



**DOW SUSTAINABILITY FELLOWS**  
UNIVERSITY OF MICHIGAN



# **Impact of Solar Arrays on Water Quality and Options for Mitigation**

By Praneet Chotalia, Raisa Faatimah, Gavin Silveira, & Jessie Williams

Project Partner: Friends of the Shiawassee River (FOSR)

Dow Sustainability Fellows Final Report

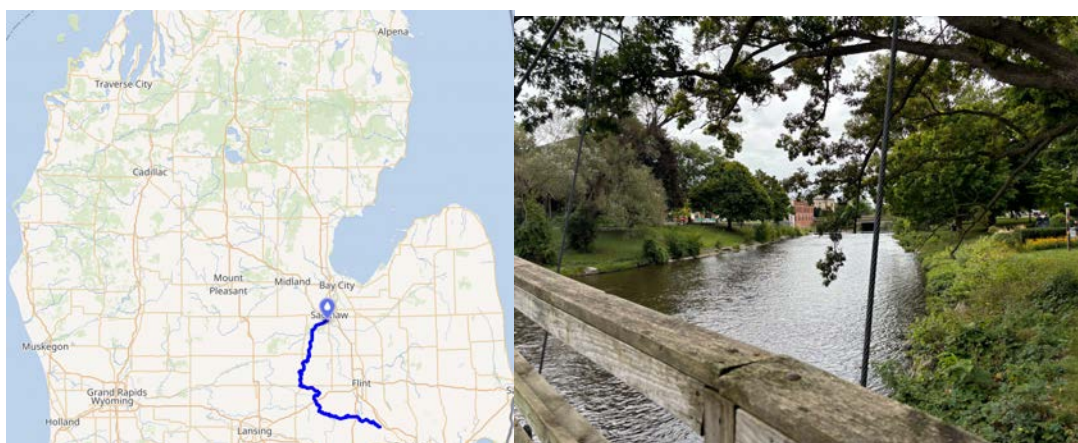
2024

# Table of Contents

<b>Executive Summary .....</b>	<b>3</b>
<b>Introduction and Background.....</b>	<b>5</b>
<b>Methods .....</b>	<b>7</b>
Phase 1: Literature Review.....	7
Site Visit & Stakeholder Engagement.....	7
Phase 2: Analysis and Modeling.....	8
Modeling Team: PhotoVoltaic Stormwater Management and Testing (PV-SMaRT) .....	8
Policy Team: Local- and State-Level Policy Analysis .....	10
<b>Deliverables.....</b>	<b>11</b>
Initial Literature Review.....	11
Modeling Deliverables .....	11
Policy Deliverables.....	13
<b>Recommendations and Opportunities.....</b>	<b>18</b>
<b>Impact .....</b>	<b>19</b>
<b>Acknowledgements .....</b>	<b>21</b>
<b>References .....</b>	<b>22</b>
<b>Appendix .....</b>	<b>23</b>

# Executive Summary

Our Dow Fellows team worked with the mid-Michigan nonprofit environmental protection organization Friends of the Shiawassee River (FOSR), headquartered in Owosso, MI. FOSR’s mission is to “help care for, share, and enjoy the Shiawassee River,” as they continually work to provide “educational resources and activities related to watershed conservation.”<sup>1</sup> The Shiawassee River is a 110 mile-long river, spanning six mid-Michigan counties, and fed by groundwater and runoff sources from over 809,000 acres.<sup>2</sup> The river provides habitat for wildlife, fish, and macroinvertebrates, with several wildlife and game refuges, and also provides recreational opportunities through the Shiawassee River Water Trail.



*Image 1: A map of the Shiawassee River in the context of the Lower Peninsula of Michigan.*<sup>3</sup>

*Image 2: The Shiawassee River as it runs through downtown Owosso, MI.*<sup>4</sup>

Within a landscape of increased utility-scale solar utilization in Shiawassee County and mid-Michigan, FOSR and other environmental organizations have raised concerns about the stormwater impacts of utility-scale solar on the Shiawassee River and bodies of water more generally. There is a current lack of information on the overall stormwater impact of large-scale solar installations. With recent changes in Michigan legislation for permitting of major solar projects (Public Acts 233 and 234 of 2023), which allow developers to receive permits for their projects through the state-level Michigan Public Service Commission (MPSC) under certain

---

<sup>1</sup> “About the Friends.” *Friends of the Shiawassee River*. <https://shiawasseeiver.org/about-the-friends>.

<sup>2</sup> “2015 Shiawassee River Watershed Biosurvey Monitoring Report.” *Michigan Department of Environmental Quality* (2016). <https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/GLWARM/Monitoring-Watershed/Biosurvey/report-2015-shiawassee.pdf?rev=5edb2918e1d543369f1b0fff20e101bb>.

<sup>3</sup> “Shiawassee River.” *Wikipedia*. [https://en.wikipedia.org/wiki/Shiawassee\\_River](https://en.wikipedia.org/wiki/Shiawassee_River). Accessed Dec. 5, 2024.

<sup>4</sup> Photo taken September 9, 2024 by Dow Fellows team member.

conditions, the responsibility for solar stormwater management is unclear. As recent legislative changes will lead to an increase in solar siting, the goals of our project were as follows:

- 1) To model and summarize the forecasted stormwater impacts of industrial-scale solar development for the Shiawassee County region;
- 2) To clarify the entities and processes responsible for regulation of stormwater in solar energy developments in Michigan post-PA 233.

Our interdisciplinary Dow Fellows team included two engineering students; one law student; and one dual-degree law and urban planning student. Utilizing backgrounds in modeling and forecasting, renewable energy, legislative research and analysis, local and state land use regulation, and local land use regulation and planning, our team aimed to investigate these questions in two sub-groups: the modeling team and the policy team.

The **modeling team** used PV SMaRT modeling software to calculate site-specific runoff for utility-scale solar installations in the Shiawassee River watershed. Inputting data on land cover, precipitation, and site characteristics from USDA soil databases, the model forecasted runoff patterns post-installation. Hypotheses based on stormwater data suggested potential runoff increases due to soil compaction during site preparation, with runoff being particularly sensitive to Bulk Density values. These findings can help to guide best management practices on solar sites, and approaches to mitigate adverse impacts on water quality and watershed health, key concerns for regulatory and non-regulatory policy options.

The **policy team** reviewed PA 233 statutory language and draft siting guidelines, existing literature on the renewable energy siting framework in Michigan and other states, state and administrative guidance, and pre-existing statutes. The team found that under PA 233, stormwater mitigation may be accomplished at either the state or local levels, depending on the body permitting the project.<sup>5</sup> At the state level, stormwater and environmental review of large-scale solar projects are considered by the state-level Michigan Public Service Commission (MPSC) in siting conditions, with county drain commissioner review also required. Additionally, general state-level environmental rules and requirements apply regardless of state or local siting, through Michigan's Natural Resources and Environmental Protection Act (NREPA) and PA 116 farmland preservation statute. At the local level, local regulators may wish to adopt (or may have) ordinances that have reasonable stormwater mitigation standards but would likely be deemed workable by a developer. These standards may include vegetative groundcover, soil compaction, and site restoration standards. Even if solar siting is elected at the state level, local stakeholders may wish to engage in collaborative alternatives and conversations with energy developers to address concerns. These conversations may be informed by the land use and

---

<sup>5</sup> This information is provided for educational purposes only and should not be interpreted as legal advice. Interested stakeholders are encouraged to consult with an attorney.

watershed planning work of specialized governmental bodies (e.g., conservation districts) and non-governmental organizations with a focus on environmental protection such as FOSR.

## Introduction and Background

An emphasis on renewable energy in Michigan has been driven by desires to lower carbon emissions and increase energy independence within the state. The state has set ambitious renewable energy goals, aiming to have 100% of its energy sourced from renewable methods by 2040; as of 2024, the state has met its current goal of 15% of its energy sourced from renewable methods.<sup>6</sup> To meet the State of Michigan’s renewable energy goals, increased construction of renewable energy facilities within the State will be expected; recent land use policy changes have attempted to increase the feasibility of siting renewable energy projects.

PA 233 of 2023 (“PA 233”) creates a state-level pathway for siting large-scale solar projects, bypassing local governments’ traditional land use regulatory authority.<sup>7</sup> Michigan has many municipal governments, each with individual land use regulations and plans. At times, large solar projects span multiple township, village, and county governments, which may have differing regulations. PA 233 allows a developer (or “applicant”) to circumvent a local ordinance that is stricter than the state level and obtain approval at the state level. If developers elect the state-level process, the project will be evaluated by the Michigan Public Service Commission (MPSC), the body responsible for permitting public utilities.<sup>8</sup> As PA 233 does not require projects to be sited through the state, the developer may still choose to work under a local ordinance. Therefore, the state siting pathway will be of most importance in governments where, a) a landowner or developer seeks to develop a large-scale solar site, b) the local government does not have a Compatible Renewable Energy Ordinance, and c) the applicant finds one or more local ordinances regulating solar siting to be unworkable for siting their project.

Impactful rainfall and flooding events are occurring more frequently in general, as experienced in Shiawassee County. The county’s Hazard Mitigation Plan reflects that there have been 4 major flooding events between 1994-2016.<sup>9</sup> These flooding events result in adverse effects on property owners, including property and road damage, diminished quality for bodies

---

<sup>6</sup> “MI Healthy Climate Plan,” Michigan Department of Environment, Great Lakes, and Energy. <https://www.michigan.gov/egle/about/organization/climate-and-energy/mi-healthy-climate-plan>. Accessed Dec. 5, 2024.

<sup>7</sup> PA 233 of 2023, § 222(2).

<sup>8</sup> “Michigan Public Service Commission.” <https://www.michigan.gov/mpsc>. Accessed Dec. 5, 2024.

<sup>9</sup> Shiawassee County Local Hazard Mitigation Plan (August 2024), <https://shiawassee.net/wp-content/uploads/2024/09/Shiawassee-County-Local-Hazard-Mitigation-Plan-August-2024.pdf>. Accessed Dec. 5, 2024.

of water, erosion, and loss of topsoil. As the Shiawassee River is groundwater-fed, this makes it particularly vulnerable to pollution and adverse effects from increased runoff.<sup>10</sup>

Stormwater impacts and runoff may be mitigated through adaptations. Other states have addressed concerns about stormwater impacts from solar development, finding solutions to address runoff concerns. The following best practices are a baseline of recommendations by the Wisconsin Department of Natural Resources: vegetation under and between solar panel modules to a 70% density; a distance between the lowest point of any panel and the ground not greater than 10 feet; maintaining groundwater at least 12 inches below the proposed grade, which may require repair or replacement of drain tile; a ground slope of not steeper than 20%; flow from the panels to a well-vegetated area; a plan to mitigate soil compaction is established; runoff from outside is kept out of the solar array area.<sup>11</sup> These practices serve as examples of goals for mitigation on large-scale solar projects.

Measures like PV-SMaRT and other forecasting (including by developers) can aid in estimates of stormwater impact. Under PA 233, there are policy options at the local and state levels to address stormwater impacts resulting from utility-scale solar development: through regulation, recommendation, and non-governmental organization and community involvement in the siting process. The PV-SMaRT (Photovoltaic Stormwater Management Research and Testing) initiative provides essential tools and insights for mitigating stormwater runoff impacts from solar developments. Central to its effort is the development of a user-friendly runoff calculator based on extensive modeling and data from various solar farms across the U.S. This tool integrates factors such as soil texture, bulk density, depth, vegetation, and panel spacing to forecast stormwater behavior. These projections help stakeholders, including developers and policymakers, address site-specific runoff challenges and implement tailored strategies that improve water quality while maintaining solar project sustainability.

---

<sup>10</sup> “However, it [is] still negatively affected by several dams and from runoff contaminated by excess sediment, fertilizer, city storm drainage, and trash. ... [T]he Shiawassee River is considered one of the healthiest warm-water rivers in Michigan (a warm-water river is *fed mostly from surface runoff*, thereby causing mild temperatures)” (emphasis added). “Shiawassee River History,” *Friends of the Shiawassee River*. <https://shiawasseeiver.org/History>. Accessed Dec. 5, 2024.

<sup>11</sup> “Bureau of Watershed Management Program Guidance Post-Construction Storm Water Management Options for Ground-Mounted Solar Array,” Wisconsin Department of Natural Resources (February 2024), <https://apps.dnr.wi.gov/water/wsSWIMSDocument.ashx?documentSeqNo%3D356830879&sa=D&source=docs&us t=1733447416054372&usg=AOvVaw1xu7txsQvknJp0I500q19a>.

# Methods

The Friends of the Shiawassee River Dow Fellows team sub-divided into two sub-groups based on prior knowledge, areas of academic and research interest, and expertise. The **modeling** team, composed of the team’s two engineering students, focused on the question of modeling the forecasted stormwater impacts for industrial-scale solar development for the Shiawassee County region, based on site-specific soil information. The **policy team**, composed of the team’s two law students, focused on identifying the state- and local-level entities and processes responsible for management of stormwater in solar energy developments in Michigan post-PA 233.

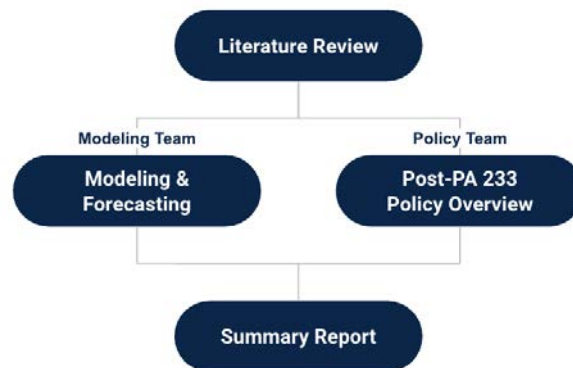


Figure 1: A description of the Dow Fellows team’s work delegation and deliverable process.

## Phase 1: Literature Review

The modeling literature review was based on the assumption that ground-mounted solar arrays impact water flow by changing soil compaction, panel spacing, and vegetation. To meet project goals, we reviewed studies using hydrological models like EPA-SWMM<sup>12</sup> and Hydrus-3D<sup>13</sup> to estimate runoff and water absorption. We focused on studies that included factors such as rainfall, soil type, and terrain. By analyzing differences in water flow before and after solar panels are installed, we highlighted the importance of features like panel gaps<sup>14</sup> and the benefits

<sup>12</sup> Gullotta, A., & Peres, D. J. (2023). Modeling stormwater runoff changes induced by ground-mounted photovoltaic solar parks: A conceptualization in EPA-SWMM. *Water Resources Management*, 37(11), 4507–4520. <https://doi.org/10.1007/s11269-023-03572-3>

<sup>13</sup> Mulla, D. J., Galzki, J., Hanson, A., & Šimůnek, J. (2024). Measuring and modeling soil moisture and runoff at solar farms using a disconnected impervious surface approach. *Vadose Zone Journal*, 23(4), e20335. <https://doi.org/10.1002/vzj2.20335>

<sup>14</sup> Cook, L. M., & Wasko, C. (2023). Hydrologic response of solar farms to storm events: A simulation-based analysis. *Journal of Hydrologic Engineering*, 18(5), 678–690. [https://doi.org/10.1061/\(ASCE\)HE.1943-5584.0000530](https://doi.org/10.1061/(ASCE)HE.1943-5584.0000530)

of maintaining vegetation to reduce runoff.<sup>15</sup> Sensitivity tests across different slopes and weather patterns showed the need to adjust designs to fit specific site conditions. This clear, step-by-step approach provides a reliable method to understand and manage stormwater for solar farms.

The policy literature review was based on the assumption that other states have existing renewable energy siting schemes designed similarly to Michigan's new scheme under PA 233. PA 233 is a "preemptive" scheme, meaning that state authority may displace local authority under certain circumstances. Literature reviewed by the policy team included overviews of other preemptive land use siting processes,<sup>16</sup> varying perspectives on renewable energy siting within local political and administrative environments,<sup>17</sup> balancing the public good with local land use regulatory authority,<sup>18</sup> the composition of typical state and local government renewable energy siting regulations,<sup>19</sup> and other recently-enacted preemptive state statutes.

## Site Visit & Stakeholder Engagement

On September 20, 2024, the project team conducted a site visit, organized by Friends of the Shiawassee River, to the Assembly Solar site, Michigan's largest utility-scale solar installation. Assembly Solar located in Lennon, MI. The team met with the operation and maintenance manager of the site, accompanied by local stakeholders in Shiawassee County. This gave the team an opportunity to ask questions directly regarding the environmental management of the solar farm, current stormwater conditions, adaptations to changes in weather conditions and rainfall, and to conduct observations necessary for model calculations (such as vegetation / soil type, array configuration, etc.).

---

<sup>15</sup> Bajehbaj, R. Y. (2023). Minimizing environmental impacts of solar farms: A review of current science on landscape hydrology and guidance on stormwater management. *Environmental Research Communications*, 5(4), 045002. <https://doi.org/10.1088/2634-4505/ac76dd>

<sup>16</sup> Kristl, Kenneth T. "Renewable Energy and Preemption: Lessons from Siting LNG Terminals." *Natural Resources & Environment*, vol. 23, no. 3, 2009, pp. 58–60. JSTOR, <http://www.jstor.org/stable/40925026>.

<sup>17</sup> Engelman, Alexa Burt. "Against the Wind: Conflict over Wind Energy Siting." *Environmental Law Reporter News & Analysis*, vol. 41, no. 6, June 2011, pp. 10549-10566. HeinOnline, <https://heinonline.org/HOL/P?h=hein.journals/elrna41&i=572>.

<sup>18</sup> Ostrow, Ashira. (2011). "Process Preemption In Federal Siting Regimes." 48 *Harv. J. on Legis.* 289. [https://scholarlycommons.law.hofstra.edu/faculty\\_scholarship/607](https://scholarlycommons.law.hofstra.edu/faculty_scholarship/607).

<sup>19</sup> McElfish, J. M., & Gersen, S. (2011). *State Enabling Legislation for Commercial-Scale Wind Power Siting and the Local Government Role*. Environmental Law Institute. <https://www.eli.org/research-report/state-enabling-legislation-commercial-scale-wind-power-siting-and-local-government>.



*Image 3: An on-site photo from the site visit to Assembly Solar, Michigan's largest utility scale solar farm located in Lennon, MI, with a capacity of 339 MW.*

### **Meeting with Stakeholders**

Following the site visit, our team had the opportunity to speak to critical stakeholders in Shiawassee County and surrounding areas through a meeting arranged by our community partner, Friends of the Shiawassee River. We were joined by Tony Newman, the county drain commissioner as well as representatives from the St. Clair River Watershed, Shiawassee County Conservation District, and Shiawassee County Health Department. The team's Dow Fellows Mentor, Dr. Amy Beasley of Dow Corporation, also attended. The team began by providing an overview of the scope of our project and research interests; the primary purpose was to understand the local needs and perspectives of stakeholders and community members.

The discussion highlighted a range of concerns and opportunities surrounding solar developments and stormwater management in Shiawassee County and other communities expecting an increase in solar development. Key concerns included challenges with the local ability to regulate solar developments, understanding and managing environmental impacts, adverse noise impacts on neighbors, effects on public health, macroinvertebrate and pollinator health, and invasive vegetation management. Practical challenges included coordinating permitting across townships, managing heavy clay soils prone to flooding, and balancing agricultural land preservation with renewable energy goals. Stakeholders emphasized the need for comprehensive soil and water testing, noise management, innovative soil health strategies, and vegetation management, including livestock integration.

Some stakeholders also expressed uncertainty regarding state-level permitting under PA 233, particularly due to the uncertainty of diminishing local control. From this conversation, the team realized several needs, including the need to specifically clarify the regulatory options available to local governments under the framework of PA 233. By understanding both regulatory and non-regulatory approaches available within the constraints of PA 233, local

communities (both regulators and community members) can engage in collaborative opportunities for stormwater management, and maintain community goals.

## Phase 2: Analysis and Modeling

After completing the literature review, next steps were completed in sub-groups. The policy team worked to compile a policy analysis of Michigan statutes relevant to solar siting and environmental regulation (e.g., PA 233 and the MPSC’s draft permitting guidelines; PA 116; the Natural Resources and Environmental Protection Act) and remaining local options for regulation and collaboration. Concurrently, an engineering model (PV-SMaRT) was used to simulate and forecast the stormwater runoff of solar farms using site specific data. The aim was to determine the range of soil erosion and water runoff to be expected in Shiawassee County with the increase in utility-scale solar installations, which can subsequently inform local policy.

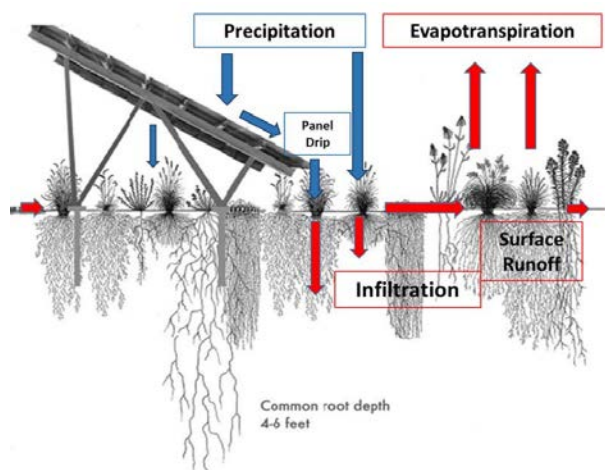


Figure xx: Graphical representation of pathways of rainfall after impacting a solar array (water cycle)<sup>20</sup>

### Modeling Team: PhotoVoltaic Stormwater Management and Testing (PV-SMaRT)

PV-SMaRT was developed by the University of Minnesota in collaboration with the National Renewable Energy Laboratory (NREL), the Great Plains Institute, and Fresh Energy and is aimed to address the challenges posed by stormwater runoff at large utility scale solar,

<sup>20</sup> PV-SMaRT Case Study Presentation — Dr. David Mulla, University of Minnesota

enhancing runoff accuracy, and reducing regulatory issues. The license for the model was obtained by the Dow Fellows team with permission from the University of Minnesota.<sup>21</sup>

The model has the following assumptions relevant to Shiawassee County:

- 1) Soils are uniform throughout the profile
- 2) Solar panels are 45 degrees tilted
- 3) Soil is free of snow and frost, with uniform vegetation (or lack of)
- 4) The effects of drain tiles beneath the soil are not considered

Assumption (3) implies that the analysis is only valid during the months of the year that the ground is not frozen. In Michigan, we have assumed that this is from April to September of each year. Soil runoff and erosion is not usually a concern during winter, but may have significant negative outcomes during periods of ice melt (warm spells and spring) since soil runoff is exacerbated during thaw periods when the ground is still frozen.<sup>22</sup>

PV-SMaRT allows for the estimation of stormwater runoff curve number (CN) and subsequently expected runoff by considering factors such as amount of rainfall hitting the panels, soil texture, soil depth, soil bulk density (a measure of soil compaction), panel dimensions, array spacing, and slope gradients. Each factor plays an important role in determining potential runoff. The goal of this analysis is to determine which are the key factors that local regulatory bodies should consider in Shiawassee County to evaluate stormwater and runoff related environmental concerns during solar farm siting.

---

<sup>21</sup> “Photovoltaic Stormwater Management Research and Testing,” National Renewable Energy Laboratory. <https://www.nrel.gov/solar/market-research-analysis/pv-smart.html>. Accessed Dec. 5, 2025.

<sup>22</sup> [Wunderlin, Aaron, and Laura Paletta. "Bouncing Between Frozen and Thawed." *Journal of Natural Mechanics*, vol. 23, no. 6, 2024, <https://jofnm.com/article-236-Bouncing-between-frozen-and-thawed.html>.]

**Table 1: Minimum, Maximum, and Nominal values for model parameters in Shiawassee County, Michigan**

Parameter	Min	Nominal	Max	Description
Soil Bulk Density ( $g/cm^3$ ) <sup>23</sup>	1.3	1.5	1.8	Weight of soil in a given volume, reflecting soil compaction.
Max Rainfall (1950 - 2024) from April - September (in) <sup>24</sup>	2.62	5.23	10.28	Maximum rainfall recorded
Average Soil Depth (in) <sup>25</sup>	32	38	44	Thickness of soil available for water infiltration and root growth.
Solar Panel Width (ft) <sup>26</sup>	2	5	8	Width of solar panels in feet, affecting rainfall runoff distribution.
Solar Panel Spacing (ft) <sup>27</sup>	15	25	50	Distance between panels, influencing infiltration and runoff patterns.
Slope <sup>28</sup>	0 %	0.25 %	10 %	Steepness of land surface, impacting water flow and potential runoff.

In addition to the parameters in Table 1, the predominant soil type in Shiawassee County was determined to be a mixture of loam (Brookston and Conover). During the team’s site visit to Lennon, MI and observing similar solar farms in the area, there is vegetation present beneath the panels consisting of newly established pollinator vegetation. These plantings play a critical role

<sup>23</sup> Natural Resources Conservation Service. (n.d.). Web Soil Survey. Retrieved from <https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>.

<sup>24</sup> National Centers for Environmental Information. Climate at a Glance: Precipitation. Retrieved from <https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series/MI-155/pcp/1/0/1950-2024>.

<sup>25</sup> Natural Resources Conservation Service. (n.d.). Web Soil Survey. Retrieved from <https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>

<sup>26</sup> Mulla, D. J., Galzki, J., & Hanson, A. (2024). PV-SMaRT Runoff Modeling and Calculator InSPIRE. University of Minnesota.

<sup>27</sup> Mulla, D. J., Galzki, J., & Hanson, A. (2024). PV-SMaRT Runoff Modeling and Calculator InSPIRE. University of Minnesota.

<sup>28</sup> Natural Resources Conservation Service. (n.d.). Web Soil Survey. Retrieved from <https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>.

in stormwater management by improving soil structure, enhancing infiltration, and reducing surface runoff.

Using the above data for Shiawassee County, the team used the PV-SMaRT model to evaluate the sensitivities of the expected soil runoff to each parameter.

## **Policy Team: Local- and State-Level Policy Analysis**

The goal of the policy analysis was to answer the question posed by our project partner: **who is addressing stormwater impacts** for industrial-scale solar in a post-PA 233 regulatory scheme? Policy methods began with a review of PA 233 language to determine what the stormwater-related statutory standards were. Subsequently, as part of the literature review and final report, the policy team reviewed comparable states' renewable energy siting schemes, to see if any had a preemptive scope similar to Michigan's. The policy team also reviewed other states' stormwater regulations and best practices, as related to utility-scale solar energy.

The policy team then began the Phase 2 work of compiling a policy analysis report, summarizing local and state regulatory and non-regulatory options. In an effort to increase clarity and solidify expectations about PA 233, the MPSC has been conducting substantive outreach regarding the PA 233 state-level siting process. This has included webinars, which the policy team viewed to gain more knowledge about the logistics of siting, and particular stormwater-related issues such as drain commissioner review.<sup>29</sup> For reference and deepened understanding, the policy team reviewed educational materials previously created by the Graham Institute's EmPowering Communities initiative.<sup>30</sup> The policy team additionally conducted statutory searches regarding Michigan's existing environmental review statutes and regulations related to groundwater.

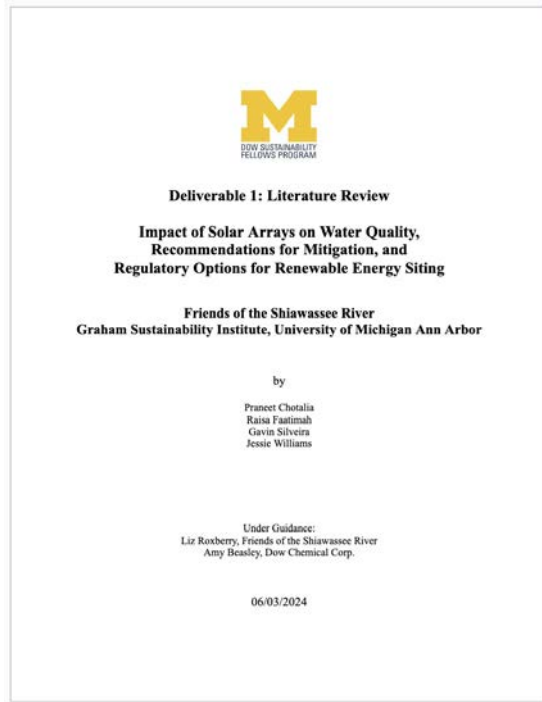
---

<sup>29</sup> "Renewable Energy and Energy Storage Facility Siting," Michigan Public Service Commission, <https://www.michigan.gov/mpsc/commission/workgroups/2023-energy-legislation/renewable-energy-and-energy-storage-facility-siting>. Accessed Dec. 5, 2024.

<sup>30</sup> "Michigan's New Renewable Energy Siting Law," Graham Sustainability Institute, <https://graham.umich.edu/project/MI-energy-siting>. Accessed Dec. 5, 2024.

# Deliverables

## Initial Literature Review



The literature review was the deliverable outcome for the group’s preliminary examination of both stormwater modeling for solar development and preemptive schemes for renewable energy siting across states. As described in the Methods section, the modeling literature review focused on the impact of ground-mounted solar arrays on water flow, including the impacts of soil compaction, panel spacing, and vegetation using hydrological models.<sup>31</sup> The modeling literature review examined studies using rainfall, soil type, and terrain factors, analyzing differences in water flow before and after the installation of solar panels. This led to

---

<sup>31</sup> Gullotta, A., & Peres, D. J. (2023). Modeling stormwater runoff changes induced by ground-mounted photovoltaic solar parks: A conceptualization in EPA-SWMM. *Water Resources Management*, 37(11), 4507–4520. <https://doi.org/10.1007/s11269-023-03572-3>; Mulla, D. J., Galzki, J., Hanson, A., & Šimůnek, J. (2024). Measuring and modeling soil moisture and runoff at solar farms using a disconnected impervious surface approach. *Vadose Zone Journal*, 23(4), e20335. <https://doi.org/10.1002/vzj2.20335>.

certain identified factors, such as panel gaps<sup>32</sup> and vegetation to reduce runoff,<sup>33</sup> and the need to adjust designs to fit specific site conditions.

The policy literature review examined overall preemption, including for comparable states' renewable energy siting schemes designed similarly to Michigan's new scheme under PA 233. Part of the literature review also describes the process for PA 233, based on existing guidance documents. The literature review includes overviews of other preemptive land use siting processes (such as those for liquified natural gas),<sup>34</sup> summaries of renewable energy siting within local political and administrative environments,<sup>35</sup> the impact of land use regulatory authority with potentially locally undesirable land uses,<sup>36</sup> and an analysis of typical provisions which are included in typical state and local government renewable energy siting regulations.<sup>37</sup>

The policy literature review included an examination of comparable states' approaches to stormwater management. Maryland has issued stormwater design guidance for solar panels, which has been implemented by counties including St. Mary's County, which has a Solar Task Force to evaluate and recommend zoning policies and ordinances that facilitate solar while protecting agricultural land. Virginia's Department of Environmental Quality has issued guidelines requiring consideration of panel surfaces in stormwater quality calculations. Pennsylvania maintains stricter vegetative cover requirements than other states; the Pennsylvania Department of Environmental Protection (PA-DEP) requires post-construction sites to maintain at least 90% perennial vegetative cover to prevent erosion, as compared to 70% for other types of developments. North Carolina has additionally issued state-specific guidelines for solar farms within its Stormwater Design Manual, including recommendations to control stormwater runoff.

---

<sup>32</sup> Cook, L. M., & Wasko, C. (2023). Hydrologic response of solar farms to storm events: A simulation-based analysis. *Journal of Hydrologic Engineering*, 18(5), 678–690. [https://doi.org/10.1061/\(ASCE\)HE.1943-5584.0000530](https://doi.org/10.1061/(ASCE)HE.1943-5584.0000530)

<sup>33</sup> Bajehbaj, R. Y. (2023). Minimizing environmental impacts of solar farms: A review of current science on landscape hydrology and guidance on stormwater management. *Environmental Research Communications*, 5(4), 045002. <https://doi.org/10.1088/2634-4505/ac76dd>

<sup>34</sup> Kristl, Kenneth T. "Renewable Energy and Preemption: Lessons from Siting LNG Terminals." *Natural Resources & Environment*, vol. 23, no. 3, 2009, pp. 58–60. JSTOR, <http://www.jstor.org/stable/40925026>.

<sup>35</sup> Engelman, Alexa Burt. "Against the Wind: Conflict over Wind Energy Siting." *Environmental Law Reporter News & Analysis*, vol. 41, no. 6, June 2011, pp. 10549-10566. HeinOnline, <https://heinonline.org/HOL/P?h=hein.journals/elrna41&i=572>.

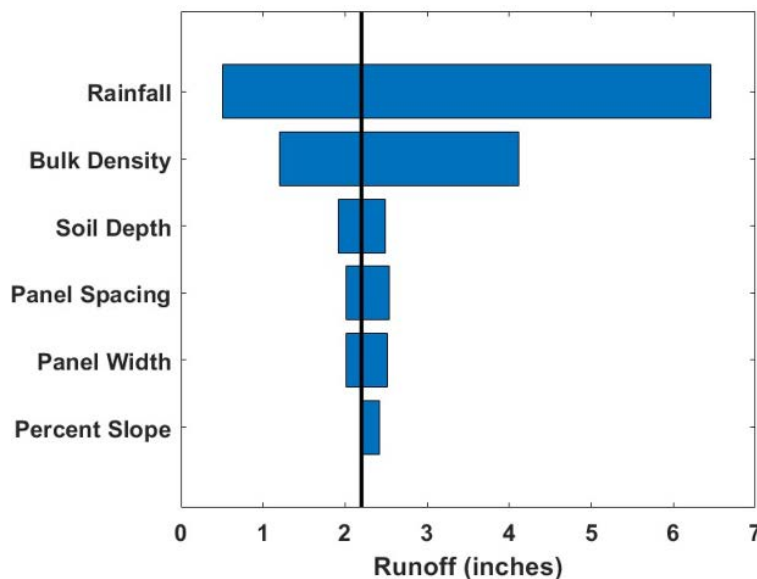
<sup>36</sup> Ostrow, Ashira. (2011). "Process Preemption In Federal Siting Regimes." 48 *Harv. J. on Legis.* 289. [https://scholarlycommons.law.hofstra.edu/faculty\\_scholarship/607](https://scholarlycommons.law.hofstra.edu/faculty_scholarship/607).

<sup>37</sup> McElfish, J. M., & Gersen, S. (2011). State Enabling Legislation for Commercial-Scale Wind Power Siting and the Local Government Role. Environmental Law Institute. <https://www.eli.org/research-report/state-enabling-legislation-commercial-scale-wind-power-siting-and-local-government>.

## Modeling Deliverables

The modeling deliverable focuses on assessing stormwater runoff for utility-scale solar installations in the Shiawassee River watershed. Using PV-SMaRT modeling software, site-specific data on land cover, precipitation patterns, and soil characteristics were analyzed to predict post-construction runoff behavior.

Using the PV-SMaRT model and the site specific parameters listed in Table 1, the nominal expected stormwater runoff was calculated to be 2.2 inches (Figure 2). Varying parameters like historical minimum and maximum values for our Shiawassee site, we can determine the effect of the change to the expected soil runoff. This helps us identify which variable most influence the stormwater behavior and inform management strategies.



*Figure 2: Sensitivity analysis of soil runoff to changes in rainfall, soil density, and other parameters in Shiawassee County, Michigan*

From Figure 2, variation in rainfall has the largest effect on expected soil runoff. This relationship, while seemingly trivial, shows us that in the last 75 years, the expected soil runoff can be as low as 0.51 inches and as high as 6.46 inches (all other parameters being equal). Changing weather conditions, including changing patterns over time, may have a large effect on expected soil runoff as rainfall patterns in Michigan (and the rest of the US) may be disrupted in the future.

Soil bulk density, defined as the ratio of the dry weight of soil to its volume, plays another important role in mitigating (or aggravating) soil runoff and hence erosion. Shiawassee County has predominantly loamy soil (mixture of sand, silt, and clay) which tends to have higher

bulk densities compared to other soil types (that are more sandy).<sup>38</sup> As the soil bulk density increases, the expected runoff increases. Shiawassee County can have a bulk density ranging from about 1.3 - 1.8  $g/cm^3$  which can vary the expected run off from 1.3 inches to 4.1 inches. The increase in runoff with higher bulk density reflects reduced soil infiltration capacity. Bulk density near 1.8  $g/cm^3$  lead to significantly more surface flow, highlighting the need for soil management to control water flow and erosion effectively. However, even the 4.1 inches of water runoff at peak is not a significant number in isolation, as well-drained soils and functional drainage systems can typically manage such runoff without leading to severe erosion.<sup>39</sup>

From the sensitivity analysis, expected variations in soil depth, panel spacing, panel width, and slope do not have a significant effect on soil runoff and have less potential to cause negative stormwater management outcomes. An important note to be considered is that these parameters may influence other important considerations (such as land use, energy intensity, etc.) of the solar farm which are outside the scope of this report.

During solar farm construction, the installation of trenches for electrical wiring and foundations can also disrupt existing drainage tile systems commonly used in agricultural fields like those in Shiawassee County.<sup>40</sup> Drain tiles play a critical role in maintaining soil drainage and preventing waterlogging, particularly in loamy soils prone to compaction. Shifting or damaging these tiles during installation can lead to localized flooding, reduced agricultural productivity in surrounding areas, and altered hydrological patterns that exacerbate runoff into the Shiawassee River. Ensuring that drain tiles are carefully relocated or replaced during construction is vital to maintaining the site's natural drainage and minimizing hydrological disruptions. Post-construction assessments, including drainage system inspections and soil remediation tests, can help verify the effectiveness of these measures.

The modeling deliverables highlight the pressing challenges of soil compaction and drainage tile disruption during solar farm construction, leading to increased runoff from 1.3 inches to 4.1 inches, and erosion that may threaten the Shiawassee River's ecological health. Addressing these impacts requires not only effective soil remediation and drainage management but also policies to enforce the practices. These insights emphasize the importance of integrating the hydrological insights to the regulatory frameworks like PA 233 for stormwater management.

---

<sup>38</sup>Natural Resources Conservation Service. (n.d.). Web Soil Survey. Retrieved from <https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>.

<sup>39</sup> Nolin, J. D., & Hill, J. L. (2021). *Agricultural Drainage Management Systems*. Journal of Soil and Water Conservation, 76(3), 213-222. <https://doi.org/10.2489/jswc.2021.00045>.

<sup>40</sup> "The Shiawassee County Drain Commissioner maintains approximately 2,500 miles of open and tiled drains representing more than 500 county drains." "Drain Petition Procedures," Shiawassee County Drain Commissioner, <https://shiawassee.net/wp-content/uploads/2023/01/Drain-Brochure-FAQ-Drain-Petition-Process-2022.pdf>.

## Policy Deliverables

**Impact of Solar Arrays on Water Quality and Recommendations for Mitigation: Policy Overview**  
**Dow Fellows 2023-2024 Cohort: Friends of the Shiawassee River**

*The following is a step-by-step process guide describing the process of planning to address stormwater runoff from industrial-scale solar in the Watershed Management Plan, as well as any other applicable regulatory tools local governments and conservation districts have that do not conflict with PA 233. This can also serve as a guide to regulating potential water and land use issues and considerations that may be encountered where industrial-scale solar is found (e.g., drainage capacity considerations, agriculture).*

<b>Introduction: Project Summary</b>	<b>2</b>
<b>Stage 1: PA 233 Preemptive Background</b>	<b>3</b>
Introduction: PA 233 and Solar Siting	3
Summary: Addressing Impacts at the Local Level	7
<b>Stage 2: State-Level Regulatory Considerations</b>	<b>8</b>
PA 233 State-Level Siting Pathways	9
1) Developer Chooses State-Level Review	9
2) Local Government Requests State-Level Certification	9
3) Absence of a Compatible Renewable Energy Ordinance (CREO) - Section 222	10
Definition and Criteria for a CREO under Section 221(f) & Section 226(8)	10
4) Local Government Fails to Approve or Deny the Application - Section 223(c)	10
5) Local Denial of Application After Meeting State Standards	10
State Administrative Siting Considerations: the Michigan Public Service Commission	11
MPSC General Filing Requirements: Stormwater and Environment-Related	12
MPSC Site Plan: Stormwater and Environment-Related	13
Section 225 (1)p	15
PA 233 and MPSC Site Plan: Groundcover Provisions	15
Other State Environmental Review Processes	16
NREPA Review	16
EGLE Permitting	17
Part 91 --- Construction Stormwater Program, Soil Erosion and Sedimentation Control	18
Part 303 --- Wetland Permitting	18
PA 116 and Farmland Preservation Goals	19
Comparison: State-to-State Regulation (Preemption)	21
<b>Stage 3: Local Regulatory Tools and PA 233 Impact</b>	<b>22</b>
Zoning (Compatible Renewable Energy Ordinance)	22
Zoning (Workable Ordinance)	24
Local Drain Regulation and Monitoring	26
Drain Commissioner Approval	26

The policy team compiled a report describing options and policies to regulate stormwater in place under a PA 233 siting landscape, as well as non-regulatory opportunities to encourage best practices. The report also provides a description of existing stormwater governance, such as drain commissioners and conservation districts, which may provide input and influence in the state siting process based on estimated impacts, or may take a more leading role under a local siting process. The policy team found that there are several options to address & manage impacts of industrial solar runoff:

**Table 2: Summary Table of Local and State Stormwater Mitigation Options**

State Level	Local Level
PA 233 stormwater provisions	Workable Ordinance*
MPSC Siting Guidelines (stormwater and environmental assessment requirements)	Soil Erosion & Sediment Control Ordinance*
NREPA Review	Watershed Management Plans
Construction Stormwater (Part 91)	Land Use Planning
Wetland Permitting (Part 303)	Compatible Renewable Energy Ordinance

PA 116 farmland preservation regulations	Other Non-Regulatory Tools (e.g., collaboration)
--	--

\*= potential for preemption if deemed not workable by a developer

PA 233 allows renewable energy developers the option to pursue approval for projects through the **Michigan Public Service Commission (MPSC)** (which regulates utilities), rather than local governments.<sup>41</sup> PA 233 sets state-level standards for the development of renewable projects (e.g., sound limits, setbacks).<sup>42</sup> When determining whether to authorize siting of the project, the MPSC will follow administrative procedures and standards for project evaluation. On June 21, 2024, the Michigan Public Service Commission released the “Draft Application Instructions and Procedures for Renewable Energy and Energy Storage Facility Siting pursuant to PA 233 of 2023.”<sup>43</sup> These instructions indicate additional reports, maps, and plans which must be submitted by an applicant in the state-level siting process.

The statute does not require developers to site their projects through the MPSC or a compatible local ordinance. Developers may choose to site under **local zoning ordinances they consider “workable,”** with requirements which may be deemed to be stricter than the state statute (such as stormwater-related provisions). The Michigan Public Service Commission has recently recognized that “workable” local ordinance siting remains an avenue for siting, and separates it as outside the PA 233 process.<sup>44</sup> Local governments’ land use regulatory measures are rooted in a delegation from the state to preserve the “health, safety, [...] and general welfare” of their community.<sup>45</sup> As local governments have encountered solar projects, many have implemented zoning to address stormwater and site restoration concerns. Many local governments also have stormwater management and sedimentation control ordinances that address runoff.

A wide variety of regulatory stakeholders are involved in local- and state-level establishment of **environmental standards** for regulation and guidance. These stakeholders include administrative agencies (such as Michigan’s Department of Environment, Great Lakes,

<sup>41</sup> PA 233 of 2023, § 222(2).

<sup>42</sup> PA 233 of 2023, § 226(8)(a)(iv).

<sup>43</sup> “Case No. U-21547 Staff Draft Application Instructions and Procedures for Renewable Energy and Energy Storage Facility Siting pursuant to PA 233 of 2023.” Michigan Public Service Commission (June 21, 2024). <https://mi-psc.my.site.com/sfc/servlet.shepherd/version/download/0688y00000E9g7hAAB>.

<sup>44</sup> “The option for an electric provider [...] to site an energy facility through the local siting process, and outside of the process established by Act 233, remains available. [...] The express limitation on the Commission’s ability to review an application for a certificate under Act 233 only reinforces the continued availability of local approval paths.” “In the matter, on the Commission’s own motion, to open a docket to implement the provisions of Public Act 233 of 2023. At the October 10, 2024 meeting of the Michigan Public Service Commission in Escanaba, Michigan.” Case No. U-21547 (October 10, 2024). <https://mi-psc.my.site.com/sfc/servlet.shepherd/version/download/068cs00000EuxDUAZ>.

<sup>45</sup> Michigan Zoning Enabling Act, § 125.3201.

and Energy); conservation districts; non-governmental organizations (such as our client, Friends of the Shiawassee River); and general-purpose local governments such as counties, townships, and villages. Existing state-level environmental regulations (e.g., the Natural Resources and Environmental Protection Act) require review and permitting for solar projects as with other projects that would require permitting.<sup>46</sup>

### **State Level**

- **PA 233 Stormwater Statutory Provisions:** When applying for siting through the MPSC, applicants must include in their application a stormwater assessment and a plan to minimize, mitigate, and repair any drainage damage. The statute requires that applicants should make reasonable effort to consult with the county drain commissioner and include evidence of efforts in their application.<sup>47</sup> The statute also requires that the applicant show consideration of alternative locations and evaluate the overall impact on local land use.<sup>48</sup> The MPSC under this provision can require applicants to establish and maintain vegetative ground cover to manage the environmental impacts of the development.<sup>49</sup>
- **MPSC Siting Guidelines:** Draft MPSC siting guidelines were released by the state, with relevant considerations including the following: a required consultation with EGLE, a soil and economic survey report, a description of direct environmental impacts and mitigation, proposed locations of stormwater drainage lines, location of bodies of water listed in site plan, and a requirement to consult with the county drain commissioner.<sup>50</sup> “A stormwater assessment and a plan to minimize, mitigate, and repair any drainage impacts and any additional guidance received during a consultation with the county drain commissioner. [...] copies of correspondence listing necessary permits, next steps, and associated timeline should be provided for each consultation.”<sup>51</sup>
- **Natural Resources and Environmental Protection Act and Environmental Review:** PA 233 explicitly states that utility-scale solar projects sited under the MPSC’s authority are subject to state-level environmental review.<sup>52</sup> Michigan’s environmental review processes authorizes a multitude of permitting requirements seen in solar sites, including

---

<sup>46</sup> MCL 324.101 *et seq.*

<sup>47</sup> PA 233 of 2023, § 225(1)(p).

<sup>48</sup> PA 233 of 2023, § 226(6)(a).

<sup>49</sup> PA 233 of 2023, § 226(6)(a).

<sup>50</sup> “Case No. U-21547 Staff Draft Application Instructions and Procedures for Renewable Energy and Energy Storage Facility Siting pursuant to PA 233 of 2023.” Michigan Public Service Commission (June 21, 2024). <https://mi-psc.my.site.com/sfc/servlet.shepherd/version/download/0688y00000E9g7hAAB>.

<sup>51</sup> “Case No. U-21547 Staff Draft Application Instructions and Procedures for Renewable Energy and Energy Storage Facility Siting pursuant to PA 233 of 2023.” Michigan Public Service Commission (June 21, 2024). <https://mi-psc.my.site.com/sfc/servlet.shepherd/version/download/0688y00000E9g7hAAB>.

<sup>52</sup> PA 233 of 2023, § 231(5).

Part 91 construction stormwater permitting,<sup>53</sup> as well as Part 303 wetlands permitting.<sup>54</sup> These review requirements primarily pertain to site clearance.

- **PA 116 and State Farmland Preservation Goals:** Michigan’s PA 116 farmland preservation statute allows for a reduction in taxation in exchange for a commitment to keep land in agricultural use.<sup>55</sup> As non-agricultural use is prohibited under PA 116, solar development was formerly not allowed on PA 116 land. However, changes in policy by the Michigan Department of Agriculture and Rural Development allow a landowner who wishes to engage in solar development on PA 116-protected land, so long as certain requirements are met: the same amount of drainage must be maintained to prevent wetland formation, and vegetative cover beneath panels must meet pollinator cover or conservation cover standards.<sup>56</sup>

### **Local Level:**

- **Local Non-Regulatory Options:** Local land use planning (typically found in a locality’s master plan) is not legally binding, but helps to substantiate zoning decisions, as well to inform the locality’s overall plan and zoning regulations. Land use planning may plan for areas with more intense impacts, and other areas to remain in agricultural use — for example, prime farmland areas. An overall land use plan can be used as support, additionally, to substantiate any local input provided into a state-level siting process.
- **Collaboration with Landowners + Applicants:** This approach involves engaging in early conversations to develop shared goals around regulatory expectations. This is an approach taken by several other states with respect to siting for renewable energy, involving communicating what regulators would like to see, and reaching agreements.
- **Voluntary Guidelines and Best Practices:** Local regulatory and non-regulatory stakeholders can share resources & guidance on best practices (e.g. vegetative groundcovers, pervious surfaces). Some states, additionally, provide incentives (such as expedited review) to adhere to higher environmental standards.
- **Land Use Planning:** Through the master planning process, localities can identify environmentally sensitive areas to ensure that solar developments do not exacerbate

---

<sup>53</sup> “Soil Erosion and Sedimentation Control,” Michigan Department of Environment, Great Lakes, & Energy, <https://www.michigan.gov/egle/about/organization/water-resources/soil-erosion/sesc-overview>. Accessed Dec. 5, 2024.

<sup>54</sup> “State and Federal Wetland Regulations,” Michigan Department of Environment, Great Lakes, & Energy, <https://www.michigan.gov/egle/about/organization/water-resources/wetlands/state-and-federal-wetland-regulations>. Accessed Dec. 5, 2024.

<sup>55</sup> “Farmland and Open Space Preservation Frequently Asked Questions,” Michigan Department of Agriculture & Rural Development, <https://www.michigan.gov/mdard/environment/farmland/pa116/farmland-and-open-space-preservation-frequently-asked-questions>. Accessed Dec. 5, 2024.

<sup>56</sup> “Commercial Solar Facilities on PA 116 Land FAQ,” Michigan Department of Agriculture & Rural Development (February 2024), [https://www.michigan.gov/-/media/Project/Websites/mdard/documents/environment/farmland/pa\\_116\\_solar\\_panel\\_faq.pdf?rev=3ba761e4f0ba44bfab9e94c618779ee5](https://www.michigan.gov/-/media/Project/Websites/mdard/documents/environment/farmland/pa_116_solar_panel_faq.pdf?rev=3ba761e4f0ba44bfab9e94c618779ee5). Accessed Dec. 5, 2024.

stormwater issues, as well as prime farmland areas prioritized for preservation. Master plans provide a foundation for zoning decisions and can influence state-level decisions by the Michigan Public Service Commission (MPSC) by supplying detailed maps (and potentially environmental data) to guide site approval processes.

- **Compatible Renewable Energy Ordinance:** A local government may maintain local control under PA 233 by having a Compatible Renewable Energy Ordinance (**CREO**), which has provisions no more restrictive than those of the statute.<sup>57</sup> Per the state’s recent interpretation, a CREO may only contain standards from Section 226(8) of PA 233, including setback, fencing, height, and sound amongst other requirements.<sup>58</sup> Section 226(8) does not include stormwater review provisions,<sup>59</sup> making the CREO path currently an uncertain path for addressing stormwater concerns.

---

<sup>57</sup> PA 233 of 2023, § 221(f).

<sup>58</sup> PA 233 of 2023, § 226(8); “In the matter, on the Commission’s own motion, to open a docket to implement the provisions of Public Act 233 of 2023. At the October 10, 2024 meeting of the Michigan Public Service Commission in Escanaba, Michigan.” Case No. U-21547 (October 10, 2024). <https://mi-psc.my.site.com/sfc/servlet.shepherd/version/download/068cs00000EuxDUAAZ>. This interpretation is currently subject to challenge through a class action lawsuit by several local governments. “Michigan wants to fast-track renewable development. Local townships are suing.” Grist (November 2024), <https://grist.org/energy/michigan-public-service-commission-permitting-reform-lawsuit/>.

<sup>59</sup> Stormwater review provisions are included in the PA 233 statute, but under § 225(1)(p).

# Recommendations and Opportunities

In the evolving regulatory landscape post-PA 233, both state and local regulators may maintain a range of policy and regulatory options to address the need for stormwater management for solar developments. This section outlines actionable recommendations and future opportunities to address these challenges.

**Site-Specific Modeling & Recommendations:** Stormwater analysis should be considered prior to siting all utility scale solar projects using models such as PV-SMaRT. Previous assumptions of impervious surfaces are largely not accurate when determining potential runoff. Soil parameters (bulk density, composition, depth, etc.) should be tested, measured and documented prior to construction. Post-construction land remediation measures are important to ensure that excessive soil compaction has not occurred which will lead to higher runoff and erosion than previously estimated. Soil compaction and runoff may be considered in a variety of regulatory and non-regulatory options to accomplish means.

**Workable Ordinances:** Even with the option for state-level siting, developers may prefer workable local ordinances over state siting due to lower costs, shorter timelines, and greater opportunities for collaboration with local regulators. Local governments can adopt “workable” ordinances that set clear but flexible standards for stormwater management. When found acceptable by a developer, workable ordinances can allow local governments to regulate stormwater management for solar developments by requiring mitigation measures like vegetative groundcover, soil restoration, prevention of soil compaction, and runoff mitigation.

**Land Use Planning:** Through the master planning process, localities can identify environmentally sensitive areas to ensure that solar developments do not exacerbate stormwater issues, as well as prime farmland areas prioritized for preservation. Master plans provide a foundation for zoning decisions and can influence state-level decisions by the Michigan Public Service Commission (MPSC) by supplying detailed maps (and potentially environmental data) to guide site approval processes.

**Watershed Management Plans:** Local governments can expand watershed management plans to include considerations for industrial solar developments. Watershed management plans assess watershed conditions, identify sources of pollution, and address land uses impacting water quality. These plans are developed at the watershed level, involving collaboration across multiple jurisdictions, and serve as a foundation for Phase II NPDES permitting upon approval by EGLE.

**Voluntary Guidelines and Best Practices:** Voluntary guidelines and best practices offer local communities a flexible and collaborative approach to managing stormwater impacts from solar developments. Communities can use these guidelines and education materials to engage

proactively with developers during project planning. Voluntary measures can also inform state-level decision-making of local priorities and needs.

While PA 233 has led to uncertainty about the scope of state-level preemption of local authority, it still provides room for local non-governmental organizations, as well as local regulators, to influence renewable energy siting through thoughtful engagement and planning. These opportunities and recommendations highlight the agency that localities retain under this evolving regulatory framework. By leveraging both regulatory and non-regulatory tools, stakeholders can collaborate to manage the stormwater impacts of industrial solar projects — including localities, non-profit partners, and applicants.

# Impact

## Short-Term Impact

The findings from the deliverables will support advocacy efforts for our project partner, Friends of the Shiawassee River, with the modelled site-specific water runoff numbers providing evidence with which to engage with local stakeholders, policymakers and renewable energy developers. Through these efforts, the project partner can advocate for better construction practices and compliance with existing policies, helping to reduce the immediate risk of increased runoff and erosion into the Shiawassee River.

The policy deliverables will aid in providing background for both regulators and non-regulatory stakeholders regarding continued local options for regulation and influence. Both policy and modeling deliverables will also provide recommendations as to the mitigation options that regulators may wish to consider. Additionally, since PA 233 maintains local control over projects under 50 mW, local regulators will have a direct menu of options and recommendations to prevent adverse stormwater impacts in smaller developments. Whether a project is sited at the local or state level, the policy guide offers a description of the process and options for influence to non-governmental stakeholders as well as regulators.

## Potential Long-Term Impact

Over the long term, this project has the potential to improve stormwater management practices for renewable energy projects in Shiawassee County and in other areas of the state facing similar concerns regarding renewable energy developments. This was highlighted during stakeholder engagement discussions. Both policy and modeling deliverables can aid in recommending and developing more sustainable land use practices that balance renewable energy development with environmental protection. The detailed modeling outputs and recommendations can serve as a replicable framework for other watersheds facing similar challenges, helping to standardize approaches to runoff management in solar farm installations.

The menu of policy options will allow community members and regulators to more fully understand the scope of state authority, the kinds of regulation already being done at the state level, as well as the local regulatory and non-regulatory options available to them. The best practices may lead to potential ideas for the kinds of mitigation measures they may wish to regulate or advocate for.

Moreover, the project lays the groundwork for community and ecological benefits by providing methods and projections to protect the Shiawassee River from sedimentation and nutrient runoff, thus preserving its biodiversity and water quality. These outcomes align with the Project Partner's sustainability mission, reinforcing their role as a key advocate for watershed health. In the long term, this project can help prevent costly ecological degradation and ensure the compatibility of renewable energy projects with local environmental priorities.

This work addresses the following United Nations Sustainable Development Goals:

- **7: Affordable and Clean Energy**
  - By supporting better stormwater management practices, the project ensures that industrial scale solar developments are implemented sustainably.
- **9: Industry, Innovation, and Infrastructure**
  - The use of the PV-SMaRT model highlights how innovative tools can provide site-specific data to guide local decision-making on the environmental impacts of industrial renewable energy projects.
- **11: Sustainable Cities and Communities**
  - The advocacy and policy options presented to localities as a part of this project helps ensure that renewable energy development aligns with local priorities.
- **13: Climate Action**
  - Supporting the expansion of renewable energy projects like solar farms is vital for reducing carbon emissions and combating climate change.
- **15: Life on Land**
  - The focus on sustainable stormwater management promotes sustainable land use and ensures that renewable energy development does not undermine environmental resilience.

# Appendix A: Policy Report

**Impact of Solar Arrays on Water Quality and Recommendations for Mitigation: Policy Overview**  
**Dow Fellows 2023-2024 Cohort: Friends of the Shiawassee River**

*The following is a step-by-step process guide describing the process of planning to address stormwater runoff from industrial-scale solar in the Watershed Management Plan, as well as any other applicable regulatory tools local governments and conservation districts have that do not conflict with PA 233. This can also serve as a guide to regulating potential water and land use issues and considerations that may be encountered where industrial-scale solar is found (e.g., drainage capacity considerations, agriculture).*

<b>Introduction: Project Summary</b>	<b>2</b>
<b>Stage 1: PA 233 Preemptive Background</b>	<b>3</b>
Introduction: PA 233 and Solar Siting	3
Summary: Addressing Impacts at the Local Level	7
<b>Stage 2: State-Level Regulatory Considerations</b>	<b>8</b>
PA 233 State-Level Siting Pathways	9
1) Developer Chooses State-Level Review	9
2) Local Government Requests State-Level Certification	9
3) Absence of a Compatible Renewable Energy Ordinance (CREO) - Section 222 Definition and Criteria for a CREO under Section 221(f) & Section 226(8)	10
4) Local Government Fails to Approve or Deny the Application - Section 223(f)(c)	10
5) Local Denial of Application After Meeting State Standards	10
State Administrative Siting Considerations: the Michigan Public Service Commission	11
MPSC General Filing Requirements: Stormwater and Environment-Related	12
MPSC Site Plan: Stormwater and Environment-Related	13
Section 225 (1) p	15
PA 233 and MPSC Site Plan: Groundcover Provisions	15
Other State Environmental Review Processes	16
NREPA Review	16
EGLLE Permitting	17
Part 91 --- Construction Stormwater Program, Soil Erosion and Sedimentation Control	18
Part 303 --- Wetland Permitting	18
PA 116 and Farmland Preservation Goals	19
Comparison: State-to-State Regulation (Preemption)	21
<b>Stage 3: Local Regulatory Tools and PA 233 Impact</b>	<b>22</b>
Zoning (Compatible Renewable Energy Ordinance)	22
Zoning (Workable Ordinances)	24
Local Drain Regulation and Monitoring	26
Drain Commissioner Approval	26

The policy team’s additional deliverable report is attached at the following [link](#).

## Acknowledgements

We wish to thank everyone who has shared their knowledge and expertise with our team throughout this project — specifically, Liz Roxberry, Executive Director of the Friends of the Shiawassee River, Dr. Amy Beasley of the Dow Corporation, and Dr. Sarah Mills of the Graham Sustainability Institute. We wish to thank all participants in the Shiawassee County site visit for providing their concerns, impressions, and input to guide the topics addressed in our report. We also wish to thank the operators of the Assembly Solar site for allowing our team to visit the site and for answering questions. We also wish to thank the Graham Institute for their broad support of this project, including Bridget Gruber and Jen Maigret. We greatly thank the Dow Company Foundation for supporting this work through the Dow Sustainability Fellows Program at the University of Michigan.