1 INTRODUCTION

The purpose of this paper is to identify the range of tools available to municipalities or other local jurisdictions to support smarter floodplain planning and management at the site and reach/basin scales. The paper surveyed a variety technical tools that can quantify different aspects of floodplains, with a particular focus on tools available in the Pacific Northwest. To develop an effective floodplain management strategy that considers natural floodplain function, it is important to be able to identify the best means for quantifying the related attributes of natural floodplain function. These attributes can include benefits such as increasing flood storage, reducing flooding hazards/risk, improvements to water quality, and the provision of fish habitat. This can allow decision makers to better compare approaches, prioritize areas for floodplain restoration or development, and develop quantitative management targets for monitoring and evaluation.

The tools presented in this paper are also representative of the types of tools that are available to improve floodplain management outcomes that are generally aligned with regulatory requirements surrounding floodplains. This document provides a snapshot of best available tools for floodplain management and encourages consistency and adaption of existing tools and their methodologies for future tools.

2 RELEVANCE TO SMARTER FLOODPLAIN MANAGEMENT AND REGULATIONS

The tools summarized in this paper provide support in analyzing how changes in floodplain management actions can change metrics such as flood storage, flood hazards/risk, water quality, and fish habitat. Being able to quantify the type and amount of change in these floodplain-related attributes can help to design restoration or management strategies that maximize the benefits of natural floodplain functions. Quantification of benefits allows these strategies to be compared to each other and in different locations, and allows projects to be monitored and evaluated for performance and cost-effectiveness.

Another aspect of smarter floodplain management can be additive progress towards regulatory compliance. As such, this white paper attempts to identify tools that are applicable to or may advance compliance with different floodplain regulations. These regulations include the Endangered Species Act (ESA), Clean Water Act Section 404 requirements for dredge and fill, Clean Water Act Section 303(d) requirements for Total Maximum Daily Loads (TMDLs), FEMA National Flood Insurance Program (NFIP) Community Rating System credits, National Pollution Discharge Elimination System permits, Municipal Separate Storm Sewer Systems (MS4s), and other state and local regulations related to flooding and floodplain management.
3 TECHNICAL TOOLS MATRIX

This paper recognizes that the suite of methods implemented for floodplain management, such as investment in restoration, voluntary buyouts of flood-prone areas, and restricting development in floodplains, will be different in every community. Additionally, each community will have a unique capacity and set of resources for addressing floodplain management. As such, the technical tools required for each community's individual floodplain management needs to span a variety of functional categories.

The technical tools investigated in this paper are organized by tool type, as described below and listed in Table 1.

**Tool type:**

1. **Mapping**
   - a. Map/Data Viewer: displays spatial data and/or mapping products that help with floodplain planning and management
   - b. Mapping Methods: methods for mapping floodplain risks, features, or other related information

2. **Floodplain Function Quantification (Habitat/Stream):** methods or protocols to assess floodplain function

3. **Hydrologic Modeling/Flood Storage:** modeling approaches that simulate water flow

4. **Flood Risk Prioritization:** metrics including indices and indicators that allow for ranking and/or prioritization of one location over another

5. **Development Standards and Approaches:** standards or approaches that lead to smarter floodplain management outcomes

6. **Incentive Programs:** programs that incentivize actions that result in reduced flood risk and/or increased flood resilience.

In total, 25 technical tools were assessed. The following information was determined for each tool and is summarized in Table 2:

1. Scale and geography(ies) addressed
2. Outputs or metrics
3. Resources and knowledge required for use
4. Tool developer
5. Important notes

By presenting this information in a matrix form, different tools can be compared to help in understanding the potential the roles, capabilities, and benefits of these tools so users can assess the best fit for their needs.
### Table 1: Technical Tool Name and Description

#### Map/Data Viewer:
1. Oregon HazVu: Statewide Geohazards Viewer
2. Flood Risk Explorer
3. Risk MAP Flood Risk Products
4. FEMA Mapping Tool - National Flood Hazard Layer
5. Sea Level Rise and Coastal Flooding Impacts
6. Floodplains by Design Decision Support Tool

#### Mapping Methods:
7. Channel Migration Zone Delineation
8. Statewide Subbasin-Level Channel Migration Screening For Oregon
9. Active River Area

#### Floodplain Function Quantification (Habitat/Stream):
10. Floodplain Function Assessment*
11. Floodplain Habitat Calculator (Spreadsheet link)
12. Stream Function Assessment Methodology

#### Hydrologic Modeling/Flood Storage:
13. Win TR-20
14. HEC-RAS

#### Flood Risk Prioritization:
15. Aqueduct Flood Analyzer
16. State Flood Vulnerability Index

#### Development Standards and Approaches:
18. No Adverse Impact: A Toolkit for Common Sense Floodplain Management
19. Low Impact Development
20. Template for LID Stormwater Manual for Western Oregon
21. Green Infrastructure

#### Incentive Programs:
22. Community Rating System Program
23. EWEB (Eugene Water & Electric Board) Voluntary Incentive Program
25. Pre-Disaster Mitigation Grant Program
4 TECHNICAL TOOLS ADDITIONAL INFORMATION AND RESOURCES

This section provides additional information relevant to each of the tools investigated in this white paper, including more detailed descriptions of the tool capabilities, recommendations for use, limitations, other relevant similar or additive tools, and applicability of the tool for regulatory compliance.

Map/Data Viewer:

(1) Oregon HazVu: Statewide Geohazards Viewer – The intended primary users of this tool are urban planners with intended secondary users as insurance organizations, real estate agents, floodplain managers, natural resource agencies, and project developers. The tool addresses flood risk and hazard identification/assessment. The hazard areas described in the tool do not include information on hazard mitigation. As such, they represent a worst-case scenario for these areas and may not accurately reflect on-the-ground realities. The tool is recommended for regional use only and not for site-specific assessments, but could be useful for general comparison of floodplain sizes and locations across a basin. The tool can be used in conjunction with FEMA Nation Flood Insurance Program mapping tools, the Department of Land Conservation and Development (DLCD) Oregon Risk Map, and the Oregon Explorer Hazards Reporter for crosschecking and additional information on floodplain locations.

(2) Flood Risk Explorer – This tool can inform floodplain management through an estimate of potential flooding damages associated with different climate change scenarios. It is limited to Snohomish County, WA, but similar information can be determined for locations within the U.S. using FEMA Hazus. Another useful tool for valuing floodplain protection nationally is FEMA’s Supplemental Guidance For Conducting a Benefit-Cost Analysis (BCA) for a Floodplain and Stream Restoration Project.

(3) Risk MAP Flood Risk Products – FEMA develops flood risk products to supplement the flood hazard information in the Flood Insurance Rate Map and Flood Insurance Study, including potential flood loss, key watershed features affecting flood risk, and historical flood control projects. However, they are not intended to be used for official actions under the National Flood Insurance Program. Additionally, the flood risk products are only developed as regulatory flood maps are updated so they may not be available in all locations.

(4) FEMA Mapping Tool - National Flood Hazard Layer – This is limited to visualization of FEMA Flood Insurance Rate Maps by specific FIRM or FIRMette or can use downloaded county level data if it available. It can be used in conjunction with FEMA Hazus, which estimates potential losses from disasters, including flooding, using a nationally applicable standardized methodology.

(5) Sea Level Rise and Coastal Flooding Impacts – Allows users to visually depict degrees of vulnerability to coastal or tidal flooding, marsh migration locations, and view multiple sea level rise scenarios in some local communities.

(6) Floodplains by Design Decision Support Tool – Limited to the marine and freshwater shoreline areas in the Puget Sound and focused on sea level rise impacts and risk reduction from
natural habitat.

Mapping Methods:

(7) Channel Migration Zone Delineation – Addresses Washington State regulations for managing channel migration areas under the Shoreline Management Act. Similar regional guidance has been developed by FEMA for the Puget Sound Basin that includes both methodologies for hydrologic studies and channel migration zones for Community Rating System credits under the National Flood Insurance Program.

(8) Statewide Subbasin-Level Channel Migration Screening For Oregon – This approach was adapted from methodologies developed in 2013 by the Washington Department of Ecology. Another similar methodology published by Legg and Olson (2015) incorporates channel gradient with stream discharge to calculate “stream power index” that is equated to erosion potential and can be used in channel migration zone mapping efforts as a recommended improvement.

(9) Active River Area – The methodology involves three steps: 1) calculating a cost-distance (a value-based path that water from the centerline of the river would have to travel to reach a certain point), 2) high moisture-index areas (low-gradient areas with high levels of flow accumulation), and 3) areas within 30 to 60 meters of rivers above a certain elevation that are considered material contribution areas. The methodology is GIS-based and can be performed given a river centerline and digital elevation map (DEM) (although wetland maps are helpful for determining high moisture-index areas).

Floodplain Function Quantification (Habitat/Stream):

(10) Floodplain Function Assessment – This assessment methodology allows compliance with the Washington State Biological Opinion by using it to assess the effectiveness of existing state-level regulations (and any edits or supplements to those regulations as needed on an individual community basis) that in aggregate result in compliance. These other state-level regulations include the Shoreline Management Act, Growth Management Act, and Floodplain Management Act.

(11) Floodplain Habitat Calculator – Allows the ranking, comparison, and quantification of habitat quality in floodplain sites that can be used to inform development or restoration decisions from a habitat perspective. The methodology is not limited to use in a specific region.

(12) Stream Function Assessment Methodology for Oregon – Currently applicable for non-regulatory purposes including assessment, restoration planning, and project monitoring and evaluation. A new aquatic resource compensatory mitigation program for wetland and stream losses is being developed (anticipated in February 2019) for Oregon by Oregon Department of State Lands, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency for compliance with Oregon’s Removal-Fill Law and Section 404 of the federal Clean Water Act. Other stream assessment methodologies have been developed in other regions of the U.S., including the North Carolina Stream Assessment Method, which also includes a stream quantification tool (spreadsheet).
Hydrologic Modeling/Flood Storage:

(13) Win TR-20 – A hydrologic model for small watersheds of 10 or fewer sub-watersheds (fewer than 25 square miles).

(14) HEC-RAS – This model uses the hydrologic results developed in another model, (HEC-HMS) to model the complete hydrologic processes of dendritic watershed systems.

Flood Risk Prioritization:

(15) Aqueduct Flood Analyzer – Useful for high level (e.g., state or country) comparisons of overall flood vulnerability that could be used as background and for general communications and public outreach around the need for smarter floodplain management.

(16) State Flood Vulnerability Index – Primarily intended for floodplain managers and natural resources agencies. The tool addresses flood risk and planning/scenario development for floodplain management. Scores are determined by a county’s level of deviation from the state mean for five different datasets: number of flood events, structures damage estimates, crop damage estimates, number of NFIP claims, and value of NFIP claims from 1978 through 2013. The tool is able to compare counties based on the state average, but not applicable for comparison across state boundaries or for comparison of cities.

(17) Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores – The primary intended tool users are planners and floodplain managers. The tool addresses flood risk, hazard identification/assessment, and planning/scenario development. Qualitative comparison of flood risk is available at the county level in Oregon, but not applicable for comparisons across states or for cities.

Development Standards and Approaches:

(18) No Adverse Impact: A Toolkit for Common Sense Floodplain Management – Primarily intended for use by planners, floodplain managers, and natural resource agencies. The tool addresses flood risk, floodplain function, flood/hazard mitigation, and hazard identification/assessment. The principles for creating no adverse impact from floodplain management are similar in intent to those that can be applied for Community Rating System credit under the National Flood Insurance Program.

(19) Low Impact Development – The primary intended users are planners, natural resource agencies, and project developers. The tool addresses flood/hazard mitigation and planning/scenario development for floodplain management. A multitude of local and regional low impact development manuals and standards exist throughout the U.S. either as tools to improve development or as codified minimum requirements for development.

(20) Template for LID Stormwater Manual for Western Oregon – Meets regulatory requirements for TMDL, MS4 Phase I and Phase II regulations, and NMFS Biological Opinion for stormwater
requirements for federal permits.

(21) **Green Infrastructure** – The primary intended users are planners, natural resource agencies, and floodplain managers and addresses flood/hazard mitigation and planning/scenario development. To support green infrastructure the EPA has developed innovative models, tools, and technologies for communities to manage water runoff and reduce flooding hazards. These include the Green Infrastructure Wizard (provides customized reports of tools and resources for green infrastructure), Watershed Management Optimization Support Tool (software application that facilitates integrated water resources management), Visualizing Ecosystems for Land Management Assessment Model (model for quantifying the effectiveness of natural and engineered green infrastructure), Storm Water Management Model (model for large-scale planning of stormwater runoff with green infrastructure), National Stormwater Calculator (simplified model that estimates stormwater runoff reduction with green infrastructure), and the Green Infrastructure Flexible Model (evaluates performance of urban and agricultural green infrastructure).

**Incentive Programs:**

(22) **Community Rating System Program** – The intended primary users are floodplain managers and the tool addresses flood/hazard mitigation, hazard identification/assessment, and planning/scenario development for floodplain management. The program has 19 credited activities that can be implemented to reduce federal floodplain insurance premiums that fall into the following categories: assessing your community’s flood problem, mapping and flood data, managing new development to minimize future damage, developing a floodplain management plan for your community, reducing flood losses to existing development, improving emergency preparedness and response, and implementing public information activities.
(23) **EWEB (Eugene Water & Electric Board) Voluntary Incentive Program** – Primary intended users are planners and natural resource agencies with the tool addressing floodplain function and hazard identification/assessment. Best used as an example program, but is limited to locations mostly in the McKenzie River watershed. The Evaluation of EWEB’s Voluntary Incentive Program Pilot can offer insights into common ways to improve similar voluntary incentive programs.

(24) **Emergency Watershed Protection Program – Floodplain Easement Option (EWP-FPE)** – NRCS may purchase EWP-FPE permanent easements in floodplains for the following reasons: 1) the land has been damaged by flooding at least once during the previous calendar year or subject to flood damage at least twice within the previous 10 years; 2) other lands within the floodplain may be eligible if they contribute to the restoration of floodwater storage and flow, offer a way to control erosion, or improve the practical management of the floodplain easement; or 3) lands that would be inundated or adversely impacted as a result of a dam breach. NRCS offers landowners the opportunity to participate in restoration of the floodplain’s natural functions and values, including through removal of buildings within the floodplain.

(25) **Pre-Disaster Mitigation Grant Program** – Applicants are split into two subgroups: project and planning. Grants are awarded to project subapplicants for specific projects that are consistent with the goals and objections of a FEMA-approved Hazard Mitigation Plan. Planning subapplicants are awarded grants for creation of a Hazard Mitigation Plan (meeting the requirements of 44 CFR Part 201) to be adopted by the jurisdiction and approved by FEMA.

5 **TAKE HOME MESSAGES ON AVAILABLE TOOLS AND IDENTIFIED GAPS**

- **Multitude of Flood Map/Viewer Tools** – There are many tools that are available to view flood risk and regulatory mapping products through online viewer applications. These tools are available from a variety of sources including non-profit organizations, state governments, and the federal government. Although many local and regional tools provide similar information on flood risk, it is difficult to determine if the underlying data are the same or if they provide additive value to existing national-level tools (e.g., FEMA Flood Insurance Rate Maps). Also, mapping products that may assist with mapping additional flood hazards for regulatory compliance vary greatly between jurisdictions especially in less populated areas.

- **Incentive Programs Utilize Quantification** – The incentive programs evaluated here incorporate quantification of benefits from floodplains to guide investments into reducing flood risk. The ability to quantify specific functions and values from floodplain restoration or conservation activities is a critical step in developing voluntary incentive programs and the ability to monitor and evaluate the cost-effectiveness of these investment strategies.

- **Regulatory Compliant Tools Are Location Specific or Complex** – Tools that can be used for compliance with state or federal regulations are often highly specific to particular geographies and circumstances or are nationally recognized, but are sufficiently complex to tailor to local or site-specific conditions present a barrier to usability for non-experts. For example, HEC-RAS has potential to be adapted to quantify flood storage for compensatory mitigation, however it requires specific expertise and data and there are limited flood storage/hydrological modeling options that have low data input requirements. In contrast, tools for larger scale quantifications...
or that provide viewers/maps that cover larger geographies typically are only able to be used for non-regulatory purposes. A common example is the many flood risk viewing tools that include an online viewing option but are not intended to be used for regulatory compliance.

- **Flood Risk Prioritization and Scenario Planning Tools Lack Geographic Granularity** – The flood risk prioritization tools assessed in this paper include fairly coarse grain analyses and do not provide much information for ranking specific locations (particularly at the city or site scale) over another (i.e., the assessments are mostly at the regional scale or higher level). This limits the benefits of these prioritization tools for programs that are administered at a site, city, or sub-county level in order to compare locations based on floodplain storage and attenuation function and cost-effectiveness. Similarly, scenario planning or evaluation functions that have been included in mapping/viewer tools typically only provide information on a regional or state level scale. This level of information is difficult to translate into floodplain priority locations for planning on a local or site-specific level.

- **Templates for Local Incorporation of Design Standards Is Limited** – There are a limited number of templates that are specifically designed for local jurisdictions/communities to incorporate design standards and approaches into code or regulation. Available templates are created at a national or regional level, creating a barrier to incorporation into local codes/regulations because of the amount of work necessary to tailor them to community-specific needs and conditions. One notable exception to this is the availability of Low Impact Development (LID) templates. The template for LID Stormwater Manual for Western Oregon, for example, provides a good starting point for communities and has been vetted for regulatory use.

- **Coastal Flooding Tools Lack Specificity** – The coastal flood tools assessed in this paper typically present or analyze information at a regional scale. This can be beneficial for comparative analysis on a regional level, but does provide opportunities for site-specific identification and characterization in coastal areas.

- **Lack of Floodplain Development Prioritization Tools** – Development prioritization and buyouts are a prominent method for floodplain management, but of the tools assessed in this paper, no tools directly address prioritization of development in the floodplain. Development prioritization within a floodplain would require integrated information from multiple perspectives (flood risk, development potential, habitat, etc.) on a local level.

- **Effect of Floodplain Restoration Can Be Quantified** – There are a number of site-level tools that are available to quantify the impact of restoration to floodplain function. Additionally, these tools are often applicable over large geographies and allow for comparison of different floodplain restoration locations and methods.
<table>
<thead>
<tr>
<th>Tool Name and Description</th>
<th>Scale and Geographies Addressed</th>
<th>Outputs/metrics</th>
<th>Resources/knowledge required for use</th>
<th>Developer</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Map/Data Viewer</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Oregon HazVu: Statewide Geohazards Viewer</strong></td>
<td>Local scale – not site-specific. Data for Oregon only.</td>
<td>Mapped geohazards (100-year flood, Cascadia Subduction Zone, volcanoes, landslides, active faults)</td>
<td>Internet access; general knowledge of area of interest</td>
<td>DOGAMI</td>
<td>Does not provide information on coastal erosion.</td>
</tr>
<tr>
<td><strong>Flood Risk Explorer</strong></td>
<td>Reach scale. Snohomish County only.</td>
<td>Projected economic loss in dollars and projected flood depth diagrams/images for selected climate change scenarios.</td>
<td>Internet access; general knowledge of area.</td>
<td>Climate Impacts Group, UoW</td>
<td>Part of Floodplains by Design.</td>
</tr>
<tr>
<td><strong>Risk MAP Flood Risk Products</strong></td>
<td>Watershed level modeling with data presented at the community/jurisdiction scale.</td>
<td>Flood Risk Map showing flood risk (very low, low, medium, high and very high), report with community specific flood risk results, and database of spatial files.</td>
<td>Internet access; basic GIS use and knowledge.</td>
<td>FEMA</td>
<td>Not available for all communities in Oregon.</td>
</tr>
<tr>
<td><strong>FEMA Mapping Tool - National Flood Hazard Layer</strong></td>
<td>Local/community scale for flood hazard maps; other mapping data are at regional scales.</td>
<td>Flood hazard information</td>
<td>Internet access; GIS platform</td>
<td>FEMA</td>
<td></td>
</tr>
<tr>
<td><strong>Sea Level Rise and Coastal Flooding Impacts</strong></td>
<td>Regional scale. Coastal counties in the United States only.</td>
<td>Visualizations on sea level rise</td>
<td>Internet access</td>
<td>NOAA</td>
<td>Only available for coastal communities in the U.S.</td>
</tr>
<tr>
<td><strong>Floodplains by Design Decision Support (DSS) Tool</strong></td>
<td>Reach scale. Puget Sound in WA.</td>
<td>Visualization: current ecological function (store and route floodwaters, supply sediment and wood, retain and transform water pollutants, support floodplain forest ecosystems, and salmon habitat), potential ecological function (restore connectivity, restore condition), and flood hazards (building losses).</td>
<td>Internet access; general knowledge of area.</td>
<td>Climate Impacts Group, UoW</td>
<td>Part of Floodplains by Design program.</td>
</tr>
</tbody>
</table>
function-based approach to measure existing functions and values at the stream reach scale. The methodology uses a Rapid, function-based assessment approach designed to support stream compensatory
offsets, this metric may be used to measure the impact on development sites, and to
implementation of conservation actions on floodplain habitat. Where floodplain
management strategies to the protection of those functions. A key element this approach
involves outlining specific processes and functions for floodplains in various landscape
grouped functions (hydrology, geomorphology, biology, and water quality). Stream value scores.

### Floodplain Function Assessment Methodology

Method provides a common protocol for: 1) identifying which functions are present in a floodplain, 2) describing the level or quality of the functions present, and 3) tailoring management strategies to the protection of those functions. A key element this approach involves outlining specific processes and functions for floodplains in various landscape positions such that a community can focus on and assess those floodplain functions that are relevant to their locality.

### Floodplain Habitat Calculator (Spreadsheet link)

Method calculates the ecological impact and improvement associated with the implementation of conservation actions on floodplain habitat. Where floodplain development is regulated, or where developers are willing to invest voluntarily in habitat offsets, this metric may be used to measure the impact on development sites, and to measure the habitat improvement on sites managed for conservation.

### Stream Function Assessment Methodology

Rapid, function-based assessment approach designed to support stream compensatory mitigation efforts under Section 404 of the Clean Water Act. The methodology uses a function-based approach to measure existing functions and values at the stream reach scale.

### Table 2: Floodplain Management Technical Tools Matrix

<table>
<thead>
<tr>
<th>Tool Name and Description</th>
<th>Scale and Geographies Addressed</th>
<th>Outputs/metrics</th>
<th>Resources/knowledge required for use</th>
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<tbody>
<tr>
<td><strong>Mapping Methods</strong></td>
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<tr>
<td>Channel Migration Zone Delineation*</td>
<td>Local/community reach scale. Used in WA as part of WA Shoreline Management Act.</td>
<td>Delineation of Channel Migration Zone</td>
<td>Field observations (channel survey), GIS platform for mapping; aerial photographs; State and County GIS resources.</td>
<td>Washington State Department of Ecology and Herrera Environmental Consultants</td>
<td>Guidance document for local governments and practitioners to incorporate CMZ into floodplain management plans as part of requirements under WA Shoreline Management Act.</td>
</tr>
<tr>
<td>Statewide Subbasin/Level Channel Migration Screening For Oregon</td>
<td>Reach scale for regionally significant streams and rivers throughout Oregon.</td>
<td>Categorization of channel confinement, channel pattern, and channel gradient; High, medium, or low channel migration hazard relative susceptibility.</td>
<td>Field observations (channel survey), GIS platform for mapping, aerial photographs</td>
<td>Oregon Department of Geology and Mineral Industries</td>
<td>Does not include stream power index (channel gradient combined with stream discharge) as a metric for susceptibility.</td>
</tr>
</tbody>
</table>

| **Active River Area** | General level analysis for individual rivers. No specific geography. | Mapped Active River Area | GIS platform, river centerline, digital elevation map, vegetation/wetland maps optional | The Nature Conservancy |       |

| **Floodplain Function Quantification (Habitat/Stream)** | | | | | |
| Floodplain Habitat Calculator (Spreadsheet link) | Site-level assessment. No specific geography. | Floodplain Habitat Quality Score | Intermediate Excel knowledge; field habitat assessment; intermediate ecological landscape knowledge | Willamette Partnership | Has not been widely field tested or applied. |

**Notes**: *=not available in Oregon
## Table 2: Floodplain Management Technical Tools Matrix

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<tr>
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<tr>
<td><em>Win TR-20</em></td>
<td>Local/community reach</td>
<td>Peak discharge information, drainage area, runoff amount, time of peak for each sub-area and reach by storm, and hydrographs</td>
<td>Knowledge of river modeling/hydraulics (particularly methodologies used to calculate water surface profiles); Windows-based TR-20 software (free)</td>
<td>USDA Natural Resources Conservation Service</td>
<td>Recent updates allow importing of precipitation data from NOAA.</td>
</tr>
<tr>
<td><strong>HEC-RAS</strong></td>
<td>Local/community reach</td>
<td>Computation of water surface profiles to get outputs such as cross section profiles, perspective plots, and various data tables</td>
<td>Knowledge of river modeling/hydraulics (particularly methodologies used to calculate water surface profiles); Windows-based HEC-RAS software (free); cross-section data; forecasted hydrographs</td>
<td>US Army Corps of Engineers</td>
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<tr>
<td><strong>Floodplains By Design</strong> (see Floodplain Function Decision Support Tool above)</td>
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<tr>
<td><strong>Flood Risk Prioritization</strong></td>
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<tr>
<td><strong>Aqueduct Flood Analyzer</strong></td>
<td>State level aggregate data for all states, country level aggregate data, but only select cities – no cities in Oregon.</td>
<td>Flood risk for three scenarios in terms of urban damage ($), affected GDP ($), and affected population (number of people)</td>
<td>Internet access</td>
<td>World Resources Institute</td>
<td></td>
</tr>
<tr>
<td><strong>State Flood Vulnerability Index</strong></td>
<td>County level. Data for Oregon only.</td>
<td>Score ranging from 0 to 3 to rank susceptibility to flood by county.</td>
<td>Access to rankings in Natural Hazard Mitigation Plan.</td>
<td>Oregon State Agencies; University of Oregon, FEMA, US Army Corps of Engineers</td>
<td>State of Oregon Interagency Hazard Mitigation Team</td>
</tr>
<tr>
<td><strong>Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores</strong></td>
<td>County level. Data for Oregon only.</td>
<td>Each relevant hazard for a county is given a low, medium, or high ranking.</td>
<td>Oregon Natural Hazards Mitigation Plan</td>
<td>Oregon Military Department’s Office of Emergency Management (OEM)</td>
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</tr>
<tr>
<td><strong>No Adverse Impact: A Toolkit for Common Sense Floodplain Management</strong></td>
<td>Local scale. Jurisdictions with floodplains.</td>
<td>Identification of floodplain management activities and where to find information to support a community’s ongoing programs.</td>
<td>Basic to intermediate knowledge of floodplain management</td>
<td>French Wetmore, French &amp; Associates, Ltd., ASFPM and the NAI (No Adverse Impact) Steering Committee</td>
<td></td>
</tr>
<tr>
<td><strong>Low Impact Development</strong></td>
<td>Site scale. No specific geography.</td>
<td>Additional stormwater management practices.</td>
<td>Knowledge of stormwater management</td>
<td>Started in 1990 in Prince George’s County Maryland’s Department of Environmental Resources but numerous local application of standards now exist.</td>
<td>Principle/design technique</td>
</tr>
<tr>
<td><strong>Template for LID Stormwater Manual for Western Oregon</strong></td>
<td>Community/jurisdiction level. Western Oregon communities only.</td>
<td>LID Stormwater Manual for jurisdictions to address MS4 and TMDL regulatory requirements for water quality during “post-construction”.</td>
<td>Knowledge of stormwater management; MS4 permits; TMDL requirements; Basic/Intermediate Excel skills</td>
<td>Oregon DEQ with support from OEC, Green Girl, OR Dept of Forestry, USFS.</td>
<td></td>
</tr>
<tr>
<td><strong>Green Infrastructure</strong></td>
<td>Local to regional scale (i.e. watershed/landscape level). No specific geography</td>
<td>Management approaches that mimic the natural water scale.</td>
<td>Knowledge of stormwater management and planning processes</td>
<td>Not applicable</td>
<td>Principle/planning technique</td>
</tr>
</tbody>
</table>

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**Development standards and approaches**

- **No Adverse Impact (NAI)** in floodplain management is an approach/principle that means that the action of any community or property owner, public or private, should not adversely impact the property and rights of others. The toolkit is not a “how-to” manual; rather it is a reference document that helps a community incorporate the NAI principle into ongoing programs by identifying three levels of floodplain management practices: basic (minimum federal and/or state requirements), better (tools that usually prevent or minimize impacts), and no adverse impact.

- **Low Impact Development**
  - A stormwater management approach at the site scale that focuses on reproducing the natural preddevelopment hydrologic functional landscape emphasizing on-site treatment and infiltration methods in contrast to conventional stormwater controls that vastly alter the hydrologic cycle because they are designed to route untreated runoff into local streams or underground through injection. In practice, this means using a combination of small-scale stormwater management practices to capture and treat runoff with vegetation, utilizing existing natural site features as possible. These practices include bioswales, rain gardens, green streets, and pervious pavers, which helps to keep water onsite, reducing impacts of runoff and maintaining hydrologic functions.

- **Template for LID Stormwater Manual for Western Oregon**
  - A step-by-step guide that cities and counties throughout Western Oregon can use to reduce stormwater runoff, prevent flooding, and improve the health of rivers, lakes and streams. The LID manual gives communities guidance in designing, constructing, and maintaining greener storm water facilities. Involvement from Oregon DEQ helped ensure that this resource for our communities meets regulatory requirements for TMDL and MS4 Phase I and Phase II regulations. The goal is to do the same for the NMFS Biological Opinion on implementation of the NFIP for stormwater requirements for federal permits in Oregon.

- **Green Infrastructure**
  - Green infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle. It is similar to LID, but can be applied at different scales and oftentimes is applied on a broader landscape level, while LID focuses at the site level. For example, an investment in green infrastructure at a broader scale would involve strategically locating natural areas within a basin or watershed to lower downstream flood damages; at a local/site level, it could include rain gardens, permeable pavements, and infiltration planters.
<table>
<thead>
<tr>
<th>Tool Name and Description</th>
<th>Scale and Geographies Addressed</th>
<th>Outputs/metrics</th>
<th>Resources/knowledge required for use</th>
<th>Developer</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td><strong>Incentive Programs</strong></td>
<td></td>
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<tr>
<td>Community Rating System (CRS) Program</td>
<td>Community/jurisdiction level. Communities participating in the NFIP.</td>
<td>Rating between 1 and 10 based on the number of points amassed (with a rating of 1 providing the greatest discount).</td>
<td>CRS Coordinator’s Manual; necessary documentation and reports to confirm activities; knowledge of floodplain management.</td>
<td>FEMA</td>
<td></td>
</tr>
<tr>
<td>Pre-Disaster Mitigation Grant Program</td>
<td>Project and planning (state and tribal) scales.</td>
<td>Funding for flood hazard reduction projects or mitigation plans.</td>
<td>FEMA requires state, territorial, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance.</td>
<td>FEMA</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Floodplain Management Technical Tools Matrix**

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**Notes:**
- *=not available in Oregon

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**Community Rating System (CRS) Program**
This is a voluntary incentive program administered by FEMA for communities in full compliance with the NFIP. It rewards communities with discounts in flood insurance in the special flood hazard area (SFHA) for practices beyond the minimum NFIP requirements that prevent or reduce flood losses. The CRS uses a class rating system between 1 and 10, which corresponds to efforts undertaken above requirements and a corresponding percentage discount. Credits can be granted from 19 different floodplain management activities such as maintaining elevation certificates, providing a map information service, various outreach projects, open space preservation, floodplain mapping, higher regulatory standards, and more.

**EWEB (Eugene Water & Electric Board) Voluntary Incentive Program**
This incentive program rewards landowners with cash payments or vouchers for in-kind services such as landscape plans or riparian in exchange for either a) protecting existing healthy riparian areas or b) restoring land along the McKenzie River. The program was a result of four years of EWEB working with landowners and other stakeholders.

**Emergency Watershed Protection Program – Floodplain Easement Option (EWP-FPE)**
This program offers an alternative method to traditional EWP Program Recovery by purchasing permanent conservation easements for the purpose of restoring, protecting, maintaining, and enhancing the nature functions of these floodplains. The program is voluntary and the USDA NRCS provides compensation for easement rights on primarily agricultural, open space, and residential lands.

**Pre-Disaster Mitigation Grant Program**
The goal of the program is to reduce overall risk to the population and structures from future hazard events, while reducing reliance on federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. Grants are awarded to specific projects that mitigate disaster risk or for development of a Hazard Mitigation Plan.