

September 2023

MEMORANDUM: FLOOD RISK MAPPING FOR THE GENERAL PLAN

Introduction

The City of Petaluma is currently updating its General Plan, a plan that will guide the future development and management of the City for the next 20 years. As part of this work, the City has is looking at new data and technology to prepare for future flood risks in the community.

To gain the best possible understanding of flooding in Petaluma over the next 20 years and out to the end of the century, the City engaged experts to develop state-of-the-art computer models that closely examine flood risks. The models examine several factors including terrain, anticipated storm and rainwater patterns, and water coming up the River due to sea levels, tides, and storm surges.

Another major consideration when thinking about flooding over time is climate change will impact flooding. Climate change will bring higher seas, extreme weather events, and higher San Francisco Bay waters, along with changes in rain intensity and frequency. Because the Petaluma River is tidal, river levels is also influenced by sea level rise (SLR). There is guidance from the State and general agreement in the scientific community on probability ranges of sea level rise we can anticipate over time. The modeling team used these ranges to help predict future flooding.

It is important to note that these are projections have varying levels of likelihood. While the flood model shows that the likely mid-century condition will be similar to the current 100-year floodplain, it's important to consider various scenarios for long term planning.

Past Flood Modeling

The creation of the City's current General Plan, adopted in 2008, included a study of hydrologic/hydraulic modeling (the way water moves from storms and the tide in our river; and, how water behaves when it is moving in our creeks and River) using less sophisticated software modeling that what is currently available. The floodplain and watershed data used in the computer application, referred to as a model, is based solely on past storm and rainfall information.

The 2008 model, using the "XP-Storm" modeling application, also included topographical information, like hills and valleys, and conditions of our creeks and the River such as trees and

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other plants that slow down or reduce the amount of water that will easily flow through the channel.

The City used the model to design flood reduction projects, such as the three Denman Reach flood terrace projects, along Industrial Avenue, and the Capri Creek restoration and flood reduction project, along Sunrise Parkway. The model was also used to evaluate proposed development projects to understand their relationship to the floodplain and drainage and inform the project design parameters and appropriateness.

Shifting from XP-Storm to HEC-RAS

Over time the City's model was updated, and new flood modeling programs became available. In 2022, the City partnered with Sonoma Water to fund the development of a flood model using a new platform called "HEC-RAS 2D". The HEC-RAS software is developed/maintained by the U. S. Corps of Engineers, is free to download, and is regularly updated with new features.

Sonoma Water, the Sonoma County agency for water-related services, recently converted the Petaluma's upper watershed to HEC-RAS 2D. The Petaluma Watershed encompasses ~137 square miles, ~14 square miles of which is located within City limits. The watershed is the area that drains all rainfall and creeks toward the Petaluma River. This means that our new model fits seamlessly with that of our surrounding area, giving us better data on factors outside City boundaries, and allowing for improved collaboration between the City, County, and Sonoma Water.

The HEC-RAS 2D model also provides much better detail on the overall topography of the city [areas inside and outside the creek channels] to understand the direction water will go as well as the amount of flow, depths, and the speed of the water movement [called velocity]. The HEC-RAS model, like the XP-Storm model that preceded it focuses on flooding that is a result of rainfall. To develop the model, City staff worked closely with WEST Consultants, including their expert in the study of the hydrologic cycle and the rainfall statistics of storms (hydrometeorology) Dr. Luciana Kindl Da Cunha.

Flooding from the Sea

The Petaluma River is a Tidal Slough. This means that the river carries water both down from the hills as well as up from the bay. The water levels in the river fluctuate with the tide. As Climate Change impacts the level of the ocean, and we begin to see average higher sea levels (Sea Level Rise), we will see increased flooding from Bay water. The City included modeling of impacts of Sea Level Rise (SLR) and associated salt-water flood risks, like King Tides, into the flood mapping effort.

The Petaluma River is affected by tides from the San Francisco and San Pablo Bay, which means twice a day the River rises in elevation as the tide comes into our River. A "King Tide" is a term used to describe exceptionally high tides, which occur when the sun and moon are both at their closest to Earth – pulling on the ocean with their strongest gravitational force. These tides

typically occur a few times a year when a new or full moon is closest to Earth around the summer and winter solstice. King Tides are the highest tides expected in a year and occur without any rainfall or storms. King Tides are modeled with a simpler method than HEC-RAS, by determining the elevation the river will be, then seeing what parts of the City are below that elevation.

“Storm Surges” are extreme high-water levels in the river due to atmospheric conditions such as low atmospheric pressure from storms, regional climate, wind, or increased freshwater flows into the bay. The 100-year storm surge is independent of the 100-year rainfall because storm surges are not linked to rainfall events in the watershed. Storm Surges are not expected to ever happen at the same time as flooding from rainfall. King Tide and Storm Surge are modeled with a simpler method than HEC-RAS, by determining the elevation the river will be, then seeing what parts of the City are below that elevation.

High-Level Flood Model Results

The flood models completed for the General Plan Update look at potential flood risks caused by rainfall draining into our river from or by seawater coming up the Petaluma River from the San Francisco Bay. Flooding from rainfall comes down the river and creeks as a result of rain in the Petaluma Watershed. The water that comes down the river and creeks all flows out to the Bay. At high tide the Petaluma River is close to the top of the river bank in Downtown Petaluma. This means that as the sea level rises over time due to climate change, rainwater can get backed up in the river during storms, leading to more potential flooding.

Climate change will also change flood (or inundation) risks from seawater coming up the river. It is possible to see the river level rise and fall in Downtown Petaluma every day with the tides. Several times a year there are particularly high tides, called King Tides. King Tides are exceptionally high tides that typically occur several times per year during a new or full moon and when the earth is closest to the moon. They occur several times a year and cause water levels to increase as much as 12-inches above normal high tide. There can also be increases in the Bay and river level from large storms in the Pacific Ocean. This is called storm surge. As sea levels rise, king tides and storm surges will likely be higher.

The maps look at rainwater flooding and flooding due to elevated seas, including king tides and storm surges. It is very unlikely that a significant storm will come during a king tide or when there is a storm surge due to a storm far out at sea. Therefore, the rain-related flooding and king tide/storm surge flooding are considered as happening on different days, and are shown on different maps.

The flood model shows that the likely mid-century condition will be similar to the current 100-year floodplain. To inform its General Plan Update, the City has developed four scenarios that reflect more conservative, less likely, scenarios that show a higher than anticipated amount of sea level rise. These scenarios include maps that show Petaluma’s flooding and inundation risks in the middle of the century (around 2050) and towards the end of the century (around 2100). There are two maps for each time period, including a projected 100-year flooding risk map (also described as 1% annual flood risk map) that also includes storm surge risks, and a map of projected King

Tide flood risks. The scenarios also take into account climate change, which will increase the average sea level. The scenarios developed are:

Map 1: Year 2050 (approx): Mid-Century Flood Model for Rain and Storm Surge

Projected Rain with Sea Level Rise of 1.9 feet, including storm surge risks

Note: this sea level rise has a *0.5% chance of happening and not expected to occur. We expect mid-century to be similar to our existing 100-year floodplain*

Map 1a: Year 2050: Mid-Century Flood Model for King Tides

Note: King Tides occur a few times a year

Map 2: Year 2100 (approx): End-of-Century Flood Model for Rain and Storm Surge

Projected Rain with Sea Level Rise of 3.4 feet, including Storm Surge Risks

Note: *this sea level rise has a 17% chance of happening*

Map 2a: Year 2100: End-of-Century Flood Model for King Tides

Note: King Tides occur a few times a year

The maps will be shared at the September 21, 2023 General Plan Advisory Committee meeting, and will then be posted on the General Plan website.

Next Steps for the General Plan

The City of Petaluma is in the process of updating our General Plan, the plan that will guide the development of the city for the next 20 years. One of the primary considerations is future flooding up the river from the sea, as well as down the river and creeks during storms. The General Plan will use the modeling developed through this effort to develop alternatives, or options, for land use in the City, essentially the kind of buildings or uses of buildings that are allowed in different parts of town. The General Plan will also establish policies that are designed to reduce the risk of flood impacts and adapt to the changing climate, including development requirements, infrastructure approaches, and nature-based solutions.

The next phase of the General Plan will be to present Land Use Alternatives for GPAC, Planning Commission and City Council review and discussion, leading to the identification of a preferred development scenario that the General Plan will be built on. Following the introduction of the Land Use Alternatives, the GPAC will be asked to weigh in on draft flood and adaptation-related policies and topic-related policy frameworks before they are brought forward to the public for discussion. Ultimately, the General Plan will also recommend an approach to infrastructure planning for flood management and adaptation. This is likely to include more specific infrastructure planning after the General Plan is adopted.

Upcoming Meetings on General Plan Flood Maps

The **General Plan Advisory Committee (GPAC)** will review mapping that shows projected flood scenarios for mid-century and the end of the century on **September 21, 2023 at 6:30 PM at the Community Center in Lucchesi Park**. These maps will inform how the General Plan addresses many issues, including future land use alternatives, climate adaptation, the natural environment, and climate adaptation. The GPAC will address these issues in future meetings. While members of the public are welcome to attend the GPAC meeting and provide comments, there will be more opportunities for public discussion and questions at the Community Meeting, described below.

There will be a virtual **Community Meeting** dedicated to public review and discussion of the maps, and how they will be used to help shape the General Plan. There will be opportunities to ask questions and discuss the maps with staff and consultants at this meeting. The meeting will be held **virtually** on **September 27, 2024, 6:00pm- 8:00pm**. Details on the meeting, including a Zoom link, will be posted shortly.

Please visit <https://cityofpetaluma.org/meetings/> for meeting details. GPAC materials are also available on the General Plan website: <https://www.planpetaluma.org/gpac-page>

Updating Petaluma's FEMA Map

The General Plan focuses on planning for the next 20 years, and maps have been produced for this purpose. Over the next two years, the Department of Public Works will start working with FEMA on updating the City's FEMA Flood Insurance Rate Maps (FIRM's) that will include its own community engagement process.

Learn More

More information on the General Plan, please visit <https://www.planpetaluma.org/>