The City of Oshkosh
Stormwater Management
&
Architectural Design Standards

An analysis and discussion of current standards.

Research and Proposal Conducted By:
Kadieann Vandergrinten and Hannah Weber
December 2018

Table of Contents

Executive summary

This report audits the City of Oshkosh's architectural and design standards as they relate to stormwater management, completed by the University of Wisconsin Oshkosh Environmental Studies, senior seminar students of fall 2018. The goal of this report is to propose to the City of Oshkosh that the architectural and design standards for stormwater management be updated. The reasoning for an update is because there is a disconnect of knowledge about green infrastructure and its benefits for stormwater management. In general, the City failed to provide community members with clear and complete information relating to options for green infrastructure implementation for existing or new residential or commercial development projects. Community members should be informed of various green infrastructure options and allowed to carry out implementation of these various projects. This report explains different aspects of architectural and design standards that need to be considered in implementation, such as: relevant stakeholders, costs, barriers, and benefits. The report analyzes the strategies of other communities and their successes with green infrastructure implementation. The report also uses an audit tool from the Wisconsin Sea Grant to evaluate current codes and ordinances in place for the City of Oshkosh. Finally, the report proposes recommendations for the City of Oshkosh and the significance of our findings. Our research and feedback from community members presents a poor outcome for what the City has currently done for architectural and design standards. The goal of this report is that our information will be used to inform the City of Oshkosh Common Council and the Sustainability Advisory Board of new advances in sustainability so they can improve the current ordinances to be the most up-to-date with technology. Through all of this we

hope our thoughts and ideas will be considered when thinking about the City of Oshkosh's stormwater management.

Background/ Context/ Problem Identification

This report takes an in depth look at the City of Oshkosh architectural and design standards for their ordinances for stormwater management. Architectural and design standards includes design guidelines, streetscape guidelines and dimensional standards in the zoning and planning of the City of Oshkosh. Oshkosh primarily uses grey infrastructure for stormwater management and the adoption of green infrastructure is under review in the following report. Green infrastructure that is included in Oshkosh's architectural and design standards includes; planter boxes, curb bump outs, rain barrels, cisterns, green roofs, trees, bioswales, and rain gardens.

The focus of this report is to analyze the City of Oshkosh's inclusion of green infrastructure in zoning and planning ordinances. Oshkosh's current ordinances do not include language that encourages or acknowledges the adoption of green infrastructure. Language in the ordinances can either directly encourage or prohibit implementation of green infrastructure. Lack of language, where a City does not encourage or prohibit implementation, can be just as detrimental as prohibiting green infrastructure. Furthermore, unclear definitions and ideas about green infrastructure can lead to lack of policy or inefficiencies (Matthew, 2015). This report seeks to understand and assess the ordinances currently in place in order to provide changes that favor and support green infrastructure.

If this problem continues to remain unaddressed the City will continue to miss out on a variety of benefits that green infrastructure can provide. Green infrastructure can be a tool for

intercepting rain to manage and reduce stormwater runoff. Implementing green infrastructure can help to provide greenscape for community revitalization (Keeley, 2013) and mitigate the loss of natural environments, which are critical to the mental and physical health of citizens (Ferguson, 2018). Furthermore, if this issue is not addressed, residents will continue to be uninformed about green infrastructure and not have knowledge about green infrastructure as an alternative for their properties. Not knowing green infrastructure is an option hinders a citizens ability to make informed choices for a healthier environment.

In addressing these issues, we hope to enhance understanding of multifunctional green infrastructure, its importance, and benefits. As previously stated, green infrastructure has many benefits, such as: human health, improved environmental processes, community engagement, regulating climate change problems, reducing energy consumption, carbon sequestration, food provisions, and stormwater management (Matthews, 2015). Improving stormwater management strategies for integrating and implementing green infrastructure into architecture and design standards ideally involves public engagement. Gaining public support and opinion is important to ensure everyone can access and benefit from green infrastructure (Ferguson 2018). We hope to show how green infrastructure can provide support and assistance with current management practices and policies, rather than dismiss grey infrastructure entirely. Correcting and changing ordinance language to encourage green infrastructure implementation in architecture and design standards is the first step to incorporating green infrastructure

Oshkosh has not begun to take many steps on these issues. Oshkosh currently focuses on using their current grey infrastructure for stormwater management practices. However, the City participates in the Green Tier sustainable communities program through the Department of

Natural Resources. Oshkosh has also taken on tree planting initiatives since the City has lost a large amount of trees due to storms and development. Trees are important for intercepting precipitation (Berland, 2017) and lowering the heat island index (McCombs, 2018). An example of change to ordinances was initiated by Misty Mcphee when she fought for changes in the ordinances to allow for metal/tin roofs in development and construction of her residential property. Despite the few examples, the City of Oshkosh fails to include explicit encouragement of green infrastructure in their architectural design standards which is a major problem. Outlining and including language that states this encouragement is a key goal to changing City and community attitudes and participation in implementing green infrastructure.

Implementing these changes and moving forward with achieving goals requires consideration of larger social, environmental, and economic issues to understand the proposal. As previously stated, there are many environmental benefits to green infrastructure. These benefits, should be highly regarded and considered during planning processes. Adaptability and resilience of tree species and native vegetation needs to be taken into consideration. Specific species are better suited for Wisconsin's climate and their longevity will be more efficient and feasible for planting (Traas, 2018). Diversity of these species is important for consideration to ensure that we do not promote monocultures in urban greenspace. Multifunctionality is another important component of green infrastructure. While green infrastructure can help with stormwater management, it can also aid with healthier communities and revitalization.

Social issues that need to be considered in the process include community approval and aesthetics. While we understand that green infrastructure is important and beneficial, opposition from the community is a possibility if community members feel their rights are infringed on.

Creating mandatory policies or regulations in the ordinances may negatively impact our goals. Not only is approval and acceptance necessary, we must also take into account the aesthetics of the City. Oshkosh is an older City with many historical building that would require retrofitting (Brabender Mattox, 2018). While this is possible, the design of something may not be appealing and therefore people will not support it. Finally, the perception of certain areas may influence decisions for where green infrastructure deserves to be. Green infrastructure should be allowed, encouraged, and implemented in all areas despite the status of neighborhoods.

Standard economic considerations are the costs of development, implementation, operation and maintenance. The need for immediate short term profits needs to be done away with, in order to understand that green infrastructure may cost a bit more up front than traditional grey infrastructure; however, the long term gains are far greater (WEF, 2015). These gains come in the form of lower operation costs, higher returns in the future, longevity of material and infrastructure, and increased efficiency and functionality. This shift requires rethinking of current management to include and integrate new ideas and strategies.

Audit

Are rainwater- harvesting and stormwater-control elements acknowledged in design standards?				
Barrier	Tips	Code Reference and Language	Notes	Grade
Design Guidelines Architectural Standards	Include illustration or definitions of green roofs, planter boxes and cisterns; this ensures	Nothing in the standards	There are no definitions for green roofs, planter boxes, or cisterns.	F

	reviewers and designers will know that these elements are allowed and encouraged.			
Are green infrastructure practices suitable for high-density areas (planter boxes, cisterns) allowed to extend into the right-of-way or onto sidewalks?				
Barrier	Tips	Code Reference and Language	Notes	Grade
Design Guidelines Architectural Standards Municipal Code Table of Dimensional Standards	Most zoning ordinances specify what elements, like awnings or signs, may extend into the public right of way. Planter boxes and cisterns often need to be added to this list and allowed to extend at least 24 in into the right of way or other setbacks.	Nothing in the ordinances	No language related to planter boxes or cisterns.	F
Do design standards allow siting of stormwater-control measures along facade?				
Barrier	Tips	Code Reference and Language	Notes	Grade
Design Guidelines Architectural Standards Zoning Setbacks	Zoning often will limit the structures that can be attached to a building facade or located within a setback. Codes should	Nothing in the standards	Items cannot hang more than two feet off of a building. There is no language related to stormwater-control measures.	F

	specify that rain barrels or cisterns and planter boxes may be sited along facades or extend into setbacks.			
Do standards allow for the waiver of design or architectural provisions to accommodate stormwater-control measures (planters, cisterns, green roofs)?				
Barrier	Tips	Code Reference and Language	Notes	Grade
Design Guidelines Architectural Standards Zoning Setbacks	Where a community provides for waivers of architectural standards, "siting of green infrastructure measures" should be a specific reason for the grant of a waiver	Non existent	Not applicable, there could be more reference.	F
Are pitched roofs required? If so, is a waiver or provision for green roofs or rainwater harvesting made?				
Barrier	Tips	Code Reference and Language	Notes	Grade
Design Guidelines Architectural Standards Zoning Setbacks	If design standards require pitched roofs of a certain slope (3:1) or for buildings to match adjacent roof pitches, some allowance for changing	No requirement	Need language about pitched roofs and slope requirements.	F

	pitch should be made for rainwater harvesting or green roof installation.			
Are green infrastructure practices suitable for high-density areas allowed or encouraged in streetscapes (tree boxes, sidewalks, bioretention, curb bump outs)?				
Barrier	Tips	Code Reference and Language	Notes	Grade
Design Guidelines Architectural Standards Streetscape Standards	Streetscape standards often need amendments to specifically enable stormwater trees, sidewalk bioretention or curb bump-outs to be included in renovated or new streets.	Nothing in ordinances	These are not prohibited in the City and complete street projects have been implemented	F

Notes on the audit

Are rainwater- harvesting and stormwater-control elements acknowledged in design standards?

Within the introduction of the Stormwater Management Plan there are no definitions to state what green roofs, planter boxes, and cisterns are. This code can be improved by including the language; Green Roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. A Planter Box is an object that contains live flowers, usually affixed outside, just below a window. As well as, a

Cistern is a tank for storing water.

Are green infrastructure practices suitable for high-density areas (planter boxes, cisterns) allowed to extend into the right-of-way or onto sidewalks?

In section 30-255(C)(3) the ordinance prohibits landscaping from developments to extend into the public-right-of way. Even though extensions into public-right-of-ways are prohibited, there is no mention of allowing green infrastructure to stretch into right-of-ways, such as: planter boxes and cisterns.

Do design standards allow siting of stormwater-control measures along facade?

Within the Bulk Regulation Section 30-114(B) it explains what types of objects can project into the yard no more than two feet. These items include: sills, belt courses, cornices, gutters, overhangs, eaves, ornamental features, pilasters, lintels, bay windows, chimneys, and flues. This section could be updated to include stormwater-control measures such as rain barrels, and planter boxes. These would also need to have language for how far they would be allowed to project along facades.

Do standards allow for the waiver of design or architectural provisions to accommodate stormwater-control measures (planters, cisterns, green roofs)?

These types of waivers are non existent; however, waivers of design should be allowed for green infrastructure, such as: planter boxes, cisterns, and green roofs to accommodate stormwater-control measures.

Are pitched roofs required? If so, is a waiver or provision for green roofs or rainwater harvesting made?

Currently there is no requirement in place for pitched roofs. It is important to note that

while there is no requirements for pitched roofs, the ordinance fails to include verbiage that states green roofs are an option. Green roofs are primarily flat with no slope. The slope is important to managing stormwater because the angle is a key factor to runoff rates. An experimental study on residential water fluxes analyzed the importance of roof slope. "Depending on height, flat roofs collected 90 to 99% of rainfall recorded at ground level. Roofs with a 22° slope; facing south-south-west (i.e. facing the prevailing wind) captured most rain, whereas east-south-east facing roofs with slopes of 50° received the least. Depending on the roof slope, the average rainfall captured ranged from 62 to 93% of that at ground level" (Ragab et al., 2003). Pitched roofs influence the speed of runoff and this experiment shows how flat roofs catch the largest amount of rainwater.

Are green infrastructure practices suitable for high-density areas allowed or encouraged in streetscapes (tree boxes, sidewalks, bioretention, curb bump outs)?

Green infrastructure practices are not mentioned to be allowed or prohibited in high-density areas; therefore, planners are not required to implement these practices. The City of Oshkosh has implemented some aspects of a complete streets project, such as having bike lanes on Irving Avenue and pedestrian friendly features on North Main Street. These practices should be used as examples for further green infrastructure practices. Ordinances should be more detailed to explain and encourage the use of tree boxes, sidewalks, bioretentions, and curb bump outs in streetscaping and high-density areas.

Stakeholder Identification

A valuable aspect to our research was talking with multiple people to acquire insight from different perspectives. The first person we met with was Misty McPhee, who is a primary stakeholder to us. McPhee is a resident of the City of Oshkosh and is a professor of biology and environmental studies at the University of Wisconsin Oshkosh. She believes that the City makes it hard to do the right thing when it come to implementing green infrastructure. In her experience she has had to pay to be allowed to implement green infrastructure and wishes there were more penalties to use harmful practices such as having an asphalt roof. Recently McPhee and her husband have decided to build a house on Jackson Street. When designing the house both McPhee and her husband wanted to replace the asphalt roof with a tin roof. They ran into a problem with the City because the ordinance prohibited a tin roof, even though a tin roof is better for the environment. A tin roof would be a better option over an asphalt roof because a tin roof does not contribute to the heat island effect and they have longer lifespans (State Farm, 2018).

The next stakeholder we met with is Bill Sturm who we identified as an expert stakeholder. Sturm is a resident of the City of Oshkosh. He is a certified arborist and works in the forestry department for the City where he is in charge of decision making when it comes to picking what types of plants would be best suited for different projects. While talking with him he thinks the City could use more language about planter boxes because he has to get special permission for them to be implemented. He also thinks that eventually more of the stormwater utility profit should be distributed for more landscaping funds. Additionally, he is a strong advocate for making green infrastructure mandatory in all construction projects.

Next we met with Shirley Brabender Mattox who we identified as both a primary and key stakeholder. Brabender Mattox is a resident of the City of Oshkosh and is a retired school teacher. Currently she works with the Landmark Commission to help protect historic pieces. She works with two historic buildings and is working to include a third in the City of Oshkosh. She used to help write codes for the City and understands how long the process can be, but she thinks that there needs to be a faster way to get things done. She also believes that the wording of codes should be updated to be more specific. Especially when it comes to preserving history.

Dan Traas is an expert stakeholder and currently works in Appleton at Ranger Services, an urban land management company. Traas has extensive experience with managing urban forestry and wrote the plan for Oshkosh's Community Foundation tree planting initiative. He believes that restoring and protecting tree canopies, along streetscapes and hardscapes, is the best stormwater management practice to provide shade, intercept precipitation, and reduce runoff. Traas also is an advocate for making spaces more accessible to the public. He told us about a property that was a large open lot full of turf grass that was never used. Once they let the grass grow out, they cut paths through the grass. This saved time in maintenance and caused more people to come visit the park and walk through the paths.

Another expert stakeholder we interviewed was Heather McCombs. McCombs was a professor at UW Oshkosh and currently works as an interior designer at Lawrence University. She is a sustainability specialist and strongly supports making green infrastructure mandatory. LEED design is also something that McCombs feels is important for communities to incorporate into new developments. Additionally, McCombs feels cities can improve stormwater management practices by making terrace trees and curb bump outs mandatory, requiring all

hardscapes to be permeable pavements, and encouraging green roofs. Rainwater harvesting is important for stormwater management as well, and McCombs feels it could be more efficient if we find a way to use captured rainwater indoors. As a strong advocate for green and sustainable solutions, McCombs also recognizes that cost and lack of understanding from community members may stand as barriers; however, education can be provided to the community and upfront costs do not outweigh long term benefits.

A key stakeholder in our analysis and proposal is the City of Oshkosh Mayor, Steve Cummings. As a government official and mayor of the City, Cummings has oversight and knowledge on the operations of departments and ordinances in Oshkosh. He feels that Oshkosh has made progress in green infrastructure and better stormwater management. In the community, he has seen citizens contribute to less dumping of debris into the streets, and a decrease in use of fertilizers and chemicals on lawns which have an impact on stormwater management. He feels that there are more changes that could be made, such as: more aesthetically pleasing rain barrels, strips of concrete for driveways, diversity in terrace plantings such as flowers or produce, and a clearer definition of what constitutes native vegetation. Oshkosh does have old buildings but there are possibilities for integrating green infrastructure that can be accepted by everyone. It is difficult for there to be mandatory regulations on implementation of green infrastructure but encouragement through a incentive program may prove to beneficial.

Finally, we talked to John Ferris, who we identified as an expert stakeholder for stormwater management. Ferris is an employee for the City of Oshkosh. He is one of the civil engineers who works on projects related to stormwater management. He wishes that citizens were more educated and aware of the benefits that green infrastructure provides. Two changes he

would like to see, include: more consideration for installing bioswales and a different kind of point system for native vegetation. A different kind of vegetation point system for new construction would give native plants a higher priority to be included on the planting list. It is important to note that, the point system for vegetation in new construction is not outlined in this paper; however, for more information on this, please see the Landscaping stormwater management proposal.

Comparison of stakeholders

Of the stakeholders we have met with each one of them came at the project from a different perspective; although most of our stakeholders seem to be on the same page when it comes to knowing there could be improvements to the architectural and design standards for the City's stormwater management plan. From meeting and talking with each of these stakeholders we have been able to gain insight of the things they all have in common as well as how each of them differ in their opinions about stormwater management. As mentioned, the stakeholders we have met with are all in agreeance that there should be more green infrastructure added to the City of Oshkosh ordinances. The difference between our stakeholders comes down to their education. There were comments such as; it takes too long for codes to pass, there are too many hoops to jump through, and frankly not understanding why things are done the way they are. These differences could be bridged if the City were to come up with a new system to that passes codes sooner. By changing the system people would be able to accomplish projects faster, especially if they are in relation to architectural design standards for stormwater management. It is also important for the City members to all be on the same page and broaden their knowledge on various and sometimes opposing viewpoints. Taking opposing viewpoints into consideration

helps community members, city officials, and other stakeholders, from different backgrounds understand why certain decisions are made in terms of stormwater management. All personnel who come into contact with the stormwater management plan for the City of Oshkosh must be accepting and understanding of ordinance proposals. Ideally, the City would enforce the new ordinances, while engineers, planners, and architectural companies follow the guidelines set by the City, and finally community members will have the ability and option to pursue green infrastructure upon their own discretion.

Benchmarking

Many of our stakeholders noted that evaluating and analyzing green infrastructure practices of other cities can be beneficial for the City of Oshkosh. This section provides some details on five cities and their success with adoption of various green infrastructure practices and projects. The five cities we identified are: Appleton, WI, La Crosse, WI, Eau Claire, WI, Milwaukee WI, and Lancaster City, PA.

Appleton, Wisconsin is almost always looking and finding ways to better support its community members. Stormwater management is a high priority for the city and therefore, they highly support green infrastructure as a sustainable option (McCombs, 2018). The two major focuses in green infrastructure for stormwater management are permeable pavements and ponds. Appleton uses retention and detention ponds as methods for capturing stormwater runoff to better manage it. In 2014 there were 63 stormwater facilities, such as: 39 wet ponds, seven dry ponds, four biofilters, and two underground holding tanks (Behnke, 2014). This number has since increased and despite high costs of implementation, the city continues to allocate funds for

green infrastructure. This is because of the payout in benefits for stormwater management and its effectiveness. The city also has stormwater credit policies in place that encourages community members to adopt green infrastructure for financial incentives. The most important thing Oshkosh can take away from the efforts of Appleton is the inclusion of green infrastructure language. Ordinances and policies include reference to green infrastructure as options and provides definitions for certain types, such as: bioswales and and ponds.

The next city we looked at was La Crosse, Wisconsin. This city was recognized by the Environmental Protection Agency as a model community for adopting green infrastructure. Their main goal is reducing flood hazards due to climate change. Throughout the city, a series of projects were implemented, such as: bioretention ponds and permeable pavements to understand the full extent of green infrastructure at varying levels of implementation. Additionally, the city is a participant in Complete Streets programs. This program aims to make streets more accessible, safe, diverse, and most importantly, green. The combination of these two efforts has helped La Crosse advances its sustainability goals and see successful results with green infrastructure. Results of their efforts are predicted to show flooding reductions of almost 90%. Cost stands as a barrier; however, the city recognizes that identifying and addressing problem areas first will help with lowering costs (EPA, 2012).

Eau Claire, Wisconsin has taken many strides to advance their sustainability goals for the city. Some of these examples include: ordinance language to encourage green infrastructure and their cities green team. In the City's Comprehensive Plan for Sustainable Development proper language is used to include various forms of green infrastructure as options or mandatory policies in development and restoration. Not only does Eau Claire have a Sustainability Advisory

Board like Oshkosh, but they also have a Green Team to assist with sustainability efforts within the City government. Eau Claire has also focused on tree planting initiatives and is recognized as an energy independent community. There is not much opposition to the sustainability efforts, which has made community involvement more beneficial. The practices in Eau Claire could be used and applied very similarly in Oshkosh.

Milwaukee, Wisconsin is a much larger City than Oshkosh; however, their sustainability efforts are significant. The City has a Green Seams Program that focuses on purchasing land along the waterfront for preservation and flood control. This program has resulted in more than 123,000 trees being planted, the protection of 3,700 acres, and creation of recreational opportunities for community members (MMSD). The City's rain barrel program resulted in the sale of 50,000 rain barrels. Milwaukee educated community members on the importance of rain barrels and provided access to starter kits for a relatively low cost (MMSD). The final program we looked at in Milwaukee was the Fresh Coasts Green Solutions Program. The program focused on combining grey and green infrastructure in pilot areas, for evaluation of the effectiveness of green infrastructure. This project is further outlined within the costs section.

Our final City we researched was Lancaster City, Pennsylvania. Their green infrastructure implementation plan and project initiatives have shown just how beneficial green infrastructure can be. Choosing green infrastructure over grey is expected to save the city $121.7 million over 35 years. Stormwater management was one of the reasons green infrastructure was adopted; however, the city also recognized multiple other benefits. There has been a total of 50 green infrastructure projects completed (Harris, 2014). More details regarding implementation can be found within the costs section.

Many cities are implementing green infrastructure at various degrees and we feel Oshkosh can and should do the same. The cities we reviewed are very similar to Oshkosh and would make it easy to apply their methods to Oshkosh. It is also important to note that cities are not implementing only a few small projects because they recognize that importance of multiple projects. Higher benefits are seen when there are more implementations.

Costs

Costs stand to be a large factor and barrier in implementing green infrastructure. In this section we hope to provide a better understanding of the variables that influence green infrastructure costs. Additionally, we looked at costs and savings of green infrastructure in Milwaukee and Lancaster City, to address economic feasibility and analyzed tradeoffs. It is pertinent to keep in mind that the costs presented are estimates and not exact quotes for these types of implementation.

Green infrastructure is highly variable and project costs for implementation can depend on a variety of factors, such as: size, existing infrastructure, materials used and quality of materials, space limitations, environmental conditions, labor costs, and land value (WEF, 2015). Variability can be both a barrier and an asset during the process. Variability does not allow for exact knowledge of price until the planning process; however, the planning process is also where you can reduce costs by addressing operation and maintenance costs (WEF 2015).

Below is a cost comparison chart that outlines estimated costs for various types of green infrastructure. Again, these costs are subject to change based on various factors. We cannot assume a single cost per square foot because all projects and areas are unique.

	Cost of G.I. with Relation to Size		
Type of G.I.	Low	Medium	High
Rain Barrels	$0.72/gallon	$1.09/gallon	$2.54/gallon
Rain Gardens	$5.15/sq ft	$7.00/sq ft	$16.05/sq ft
Bioswales	$5.50/ sq ft	$15.00/sq ft	$24.00/sq ft
Green Roofs	$8.75/sq ft.	$15.75/sq ft.	$31.80/sq ft.
Terrace Trees	$175.00/each	$275.0/each	$400.00/each
Curb-Bump Outs	$13.00/linear ft	$17.25/linear ft	$29.50/linear ft
Cisterns	$0.61/gallon	$1.45/gallon	$2.88/gallon
Planter Boxes	$0.55/sq ft	$8.00/sq/ft	$24.52/sq ft
Bio-Cells	$69.44/sq ft	$222.22/sq ft	$600.00/sq ft
Native Plants	$0.02/sq ft	$0.10/sq ft	$0.13/sq ft

http://greenvalues.cnt.org/national/cost_detail.php

To pull out a few examples, rain barrels can vary anywhere from $.72/gal to $2.50/gal. These costs depend mainly on quality of material and size of barrel. Terrace trees are a type of green infrastructure important for shading and stormwater management. Higher quality and more mature trees cost more but should be used over cheaper trees because they provide a higher yield in benefits (Cummings, 2018). Prices for trees also depends on the species being planted.

Upfront costs for implementing green infrastructure may be higher; however, there is a lot of room to reduce costs and increase savings over the long run. This requires an approach that fully understands all of the factors and benefits of green infrastructure. Understanding the multifunctional benefits of green infrastructure is important because it can enhance ecosystem services within communities (Connop, 2016). Not only does green infrastructure provide benefits for stormwater management, but it also can improve air and water quality, promote healthy and sustainable communities, and be aesthetically pleasing. Green infrastructure should include both functional purposes and an aesthetically pleasing appearance. Additionally, recognizing the multifunctionality of green infrastructure projects during planning phases can help with lowering costs. This would mean including foresters and conservation planners to help plan (Traas, 2018).

Another cost variable is retrofitting old infrastructure with new green infrastructure. Retrofitting can be costly but if green infrastructure is treating the area surrounding the building, this will increase efficiency and make it more cost effective. In the City of Oshkosh if a building is apart of the Historic Landmark Commission, then the owner must work with and obtain approval for projections. Since these implementations must not overcompensate on the historic presence (Barbender Mattox 2018). When integrating green infrastructure as improvements to existing infrastructure, cities can see costs savings of 30-60% (WEF, 2015).

Cost is an important factor for citizen participation in green infrastructure implementation. Citizens will be more likely to adopt green infrastructure policies if costs are not high and there are possible incentives. Implementing green infrastructure can be fairly low in costs by using recycled materials for projects such as rain barrels.

There are many factors that need to be taken into consideration for costs of green infrastructure. As we mentioned in our benchmarking section, the city of Milwaukee's Fresh Coasts Green Solutions Program focuses on the use of existing grey infrastructure and new green infrastructure. The City of Milwaukee used the SUSTAIN Program to measure and evaluate effectiveness of green infrastructure implementation. They chose a small pilot area of the combined sewer service area (CSSA) to look at costs and savings, which were then applied to the total CSSA (EPA, 2013). These exact savings can be seen in the chart at the end of the Appendix under Benefits of GI in Milwaukee CSSA.

In Lancaster City, PA their green infrastructure implementation plan has proven that benefits can outweigh costs. With a population of almost 60,000 (similar to that of Oshkosh), their green infrastructure plan is expected to reduce stormwater runoff by more than 1 billion gallons per year and this is not the only benefit they plan to see. Implementation costs are expected to between $51.6-94.5 million but their savings outweigh these costs. Long term benefits of implementation could save the city $120 million in avoiding gray infrastructure capital costs while earning upwards of $5 million in annual benefits. Some examples of green infrastructure projects that have been implemented include, a reconstructed parking lot with bioretention ponds that equaled about $1,100 in annual benefits. A reconstructed streetscape that included bioretention ponds and permeable pavements and equaled roughly $2,300 in annual benefits. The third example is an urban park that was combined a variety of green infrastructure that provided more than $5,500 in annual benefits (Kirkstan, 2014). Small projects alone may not reach millions in savings, but this is why multiple green infrastructure projects should be implemented to maximize the highest amount of benefits.

Barriers

With all new changes there will be barriers to overcome. This report is not requiring community members to use green infrastructure, it is only a suggestion of revising the ordinances to make it possible for community members to use green infrastructure without having to obtain a zoning variance. Nevertheless, when thinking about barriers related to architectural and design standards these include; cost, aesthetics, knowledge, code language, and personal opinion. Depending on the situation, the biggest barrier related to architectural and design standards is not having enough specific language in the ordinances. This is because there have been times when the City prohibited a project because there was no code allowing for it. An example of this was given to us from one of our stakeholders. This person shared with us that they wanted to create a mural project in the City but was not allowed to because there was no code language allowing or prohibiting this type of project. As mentioned in the costs, section high costs will deter people from using green infrastructure practices. By finding cheaper alternative and showing the long term benefits to the projects, people will be more inclined to want to use these practices. Another barrier with implementing green infrastructure into the City is having positive community member opinion. A challenge we came across was that some community members believe that some green infrastructure is not aesthetically pleasing such as traditional rain barrels. Another main problem of green infrastructure is having enough knowledge about the topic. In the City of Oshkosh there is a rain barrel project that provides community members with rain barrels and a tax credit for a positive incentive. Although, participants may not know what to do with the water once they have harvested it. This project is still beneficial because in Syracuse New York, a survey was carried out to get public opinion

based on what community members thought about implementing green infrastructure to landscapes and urban planning. The consensus of the data was that there was a strong willingness to use these practices if there was a financial incentive or the product was free (Baptiste 2015).

Specific Recommendations

Concluding our research of the City of Oshkosh's stormwater management plan, we have generated suggestions for the City to take into consideration. These suggestions range from adding to existing codes to creating new ones. As stated multiple times we would like to suggest that each ordinance listed previously above be rewritten to include more language about green infrastructure in relation to architectural and design standards. This would allow for more integration of green infrastructure with current practices. The change of language would not make green infrastructure mandatory for community members, the change would just make it possible for people to use green infrastructure without getting a zoning variance. By adding in this change of code the City and community members would save time and energy from having to grant and receive these special requests.

Specifically, in the ordinance relating to rain barrels there will also have to be additional consideration for certain circumstances. These certain circumstances would include times when green infrastructure would be implemented downtown, such as rain barrels or planter boxes. When talking with our stakeholders they emphasized how these items would need to blend in aesthetically as well as be functional. These items would need to agree upon so they fit in with their surroundings.

Furthermore, we would like to suggest a starter project to analyze the feasibility of green infrastructure in Oshkosh. This project would be a comprehensive design plan for the City of Oshkosh that details where green infrastructure will be implemented and shows its relation to other grey and green infrastructure. Utilizing programs like the SUSTAIN program to evaluate smaller areas and project would be the first step. A plan like this would require critical thinking and analyzation of where Oshkosh could benefit the most from new infrastructure and include details on how new infrastructure would work with old infrastructure to improve efficiency.

A final recommendation we would like to propose is incentives for implementation of green infrastructure. Much like the rain barrel project, the City could have similar proposals to encourage more community members to want to implement additional green infrastructure. As mentioned earlier community members will be more likely to take part in the initiative if the product is free or there are financial incentives.

Significance for Sustainability

Adoption of the recommendations outline in this paper will help Oshkosh work towards becoming a more sustainable community. Implementing green infrastructure provides multiple benefits, such as: lower annual maintenance costs, stormwater management efficiency, and healthier communities. This proposal takes into consideration various viewpoints and factors that are important to the process of adopting sustainable practices. When conducting a three pillar analysis of this proposal, goals for each pillar are considered and can be met. This proposal identifies communities benefits of adopting green infrastructure. Green infrastructure is a type of urban nature, which is important to overall physical and mental well being. When communities

are more efficient and cleaner, citizens are generally happier. Additionally, socially sustainable communities require input from all stakeholder. This proposal outlines the need for community engagement and the inclusion of environmental perspectives during planning phases. Green infrastructure is a sustainable way to integrate urban nature into cities. Integrating natural ecosystem processes improves environmental conditions overall. Finally, costs and barriers are taken into consideration as a part of the economic pillar. Green infrastructure does cost more, but annual and long term benefits outweigh these costs significantly. When all components of sustainability are taken into consideration and reviewed, communities and cities can successfully work towards adopting green infrastructure.

Summary

In closure, by editing the current stormwater management plan the City of Oshkosh will be able to overcome the barriers in place for implementation of green infrastructure. If this problem continues to remain unaddressed Oshkosh's community will miss out on multiple sustainable opportunities that would be beneficial for improving stormwater management, improving efficiency, lessening long terms cost, and cultivating healthier communities. By changing the language of the codes for architectural and design standards, the applications will help to favor the use of more green infrastructure for the City but will not necessarily require the use if it. Changing the wording would not upset the community as the stakeholders we interviewed all agree the codes could be improved to be more sustainable. We hope the City will take into consideration our recommendations because they would improve the City has a whole by providing a more cleaner and sustainable place to live.

Works cited

Baptiste, A. K., Foley, C., & Smardon, R. (2015). Understanding urban neighborhood differences in willingness to implement green infrastructure measures: a case study of Syracuse, NY. *Landscape and Urban Planning*, *136*, 1-12.

Behnke, D. (2014, November 17). Fox Cities Spend Big to Manage Urban Runoff. Post Crescent, pp.

Berland, A., Shiflett, S. A., Shuster, W. D., Garmestani, A. S., Goddard, H. C., Herrmann, D. L., & Hopton, M. E. (2017). The role of trees in urban stormwater management. *Landscape and urban planning*, *162*, 167-177.

Connop, S., Vandergert, P., Eisenberg, B., Collier, M. J., Nash, C., Clough, J., & Newport, D. (2016). Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure. *Environmental Science & Policy*, *62*, 99-111.

D. Traas, personal communication, November 16, 2018.

EPA. (2012). *Using Green infrastructure to Mitigate Flooding in La Crosse, WI (*EPA-C-11-009). La Crosse, WI: U.S. Environmental Protection Agency..

EPA. (2013). *Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs.* Washington, DC: U.S. Environmental Protection Agency

Ferguson, M., Roberts, H. E., McEachan, R. R. C., & Dallimer, M. (2018). Contrasting distributions of urban green infrastructure across social and ethno-racial groups. *Landscape and Urban Planning*, *175*, 136-148.

H. McCombs, personal communication, November 16, 2018.

Harris, B. (2014, March 4). Lancaster City a national model for “green” infrastructure. Lancaster Online, pp.

J. Ferris, personal communication, November 9, 2018.

Keeley, M., Koburger, A., Dolowitz, D. P., Medearis, D., Nickel, D., & Shuster, W. (2013). Perspectives on the use of green infrastructure for stormwater management in Cleveland and Milwaukee. *Environmental management*, *51*(6), 1093-1108.

Krikstan, C. (2014, March 5). Benefits of green infrastructure can outweigh costs. https://www.chesapeakebay.net/news/blog/benefits_of_green_infrastructure_can_outweigh_costs

M. McPhee, personal communication, October 26, 2018.

Matthews, T., Lo, A. Y., & Byrne, J. A. (2015). Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning*, *138*, 155-163.

MMSD. Greenseams. https://www.mmsd.com/what-we-do/flood-management/greenseams

MMSD. Rain Barrels. https://www.mmsd.com/what-we-do/green-infrastructure/rain-barrels

Ragab, R., Bromley, J., Rosier, P., Cooper, J. D., & Gash, J. H. C. (2003). Experimental study of water fluxes in a residential area: 1. Rainfall, roof runoff and evaporation: the effect of slope and aspect. *Hydrological Processes*, *17*(12), 2409-2422.

S. Brabender Mattox, personal communication, November 7, 2018.

S. Cummings, personal communication, November 8, 2018. W. Sturm, personal communication, November 7, 2018.

WEF. (2015, December 2). The Real Cost of Green Infrastructure. stormwater.wef.org/2015/12/real-cost-green-infrastructure/.

Writer, S. F. (2018, October 26). Wondering About Metal Roofs? Here Are the Pros and Cons. Retrieved from https://www.statefarm.com/simple-insights/smart-ideas/wondering-about-metal-roofs-here-are-the-pros-and-cons

Appendix

Cistern- a tank for storing water.

Complete Streets- Complete streets is a transportation policy and design approach that requires streets to be planned, designed, operated, and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation.

Expert Stakeholder: people who might not have a tangible relationship with the local issue at hand, but who have a relevant expertise that might inform or shape discussion.

Facades: the face of a building, especially the principal front that looks onto a street or open space.

Green infrastructure: is an approach to water management that protects, restores, or

mimics the natural water cycle.

Green Roof: roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems.

Grey infrastructure: refers to constructed structures such as treatment facilities, sewer systems, stormwater systems, or storage basins. The term “gray” refers to the fact that such structures are often made of concrete.

Heat Island Index: is an urban area or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities

Key Stakeholder: those who have a positive or negative effect on an effort, or who are important within or to an organization, agency, or institution engaged in an effort.

LEED Design: LEED, which stands for Leadership in Energy and Environmental Design, is a certification program focused primarily on new, commercial-building projects and based upon a points system. The more points you earn, the higher your rating.

Monocultures: the cultivation of a single crop in a given area.

Multifunctional: having several uses.

Planter Box: object that contains live flowers, usually affixed outside, just below a

window.

Primary Stakeholder: people or groups that stand to be directly affected, either positively or negatively, by an effort or the actions of an agency, institution, or organization.

Secondary Stakeholder: people or groups that stand to be indirectly affected, either positively or negatively, by an effort or the actions of an agency, institution, or organization.

Streetscape: design quality of the street and its visual effect.

Tree Canopy: also refers to the upper layer or habitat zone, formed by mature tree crowns and including other biological organisms

Benefits of GI in Milwaukee CSSA.

TBL indicator	Pilot area	CSSA
Improved aesthetics and quality of life	$2.7 million property value increase	$68 million property value increase
Job creation	$220,000 reduction in social costs per year, with a present value of $2.7 million over 20 years	$5.5 million reduction in social costs per year, with a present value of $68 million over 20 years
Reduced infrastructure costs	Not reported	66 to 77% reduction in per unit storage costs
Reduced pumping costs	$46,000 present value savings over 20 years	$1.2 million present value savings over 20 years
Increased recreational opportunities	11-acre increase in recreation area through green alleys and bioretention areas	275-acre increase in recreation area through green alleys and bioretention areas
Reduced stormwater volume	435 acre-feet of reduced runoff per year	10,875 acre-feet of reduced runoff per year
Reduced sediment loading	68 U.S. tons per year	1,700 U.S. tons per year
Increased groundwater recharge	406 acre-feet per year	10,150 acre-feet per year
Increased carbon sequestration	Reduction of 156 tons of carbon dioxide (CO_2) over 20 years	Reduction of 3,900 tons of CO_2 over 20 years
Reduced energy use and heat island effect	64,000 kWh reduction in energy use and $3,900 to $5,700 in energy savings over 20 years (due to increased shading)	1.8 million kWh reduction in energy use and $98,000 to $143,000 in energy savings over 20 years (due to increased shading)