

Photo courtesy of The Wetlands Conservancy

LOCAL OPTIONS FOR
SMARTER
FLOODPLAIN
MANAGEMENT

BRIDGING THE DIVIDE BETWEEN THEORY AND CODE

December 2018

SMARTER
FLOODPLAIN
MANAGEMENT





Local Options for Smarter Floodplain Management

Bridging the divide between theory and ordinance

1 INTRODUCTION

Floodplains play a vital economic and ecological role in our society. Healthy, resilient communities require functioning floodplains to reduce property damage from floods, recharge groundwater, and provide important fish and wildlife habitat, clean water, and open spaces to play.

We have known since as early as the 1940s, however, that the way we manage floodplains is often inconsistent with sustaining these essential functions (White 1945). As more homes, businesses, and infrastructure populate our floodplains, the danger to people, property, and the environment increases. Many of our rivers and floodplains no longer function well enough to buffer us from flooding. The cost of flood damages can be devastating (NOAA 2018), affecting not only homeowners and businesses in the floodplains, but also the communities that have to absorb the costs of flood-related emergency services, lost business and wages, road closures and cleanup, overwhelmed treatment facilities, and combined sewer overflows.

Communities are now struggling with a myriad of ecological, regulatory, political, and economic issues that surround floodplain development. In many areas, climate change is expected to make future floods even more frequent and severe, further increasing the risks and costs of flooding. Local governments navigate a very complex landscape when it comes to managing their floodplains. They work within a web of federal, state, and local policies that may pull decisions in unexpected or even contradictory ways. They must be responsive to a public that expects safety of people and property to be prioritized, but also wants to see many other values protected, including clean water, fish and wildlife habitat, and open space amenities. The public may not fully understand the important role flooding plays in maintaining these other values, the ecological complexity of floodplains, or the impossibility of completely eliminating flooding. In addition, many local governments face significant capacity and funding constraints and may find it challenging to design and implement long-term, integrative, and proactive solutions when crises demand their day-to-day attention.

We need a new approach to floodplain management, a smarter approach that is built on the strategies and tools that have been shown to reduce risk to communities and support natural systems. In many cases, the actions needed to meet these two goals are one and the same – the very changes needed to make our floodplains more ecologically resilient and able to support fish and wildlife and provide clean and abundant water are also some of the most effective ways to reduce flood risk and damage.

This document explores strategies from the Pacific Northwest and around the United States for improving natural floodplain functions while reducing flood impacts. It provides a starting point for answering the question: What can local governments – including not only elected officials, but also floodplain managers, stormwater managers, emergency managers, planners, hazard mitigation specialists, public works and engineering staff, concerned citizens, and other community stakeholders – do to make their floodplains safer, healthier, and more resilient?



2 LOCAL POLICY OPTIONS

What can local governments do to maintain and improve the natural functions of their floodplains? How can they reduce flood risks by allowing water to slow down and spread out over the landscape, while also protecting water quality and fish and wildlife habitat? And how do they do all that in a way that addresses the multiple regulatory requirements that intersect in local, state and federal policies and have become significant drivers of decision-making and management in floodplains?

It turns out there are a lot of options. We have found that many Oregon communities are taking important steps towards smarter ways of managing their floodplain to reduce flood hazards while protecting and restoring the natural functions of floodplains, such as water quality and fish and wildlife habitat. The diversity of approaches explored in this paper provide models to help communities manage for these natural functions, while also managing for other values, such as economic development and employment, public health, and housing affordability. These strategies can also help communities deal with increasing flood exposure associated with the effects of climate change.

This paper outlines six types of strategies that local governments can consider to help protect and restore the natural functions of floodplains and achieve more resilient communities. They are:

1. Improve mapping and communication of flood-related hazards
2. Limit new development in flood hazard areas
3. Limit the impacts of development on natural floodplain functions
4. Require compensatory mitigation for impacts to natural floodplain functions
5. Protect and restore natural floodplain functions
6. Integrated planning and management¹

This document aims to provide a menu of local policy options for smarter floodplain management. Communities interested in building more resilient floodplain systems can pick and choose from these options, combine them, adapt them, or develop new ideas. For communities with significant current or future development pressure in their floodplains, it is likely that a mix of several of these options will be needed, possibly in combination with structural flood control solutions such as detention and elevating structures. Appendix A provides a list of more detailed policy and planning actions that nest under each

Natural floodplain functions are the functions associated with the relatively undisturbed floodplain that moderate flooding, maintain water quality, recharge groundwater, reduce erosion, redistribute sand and sediment, and provide fish and wildlife habitat.

Association of State Floodplain Managers, No Adverse Impacts Floodplain Management

¹ Many of the categories and strategies, and a few of the community examples, are adapted from NAI 2017.



of these strategies, as well as examples of individual communities in the Pacific Northwest and beyond that are implementing these approaches.

Efforts to implement any of these options will benefit from a thoughtful and transparent process designed to first fully educate the public on the breadth and depth of local flooding problems occurring in the community. Local government staff can then begin to build public and decision-maker support based on the community's needs and values and how a more functional floodplain would serve them.

2.1 IMPROVE HAZARD MAPPING

Accurate and comprehensive mapping of flood hazards (and other hazards, such as flood-related erosion) is critical to protecting both public safety and natural floodplain functions. The current default for floodplain mapping is the 100-year floodplain, usually depicted on a local flood insurance rate map (FIRM) that FEMA uses to define areas of high flood hazard and where flood insurance is required. These maps, however, are widely acknowledged to be inaccurate.² Models that are used to create the maps are based on incomplete or outdated data and do not take into account ongoing development and other alterations to the landscape that change the risk of flooding. Improving flood maps includes increasing the accuracy of the topographic and bathymetric data that are used to determine base flood elevation and transitioning maps to a digital platform.

Of course, simply improving hazard maps or defining and mapping a locally-regulated floodplain does not automatically reduce flood hazards or improve natural floodplain functions³. But better mapping does allow communities to better identify and communicate areas that may be at risk or at increased risk in the future. It can help the public better prepare for flood events, because people often base their decisions about flood insurance, construction design, and emergency preparedness on whether their property is located in a mapped flood hazard zone.

Better mapping can also help contribute to maintaining natural floodplain functions. For example, local floodplain regulations are more effective – and fairer – when applied to accurately-mapped hazard areas (NAI 2017). They do a better job of steering development away from areas with higher flood hazards and ecological values and toward safer and less-sensitive parts of the landscape.

Actions that local governments have taken under this strategy include:

- Updating and improving the accuracy of flood hazard maps
- Adding an analysis of potential future conditions to maps, to reflect projected impacts of climate change and future development
- Defining and mapping an alternate floodway or locally-regulated floodplain

² According to a report from Department of Homeland Security, only 42% of FEMA's maps "adequately identify flood risk".

³ <https://www.floods.org/ace-images/MappingFinalSept2017.pdf>



- Mapping additional hazards or hazard areas, such as a 10-year (10% probability) flood zone, the boundary of a significant historical flood, channel migration zones, erosion zones, coastal hazards, and areas that would be inundated in case of dam or levee failure

There are many factors shaping how local communities improve mapping – cost, data availability, and political pressure that comes from the prospect of limiting new business and tax revenues in what can often be one of the most desirable parts of a city. Local governments working to improve their hazard mapping will need a transparent and equitable process, as well as a business case to help articulate why investing in accurate maps and making planning decisions based on good data is actually a cost-effective strategy long term for the community.

2.2 LIMIT NEW DEVELOPMENT IN FLOOD HAZARD AREAS

Increased regulation in any form can be unpopular, and local decision-makers sometimes assume that restricting development in flood hazard areas (either FEMA's 100-year floodplain or any of the other hazard areas described above) is politically unfeasible. However, with increasing awareness of the role development in floodplains plays in increasing flood risk, appetite for regulating new development in flood-prone areas may be growing. In particular, residents and business owners in and near flood hazard areas tend to be aware that any new development can increase flood risks to their own property. Some floodplain managers have begun to frame the argument for development restrictions in *property rights* terms – that any new development permitted in a flood zone can undermine the ability of current residents to protect their own property from an increased risk of flood damage (NAI 2017).

In the Pacific Northwest, FEMA consultations under the federal Endangered Species Act (ESA) have raised concerns among some local governments of a mandatory moratorium on all development within the federally regulated floodplain. Such a restriction might well be effective in halting the loss of natural floodplain functions and reducing flood damages to life and property, however, it would also face significant legal and political challenges.

Without clear regulatory drivers to limit development – but often with a clear recognition that continued development in flood-prone areas will eventually lead to problems – some local governments are taking targeted actions to steer development away from the most hazardous and sensitive areas, including:

- Prohibiting development in the floodway⁴
- Limiting subdivision within the floodplain – for example, requiring every lot division to maintain a building site above the base (100-year) flood elevation
- Establishing higher regulatory standards for higher-hazard zones such as the 10-year floodplain or channel migration zones
- Requiring critical facilities such as hospitals and schools to be located outside of flood hazard areas whenever possible
- Establishing setbacks, buffer zones, or open space dedication requirements around rivers and streams

⁴ Usually with some exceptions for water-dependent and infrastructure uses



- Designating resource protection zones in important floodplain or wetland areas, through decreased density or other development restrictions
- Prohibiting the construction of new flood control structures to allow for new development

Mechanisms to institute and implement these kinds of requirements are often located in existing local development, zoning, and flood codes. A community may approach implementation of these activities through the lens of flood management, or through the lens of protecting water quality, wetland/riparian or other environmentally sensitive zones or creation/protection of open spaces (NAI 2017).

2.3 LIMIT IMPACTS OF DEVELOPMENT TO NATURAL FUNCTIONS

When development in the floodplain is unavoidable – either legally or pragmatically – careful siting and design of that development can help minimize impacts to natural floodplain functions. Many local governments have existing requirements, often separate from local flood code, that when implemented can be effective in maintaining natural floodplain functions. Some examples include:

- “No-rise” requirement beyond the regulatory floodway (e.g. 10- or 100-year floodplain)
- Prohibiting fill in part or all of the floodplain
- Construction/design standards that go above and beyond the NFIP criteria
- Limiting additions of impervious surface in the floodplain (or beyond)
- Stormwater management regulations, especially the use of green infrastructure approaches
- Requiring rise analyses to address cumulative effects of development, not just the effects of a single development project
- Setting a lower threshold for FEMA’s substantial improvements requirements, so that more existing properties are brought into compliance with modern code over time

Similar to the mechanisms to limit development in the floodplain, these strategies can be located in different parts of local code and may require some case-making to gain decision-maker and public support. Any changes to development and construction standards may require outreach and education efforts for successful implementation.

2.4 REQUIRE COMPENSATORY MITIGATION

Compensatory mitigation – requiring compensation for any unavoidable impacts that new development has on natural resources – can be a useful tool for balancing the economic and social benefits of development with the need to maintain functioning natural systems. Effective compensatory mitigation can help allow new development to move forward without creating significant, persistent, and cumulative losses in basic ecosystem functions such as flood storage, clean water, wildlife populations, and recreational values. Carefully used, it can also help steer development away from the most hazardous and sensitive areas in a way that provides flexibility for local governments and developers alike.

Of the three primary natural functions of floodplains – flood storage, water quality, and fish and wildlife habitat – compensatory mitigation is most often required at the local level for flood storage. Balanced



cut-fill policies require any new fill added in the floodplain (or some portion of the floodplain) to be offset by removal of fill elsewhere. These policies can be a useful tool for avoiding the progressive loss of flood storage – and associated increase in flood risk – over time as a floodplain is developed. However, balanced cut-fill policies may be less effective if they do not address key factors such as where the cut is placed in the floodplain in relation to the fill (in terms of both elevation and linear distance) and how the compensatory storage will be maintained over time.

Some local governments are also exploring strategies for providing stormwater offsets that help reduce flooding in urbanized areas. For example, a city might create a larger-scale stormwater detention basin and allow developers that are not able to meet their on-site stormwater management requirements to pay fees in lieu that are used to help offset the cost of the facility.

Local governments may require or facilitate compensatory mitigation for fish and wildlife habitat through at least two pathways:

- Local requirements for vegetation replacement in the floodplain or other sensitive natural areas, and/or
- State or federal requirements for protection of species or habitat. Local code generally requires that any development permitted at the local level be consistent with relevant local, state, and federal laws, including state and federal protections for wetlands and streams; endangered species; and fish passage. Compensatory mitigation may be required or encouraged under these laws.

Compensatory mitigation programs may be an attractive mechanism for local governments wanting to achieve improved ecological outcomes while still allowing some amount of development impacts to occur in the floodplain. In order for these programs to be effective, however, there needs to be investment in restoration that generates proportional benefits (and ideally a net benefit) to the floodplain functions being impacted.

2.5 PROTECT AND RESTORE NATURAL FLOODPLAIN FUNCTIONS

As effective as all of the above strategies can be, they focus primarily on limiting further damage to natural floodplain functions. In areas where these functions have already been undermined by development or other impacts, active restoration may be needed to achieve a level of function that meets community needs. For growing communities, it may also be helpful to establish legal protections such as conservation easements to protect areas of the floodplain with high flood hazards and high ecological values. Legal protection, though either easement or purchase, and active restoration can often be combined to meet two interrelated goals: shifting extremely flood-prone areas to public ownership and conservation management, and providing room to accommodate flooding and reduce impacts on neighboring private properties.

Local approaches in this category may include:

- Willing seller programs that provide fair market value to homeowners voluntarily selling their homes to a local government that then uses that property to achieve floodplain restoration goals



- Protection of existing open space, including parks and greenways in which some degree of flooding can be accommodated
- Easements directly along streams and drainageways, allowing local government staff to access and manage waterways for flood management (e.g., small-scale detention or conveyance projects)
- Programs that allow the compensated transfer of development rights from flood-prone to other properties
- Non-structural flood mitigation activities such as floodplain reconnection and wetland restoration

2.6 INTEGRATED PLANNING AND MANAGEMENT

Floodplain management is often driven by crisis response to individual flood events, resulting in short-term, often costly solutions that do not address the larger dynamics or processes that underlie the problem. A more proactive and forward-looking approach to flood management can help ensure that efforts are coordinated and targeted at long-term community and ecosystem resilience, as well as the effective and prudent use of public funds.

A more integrated approach to flood management – one that crosses the imaginary boundaries between flood management and related fields such as stormwater management, land use planning, natural resource protection, emergency management, economic development, transportation, and so forth – can also help guide better planning and decision-making. It can also help ensure that the management decisions taking place within the various departments of a local government are all directed toward a balanced, sustainable, and resilient way of managing a community's growth. A flood management decision that is examined through these multiple lenses in advance is more likely to be made in a way that supports many different goals of the community. For example, steering planned development and infrastructure away from flood hazard areas not only reduces flood damage and increases natural floodplain functions, but can also reduce the need for built stormwater solutions, improve access to recreation and active transportation, and increase a community's resiliency to the economic impacts of natural disasters.

Strategies for a forward-looking and more integrated approach to flood management can run the gamut from basic land use planning that addresses long-term flood dynamics, to stand-alone floodplain management plans, to large-scale integrated watershed planning. Because plans are only as good as their implementation, communities may want to also develop flood control districts or other institutional structures to help fund and implement new strategies.

Local approaches in this category may include:

- Creating and implementing integrated floodplain management plans or watershed plans
- Natural hazard mitigation planning
- Incorporating flood issues into community comprehensive planning



- Establishing special districts for flood and drainage control

The good news is that preventative strategies for flood management have been demonstrated to be cheaper in the long run. The 2018 *Natural Hazard Mitigation Saves Report* from the National Institute of Building Sciences states that each dollar invested in floodplain mitigation results in an average savings of six dollars for the American public.

3 CHALLENGES AND NEXT STEPS

One of the key challenges facing local governments is the transformation of local floodplain management programs from being reactive to flooding events to being proactive in protecting communities from future flood damage. Floods are expensive and dangerous, and the traditional approach of cleaning up after a disaster rather than reducing risk to people and properties is no longer tenable. Local governments, however, face tremendous pressure when making flood management decisions that pit the seemingly far-off and unquantifiable reduction of flood risk against the more immediate economic and political benefits of continuing to develop in flood-prone areas. In addition, the complex regulatory environment in which floodplains are managed ends up favoring project-by-project compliance and ignores the cumulative effect of continued impacts to floodplain function. Measuring cumulative effects is also no simple task given the ecological and hydrological complexity of floodplain systems.

So how can local governments really start to design a flood-resilient future for their communities? One of the impetuses for this paper was a realization that while the process of building more flood-smart, resilient communities can feel daunting, many of the building blocks to a smarter approach to floodplain

SMARTER FLOODPLAIN MANAGEMENT IN ACTION

The City of Salem, Oregon, took a flood-smart approach to managing their floodplain. Technical staff across multiple departments, residents, businesses, and others worked over several years to identify both the 'why' and the 'how' for a more integrated and proactive approach to managing the risk associated with their floodplain. The result is a comprehensive planning document that serves as the City's natural hazard mitigation plan for flooding, provides a mechanism for achieving several of their Comprehensive Planning Goals, and identifies how the strategies get implemented across the relevant city planning and public works departments.

The final product is impressive – a 160 page plan that gets updated every 5 years. But they started with a straightforward idea: that the approach they had to managing flood-related impacts was insufficient to address the scale of problem within the City and required a new way of thinking about how managing floods also impacted their management of stormwater and drinking water. Once there was a vision behind a more integrated floodplain management plan, and a small group of interested staff to champion the process, it became much easier to develop and implement some of the strategies described above.



management already exist. Local governments can look to their neighbors for models or even build from relevant parts of their own existing regulations. They can choose approaches that fit their own unique set of political, regulatory, environmental, and hydrological constraints. They can build them into a stand-alone flood management approach, or they can nest them within other parts of development and zoning code to focus changes on the resources and issues that people care most about.

Working together to build a vision for a more resilient future is one of the most important things a community can do. For most cities and counties, floodplains will play a critical role in that vision. This vision can form the basis for making a convincing case that a new approach is needed, and it can help focus time and resources on the changes that are most important. A smarter approach to floodplain management – one that reduces risk to communities and supports the natural systems on which we all depend – can help start any community on the path to a better future.



CITATIONS

Association of State Floodplain Managers (ASFPM) NAI How-to Guide for Regulations and Development Standards (2017). <https://www.floods.org/ace-images/ASFPMRegulationsGuideApril2017.pdf>

National Institute of Building Sciences (NIBS) Natural Hazard Mitigation Saves Study Reports (2018). https://www.nibs.org/page/ms2_form

NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2018). <https://www.ncdc.noaa.gov/billions/>

White, G.F. (1945). Human Adjustment to Floods. Department of Geography Research Paper no. 29. Chicago: The University of Chicago. https://biotech.law.lsu.edu/climate/docs/Human_Adj_Floods_White.pdf



APPENDIX A: TABLE OF LOCAL POLICY OPTIONS AND EXAMPLES

Improve Hazard Mapping	
Policy Option	Example
Improved mapping/modeling	
Alternate floodway definition	Corvallis, Oregon uses a 0.2-foot rise floodway rather than the FEMA-mapped 1-foot rise (Corvallis Land Development Code 4.5.40.02(b)2)
Map additional hazards	
10-year or 25-year floodplain	Washington County, Oregon, defines the 25-year (4% probability) inundation area as Drainage Hazard Areas. (Washington County, OR, Community Development Code, Article I, Section 106-64) (https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIINGEPR_106DE)
Channel migration zone	Local governments in Washington State are required to identify and limit development in channel migration zones. Some Oregon communities (e.g., Troutdale) have had the channel migration zones mapped for informational purposes.
Erosion zone	Oregon State University and Tillamook County have created draft coastal erosion hazard maps for the Neskowin area (non-regulatory use). Many Oregon communities (Corvallis, Washington County, Troutdale, Happy Valley) map erosion (steeply-sloped) and landslide hazard areas
Historical flood boundaries	Many Oregon communities that were affected by Willamette River flooding in 1996 have included that inundation area on their official flood maps (Portland, Oregon City).
500-year floodplain	Salem, Oregon, and many other communities map the 500-year (0.2% probability) floodplain to indicate areas that would be at risk in a more extreme flood event
Dam and levee residual risk area	
Future conditions hydrology - climate change	



Future conditions hydrology - development build-out	
-----------------------------------------------------	--

Limit Development in Flood Hazard Areas	
Policy Option	Example
Prohibit development in floodway	Corvallis, Oregon, prohibits within the floodway "encroachments... with the exception of bridges, infrastructure, utilities, or Water-dependent uses," all of which must demonstrate zero rise. (Corvallis LDC 4.5.80.01). Washington State prohibits new development and substantial repair or improvement of residential structures in the floodway (with some exceptions) (RCW 86.16.041) (https://app.leg.wa.gov/rcw/default.aspx?cite=86.16.041)
Limit development in floodplain	Benton County, Oregon, prohibits new development in the Special Flood Hazard Area, except where insufficient buildable area outside the SFHA is available (and additional criteria are met). (83.215(1))
Limit subdivision in floodplain	Troutdale, Oregon, prohibits new land divisions for properties exclusively within the floodplain or that would create a buildable lot exclusively within the floodplain (TDC 4-37 - 4.514(A)5).
Locally regulated floodplain	Vernonia, Oregon, defines and regulates development within a Flood Plain Management Area based on the 500-year (0.2% probability) inundation area or FEMA SFHA, whichever is greater. (Ordinance 851, Section 3) http://www.vernonia-or.gov/Forms/Docs/ORD851FloodDamage_201403031446.pdf
Higher regulatory standards for higher-hazard zones	City of Portland, Oregon prohibits land divisions and planned developments in the Johnson Creek flood risk area (which is based on approximately a 10-year/10% probability event). (33.537.160)
Siting of critical facilities	



<p>Establishing setbacks and buffer zones</p>	<p>Oregon's Metro regional government requires individual jurisdictions to establish vegetation corridors around mapped Protected Water Features and protect designated beneficial uses (3.07.340, https://www.oregonmetro.gov/sites/default/files/2018/07/11/complete-Metro-Code-updated-07112018.pdf). Minimum buffer widths vary from 15-200 feet depending on the type and size of water body and bank slope.</p>
<p>Open space requirements</p>	<p>Happy Valley, Oregon requires planned unit developments to set aside 20% of a development's area as open space maintained as natural and/or recreation areas (Section 16.63.130(H)(1), https://qcode.us/codes/happyvalley/)</p>
<p>Local or state regulation of wetlands/sensitive resources</p>	<p>Oregon's Metro regional government includes designated wetlands as Protected Water Features (see above)</p>
<p>Prohibit new flood control structures to protect new development</p>	<p>Troutdale, Oregon prohibits the construction of new levees to create vacant buildable land (TDC 4-38 - 4.514(B)8)</p>
<p>Establish resource protection zones</p>	<p>Many Oregon cities protect a broad diversity of resource protection zones. For example, the City of Eugene has established a natural resource zone (9.2500), which protects wetlands and other resources included in the city's Goal 5 Inventory (see Local Comprehensive Plans, under Integrated Planning and Management, below) through development limitations and management requirements. Eugene has also established several overlay zones related to protection of wetlands and water resources (9.4700-9.4900). These zones include features such as vegetated buffer areas, setbacks and protections for native vegetation, and some zones link directly to implementation of the West Eugene Wetlands Plan.</p>
<p>Require CLOMR/LOMR for floodplain fill</p>	<p>Troutdale, Oregon requires all projects involving fill in the regulatory floodplain to achieve balanced cut-fill and obtain conditional and final letters of map revision (CLOMR-F and LOMR-F) from FEMA. (TDC 4.517G (p. 4-46))</p>



Limit development impacts	
Policy Option	Example
No-rise requirement beyond floodway	Many Oregon cities effectively require development within all or part of the floodplain to demonstrate "no-rise" by requiring compensatory mitigation for any floodplain fill. Centralia, Washington extends a "no-rise" requirement to certain flood-prone areas outside of the floodway, requiring a zero-rise engineering analysis for fill greater than 500 cubic yards (CMC 16.21.165), as well as compensatory mitigation for fill greater than 500 cubic yards throughout the floodplain (CMC 16.21.170(F)).
Prohibit fill in floodway	
Limit impervious surface	Troutdale, Oregon limits total impervious area to a maximum of thirty percent (30%) of the total area of the vegetation corridor and slope district on a lot. (TDC 4.315 (2)a (p. 4-15))
Low-impact development	Clean Water Services (Washington County, Oregon) has developed a guide to low-impact development, available at https://www.cleanwaterservices.org/permits-development/design-construction-standards/lida-handbook/
Green stormwater infrastructure	City of Salem, Oregon requires the use of green infrastructure for stormwater management to the maximum extent feasible in new development. The city allows a non-discretionary approach that maximizes certainty by requiring 10% of the impervious footprint of a development site be set aside for green stormwater management, as well as a more flexible discretionary approach in which the development proponent demonstrates that a project meets 80-100% of on-site run-off mitigation through green approaches. (City of Salem, Administrative Rules, Ch. 109 Div. 004, Appendix E)
Cumulative effects in rise analysis	
Lower threshold for "substantial improvements"	



<p>Broad avoidance and minimization language</p>	<p>Oregon's Metro regional government requires proponents of projects that affect a Water Quality Resource Area to demonstrate that "no reasonably practicable alternative design or method of development exists that would have a lesser impact... than that one proposed" and requires minimization of impacts through design and compensatory mitigation of unavoidable impacts. (Metro 3.07.40). A similar approach could be used to require avoidance, minimization, and compensatory mitigation of impacts to natural floodplain functions.</p>
--------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Require compensatory mitigation	
Policy Option	Example
<p>Balanced cut-fill</p>	<p>Oregon's Metro regional government requires development in the floodplain to maintain or increase flood storage capacity and not increase design flood elevation, including through the removal of soil material to offset fill placed at or below design flood elevation. (Metro 3.07.340) As a result, all Metro area local governments have some form of balanced cut-fill requirement.</p>
<p>Stormwater offsets</p>	<p>The Washington, DC, Department of Energy and Environment runs the country's first stormwater retention credit program. The District's stormwater management regulations require large construction and redevelopment projects to install green infrastructure to reduce runoff. Properties can meet up to half of their regulatory requirement by purchasing stormwater retention credits from other properties that install green infrastructure voluntarily. This allows regulated properties to pursue more cost-effective compliance methods and provides financial incentives for properties to voluntarily install green infrastructure. (https://doee.dc.gov/node/648432)</p>



<p>Riparian vegetation replacement</p>	<p>Oregon's Metro regional government requires establishment of vegetated corridors around water bodies, within which native vegetation must be maintained and impacts to vegetation must be mitigated. (Metro 3.07.340). As a result, all Metro area local government have established corridors or buffers of varying widths within which native vegetation must be maintained or impacts mitigated.</p>
<p>Mitigation under state and federal laws</p>	<p>Many state and federal environmental laws allow compensatory mitigation as a more flexible way of reaching regulatory compliance. Examples include the federal Endangered Species Act, Clean Water Act protections for wetlands and streams (Section 404), and Oregon's state removal-fill and fish passage requirements. Local governments generally require compliance with all relevant local, state, and federal laws as a condition of land use permitting.</p>



Protect and restore natural floodplain functions	
Policy Option	Example
Willing seller programs	City of Portland, Oregon established a willing seller program as part of implementation of its Johnson Creek Restoration Plan. Created to address flooding and other natural resource-related issues, the City acquired properties from willing sellers at fair market value. The acquired properties have been incorporated into floodplain management projects that include constructed wetlands, floodplain terraces and open space for flood management, habitat, and recreation opportunities. (https://www.portlandoregon.gov/bes/article/106234)
Open space protection (parks, greenways)	Many cities with significant river and stream frontage use open space protection (the establishment of parks, greenways, etc.) as a way to help balance development needs, flood hazards, and protection of natural resources in those sensitive areas. City of Salem, Oregon, which has more than 4000 acres in the 100-year floodplain, has significantly managed flood risk through establishing riverfront parks and open spaces, in combination with other strategies.
Stream and drainage easements	
Transfer of development rights	Washington County, Oregon allows for a transfer of development density from an area that is unbuildable due to natural resource concerns (including flood hazards) to another developable area (Washington County Community Development Code 300-3)
Active restoration	The Tillamook Southern Flow Corridor in Oregon (https://tillamookoregonsolutions.com/history-3/) is an example of a floodplain reconnection project that combines flood hazard reduction and habitat restoration benefits, developed through a collaborative process that helped limit conversion of productive agriculture land.
Regulatory streamlining for restoration projects	



Integrated planning and management	
Policy Option	Example
Flood management plans	City of Salem, Oregon has developed a comprehensive floodplain management plan that outlines a set of interconnected, strategic actions to reduce flood risk in the city (https://www.cityofsalem.net/CityDocuments/floodplain-management-plan.pdf). Implementation of the strategy thus far has allowed Salem to rise to a Class 5 in FEMA's Community Rating System, the highest rating in the state, resulting in a 25% discount in NFIP flood insurance rates.
Local comprehensive plans	In Oregon, comprehensive plans outline how each city or county will address the State's 19 land-use planning goals. Many of these goals are relevant to flood and floodplain management, and ensuring relevant language is included in comprehensive plans can help ensure a wide diversity of flood management and policy options are feasible in the future. City of Portland's comprehensive plan (https://www.portlandoregon.gov/bps/57352) includes flood-relevant language under Goal 5 (Natural Resources), Goal 6 (Air, Water, and Land Resources Quality), Goal 7 (Natural Hazards), and others.
Hazard mitigation plans	The State of Oregon and many individual communities have developed natural hazard mitigation plans, which can help jurisdictions plan for and limit the impacts of natural disasters such as flooding. Clackamas County's plan (currently under revision) provides an example for a county that experiences significant flooding challenges: https://www.clackamas.us/dm/naturalhazard.html
Flood control districts	Oregon Revised Statutes Chapter 554 allows for the establishment of special districts with taxing authority for the use or control of water, including flood control. These districts, commonly called "drainage districts" are common along the Columbia River and other flood-prone areas of the state and can provide a source of funding for flood management actions.