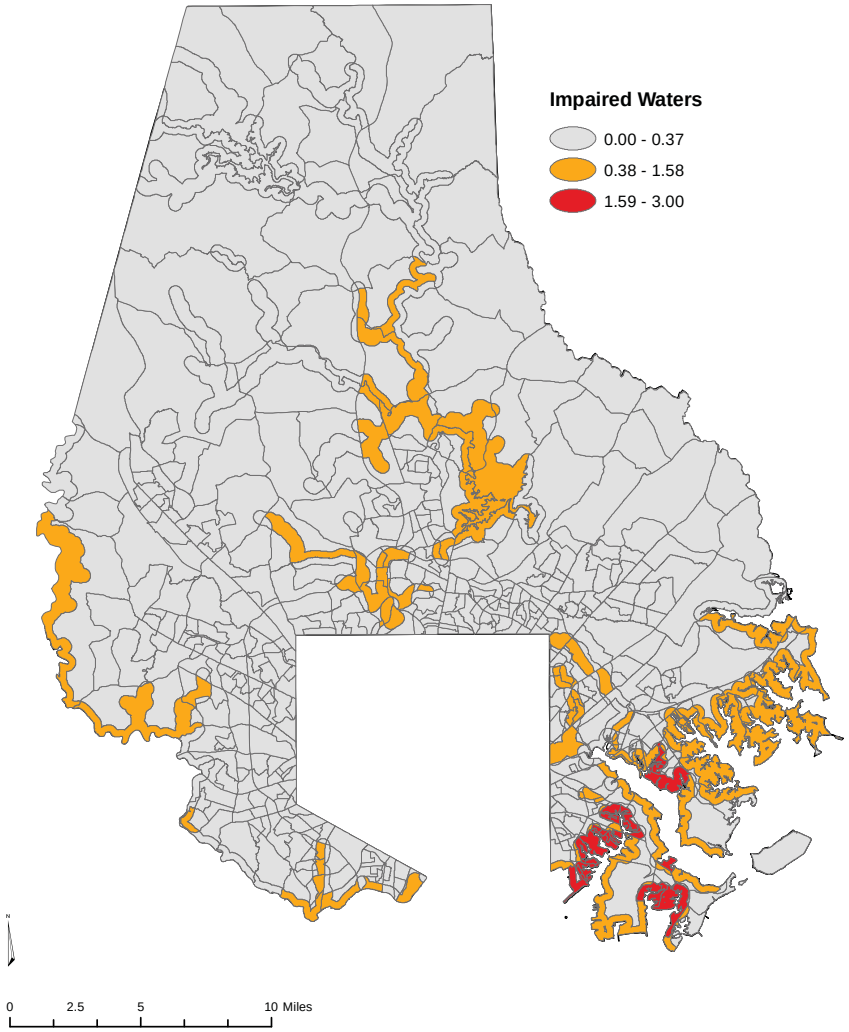
Minority Individuals within a Block Group



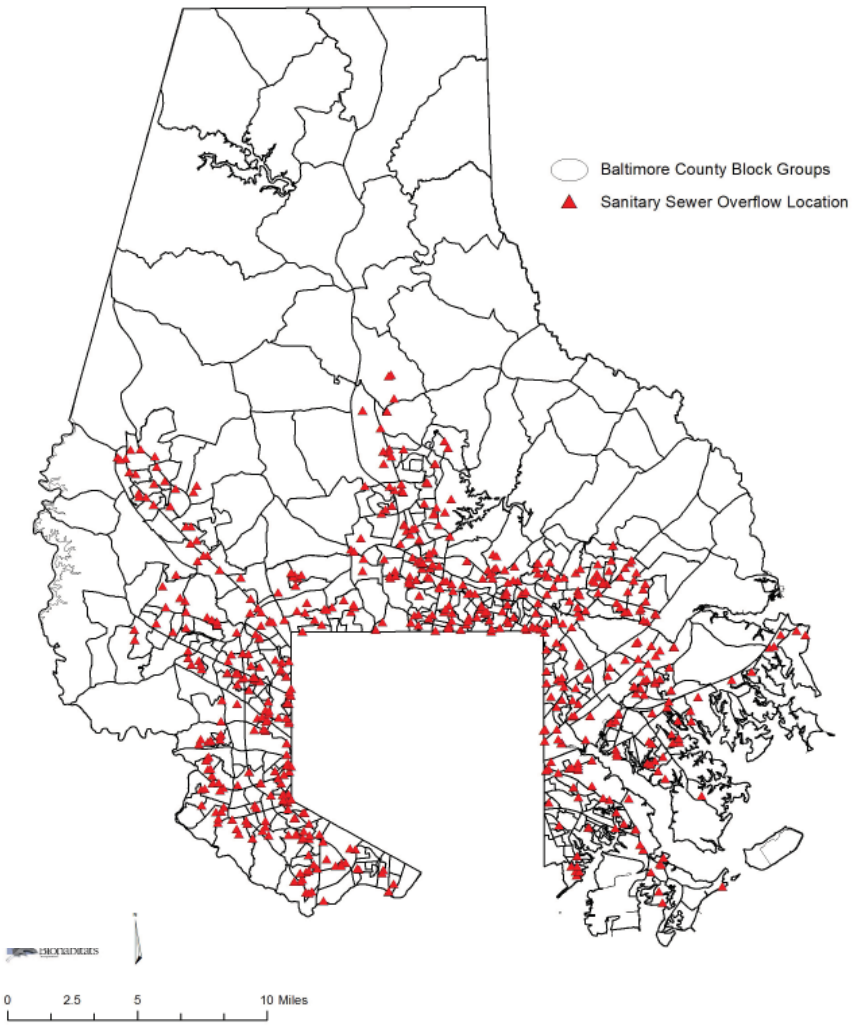
Human Health Risk: Bacteria



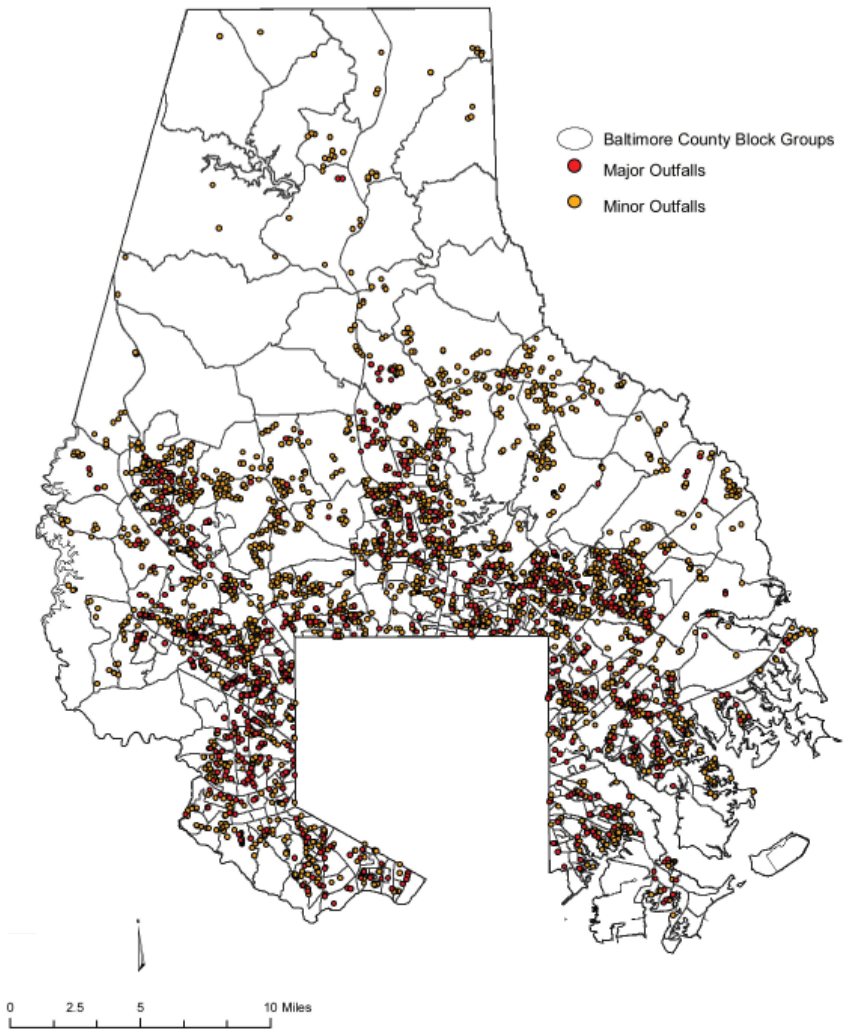
Human Health Risk: Toxics



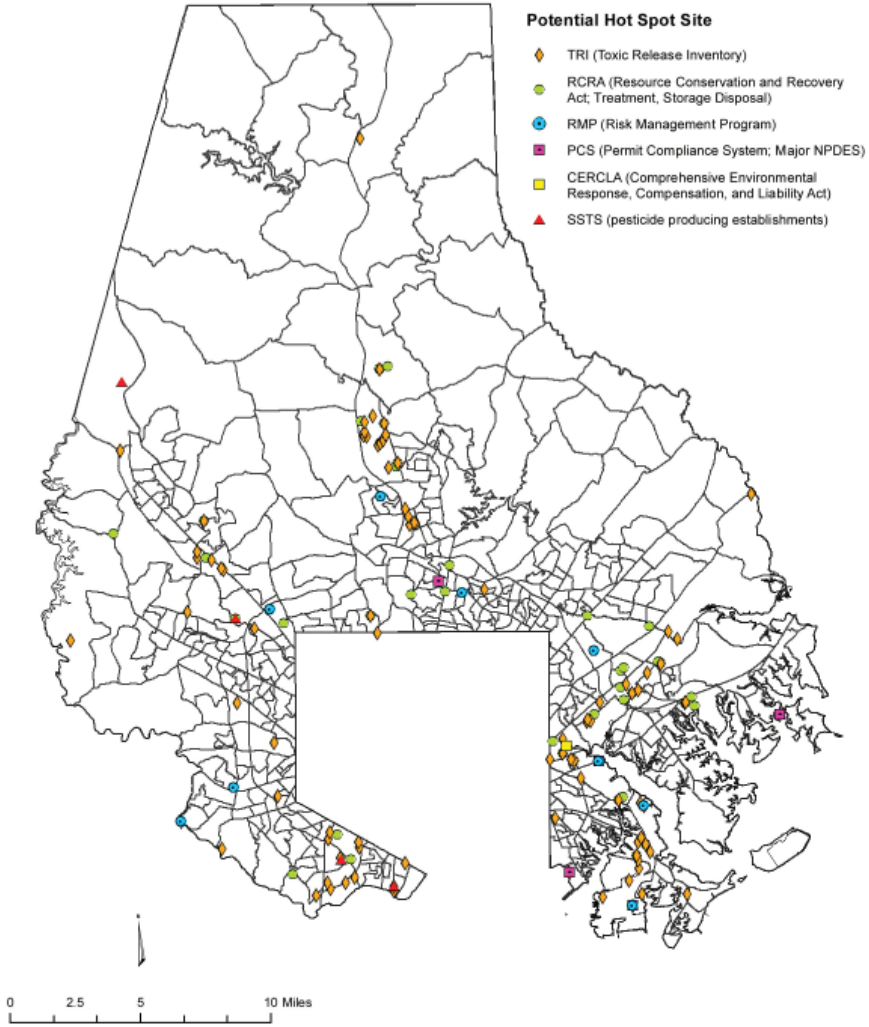
Sanitary Sewer Overflows



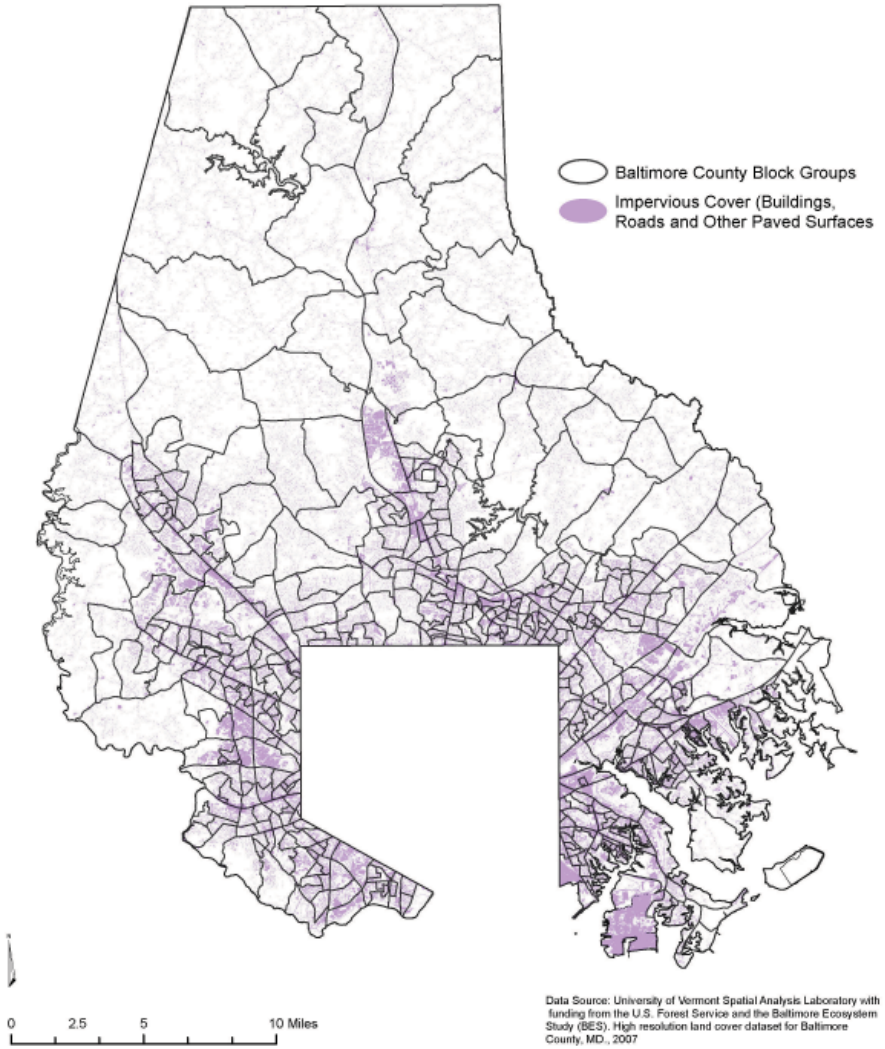
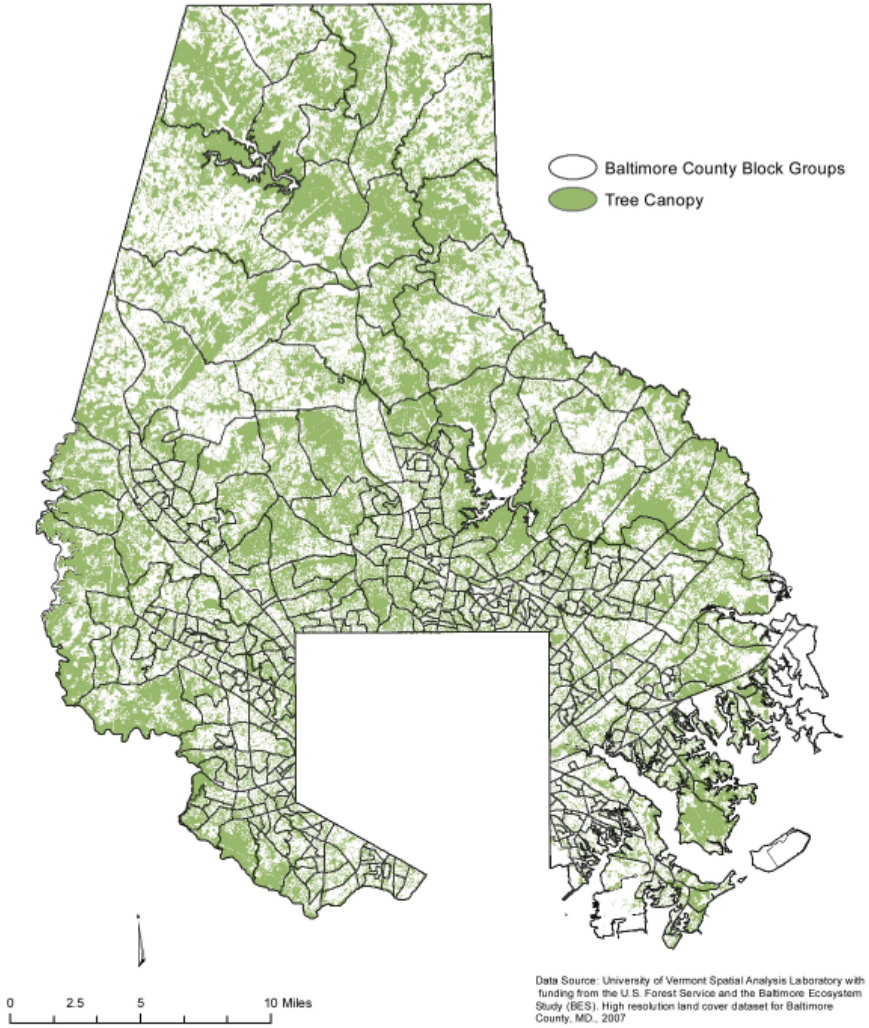
Outfall Site Locations



Potential Hot Spot Locations



Land Cover: Impervious Cover



Land Cover: Tree Canopy