Incorporating Green Infrastructure and Low Impact Development into the Ashland Hazard Mitigation Plan

EPA/FEMA Project Report

Image Source: Travel Oregon; Photo Credit: Sean Bagshaw

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Final Project and Lessons Learned Report

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Prepared by:
Community Planning Workshop

1209 University of Oregon
Eugene, OR 97403-1209
http://csc.uoregon.edu/cpw

UNIVERSITY OF OREGON CSC Community Service Center

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CSC Community Service Center

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Federal Emergency Management Agency (FEMA)

Brett Holt, FEMA Region 10 Mitigation Planning Program Manager

Environmental Protection Agency (EPA)

Krista Mendelman, EPA Region 10 Green Infrastructure Coordinator

Lisa Hair, EPA Headquarters Office of Water

City of Ashland, OR

Mike Fought, Public Works Director

Ciara Marshall, Water Resource Technician

Chris Chambers, Fire and Rescue Forestry Division Chief

Brandon Goldman, Senior Planner

Mark Schexnayder, Planner

Jason Wegner, GIS Manager

Juilie Smitherman, Water Conservation Specialist

Stephanie Danyi, Water Conservation Assistant

Jason Ribystelli, Wastewater Collections Supervisor

Avram Biondo, Street Division Supervisor

Steve Burkhalter, Streets Utility Technician

Technical Advisory Team

Kate Jackson, DEQ Regional Solutions Liaison

Chris Bayham, DEQ Clean Water State Revolving Fund Circuit Rider

Alyssa Mucken, Oregon Department of Water Resources Program Coordinator for Oregon's Integrated Water Resources Strategy

Don Boucher, USFS Stewardship Coordinator

Christine Shirley, DLCD NFIP Coordinator

Greg Stabach, RVCOG Natural Resources Manager

Jennie Morgan, RVSS Stormwater Permit Coordinator

Angie Lane, OEM State Hazard Mitigation Officer

Joseph Murray, OEM Hazard Mitigation Planner

Jed Roberts, DOGAMI Geologic Survey and Services Program Manager

Gustavo Monteverde, DOGAMI Geohazards Analyst

Bill Burns, DOGAMI Engineering Geologist

Stacey Detwiler., Rogue Riverkeeper Conservation Director

Michelle McMullin, NOAA Fisheries West Coast Region

Community Service Center Team

Josh Bruce, OPDR Director and Project Director

Ethan Lockwood, Project Manager

Emily Fenster, Student Consultant

Emily Hajarizadeh, Student Consultant

Michael Johnduff, Student Consultant

Kristen Sabo, Student Consultant

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About the Community Service Center

The Community Service Center (CSC), a research center affiliated with the Department of Planning, Public Policy, and Management at the University of Oregon, is an interdisciplinary organization that assists Oregon communities by providing planning and technical assistance to help solve local challenges and improve the quality of life for Oregon residents. The role of the CSC is to link the skills, expertise, and innovation of higher education with the transportation, economic development, and environmental needs of communities and regions in the State of Oregon, thereby providing service to Oregon and learning opportunities to the students involved.

About Community Planning Workshop

Community Planning Workshop (CPW) is an experiential program within the Department of Planning, Public Policy and Management at the University of Oregon. Students work in teams under the direction of faculty and Graduate Teaching Fellows to develop proposals, conduct research, analyze and evaluate alternatives, and make recommendations for possible solutions to planning

problems in Oregon communities. The CPW model is unique in many respects, but is transferable to any institution that desires to link pedagogy with community service.

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EXECUTIVE SUMMARY

The University of Oregon's Community Service Center (CSC) worked with Ashland, OR stakeholders, and state and regional partners to develop and workshop proposed natural hazard mitigation plan (NHMP) action items that utilize green infrastructure (GI) and low impact development (LID) best management practice (BMPs). These proposed action items not only reduce risk from natural hazards, but also provide important water quality, habitat, and community benefits. This project was one of two national pilot projects that emerged from a unique collaboration between the Federal Emergency Management Agency (FEMA) and the Environmental Protection Agency (EPA).

This report details the process, results, and lessons the CSC learned during this pilot project. A project poster and annotated presentation supplement this report. Together, they provide EPA and FEMA with tools to share the results and lessons learned from this project as they continue working to expand the use of GI and LID.

CSC also incorporated a final recommendations report as an appendix to the City of Ashland 2017 Natural Hazard Mitigation Plan. The report contains two recommended action items for adoption by the Ashland NHMP committee.

Throughout this project, the CSC sought to:

- Expand the range of tools used to mitigate flood and other natural hazard risks;
- Institutionalize GI/LID into natural hazard mitigation planning;
- Enable FEMA funds to be directed to GI/LID projects; and
- Promote the understanding of the co-benefits of GI/LID including improved water quality, hydrology, climate mitigation, air quality and quality of life.

This project presented a unique opportunity to analyze the intersecting goals of FEMA and EPA. Specifically, the team assessed the co-benefits of using GI and LID best management practices (BMPs) to achieve both environmental and community risk reduction benefits. This assessment, along with a community profile, provided the framework for the pilot project process. The CSC engaged a technical advisory team of city, regional, and state stakeholders in small meetings and at two large workshops to develop and review proposed NHMP action items. A GIS assessment, ecosystem service evaluation, and ordinance review were performed to develop and strengthen these action items. The project includes a set of ecosystem service overview sheets that explicitly identify co-benefit opportunities in Ashland.

Lessons Learned

Recommendations for Project Success

- While time and resource intensive, we strongly recommend that future efforts strive to engage partners (e.g. Department of Environmental Quality, Oregon Department of Water Resources Program, Public Works Transportation, etc.) who do not typically engage in GI/LID or NHMP planning activities. Broadening participation expands funding opportunities

and engages potential project implementation partners early in the process.
- Our recommendation for future efforts is to seek out complimentary partnerships that allow for the leveraging and extension of specific skills and expertise.

Stakeholder Engagement, Education, and Training

- Invest more time up front to identify and engage local project champion
- Focus outreach on relevant jurisdiction staff/departments: emergency management, public works (transportation), public works (storm water infrastructure and maintenance divisions), GIS, land use.
- Engage engineers earlier on in the process to provide additional expertise although perhaps not as necessary in the initial planning phase could be useful in obtaining community buy in.
- Identify professionals who can assess the feasibility, costs, and benefits of different GI/LID-based risk reduction approaches (consultants, engineers, watershed councils, etc.).
- Engage more stakeholders who could speak to the discrepancies between public and private land use. It is important to have people who can speak to the issues that mitigation does not always occur on an on-site scale.
- Develop a common language that can be shared across disciplines (e.g. "EPA as a Second Language" courses for emergency mangers, planners, public works practitioners, etc.). The following terminology or acronyms pose barriers to shared understanding:
    - From FEMA - HMA, PDM, 44 CFR 201.6, Risk, Vulnerability, Mitigation.
    - From EPA - TMDL, CWSRF, 319 Funds, MS4 Permit, Bioswale.
- Utilize full cost accounting models that can quantify long-term social and ecological benefits.
- As stated elsewhere, we strongly recommend engaging a wider range of funding partners at the front-end of hazard mitigation planning efforts to provide education and training on the range of funding products available.

Planning Process

- Start GIS assessment prior to first stakeholder workshop (Note: this is how we had scoped the project. However, we experienced several contract and capacity related delays working with our state partners.)
- Focus communication more on community benefits. If we had pitched GI/LID from a more social and economically beneficial standpoint for the city, we could have potentially had more buy-in earlier in the process.
- Start talking to the community earlier. It would have been helpful to speak with department heads with direct responsibility for hazards and environmental services first.
- Identify a local champion, preferably a well-respected individual in a position of authority to lead the project.
- Describe the NHMP as a tool to achieve multi-objective outcomes, rather than as a plan focused solely on hazards.

Organizational Structure

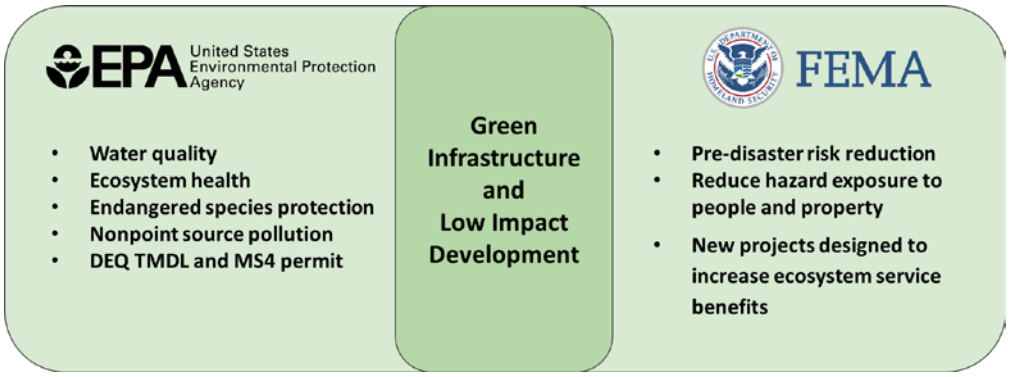
- Generally, consider regional, multi-jurisdictional NHMP actions. In Ashland specifically, consider partnering with the Rogue Valley Sewer Services district on regional water quality and floodwater management projects.
- Encourage high-level goal alignment that transcends individual departments and plans.
- Expand the range of plans being targeted for mitigation actions. For example, consider opportunities to utilize different plans to achieve hazard risk reduction objectives at different scales. In discussing the institutionalization of these projects and plans, consider whether there are benefits down the line and for what project. For example, does replacing one parking lot do anything? Or do we have to do these projects on a larger scale?
- Adopt a systems framework that promotes interdisciplinary thinking.
- Move from department-by-department decision making to a more integrated decision making model.

In 2016, the Environmental Protection Agency (EPA) Region 10 and Federal Emergency Management Agency (FEMA) Region 10 proposed a pilot project to integrate green infrastructure and low impact development strategies (GI/LID) into a natural hazard mitigation plan (NHMP). The stated goals of the project were to:

1. Expand the range of tools used to mitigate flood risk.
2. Institutionalize GI/LID into flood risk management planning.
3. Enable FEMA funds to be directed to GI/LID projects.
4. Promote the understanding of the co-benefits of GI/LID including improved water quality, hydrology, climate mitigation, air quality and quality of life.

This report presents (1) the background and methods used in the pilot, (2) summarizes project outputs, and (3) presents recommendations and lessons learned. This report is supplemented by the *City of Ashland Hazard Mitigation, Green Infrastructure, and Low Impact Development: NHMP Recommendations Report* developed by the CSC Team.

The Federal Emergency Management Agency through a grant from the Environmental Protection Agency funded this CSC team led project. The Ashland project was one of two national pilot projects that emerged from this unique partnership between the EPA and FEMA.



Background

The CSC team worked with the City of Ashland, regional stakeholders, and state agency partners to develop and workshop proposed natural hazard mitigation plan (NHMP) action items that utilize green infrastructure (GI) and low impact development (LID) best management practice (BMPs). The proposed action items are intended to reduce risk from natural hazards while providing important water quality, habitat, and community benefits.

What is GI and LID?

Green infrastructure (GI) and low impact development (LID) are cost-effective and resilient approaches to stormwater and associated natural hazard management.[1] GI and LID techniques can be used to manage weather and climate impacts in ways that also provide many environmental and community benefits. These strategies are traditionally applied to stormwater management for limiting flow, reducing pollution, and increasing the environmental health of receiving waterways.

LID and GI represent a wide range of tools and techniques that can be applied at the site, neighborhood, and regional/watershed scales. In general, the goal of GI and LID best management practices is to minimize impervious area, limit the disturbance of undeveloped lands, prevent runoff from landscapes and hardscape area, and protect land and ecosystems.[2]

Figure 1: Green Infrastructure – Low Impact Development Continuum

Source: U.S. Environmental Protection Agency

Low impact development (LID) refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration, or use of stormwater to protect water quality and associated aquatic habitat.[3] Low impact development is most commonly applied at the site or neighborhood scale. There are an extensive number of LID best management practices whose use depend on topological, environmental, and geological conditions. Common approaches include the use of rain gardens, bioswales, tree boxes, engineered soils, and stormwater planters.

Green Infrastructure (GI) uses natural and engineered practices to mimic, protect, or restore natural processes required to manage water and create healthier urban environments.[4] Green infrastructure is most commonly applied at the

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[1] https://www.epa.gov/nps/using-low-impact-development-and-green-infrastructure-get-benefits-fema-programs

[2] Best Management Practice from Low Impact Development in Western Oregon: A Practical Guide for Watershed Health

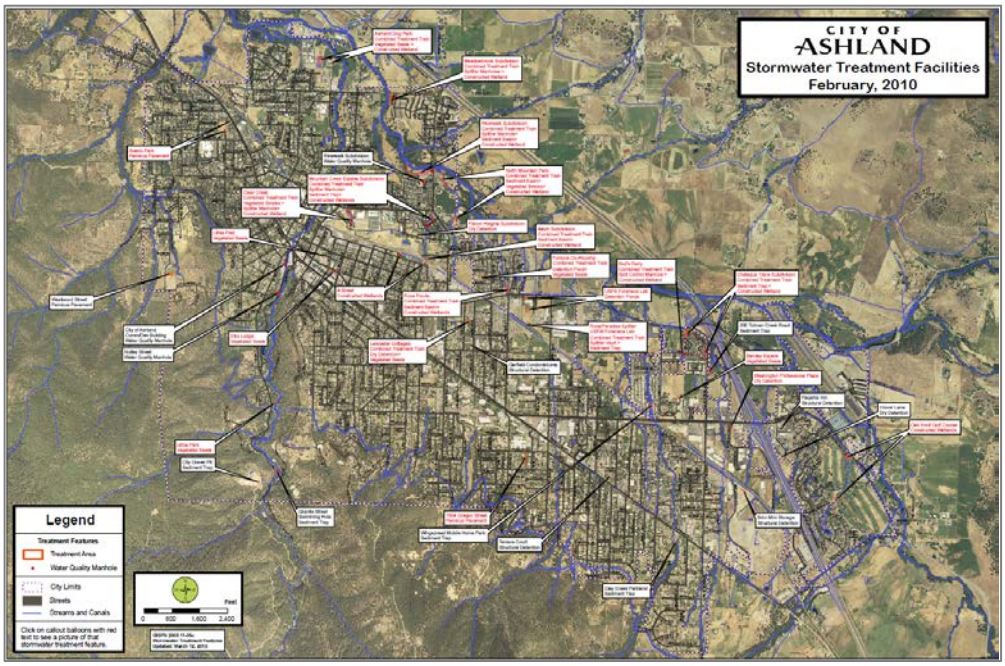
[3] Urban Runoff: Low Impact Development. EPA. https://www.epa.gov/nps/urban-runoff-low-impact-development

[4] What is Green Infrastructure? EPA. https://www.epa.gov/green-infrastructure/what-green-infrastructure

neighborhood and regional/watershed scale. Green infrastructure best management approaches can include the protection and enhancement of landscapes such as watersheds, wetlands, and floodplains. Constructed wetlands, restored and reconnected floodplains, and stream buffers are all examples of green infrastructure best management practices.

The City of Ashland is already a leader in applying GI/LID strategies to stormwater collection, conveyance, storage, and treatment. Collectively, existing GI/LID based projects already help reduce flood impacts at the local level. Figure 2 shows an inventory of stormwater facilities in Ashland as of 2010. Click on the image to access this interactive map online.

Figure 2: City of Ashland Stormwater Treatment Facilities, 2010



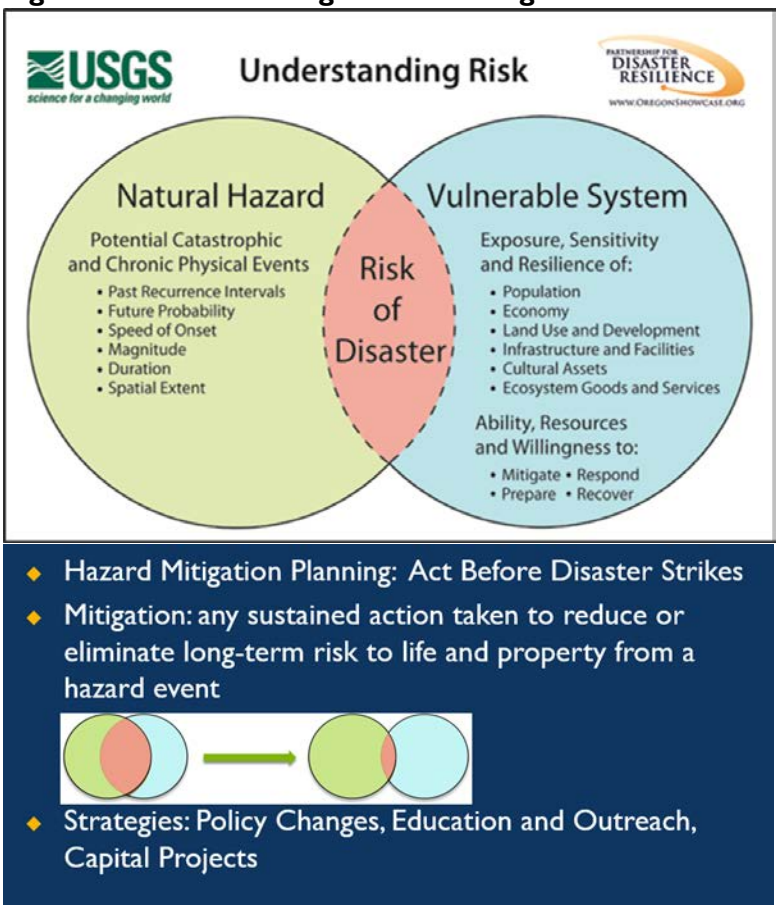
Source: City of Ashland; click on map to access interactive map online.

What is Hazard Mitigation?

The Federal Emergency Management Agency (FEMA) defines mitigation as "… the effort to reduce loss of life and property by lessening the impact of disasters …"[5] Hazard mitigation is a method of permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long- and short-term strategies. Engaging in mitigation activities provides jurisdictions with many benefits, including reduced loss of life, property, essential services, critical facilities and economic hardship; reduced short-term and long-term recovery and reconstruction costs; increased cooperation and communication within the community through the planning process; and increased potential for state and federal funding for recovery and reconstruction projects.

[5] What is Mitigation? FEMA https://www.fema.gov/what-mitigation

Figure 3: Understanding Risk and Mitigation



Source: Oregon Partnership for Disaster Resilience

Natural Hazard Mitigation Plans (NHMPs)

The Disaster Mitigation Act of 2000 (DMA2K) established regulations pertaining to planning for natural hazards. Chapter 44 Code of Federal Regulations (CFR), section 201.6, requires that local governments have an approved mitigation plan in order to receive Hazard Mitigation Assistance Grants.[6] Natural Hazard Mitigation Plans must contain the following:

- A process that includes opportunity for public comment
- A risk assessment that provides a factual basis for loss reduction strategies
- A description of community vulnerabilities
- A mitigation strategy that includes risk reduction goals and specific actions
- A plan maintenance and implementation process

Hazard mitigation plans are adopted locally and formally reviewed and approved by the Federal Emergency Management Agency. Plans must be updated at least every five years.

[6] Code of Federal Regulations, Chapter 44. Section 201.6, subsection (a), 2015

Natural Hazards in Ashland

The City of Ashland is in southwest Oregon in Jackson County between the Siskiyou and Cascade Mountains. The city is about six and a half square miles and has a population of 21,000 people. Like other cities across the country, with continued development and increased amounts of impervious surfaces, storm water runoff has increased and downstream flooding has become a large issue for the city.

Ashland's beauty and recreational opportunities have long attracted residents and visitors alike to the base of the Siskiyou and Cascade mountain ranges. Protecting and preserving Ashland's landscape is a community value that has resulted in a long-standing commitment to sustainability. Ashland's numerous energy and environmentally related city commissions, the Climate and Energy Plan, and the collaborative Ashland Forest Resiliency Project, are only a few examples. Importantly, the City is already an active user of LID infrastructure practices. As of 2010, there were close to 40 stormwater treatment facilities utilizing LID tools and approaches within the city limits.

In addition to protecting the beauty of the landscape, these existing efforts in Ashland also support hazard risk reduction objectives in the city. That said, hazard planning often appears to be secondary to environmental restoration, education, and ecosystem service goals. Importantly, our assessment is that funding requirements and contractor expertise likely informs this observation. Where EPA, USDA, or USFS funds are being used, environmental objectives are necessarily highlighted. Where FEMA funds are used, hazard risk reduction objectives are similarly highlighted. The focus of this project is to demonstrate where explicit, multi-objective outcomes can be achieved.

Wildfire

Nationally, 2017 was the most expensive wildfire season on record with roughly $2.4 billion spent on fire suppression according to the US Forest Service. The National Interagency Fire Center reports that there were 835 fires nationwide with more than 13,000 acres burned. Critical to the record breaking suppression costs were the number of fires that directly impacted communities and populated areas. Wildfires in northern and southern California resulted in numerous deaths and thousands of structures burned.

Similarly, in Ashland, recent wildfire events show that high intensity, rapid spreading, structure-threatening fires are on the rise. During the 2009 Siskiyou Fire, 109 homes and a school were evacuated under the threat of fire and in 2010, 11 homes burned in the Oak Knoll Fire. In both of these fires, none of the affected homes were in the officially designated Wildfire Hazard Zone (WHZ), a zone overlay that requires structural and environmental constraints to reduce the risk of wildfire on private property.

Hazard experts agree that Ashland and surrounding forest lands have a high risk of wildfires; a wildfire is likely to occur every 10 -35 years. Wildfire frequency and intensity are affected by complex, interrelated factors including: ecologically imbalanced forests from decades of fire suppression, development and sprawl in forested areas, and the impacts of climate change and drought.

Flooding

Flooding causes the most financial damage of any natural hazard in the United States. In 2014, flooding caused over 41% of monetary losses and 11% of all U.S. fatalities from natural hazard events. In Ashland, flooding is an annual threat, with seasonal flooding caused by intense rainy season precipitation from October to April as well as spring/summer snowmelt.

Ashland Creek is the main source of flooding in Ashland. The 15,000 acre Ashland Creek Watershed begins in the Rogue River National Forest on the slopes of Mt. Ashland and drains into Reeder Reservoir, which is south of the city and is the source of the City's municipal water supply. Ashland Creek continues below Reeder Reservoir in Ashland city limits, through Lithia Park, the Plaza, and between Oak and Helman Streets. It eventually flows into Bear Creek below the City's wastewater treatment plant along the Bear Creek Greenway. Countywide, Jackson County receives approximately 20 inches of rain per year, with about 80% occurring between October and April. Flooding in Ashland caused major damage in 1927, 1964, 1974, 1997, 2007, and 2015. The 1997 flood reached 100-year flood levels, causing $4.5 million in damage. Following the flood, Ashland was without a functional drinking water system for several weeks while crews performed repair and sanitization work.

Earthquake

The City of Ashland is categorized with a Seismic D-1 rating. This rating indicates that while Ashland is not on a fault line, earthquakes affecting the City can result in severe to destructive ground shaking. The 2011 Census shows that Ashland has 10,145 total housing units, of which 7,327 are single-family homes. A housing inventory conduction by Ashland's Community Development Department in 2013 found that 55% of all single family homes are likely not bolted to their foundation. Therefore, they are more susceptible to earthquake damage.

Similarly, brittle culvert and piped stormwater systems are susceptible to damage and failure in an earthquake event. Notably, surface stormwater conveyance systems, such as natural streams, constructed swales, or ditches are less prone to catastrophic failure during an earthquake. Further, because such systems are located at the surface, it can be easier to identify and repair damage when it occurs. This is a good example of where hazard risk reduction and ecosystem service goals and techniques can align.

Landslide

Landslides in Ashland can occur after winter flooding. An underlying issue in assessing Ashland's community risk to landslides is soil stability. Concentrated development in the Bear Creek valley is subject to increased risk from landslides, as an associated flood hazard. Steep, forested mountain slopes surrounding Bear valley pose a significant risk to Ashland from landslide events.

The Overlap of GI and LID with Natural Hazard Mitigation

GI and LID stormwater management best practices seek to treat urban stormwater onsite to improve water quality, provide habitat, and manage runoff. While these benefits are perhaps the most widely recognized, there is increasing interest in a

much wider range of co-benefits associated with GI and LID. These include natural hazard mitigation, lower lifetime infrastructure costs, improved community livability, reduced energy use, and improved air quality. GI and LID techniques can have numerous risk reduction benefits. The following list presents a range of selected examples:

- Reduce urban heat island effects through maintenance of diverse, healthy green spaces and urban forest (i.e. street trees, parking area landscaping, parks, open space, etc.);
- Improve plant health through the selection of climate appropriate species that can reduce impacts from droughts, wildfires, and landslides;
- Stabilize soils in landslide prone areas by minimizing disturbance of existing vegetation and root systems;
- Mitigate localized flooding by allowing for infiltration, surface conveyance, and storage of stormwater; and
- Reduce downstream flooding occurrences and severity by slowing, retaining, storing, and releasing collected stormwater over time.

The following table illustrates some of the co-benefits of a GI or LID project. Full circles indicate strong positive overlaps, while half circles indicate partial overlaps. The CSC utilized the Best Management Practice from Low Impact Development in Western Oregon: A Practical Guide for Watershed Health to inform the scoring categories. The CSC team then conducted a high-level evaluation of potential risk reduction and ecosystem service benefits. As presented, the results provide a starting point for discussion and should be interpreted as opportunities for further investigation.

Table 1: Co-Benefits of GI and LID

GI and LID Example Best Management Practices	Natural Hazard Mitigation			Co-Benefits		
	Flood	Wildfire	Landslide	Water Quality	Community Benefits	Habitat
Minimize Impervious Area:						
Share parking spaces						
Minimize pavement widths						
Minimize front yard setbacks	●		●	●	●	◡
Share driveway						
Minimize building footprint(s)						
Minimize roadway cross section(s)						
Limit Disturbance of Undeveloped Land:						
Sequence construction schedule						
Conserve fast(er) draining soils						
Cluster development	◡		●	◡	●	◡
Preserve/protect trees						
Minimize foundation(s)						
Minimize grading						
Prevent Runoff from Landscape and Hardscape Areas:						
Rain garden(s)						
Bioswale(s)						
Bio-retention (infiltration) basin						
(Dry) Detention basin						
Tree and landscape planting(s)	●	◡	●	●	●	◡
Remove existing pavement						
Contained planters						
Vegetated roofs (green roofs)						
Porous Pavement						
Protect Land and Ecosystems:						
Conserve open space						
Protect/preserve wetlands						
Construct wetlands	●	●	◡	●	●	●
Protect/preserve riparian areas						
Maintain/enhance urban forest (forest parks)						

Source: Best Management Practice from Low Impact Development in Western Oregon: A Practical Guide for Watershed Health with CSC additions. Co-Benefit scoring from CSC research and **should be interpreted as opportunities for further investigation**.

EPA and GI/LID

While FEMA is focused on emergency management from the human perspective, the EPA has historically focused on environmental concerns revolving around water quality and how water quality relates to the health of species and natural ecosystems. However, EPA also views GI and LID approaches as way to garner benefits associated with FEMA programs.

> "LID/GI provides many community benefits including cleaner water, wildlife habitat, enhanced aesthetics, and can be designed to supplement localized or watershed flood protection. LID/GI projects that reduce flood losses to properties insured under the National Flood Insurance Program (NFIP) may be eligible for grant funding through the Federal Emergency Management Agency

(FEMA). In addition, LID/GI projects may allow a community to claim points toward flood insurance discounts."[7]

Regarding this pilot project, the EPA has an interest in protecting endangered and threatened species and their habitat, in reducing nonpoint source pollution, and improving water quality. In improving water quality, the EPA is interested in meeting existing water quality standards such as the requirements of the Department of Environmental Quality (DEQ) Total Maximum Daily Load (TMDL) and municipal separate storm sewer systems (MS4) permits. The EPA has recognized the overlapping interest with FEMA in seeing the use of GI and LID best management practices expanded and is interested in opportunities to utilize FEMA grant funding to achieve diverse co-benefits between the agencies.

FEMA and GI/LID

In recent years, FEMA has acknowledged the risks and vulnerabilities associated with changing climate trends. Specifically siting "more intense storms, frequent heavy precipitation, heat waves, drought, extreme flooding, and higher sea levels,"[8] FEMA is focusing efforts on providing information that can help communities manage climate related risks. "FEMA's focus on risk management has expanded to anticipate climate changes and to plan and implement strategy for program development in support of climate resilient infrastructure. FEMA now integrates climate change adaptation into planning for future risk, programs, policies, and operations to strengthen the nation's resilience."[9]

Pre-disaster mitigation planning broadly focuses on reducing hazard exposure to people and property. GI and LID best management practices support FEMA goals through the use of strategies and approaches that protect, restore, and mimic natural systems. According to a recent FEMA report on innovation in hazard mitigation projects, "Implementation of LID/GI practices can help mitigate flood events by increasing the ability of the landscape to store water on site. Infiltration of these stored waters can also mitigate the effects of drought by replenishing water supply aquifers and enhancing usable water supply."[10] The report goes on to state, "GI can be used at a wide range of landscape scales in place of, or in addition to, more traditional stormwater control elements to support the principles of LID (USEPA 2014c). Both LID and GI utilize best management practices (BMPs) that can be combined in a BMP Treatment Train to enhance benefits and reduce costs."

BiOP and GI and LID

Additionally, a recently released biological opinion (BiOp) in accordance with the Endangered Species Act (ESA) compounds existing efforts to address flooding. Based on the opinion, NFIP communities, including Ashland, will need to increase habitat protections. Under the BiOp, development that degrades floodplain functions includes: clearing of native riparian vegetation; increases in impervious surface; displacement or reduction of flood storage via fill or structures;

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[7] https://www.epa.gov/nps/using-low-impact-development-and-green-infrastructure-get-benefits-fema-programs
[8] https://www.fema.gov/climate-change
[9] FEMA, *Innovative Drought and Flood Mitigation Projects*, Final Report, 2017.
[10] Ibid.

interruption of habitat forming process; increases of pollutant loading in receiving water bodies; and increases in stormwater runoff. The BiOp includes Reasonable and Prudent Alternatives (RPA) for development. These RPA's state, in part, that development cannot degrade floodplain functions in NFIP communities that are in counties with ESA listed salmonids. Thus, the introduction of GI/LID concepts to Ashland's NHMP has the potential to address flooding and floodplain management issues in an effective and cost effect manner. Further, it has the potential to benefit endangered species. NMFS's draft Reasonable and Prudent Alternatives (RPA) specifically includes recommendations that encourage the use of GI/LID related strategies in the floodplain. FEMA's *Floodplain Management and the Endangered Species Act* publication contains a number of relevant recommendations.[11]

Organization of this Report

The remainder of this report is organized as follows:

Section 2: Methods, Findings & Recommendations Summary presents the project approach and key findings.

Section 3: Lessons Learned presents key challenges, lessons learned and recommendations on how local governments and states across the county can incorporate GI/LID into their NHMPs.

[11] Federal Emergency Management Agency (2012). Floodplain Management and the Endangered Species Act. https://www.fema.gov/pdf/about/regions/regionx/nfip_esa_faq/nfip_esa_model_ordinance_final.pdf

The CSC research team used several methods to collect data and information for this project:

GIS Assessment

Existing GIS mapping data was insufficient to conduct a suitable analysis, which required detailed depth grids using current LiDAR data. To construct the necessary GIS tool would require both existing datasets from Ashland, and the generation of new datasets on flood boundaries and depths, impervious area, and alluvial deposits. The remainder of data needed to complete the analysis, such as soil types and existing wetlands projects, were obtained by using an existing tool for implementing watershed restoration.

The CSC team partnered with the Oregon Department of Geology and Mineral Industries (DOGAMI) to conduct a Geographic Information Systems (GIS) analysis of flood risk and identification of green infrastructure areas for protection and restoration and future low-impact development projects. The analysis was conducted within the City of Ashland City limits including a 200-foot buffer.

The GIS analysis consisted of data acquisition, creation, and analysis tasks. The deliverables were packaged into two geodatabases. The first database contained *secondary data* compiled from the City of Ashland's GIS office. The second database contained *primary data* created or analyzed by DOGAMI. The datasets included:

- From the City of Ashland
    - Constructed channels, creeks, pipes, and culverts layers.
- From DOGAMI
    - 10-, 25, 50-, 100-, and 500-year flood event boundaries mapped using 2009 bare earth Light Detection and Ranging (LiDAR) remote sensing data.
    - 10-, 25, 50-, 100-, and 500-year LiDAR based flood event depth grids.
    - Impervious surfaces grid based on LiDAR and orthoimagery
    - Alluvial geologic deposits

The primary data DOGAMI created for this project included raw depth grids for Ashland Creek (10%, 2%, 1% regulatory, 02%). DOGAMI used Light Detection and Ranging (LiDAR) data collected through the Oregon LiDAR consortium's (OLC) Upper Rogue Study Area. That project is part of an ongoing process collect high resolution geographic data across Oregon. Using the LiDAR information, DOGAMI created raster grids at 1m cell sizes. From these, DOGAMI processed and derived "actual flood boundaries" from the 1m raster grids. DOGAMI utilized the following steps to derive the flood boundaries: (1) raster integration, (2) boundary cleaning, and (3) delete unconnected appendages. DOGAMI output resulting maps at 300

dpi. The final step in DOGAMI's process included Certified Floodplain Manager and Technical Review Committee review and approval prior to data release.

Using this data, along with FEMA's existing Flood Insurance Rate Maps (FIRMs) and the City of Ashland's Modified Floodplain layer, the CSC team sought to identify sites where LID and GI tools could strengthen ecosystem services[12] and achieve natural hazard risk reduction. The CSC team conducted two primary GIS assessments. The first looked at floodwater storage sites and the second looked at impervious surface coverage. Importantly, because the CSC team did not receive the final Technical Review Committee approved data from DOGAMI until early May, 2017, limited in-depth data analysis or GIS comparison against local or FEMA data was feasible. Instead, the CSC team relied on non-GIS (observational) comparisons between the DOGAMI derived, locally generated, and FEMA approved flood information. Note that DOGAMI and City of Ashland GIS staff coordinated during the process. Final DOGAMI products have been delivered to the City for further analysis.

Key GIS Assessment Findings

The City of Ashland and the Oregon Department of Geology and Mineral Industries (DOGAMI) both provided GIS layers that were utilized to identify LID and GI project opportunities with natural hazard mitigation benefits. The CSC team sought to identify sites where LID and GI tools could strengthen ecosystem services and achieve natural hazard risk reduction. Two primary GIS assessments were conducted.

First, the CSC looked for undeveloped area without impervious surfaces which were inside or connected to the floodplain and had high wetland restoration potential. The DOGAMI impervious surface layer and Oregon Explorer Wetland Restoration Planning Tool (OEWRP Tool) were used.[13] The OEWRP Tool helps locate the most appropriate sites to implement restoration within a given watershed. According to Oregon Explorer, the tool strives to identify which wetland complexes are the best to restore, based on current wetland condition, land management status, suitable soils, hydrology, and proximity to existing restoration projects, and also what plant materials to use for the job. Overall, the CSC team's analysis suggested that suitable sites exist for flood storage and floodplain restoration projects along Bear Creek and Ashland Creek in the low-lying portion of Ashland's city limits.

Second, the CSC identified the 2007 Ashland Watershed Assessment's analysis of impervious surface coverage of inter-city drainages as a resource to identify portions of the city that have increased risk of localized flooding and that contribute to the severity and occurrence of water channel overtopping and

[12] Ecosystem services produce many life-sustaining benefits we receive from nature. For example, clean air and water, fertile soil for crop production, pollination, and flood control. An ecosystem is a dynamic network of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit, and ecosystem services are the benefits people obtain from ecosystems.

[13] Oregon Explorer. Oregon State University Libraries and Press and the Institute for Natural Resources. Accessed June 7, 2017 at http://oregonexplorer.info/content/oregon-wetland-restoration-planning-tool?topic=4138&ptopic=98&qt-subtopic_quicktab=3

downstream flooding.[14] The DOGAMI impervious surface layer was used to compare the findings of the Ashland Watershed Assessment against current conditions. This analysis confirmed that there is substantial public and private impervious surface within many of the inter-city drainages that are contributing to localized and downstream flooding risk.

Ecosystem Service Evaluation

According to the Environmental Protection Agency (EPA), ecosystem services produce many life-sustaining benefits we receive from nature — clean air and water, fertile soil for crop production, pollination, and flood control to name only a few.[15] An ecosystem is a dynamic network of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit, and ecosystem services are the benefits people obtain from ecosystems.[16] Urbanization and development often decreases the ability of these ecosystem services to mitigate risks from natural hazard. For instance, impervious surfaces can decrease stormwater infiltration, reducing groundwater recharge, and increase runoff exacerbating sedimentation and the rate and severity of both localized and downstream flooding. However, green infrastructure and low impact design approaches can protect, support and strengthen these services and their natural hazard mitigation benefits in Ashland and other communities.[17]

Traditionally, many ecosystem services have been taken for granted and many were not appropriately understood or valued. However, this has changed significantly in recent years. In 2013, FEMA became the first federal agency to adopt a major policy change that recognizes ecosystem services in benefit-cost analysis (BCA).[18] Further, in 2015, FEMA expanded its consideration of ecosystem services in BCA from just flood acquisition projects to include flood, fire, and drought related projects that address climate change.[19] Table 6 presents updated ecosystem service values that can be used to complete FEMA's benefit cost analysis.[20]

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[14] Bear Creek Watershed Council (2007). "Ashland Watershed Assessment and Action Plan." Accessed July 7, 2017 at http://www.rogueriverwc.org/wp-content/uploads/2015/05/Ashland-Watershed-Assessment-part-1.pdf

[15] Ecosystem Services. The Environmental Protection Agency (EPA). Accessed July 13, 2017 at https://www.epa.gov/eco-research/ecosystem-services

[16] Ecosystem Services, The National Wildlife Federation. Accessed June 4, 2017, at https://www.nwf.org/Wildlife/Wildlife-Conservation/Ecosystem-Services.aspx.

[17] Millennium Ecosystem Assessment. Accessed June 4, 2017 at http://www.millenniumassessment.org/en/index.html

[18] FEMA Takes on Climate Change – By Funding Restoration. Earth Economics. Accessed July 13, 2017, at http://www.eartheconomics.org/latest-news-blog/2016/8/29/fema-takes-on-climate-change-by-funding-restoration

[19] Benefit-Cost Analysis Tools for Drought, Ecosystem Services, and Post-Wildfire Mitigation for Hazard Mitigation Assistance. Federal Emergency Management Agency (FEMA). Accessed July 13, 2017

[20] FEMA. FY 2017 Mitigation Grant Application Cycle - Lessons Learned and Best Practices for Application Development. August, 2017. https://www.fema.gov/media-library/assets/documents/133770

Table 2: Ecosystem Service Benefit Values

Updated Ecosystem Service Matrix (USD 2014 per acre per year)					
Ecosystem Service	**Green Open Space**	**Riparian**	**Forest**	**Wetland**	**Marine & Estuary**
Aesthetic Value	$1,707	$612		**$3,640**	
Air Quality	$215	$226			
Biological Control		$173			
Climate Regulation	$61	$81	**$153**	**$136**	**$63**
Erosion Control	$68	$12,042			
Flood Hazard Reduction		$4,215	**$321**		
Food Provisioning		$641			
Habitat		$878			**$1,214**
Nutrient Cycling				**$536**	**$522**
Pollination	$305				
Recreation/Tourism	$5,644	$15,967			
Stormwater Retention	$308				
Water Filtration		$4,473		**$1,406**	
Water Supply		**$237**	**$80**	**$292**	
Total Annual Value	**$8,308**	**$39,535**	**$554**	**$6,010**	**$1,799**

Source: FEMA Hazard Mitigation Assistance – NTR Webinar.

Increased understanding and utilization of ecosystem services are based in extensive scientific study and documented in peer reviewed scientific literature. Ecosystem services are often grouped into four primary categories:[21]

- Provisioning services
  - Provide materials for humans to use.
- Regulating services
  - Preserve and maintain ecosystem benefits (e.g. water quality).
- Cultural services
  - Consist of recreational, aesthetic, and spiritual benefits; and
- Supporting services
  - Involve ecological processes which make other services possible (e.g. nutrient cycling, soil formation).

Key Ecosystem Service Findings

The CSC identified eight (8) ecosystem services with natural hazard risk reduction benefits: Stormwater infiltration, Freshwater provisioning, Surface water conveyance, Sediment retention, Floodwater storage, Wildfire resilience, Steep slope stability, Cultural and livability services. For each of these ecosystem services, the CSC team created one-page service and risk reduction overview sheets. Each sheet describes the ecosystem service, locates the service within the Ashland watershed, presents LID/GI and risk reduction best practices that support the service, and recommends specific actions the city could take in the future. The CSC team included the ecosystem service findings as an appendix to the Ashland recommendations report. The intent of the Ecosystem Service overview sheets is to explicitly identify co-benefit opportunities in Ashland.

[21] Ecosystem Services. The Economics of Ecosystems and Biodiversity (TEEB). Accessed July 13, 2017. http://www.teebweb.org/resources/ecosystem-services/

The results of this ecosystem service evaluation showed that the largest natural hazard mitigation benefits provided by ecosystem services are a reduction the occurrence and severity of localized and downstream flooding. In general, a minimization of impervious surfaces and enhancement of landscapes with flood storage potential were found to have the greatest natural hazard risk reduction potential. The ecosystem service evaluation and summary sheets can be used to inform future hazard mitigation project opportunities.

Ordinance Review

The CSC team reviewed the Ashland Municipal Code (AMC) to identify existing support and barriers to achieving natural hazard mitigation goals with GI/LID approaches. Ashland's Municipal Code (AMC) regulates development and land use at the site, neighborhood, and city-wide scale for public safety and welfare. Within the scope of natural hazard management, the AMC guides development and design standards to protect residents and developments from natural hazards, while preserving and protecting community, cultural, and environmental assets.

This ordinance review sought to first identify how natural hazard mitigation is addressed in the city's regulatory framework, and second to identify specific, existing tools for implementing green infrastructure and low impact development projects in the code.

The AMC includes both natural hazard and GI/LID design and development standards in the code's regulatory framework. These code sections often internally cross-reference natural hazard management and GI or LID design standards. For example, the Croman Mill District's Green Development Standard at AMC 8.3.2.060.C(1) regulates for conservation and preservation of water quality, natural hydrology and habitat, and biodiversity through stream and wetland protection. These development standards are to be applied in addition to natural hazard management standards under the AMC 18.3.11 Water Resources Overlay, in applicable areas.

Key Ordinance Review Findings

The Ashland Municipal Code (AMC) was reviewed to first identify how natural hazard mitigation is addressed in the city's regulatory framework, and second to identify existing tools for implementing green infrastructure and low impact development projects in the code. The following were key findings from this process:

- Within the Ashland Urban Growth Boundary (UGB), there is limited developable land left. The larger undeveloped areas, such as the Crowman Mill District, have already undergone extensive master planning processes that encourage and describe the use of LID and GI best management practices (BMPs) to treat stormwater and reduce runoff from sites.
- Ashland's Physical and Environmental Constraint Overlay and Water Resource Protection Zone Overlay provide significant protection of landscapes with ecosystem services such as steep slope stability, sediment retention, surface water conveyance, and floodwater storage that provide natural hazard risk reduction benefits.

- Ashland's Site Development and Design Standards regulate the impact of new parking lots and streets. Large parking lots must include a combination of low impact development strategies to mitigate environmental and micro-climate impacts. This section also requires minimization of pavement areas for neighborhood streets, to "reduce street and maintenance costs, storm water runoff, and negative environmental impacts." Further, the section has a "peak run-off" requirement which seeks to reduce "peak storm water run-off into the city's storm drain system and natural water ways."
- Based on this assessment of the AMC, Ashland may qualify for additional points in FEMA's Community Rating System (CRS) through their inclusion of LID and GI best management practices in the AMC. This could potentially lead to a lower-class rating that corresponds to a larger insurance premium discount for flood insurance policy holders.

NHMP Actions Review and Recommendations

To develop GI/LID based action items, the CSC team first reviewed the requirements contained in 44 CFR 201.6, the federal regulations governing the development of Natural Hazard Mitigation Plans under the Disaster Mitigation Act of 2000. The team then reviewed the City of Ashland's existing mitigation strategy documented in the 2012 NHMP. The CSC team found that a number of existing action items already contain or could incorporate GI/LID components. Table 3 presents the existing NHMP actions with highest GI/LID connection potential.

Table 3 – Existing Action Item Description

Action Item	Coordinating Agency	Action Item Description
Multi-Hazard #9	Community Development	Evaluate Land Use Policies in High Risk Areas: Evaluate the City's land use policies and develop recommendations for land use provisions for future developments.
Flood #1	Fire and Rescue	Flood Hazard Awareness Campaign: Create an awareness and education effort in Ashland of the flood prone areas with emphasis on planning and probability. Deliver an education and awareness campaign to the community to allow for private preparation and mitigation efforts.
Earthquake #3	Fire and Rescue	Non-structural seismic upgrades for the City's Critical Infrastructure: Identify cost-effective upgrades that can be implemented, and prioritize the implementation of these.
Earthquake #5	Fire and Rescue	Seismic Risk Assessment: Evaluate the risk to current critical infrastructure to prioritizing future projects for structural upgrades.
Landslide #1	Public Works	Water Treatment Plant Relocation: Construct and place into service a water treatment plant in a new location that is not prone to landslides.
Wildfire #1	Fire and Rescue	Ashland Forest Resiliency Project: Identify funding to complete the implementation of the current Ashland Forest Resiliency Stewardship Project (AFR).
Wildfire #2	Fire and Rescue	Ashland Firewise Communities: The Firewise program is Ashland's primary tool for residential vegetation management and public education of fire resistant landscaping and construction..

Source: Ashland NHMP 2012

Existing GI/LID Integration Opportunities.

For each of the existing NHMP actions with GI/LID potential, the CSC team described how the NHMP/GI/LID connection could be made explicit. Notably, the

lead agency is important in determining the extent to which GI/LID considerations are made.

Multi-Hazard #9

Evaluate Land Use Policies in High Risk Areas: Evaluate the City's land use policies and develop recommendations for land use provisions for future developments.

GI/LID Connection Opportunity

Ashland could intentionally integrate GI/LID in natural hazard mitigation through building code, zoning, and community development policy. Additionally, GI/LID model codes and ordinances could be used to identify existing risk reduction opportunities. The NHMP could include a section on how the codes and policies are to be examined for these opportunities.

Flood #1

Fire and Rescue Flood Hazard Awareness Campaign: Create an awareness and education effort in Ashland of the flood prone areas with emphasis on planning and probability. Deliver an education and awareness campaign to the community to allow for private preparation and mitigation efforts.

GI/LID Connection Opportunity

During the risk and vulnerability assessment process, there is opportunity for identification of GI/LID flood mitigation possibilities. This could be reflected through mapping or data assessment reports. Additionally, the NHMP could include awareness campaign development action(s). These could include development of education on LID tools describing how private property owners can mitigate localized flood risk. In addition, strategies and incentives for upland property owners to reduce downstream flood risks could be included.

Earthquake #3

Non-structural seismic upgrades for the City's Critical Infrastructure: Identify cost-effective upgrades that can be implemented, and prioritize the implementation of these.

GI/LID Connection Opportunity

Consider how GI/LID improvements may be cost effective methods of helping to protect some critical infrastructure in Ashland. The mitigation plan could include requirements of consideration of GI/LID opportunities in the cost/benefit analysis process. Importantly, FEMA now allows for consideration of ecosystem benefits during the Benefit Cost Assessment. Specific examples include FEMA's Flood Diversion & Storage and Floodplain & Stream Restoration BCA modules. Additional education and training for local emergency managers and floodplain managers is needed to raise awareness about these new tools.

Earthquake #5

Seismic Risk Assessment: Evaluate the risk to current critical infrastructure to prioritizing future projects for structural upgrades.

GI/LID Connection Opportunity

Consider how or where GI/LID may allow or supplement structural upgrades especially in regards to water infrastructure. Relocation of water and wastewater facilities outside flood or liquefaction prone areas is one way to address this action. Note the FEMA Hazard Mitigation Assistance funds may not be the best source for projects of this type. Identification of other funding opportunities, such as EPA, may require additional education and training of local emergency managers and floodplain managers who are unfamiliar with non-FEMA funding programs.

Landslide #1

Water Treatment Plant Relocation: Construct and place into service a water treatment plant in a new location that is not prone to landslides.

GI/LID Connection Opportunity

Consider how the existing site may function from a GI approach and utilize GI/LID in the development of the new treatment plant. EPA's Green Infrastructure Technical Assistance Program can be utilized to assess where green infrastructure can be utilized in water infrastructure projects. Specifically, EPA provides technical assistance to communities working to overcome common barriers to green infrastructure. More information is available at: http://water.epa.gov/infrastructure/greeninfrastructure/gi_support.cfm. EPA's case study on the Iowa City North Wastewater Treatment Plant Restoration project presents a detailed local implementation example.

Wildfire #1

Ashland Forest Resiliency Project: Identify funding to complete the implementation of the current Ashland Forest Resiliency Stewardship Project (AFR).

GI/LID Connection Opportunity

The AFR has demonstrated a GI approach to managing the watershed in a landscape wide, ecosystem-based approach that seeks to mitigate intensity and impact of wildfire on public/private property and public infrastructure. By approaching the AFR as watershed protection strategy in addition to a strictly wildfire risk reduction approach, funding through the Clean Water State Revolving Fund and Drinking Water State Revolving Fund may be available. Providing additional education and training of local emergency managers and fire protection agencies who are unfamiliar state revolving fund opportunities may be necessary. Note that the 1992 AFR plan was updated in 2016 and governs 1,131 acres of City and Parks Commission managed forests in and around the Ashland City limits.

Wildfire #2

Ashland Firewise Communities: The Firewise program is Ashland's primary tool for residential vegetation management and public education of fire resistant landscaping and construction.

GI/LID Connection Opportunity

Firewise provides residents the tools to create fire safe landscaping and use fire-resistant construction materials to protect lives, property and firefighters in the event of a wildfire. Notably, Firewise promotes the creation of defensible space through vegetation removal, planting of non-native species, increasing impervious surface as a fire defense around homes, etc. This highlights the potential trade-offs where multiple hazards require consideration (e.g. wildfire in landslide or flood prone areas). In such cases, Firewise and LID could be seen as have competing goals. Ashland can work to identify opportunities where LID strategies can complement the Firewise program. Ultimately, encouraging the use of compatible LID approaches as part of a Firewise program could result in multi-objective natural hazard risk reduction strategies.

GI/LID Informed Action Items

Once the CSC completed its initial review of existing actions, they engaged local community stakeholders and the TAT to investigate and develop new GI/LID based risk reduction opportunities for the City of Ashland NHMP. To engage local stakeholders, the team facilitated two workshops. At the first workshop, the CSC team delivered a presentation on EPA and FEMA's intersecting interests in (1) expanding the use of GI/LID, (2) determining what GI/LID techniques include, and (3) identifying how GI/LID tools can help mitigate Ashland's risk from natural hazards including flooding, wildfire, earthquake, and landslide.

The CSC team provided background on Jackson County's NHMP policy for natural hazard mitigation in Ashland. Using a process model called a world café,[22] the meeting participants discussed the following topics:

- local plans and regulations,
- structure and infrastructure projects,
- natural systems protections, and
- education and awareness program categories

The purpose of the world café exercise was to identify ways to institutionalize GI/LID strategies in NHMP action items. Participants also identified environmental co-benefits of GI/LID, funding opportunities, and administrative strategies for developing GI/LID objectives into NHMP action items. For more information, refer to the *City of Ashland Hazard Mitigation, Green Infrastructure, and Low Impact Development: NHMP Recommendations Report.*

At the second workshop, the CSC team began by presenting findings from the GIS assessment, ecosystem service evaluation, and ordinance review. With that context, the team then presented a set of potential GI/LID based mitigation actions for consideration and discussion. After introducing each action, the CSC team first solicited feedback on potential project timelines as well as potential lead staff,

[22] A World Café or Knowledge Café is a structured conversational process for knowledge sharing in which groups of people discuss a topic at several tables, with individuals switching tables periodically and being introduced to the previous discussion at their new table by a "table host".

departments or agencies individuals who could help move the recommended action items forward if Ashland chose to do so.

The potential actions summarized in the following table and described in more detail below. To evaluate each of the actions, the CSC team presented a modified version of FEMA's STAPLEE criteria. This set of criteria assesses possible mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) constraints and opportunities of implementing the mitigation items. Under STAPLEE, participants assign scores to each action across each of the STAPLEE categories. This approach is a recognized evaluation method for NHMP action items when detailed benefit/cost or cost effectiveness analysis may not be practical. Furthermore, it was already an existing component of Ashland's NHMP.

Table 4: Draft NHMP Action Items

Recommendation	Description	Modified STAPLEE Score (0-8)
Develop Increased Floodwater Storage Project along Bear and Ashland Creek	Initiative to increase storage of floodwater at flood risk sites through GI/LID method.	**3.6**
Develop a City "Green Streets" Program	Retrofit LID best management practices within the city owned right of way.	**3.3**
Develop a LID Retrofit Incentive Program for Private Landowners	Incentivize private landowners to retrofit LID best management practices on their property.	**3.1**

Source: CSC Team

After reviewing the TAT feedback, the team modified two of the action items as final recommendations for consideration by the Ashland NHMP committee. The final recommendations are:

- **Develop Increased Floodwater Storage Project along Bear and Ashland Creek.** Restore wetlands and use techniques like floodplain benching along Bear and Ashland Creek to increase floodwater storage capacity and reduce flood risk.
- **Develop a City Led "Green Streets" Program.** Expand the use of GI/LID BMPs in development codes such as bioswales in city owned right-of-way to minimize local and downstream flooding.

Develop Increased Floodwater Storage Projects along Bear and Ashland Creek

Action:

This would minimize the occurrence and severity of flood events by increasing floodwater storage by restoring wetlands and improving the floodplains ability to store flood water along Bear and Ashland Creek. Co-benefits would include improved habitat, water quality (including compliance with TMDL goals), and water conveyance.

GI/LID Best Management Practices

Divert and store stormwater to mitigate localized flooding, protect urbanized floodplains, and mitigate downstream flood effects through wetland restoration, bio-swale installation, and floodplain benching, increased connectivity, and vegetation.

Lead Organization

Ashland Public Works and
Ashland Parks and Recreation

Internal Partners:

- Ashland Public Works
- Ashland Community Development Department
- Bear Creek Watershed Council/ Rogue Valley Council of Governments

External Partners:

- Federal Emergency Management Agency
- Environmental Protection Agency
- National Marine Fisheries Service
- Oregon Department of State Lands
- Oregon Watershed Enhancement Board
- Oregon Department of Environmental Quality
- Oregon Water Resources Department
- U.S. Army Corps of Engineers – Silver Jackets

Potential Funding Sources:

- FEMA Hazard Mitigation Assistance (HMA) Grant
- Ashland Public Works Stormwater & Drainage Capital Improvement Plan
- Ashland Parks and Recreation Department Funds
- DEQ Clean Water State Revolving Fund and 319 funds (for TMDL waters)
- DEQ Drinking Water Fund
- Oregon Water Resources Development Program

Develop a City Led "Green Streets" Program

Action:

Increase rainwater infiltration and decrease stormwater runoff in areas with high impervious surface coverage to reduce localized and downstream flooding through expansion of City-led implementation of "green streets" in high impervious surface inter-city drainages and near floodplains. Co-benefits would include improved water quality, both on-site and downstream, through on-site stormwater treatment and increased infiltration

GI/LID Best Management Practices:

Use pervious street paving and sidewalk treatments such as flow through planters, planting strips, tree boxes and bioretention features according to approved design standards to reduce the impact of development on the Ashland watershed.

Lead Organization

Ashland Public Works

Internal Partners:

- Ashland Community Development Department
- Ashland Parks and Recreation Commission

External Partners:

- Bear Creek/Rogue Valley Council of Governments
- Oregon Department of Environmental Quality
- Oregon Water Resources Department
- Environmental Protection Agency
- Federal Emergency Management Agency

Potential Funding Sources:

- FEMA Hazard Mitigation Assistance (HMA) Grant
- Ashland Public Works Stormwater & Drainage Capital Improvement Plan
- DEQ Clean Water State Revolving Fund
- Oregon Water Resources Development Program

This section presents lessons-learned throughout this project and presents recommendations on how local governments and states across the country can incorporate GI/LID into their NHMPs. We've organized the lessons learned into the following categories:

- Project Successes
- Stakeholder Engagement
- Planning Process
- Organizational Structure

Project Successes

This project was successful on several fronts. First, we engaged disciplines and groups not normally involved in Natural Hazard Mitigation Planning. These included representatives from the Department of Environmental Quality (both at the regional and state level); the state Water Resources Department and local Water Conservation Division; local non-profits, such as Rogue Riverkeeper and Klamath Siskiyou Wild. In selected cases where stakeholders were unable to attend our workshops in Ashland, we made time to attend meetings not anticipated in our Scope of Work. For example, we attended a meeting of the Rogue River Watershed Council – Bear Creek Working Group to provide a project briefing and solicit feedback. ***While time and resource intensive, we strongly recommend that future efforts strive to engage partners who do not typically engage in GI/LID or NHMP planning activities. Broadening participation is a key principle of community resilience. Expanding the depth and breadth of participation can promote innovation and encourage multi-objective risk reduction and environmental quality outcomes.***

Another place we were successful was our contract with the Department of Geology and Mineral Industries. While we could have done a better job managing the delivery of mapping products, partnering with DOGAMI increased our capacity and provided mapping and assessment products that are consistent with other projects in the Upper Rogue Watershed. This collaboration led to the UO team partnering with a DEQ representative and member of the Governor's Regional Solutions Team to present GI/LID-based hazard mitigation approaches to other communities in Jackson County as part of the State RiskMAP program. ***Our recommendation for future efforts is to seek out complimentary partnerships that allow for the leveraging and extension of specific skills and expertise. Hazard mitigation activities should not be limited to emergency management. Partnerships encourage cross-disciplinary learning. Furthermore, collaboration can reduce duplication of effort, capitalize on existing expertise, and expose local partners to new programs, funding opportunities, and perspectives.***

Finally, this project successfully expanded the list of potential funding opportunities for mitigation planning. Too often, funding is cited as a primary constraint on project implementation. This project identified DEQ, EPA, and State Water Resources funds that can be used to achieve a range of multi-objective ecosystem

service and risk reduction benefits. Furthermore, the project achieved a stated objective to link GI/LID risk reduction approaches with FEMA funding streams. ***As stated elsewhere, we strongly recommend engaging a wider range of funding partners at the front-end of hazard mitigation planning efforts to provide education and training on the range of funding products available. FEMA funding for mitigation projects, particularly pre-event are limited. Expanding the range of funding opportunities could increase the number of risk reduction project implemented through Natural Hazard Mitigation Plans.***

Stakeholder Engagement

The integration of natural hazard planning with ecological design requires collaboration and involvement across institutions and scales. According to the Stockholm Resilience Center, "Broad and well-functioning participation can build trust, create a shared understanding and uncover perspectives that may not be acquired" through traditional, discipline-specific planning processes."[23] Along these lines, the CSC team sought to convene a broad range of project advisors. Specifically, we solicited participation from local, regional, state, and federal partners across a range of disciplines – from emergency management to ecological management. Despite this, participation varied.

Furthermore, we observed varying levels of awareness and understanding of both GI/LID and natural hazard mitigation. Emergency management personnel exhibited limited awareness of EPA programs and terminology. Conversely, watershed restoration and water quality personnel had limited awareness of FEMA programs and terminology. In retrospect, the team could have included focused training on GI/LID benefits. Providing more time to focus on the nexus between hazard risk reduction, economic, social, and environmental benefits could have been an effective way to ensure stakeholders were able to assess issues from a point of shared understanding.

Resilience research suggests that engaged stakeholder discussions require baseline knowledge and understanding of the topics, issues, and opportunities being discussed. Thus, ongoing learning and experimentation are, "important mechanisms for building resilience in social-ecological systems. It ensures that different types and sources of knowledge are valued and considered when developing solutions, and leads to greater willingness to take risks."[24] Cross-disciplinary education and training on relevant programs is one suggestion. For example, EPA could offer "EPA as a Second Language" courses targeted at emergency managers. The courses could introduce key terminology, GI/LID concepts, and funding programs relevant to risk reduction activities.

CSC identified the following challenges related to stakeholder engagement:

[23] Applying Resilience Thinking: Seven Principles for Building Resilience in Social-Ecological Systems. Stockholm Resilience Center. Stockholm University.
[24] Ibid.

Table 5: Engagement Lessons

Issue	Challenge	Impact
Participation	Funding lag contributed to lack of local capacity and buy-in at project kickoff	Limited local buy in and participation
Participation	Challenge getting the "right" people in the room	Workshops not as affective as they could have been
Participation	Engineering feasibility of specific interventions questioned	Conversation about potential strategies got sidetracked at times
Participation	Engineering disciplines not well represented	It was hard to address specific questions about GI/LID project feasibility
Participation	Limited private sector involvement	Public sector reluctant to consider private sector interventions.
Language	Lack of common language between GI/LID and NHMP audiences	Level of information was at times basic for some and advanced for others. Challenging to see shared benefits at times.
Language	Discussing GI/LID economic benefits appeared to resonate better than social, environmental, or hazard risk reduction benefits	Conversation tended to focus on short-term costs and benefits

Source: CSC Team

Engagement Lessons Learned and Recommendations

1. Invest more time up front to identify and engage local project champion
2. Focus outreach on relevant jurisdiction staff/departments: emergency management, public works (transportation), public works (stormwater infrastructure and maintenance), GIS, land use, etc.
3. Engage engineers earlier on in the process to provide additional expertise although perhaps not as necessary in the initial planning phase could be useful in obtaining community buy in.
4. Identify professionals who can assess the feasibility, costs, and benefits of different GI/LID-based risk reduction approaches.
5. Engage more stakeholders who could speak to the discrepancies between public and private land use. It is important to have people who can speak to the issues that mitigation does not always occur on an on-site scale.
6. Develop a common language that can be shared across disciplines (e.g. “EPA as a Second Language” courses for emergency mangers, planners, public works practitioners, etc.). The following terminology or acronyms pose barriers to shared understanding:
    - From FEMA - HMA, PDM, 44 CFR 201.6, Risk, Vulnerability, Mitigation.
    - From EPA - TMDL, CWSRF, 319 Funds, MS4 Permit, Bioswale.
7. Utilize full cost accounting models that can quantify long-term social and ecological benefits.

Planning Process

This process sought to link a variety of local goals and objectives. These ranged from property- and life-safety considerations to values associated with water quality, natural habitat, and “alternative” infrastructure methods. According to the Stockholm Resilience Center, acknowledging the “complex interactions and dynamics that exist between actors and ecosystems in a social-ecological system” is

vital in achieving ecosystem service benefits.[25] However, because these topics have not been explicitly linked historically in Ashland, the CSC team struggled at times to adequately address these social dynamics and complexities.

Another process issue that arose was that some state agency advisors were unable to travel to Ashland for meetings. In order to ensure participation, the team scheduled additional technical advisory meetings in Salem to solicit feedback. This was a successful way to engage a state agency technical advisors from the Office of Emergency Management, Department of Geology and Mineral Industries, Water Resources Department, and Department of Land Conservation and Development. In addition, we presented project information and solicited feedback directly from the State Interagency Hazard Mitigation Team.

CSC identified the following challenges related to planning process:

Table 6: Process Lessons

Issue	Challenge	Impact
GIS Assessment Timing	GIS outputs not available until late in the project	Limited ability to incorporate GIS into GI/LID opportunity assessment prior to stakeholder engagement
Communication	Not enough focus on community benefits	Limited local buy-in
Local Champion	No clear champion or local leader until late in the project	Limited local buy-in
Marketing	Hard to identify language that resonated with professionals from across the spectrum.	Didn't always have the "right" people in the room
Marketing	Using the NHMP to solicit engagement didn't always resonate with stakeholders.	Didn't always have the "right" people in the room

Source: CSC Team

Planning Lessons Learned and Recommendations

1. S tart GIS assessment prior to first stakeholder workshop (Note: this is how we had scoped the project. However, we experienced several contract and capacity related delays working with our state partners.)
2. Focus communication more on community benefits. If we had pitched GI/LID from a more social and economically beneficial standpoint for the city, we could have potentially had more buy-in earlier in the process.
3. Start talking to the community earlier. It would have been helpful to speak with department heads with direct responsibility for hazards and environmental services first.
4. Identify a local champion, preferably a well-respected individual in a position of authority to lead the project.
5. Describe the NHMP as a tool to achieved multi-objective outcomes, rather than as a plan focused on hazards.

Organizational Structure

The City of Ashland has a fairly typical city governance structure. As a relatively small community, most of the local stakeholders we engaged knew each other. That said, some local participants reported that they had not interacted directly in

[25] Ibid.

a work setting. Some regional, state, and federal stakeholders had never met. This lack of horizontal and vertical connectively presented challenges for this project. For example, participants had different sources of information. Particularly as it related to programmatic goals, objectives, and language used. According to the Stockholm Resilience Center, "[w]ell-connected governance structures can swiftly deal with change and disturbance because they are addresses by the right people at the right time."[26] For example, because this project focused on the City of Ashland, the CSC team struggled to address opportunities with downstream risk reduction benefits (i.e. flood storage at the edge of the city limit that would benefit county or downstream cities). Even with regional partners in the room, the various organizational, regulatory, planning, and funding structures acted to limit integration.

CSC identified the following challenges related to organizational structure:

Table 7: Organizational Structure Lessons

Issue	Challenge	Impact
Jurisdictional boundaries	Hard to capture costs locally for benefits that occur regionally	Flood storage projects challenging to implement because most benefits are outside city
City Structure	Hard to align goals across departments and plans	Limited incentives for cross-disciplinary participation
Plan Topic and Scale	Some issues may have had a risk reduction benefit, but may not have been best addressed through he NHMP	Private property interventions were not seen as viable.

Source: CSC Team

Organizational Lessons Learned and Recommendations

1. Generally, consider regional, multi-jurisdictional NHMP actions. In Ashland specifically, consider partnering with the Rogue Valley Sewer Services district on regional water quality and floodwater management projects.
2. Encourage high-level goal alignment that transcends individual departments and plans.
3. Expand the range of plans being targeted for mitigation actions. For example, consider opportunities to utilize different plans to achieve hazard risk reduction objectives at different scales. In discussing the institutionalization of these projects and plans, consider whether there are benefits down the line and for what project. For example, does replacing one parking lot do anything? Or do we have to do these projects on a larger scale?
4. Adopt a systems framework that promotes interdisciplinary thinking.
5. Move from department-by-department decision making to a more integrated decision making model.

[26] Ibid.

APPENDIX A: CPW STUDENT TEAM LESSONS LEARNED SUMMARY

This appendix is supplemental to the recommendations and lessons learned contained in the body of the report. The CSC student team prepared theses draft lessons learned as part of their reflection on the project.

Participation

- FEMA is trying to expand their scope to valuing some of the non-hazard related benefits of GI/LID projects to get community buy in. Much of this depends on engineer expertise in the project. Therefore, engaging engineers earlier on in the process to provide additional expertise although perhaps not as necessary in the initial planning phase could be useful in obtaining community buy in.

Co-Benefits

- In our discussion of the co-benefits, we should have worked in a discussion about the regional specificity and how these projects fit in on a regional scale. In this discussion, we could have talked about the co-benefits to the watershed as a whole, where in the community they could potentially see benefits, and we could have also discussed the distributed costs and benefits regarding the GI/LID action item.
- We should have discussed more of the ecosystem services within the community and how they are situated within the region and how they influence the community. More of a social approach to ecosystem services instead of purely scientific.

Process

- Received feedback that we should have discussed social, legal, and environmental criteria further, particularly social.
- We should have focused more on specific economic benefits. In workshop 1, we focused broadly on economics citing, “A dollar spent by FEMA on hazard mitigation benefits provides the nation about $4 in future benefits.” Based on feedback received in workshop #2, we should have talked more specifically about the cost-benefit analyses related to each action item.
- We should have facilitated more cross-communication. In this workshop, people were mostly discussing their individual perspectives or their organizations individual perspectives. Additionally, we should have tied the recommendations and discussion more into the context of Ashland. We should have discussed how we can use what they have already done to accomplish these projects or how these projects compliment what is already going on.
- Received feedback that we should have discussed social, legal, and environmental criteria further, particularly social.

Geographic Scale

- In the discussion of economics, we should have broken the discussion down further to community level. The FEMA statistic on economic benefits is true for aggregate costs, however the federal government is most likely dealing with those. In order to get community buy in an investment early, we have to extensively discuss the benefits. When the community has to undertake a large economic cost, but the statistics show that the net benefit is there for the government, you have to figure out how to get buy in.

Organization

- In our discussion of the action items, we should have addressed the public versus private lands issues. There are different motivations for people at an individual level and people working at the public level and engineers. This requires so much more than just a cross-jurisdictional analysis. We have to work within specific neighborhoods to address the issues relevant at a hyper-local scale. GI/LID projects are also different at a private level, where LID might be more impactful versus at a large regional scale where an infrastructure investment would be more appropriate.
- We should have discussed political feasibility further. Residents in Ashland are politically engaged. Thus, we could have tailored discussions to better capture attitudes and opinions about GI/LID risk reduction strategies and policy approaches.

Miscellaneous

- It would have been useful to engage more stakeholders who could speak to the discrepancies between public and private land use. Not only do these issues require cross-jurisdictional collaboration, they require cross-neighborhood collaboration and coordination. Therefore, coordination and collaboration between public works and private lands is a challenge. It is important to have people who can speak to the issues that mitigation does not always occur on an on-site scale. Therefore, there are hyper-local and regional effects that need to be interfaced more to get both public and private landowners on a large scale on board with these projects. It is important to inform of both the on-site and downstream effects of GI/LID projects.
- We should have focused a lot more on the placement of the community within the region and how that would influence the management of natural hazards.
- We should have focused more on the growth potential within the community, because of the influence of population patterns on the management of natural hazards and issues between the management of public and private lands.
- Other important characteristics of the city include whether they are upstream or downstream, and from where; are they in a wildfire zone; how developed out are they; how young and old in terms of an economic base are they? All of these things would have helped us better profile Ashland

towards the problem we were trying to solve. Therefore, tailoring the profiling towards your desired outcome is an important consideration.

- We should have looked at the differences between having a community plan versus having a hazard plan. There is a high ROI for hazards versus larger distributed community co-benefits. In discussing the institutionalization of these projects and plans, we have to look at whether there are benefits down the line and for what project. For example, does replacing one parking lot do anything? Or do we have to do these projects on a larger scale?
- We should have also addressed the larger concept of watersheds in our action items and discussion. The watershed concept is difficult to discuss because it involves respecting different jurisdictions. Although it is complex, it is necessary to look into and evaluate the complexities involved in nature-based planning and watershed planning.
- We could have expanded our discussion of funding to either developing a position or identifying an existing position in the community that could serve as a regional point person to track grants and manage funding. Having someone manage funding at a jurisdictional level could help communities manage grants, identify grants, and then apply for grants.