Public Handbook:
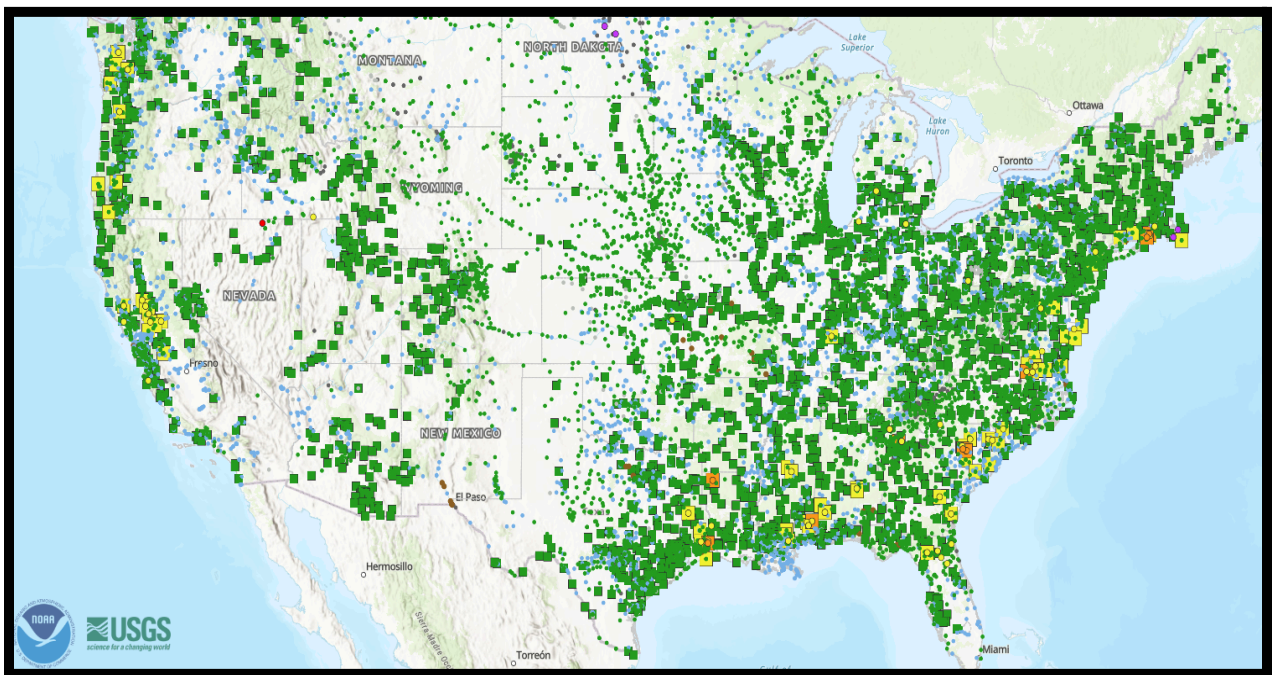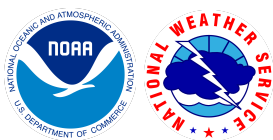
National Water Center Visualization Services

Version 2.3

Last updated: April 19, 2024

*Preliminary - Subject to Change

Introduction 3

Introduction

This handbook describes the suite of publicly available visualization services via the National Weather Service National GIS Viewer or through the National Water Prediction Service. Most of these services are developed by the NOAA National Weather Service (NWS) Office of Water Prediction (OWP) in support of the NWS and National Water Center (NWC) operations. Most of these static and dynamic services depict value added information derived from River Forecast Center (RFC) official forecasts and forecast guidance from the operational version of the National Water Model (NWM). A brief description of each service, and a summary of the methodology used to derive each service, is included in this handbook.

Services leverage geography information system (GIS) technology and are made available through the NWC's cloud-based Hydrologic Visualization and Inundation Services (HydroVIS) system, which includes an Enterprise GIS for disseminating geospatial services.

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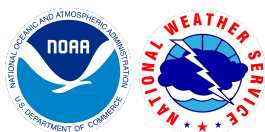
Reference Services

Service	Brief Description
NWM Flowlines	Depicts the NWM flowlines within the contiguous U.S.
NWM Flowlines - Hawaii	Depicts the NWM flowlines in Hawaii.
NWM Flowlines - Puerto Rico/U.S. Virgin Islands	Depicts the NWM flowlines in Puerto Rico and the U.S. Virgin Islands.
NWM Waterbodies	Depicts the NWM waterbodies within the contiguous U.S.
Coastal FIM Domain	Depicts areas along the coast where coastal flooding processes are not being considered in the visualization FIM output.
Public FIM Domain	Depicts the domain where the NWC FIM has been made public.

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NWM Flowlines

Service URL

https://maps.water.noaa.gov/server/rest/services/reference/static_nwm_flowlines/MapServer

Description

Depicts the NWM flowlines within the contiguous U.S.

Update Frequency

Static

Methodology

The primary source of this data can be found at https://water.noaa.gov. Several attributes are derived from the NHDPlus-Medium Resolution v2.1 (NHDPlus v2.1) dataset by crosswalking the NWM feature_id with the NHDPlus v2.1 ComID. Streamflow thresholds are derived from the National Water Model reanalysis simulation. See the High Flow Magnitude pages for more details.

NWM Flowlines - Hawaii

Service URL

https://maps.water.noaa.gov/server/rest/services/reference/static_nwm _flowlines_hi/MapServer

Description

Depicts the NWM flowlines in Hawaii.

Update Frequency

Static

Methodology

The primary source of this data can be found at https://water.noaa.gov. Several attributes are derived from the NHDPlus-Medium Resolution v2.1 (NHDPlus v2.1) dataset by crosswalking the NWM feature_id with the NHDPlus v2.1 ComID. Streamflow thresholds are derived from USGS regression equations. See the associated High Flow Magnitude pages for more details.

NWM Flowlines - Puerto Rico/U.S. Virgin Islands

Service URL

https://maps.water.noaa.gov/server/rest/services/reference/static_nwm_flowlines_prvi/MapServer

Description

Depicts the NWM flowlines in Puerto Rico and the U.S. Virgin Islands.

Update Frequency

Static

Methodology

The primary source of this data can be found at https://water.noaa.gov. Several attributes are derived from the NHDPlus-Medium Resolution v2.1 (NHDPlus v2.1) dataset by crosswalking the NWM feature_id with the NHDPlus v2.1 ComID. Streamflow thresholds are derived from USGS regression equations. See the associated High Flow Magnitude pages for more details.

NWM Waterbodies
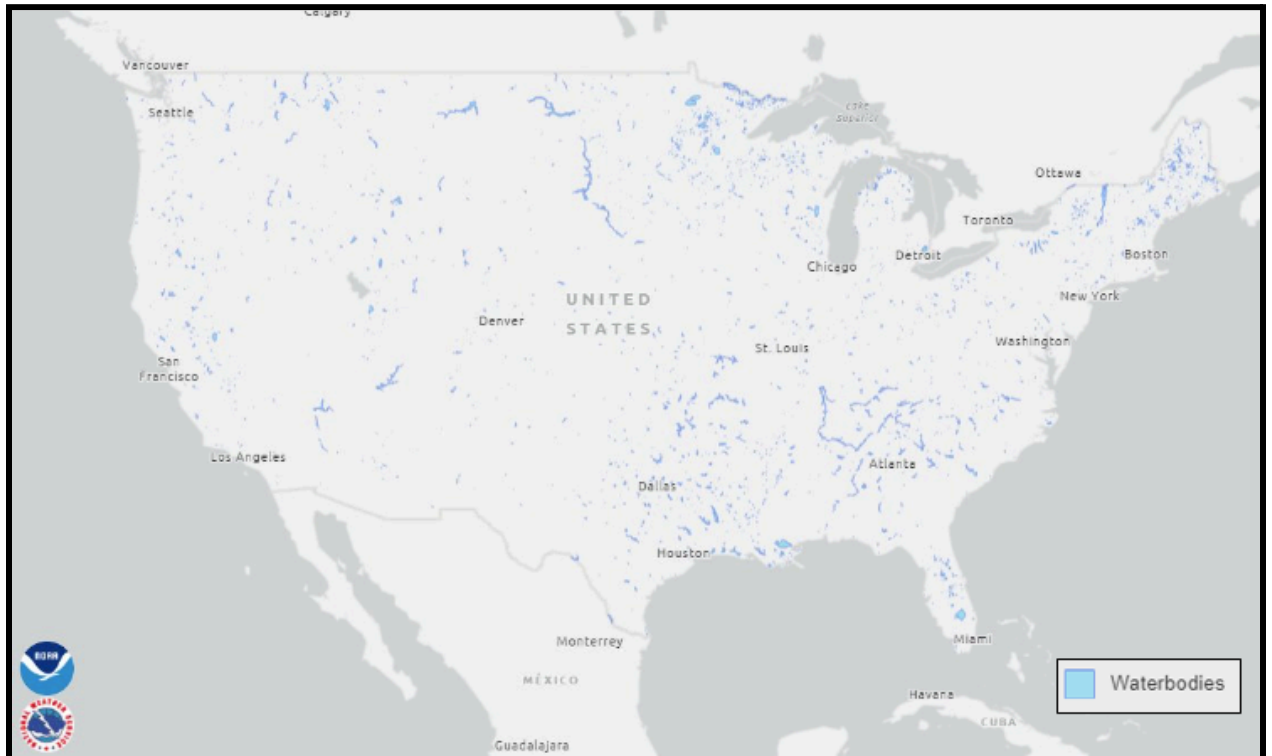
Service URL

https://mapservices.weather.noaa.gov/static/rest/services/nws_reference_maps/NWM_Lakes_and_Reservoirs/MapServer

Description

Depicts the NWM waterbodies within the contiguous U.S.

Update Frequency

Static

Methodology

The primary source of this data can be found at https://water.noaa.gov. Several attributes are derived from the NHDPlus-Medium Resolution v2.1 (NHDPlus v2.1) dataset by crosswalking the NWM feature_id with the NHDPlus v2.1 ComID. The NHDPlus waterbody data is sourced from the Watershed Boundary Dataset (WBD), a seamless national hydrologic unit geospatial dataset. The WBD is mapped and managed by the U.S. Geological Survey and is an OMB-A16 National Geospatial Data Asset.

Coastal FIM Domain

Service URL
https://maps.water.noaa.gov/server/rest/services/reference/static_nwm_coastal_domain_noaa/MapServer

Description
Depicts the domain where the NWC FIM will be made public. Shown are the WFO domains within the public FIM domain.

Update Frequency
Static

Methodology
Depicts the boundary set by the coastal water model (SCHISM) whereby inland Flood Inundation Mapping (FIM) could be questionable due to tides and surge.

Public FIM Domain

Service URL

**https://maps.water.noaa.gov/server/rest/services/reference/static_nwm
_coastal_domain_noaa/MapServer**

Description

Depicts the domain where the National Water Center (NWC) Flood Inundation
Mapping (FIM) has been made publicly available.

Update Frequency

Static

Methodology

Depicts the areas that users can see NWC FIM maps at the 10% stage. Additional
areas will become available in September 2024 (30%), September 2025 (60%) and
September 2026 (100%). In September 2026, 100% of the United States will have
FIM services.

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River Forecast Center Services

Service	Brief Description
Observed River Stages	Depicts the current river stages by flood status
Forecast River Stages	Depicts the maximum forecast stage flood status over the forecast period issued from the RFC or WFO.
Max Stage - Forecast Trend	Depicts Advanced Hydrologic Prediction Service (AHPS) River Forecast Center (RFC) forecast points with forecasts at or above action stage with icons also indicating trend (up/down) in the forecast.
Max Downstream Streamflow Forecast	Depicts maximum forecast streamflow over the next 5 days derived from the official River Forecast Center (RFC) forecast routed downstream through the National Water Model (NWM) stream network. Maximum streamflows are available downstream of RFC forecast points whose forecast reaches action status or greater.

Observed River Stages
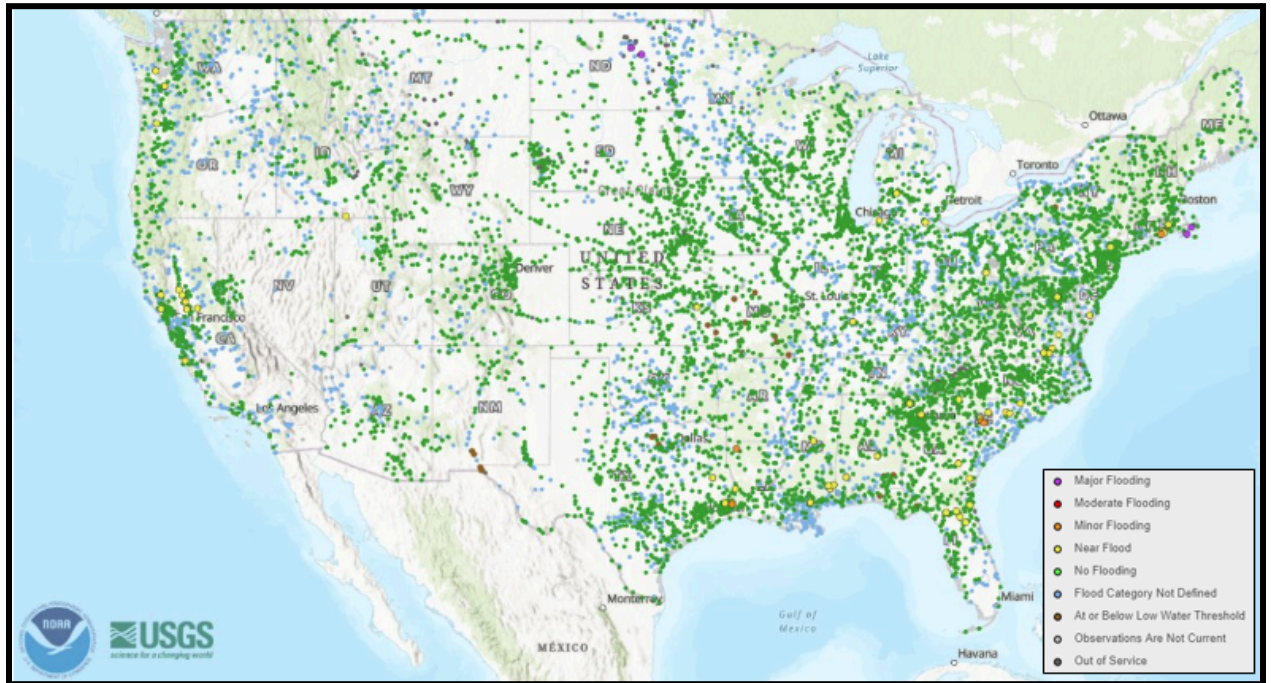
Service URL

https://mapservices.weather.noaa.gov/eventdriven/rest/services/water/ahps_riv_gauges/MapServer/

Description

Depicts current flood status of rivers and lakes at specific gauge locations.

Update Frequency

Every 15 minutes

Methodology

Forecast time series from the RFCs are analyzed to detect changes in flood stage. Change is analyzed between the initial forecast value, and the forecast value with the greatest absolute difference from the initial forecast value. Gauges forecast to change flood category will always be classified with an increasing or decreasing trend, even if the greatest absolute change is less than 5%.

Forecast River Stages
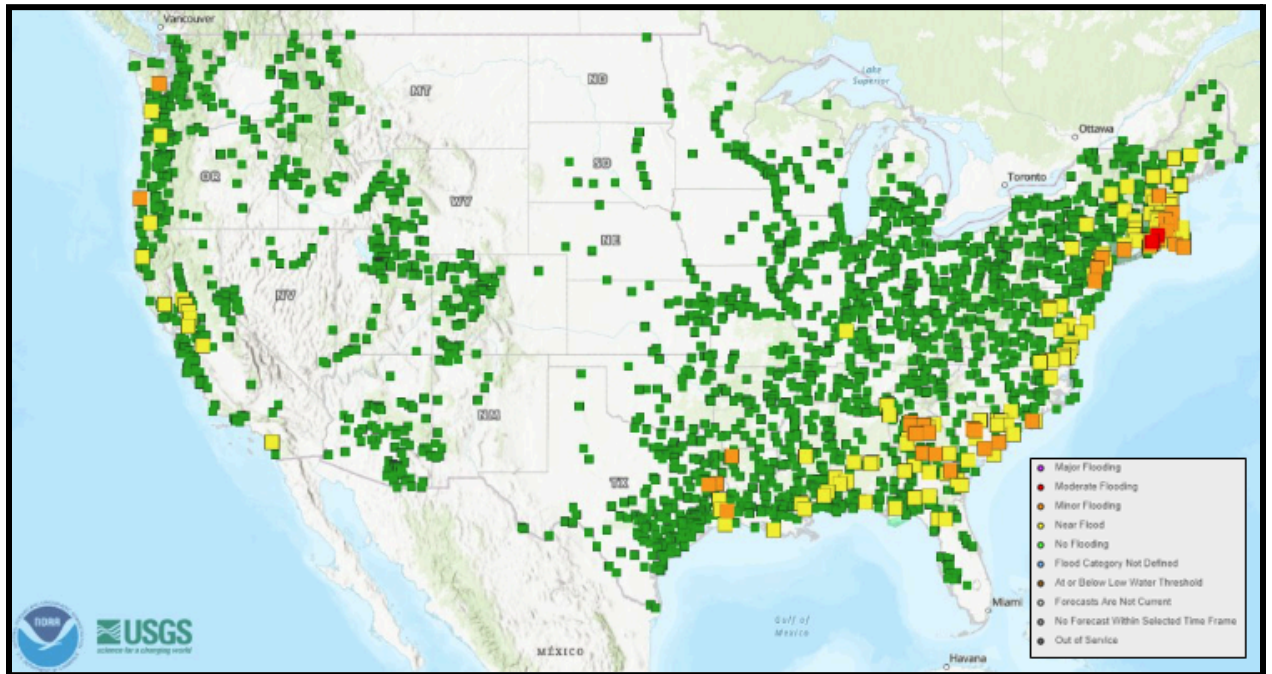
Service URL

https://mapservices.weather.noaa.gov/eventdriven/rest/services/water/ahps_riv_gauges/MapServer/15

- *Additional layers available for discrete time periods*

Description

Depicts maximum forecast height stages based on RFC or WFO river or lake forecasts. Point locations are colored by potential flood impact.

Update Frequency

Every 15 minutes

Methodology

Forecast time series from the RFCs are analyzed to produce point information colored by potential flood impact.

Max Stage - Forecast Trend
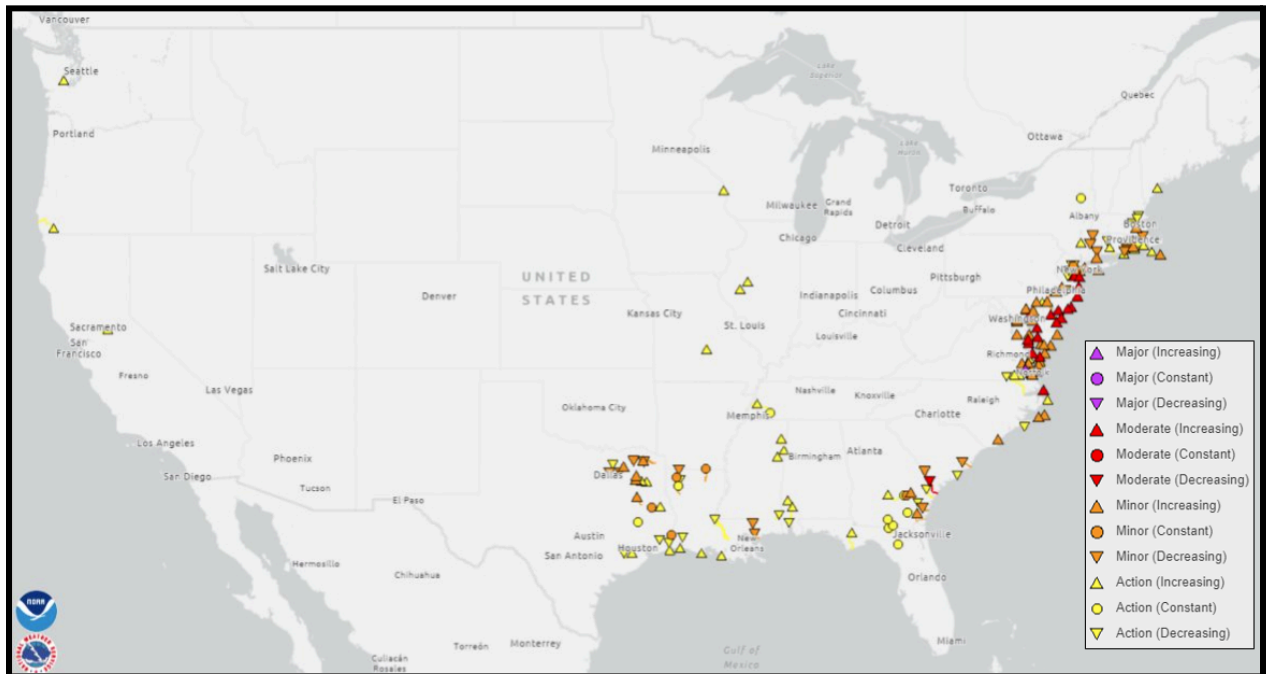
Service URL

https://maps.water.noaa.gov/server/rest/services/rfc/rfc_max_forecast/MapServer/

Description

Depicts Advanced Hydrologic Prediction Service (AHPS) River Forecast Center (RFC) forecast points with forecasts at or above action stage with icons also indicating trend (up/down) in the forecast.

Update Frequency

Every 5 minutes

Methodology

Circles represent forecast points where stages are changing by less than +/- 5% over the entire forecast period. Upward-pointing triangles represent forecast points where a greater than 5% increase in stage is expected sometime during the forecast. If stage increases greater than 5% are not expected, downward-pointing triangles represent forecast points where a greater than 5% decrease in stage is expected sometime during the forecast. Forecast points are colored by their maximum forecast flood category.

Max Downstream Streamflow Forecast
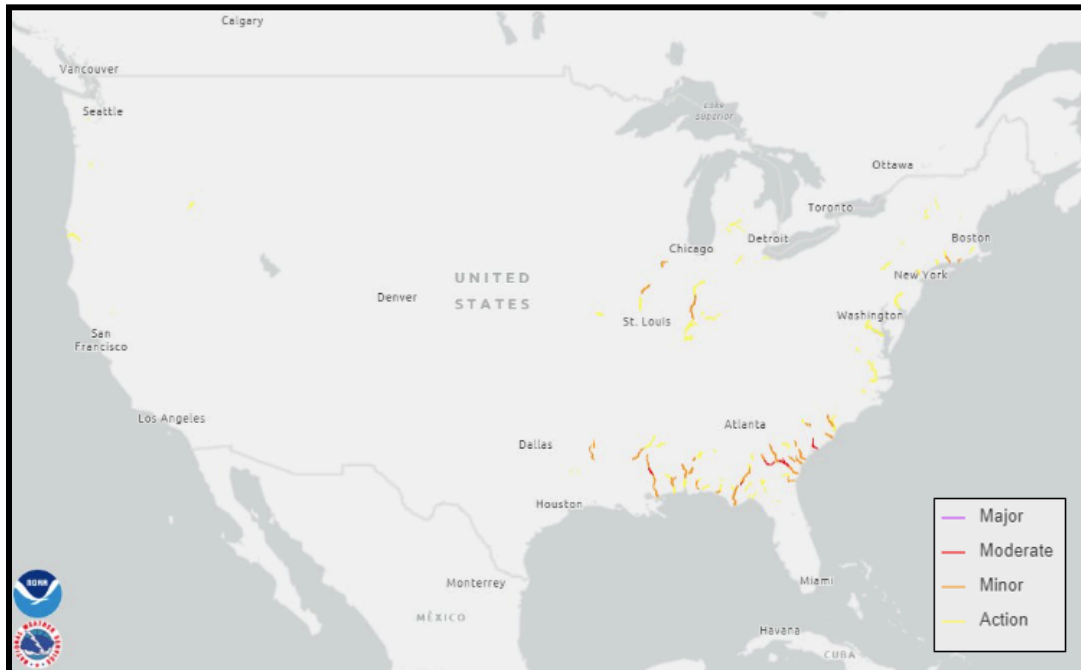
Service URL

https://maps.water.noaa.gov/server/rest/services/rfc/rfc_based_5day_max_streamflow/MapServer/

Description

Depicts maximum forecast streamflow over the next 5 days derived from the official River Forecast Center (RFC) forecast routed downstream through the National Water Model (NWM) stream network. Maximum streamflows are available downstream of RFC forecast points whose forecast reaches action status or greater.

Update Frequency

Every 15 minutes

Methodology

Forecast time series from the RFCs are assimilated into the NWM channel routing module and then routed downstream through the NWM river network. River segments are colored according to the flood status of the RFC forecast point immediately upstream. If there are several RFC forecast points immediately upstream, the maximum flood status is used to derive the color of the river segment. The NWM Analysis and Assimilation configuration provides the initial streamflow conditions for the routing.

National Water Model Services

This section outlines the suite of visualization services driven by the operational version of the National Water Model (NWM). The NWM provides estimates of current and forecast hydrologic conditions (including streamflow) across the U.S. via several model configurations: Analysis and Assimilation (current conditions), Short-Range Forecast (0 to 18-hours), Medium-Range Forecast (0 to 10-days) and Long-Range Forecast (0 to 30-days); see **Figure 1** below. For more information about the NWM, visit https://water.noaa.gov.
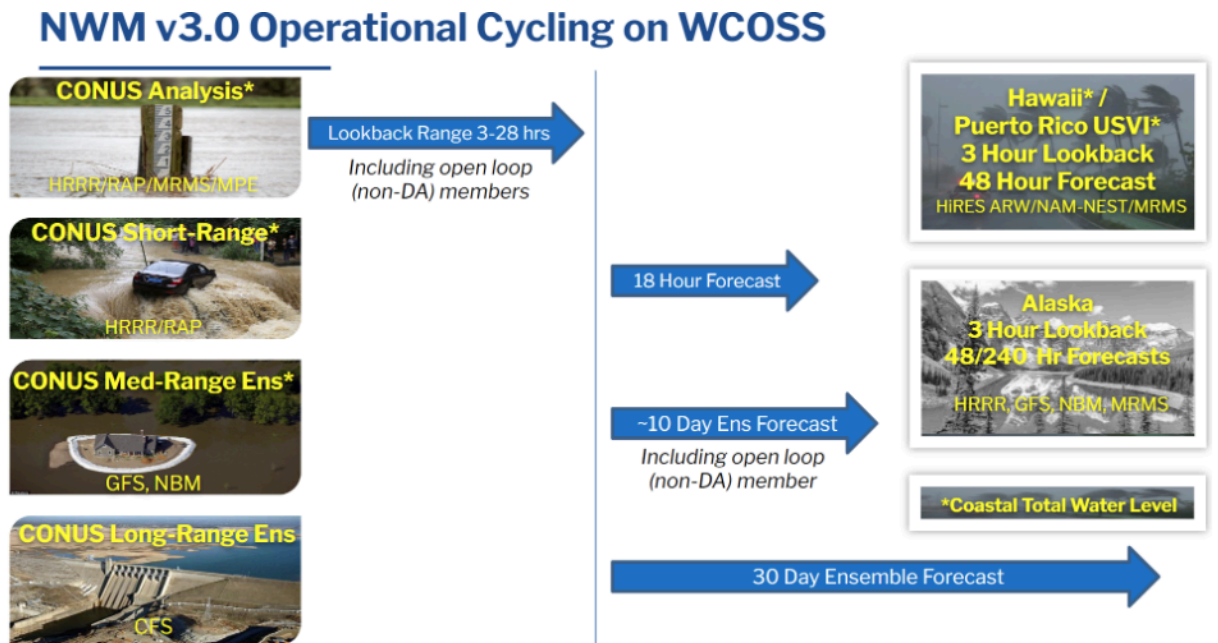

Figure 1 NWM Configurations

Analysis and Assimilation (Current Conditions)

Service	Brief Description
Soil Moisture Analysis	Depicts the soil moisture output from the operational National Water Model analysis and assimilation. Values represent soil saturation for the 0 - 40cm soil layer.
Streamflow Anomaly Analysis	Depicts current seasonal streamflow anomalies derived from the analysis and assimilation configuration of the NWM over the contiguous U.S.
High Flow Magnitude Analysis	Depicts the magnitude of the NWM streamflow forecast where the NWM is signaling high water. This service is derived from the analysis and assimilation configuration of the NWM over the contiguous U.S.
High Flow Magnitude Analysis - Hawaii	Depicts the magnitude of the NWM streamflow forecast in Hawaii where the NWM is signaling high water. This service is derived from the analysis and assimilation configuration of the NWM over Hawaii.
High Flow Magnitude Analysis - Puerto Rico/U.S. Virgin Islands	Depicts the magnitude of the NWM streamflow forecast where the NWM is signaling high water. This service is derived from the analysis and assimilation configuration of the NWM over Puerto Rico and the U.S. Virgin Islands.

Soil Moisture Analysis
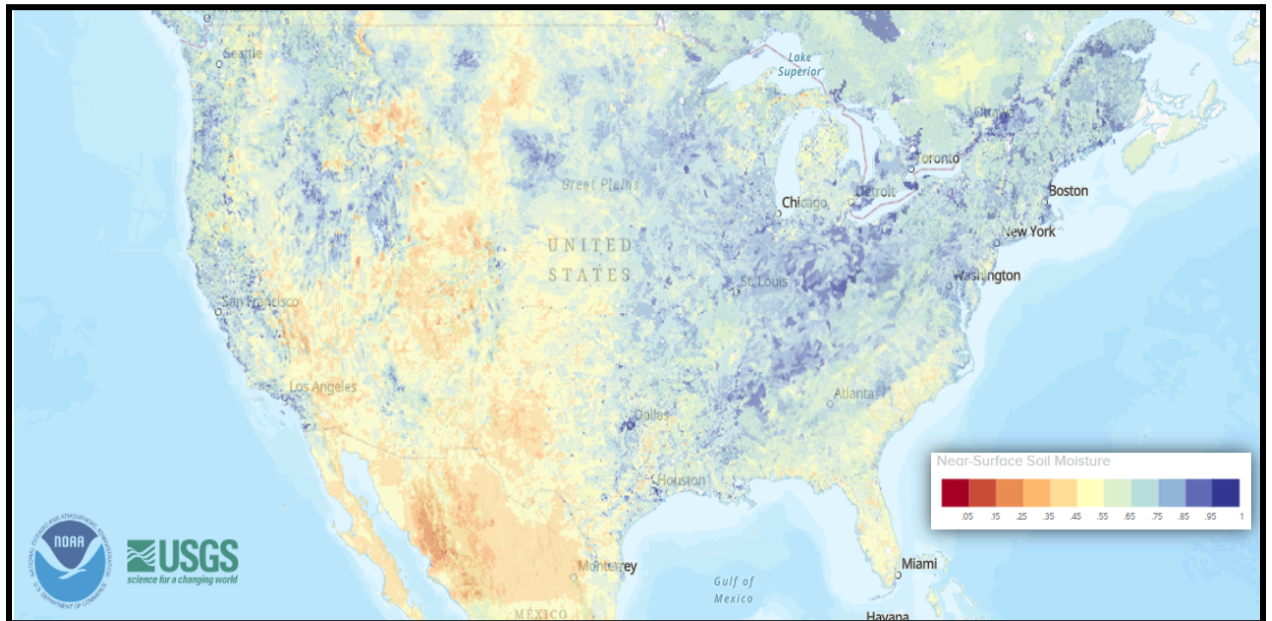
Service URL
Direct Rest Service not available.
Only available at the National Water Prediction Service [here](#).

Description
Depicts the soil moisture output from the operational National Water Model analysis and assimilation. Values represent soil saturation for the 0 - 40cm soil layer.

Update Frequency
Hourly

Streamflow Anomaly Analysis
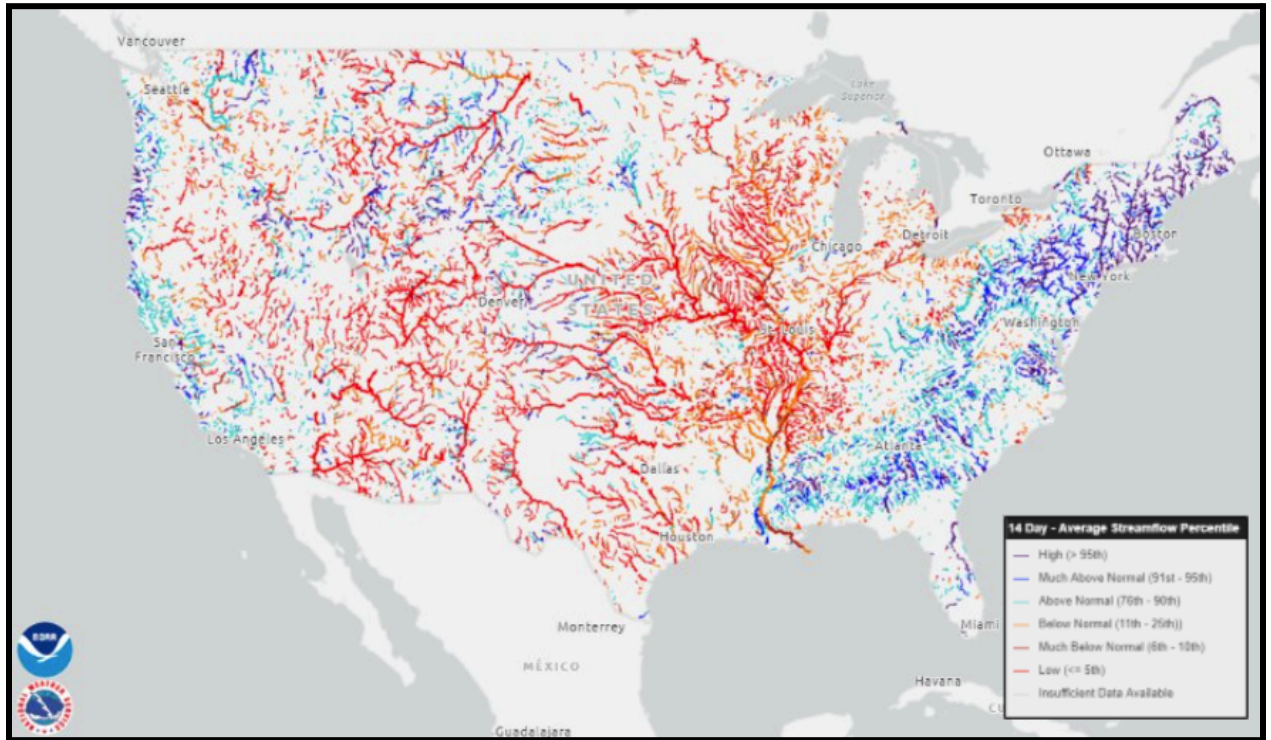
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/ana_anomaly/MapServer

Description

This services has two sublayers: Streamflow Anomaly Analysis 7-Day and Streamflow Anomaly Analysis 14-Day

Depicts seasonal streamflow anomalies derived from the analysis and assimilation configuration of the National Water Model (NWM) over the contiguous U.S. Anomalies are based on 7-day and 14-day moving average streamflow percentiles for each reach and the current calendar day.

Update Frequency

Daily

Methodology

Streamflow percentiles were derived from 7-day and 14-day moving average streamflows for each reach and each calendar day using the 40-year NWM v2.1 reanalysis simulation. Methods align with the USGS WaterWatch product.

High Flow Magnitude Analysis

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/ana_high_flow_magnitude/MapServer

Description

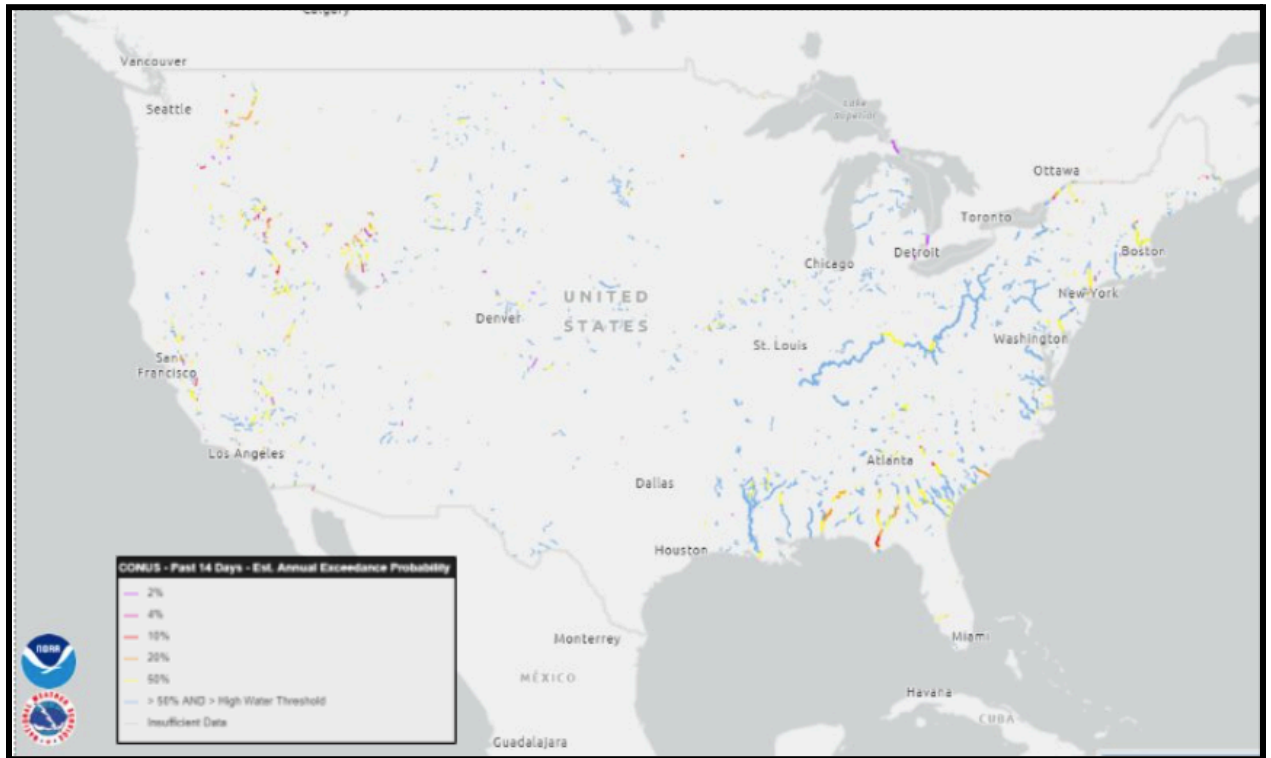Depicts the magnitude of the National Water Model (NWM) streamflow forecast where the NWM is signaling high water. This service is derived from the analysis and assimilation configuration of the NWM over the contiguous U.S. Shown are reaches with flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their current flow. High water thresholds (regionally varied) and AEPs were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency

Hourly

Methodology

AEPs were derived from the 40-year NWM v2.1 reanalysis simulation, utilizing a multi-decade flood frequency analysis and guidance from the Bulletin 17C guidelines developed by the Subcommittee on Hydrology of the Advisory Committee on Water Information (ACWI). NWM streamflow values are compared to these AEPs and

classified accordingly. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

High Flow Magnitude Analysis - Hawaii

Service URL

**https://maps.water.noaa.gov/server/rest/services/nwm/ana_high_flow_
magnitude_hi/MapServer**

Description

Depicts the magnitude of the National Water Model (NWM) streamflow forecast where the NWM is signaling high water. This service is derived from the analysis and assimilation configuration of the NWM over Hawaii. Shown are reaches with flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their current flow. High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf.

Update Frequency

Hourly

Methodology

High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf. NWM streamflow values are compared to these AEPs and classified accordingly. "High water" conditions are approximated by the 50% AEP.
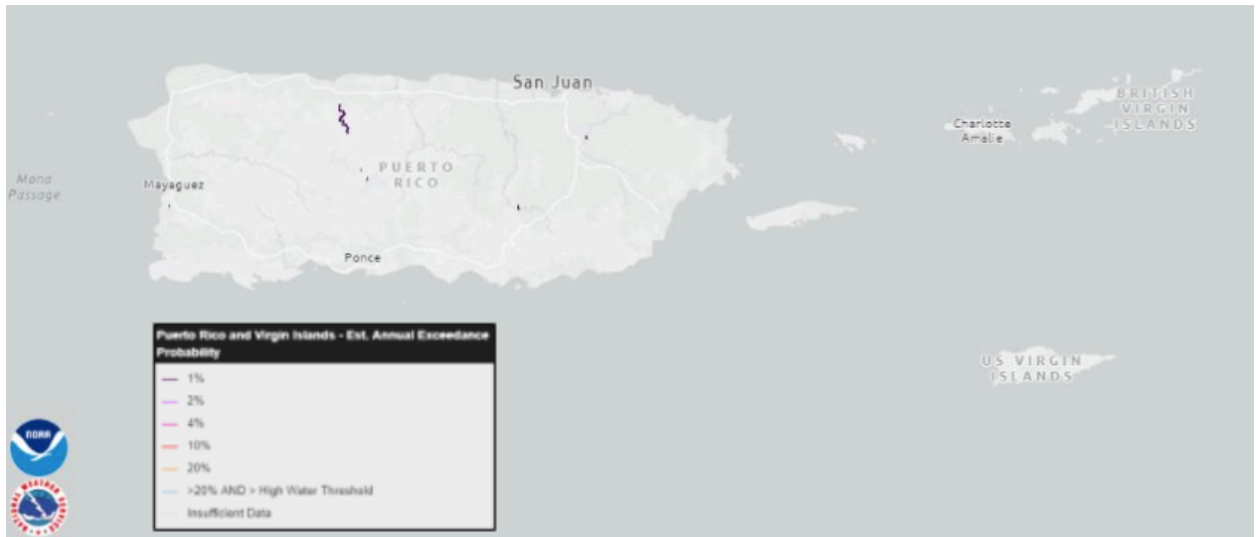
High Flow Magnitude Analysis - Puerto Rico/U.S. Virgin Islands

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/ana_high_flow_magnitude_prvi/MapServer

Description

Depicts the magnitude of the National Water Model (NWM) streamflow forecast where the NWM is signaling high water. This service is derived from the analysis and assimilation configuration of the NWM over Puerto Rico and the U.S. Virgin Islands. Shown are reaches with flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their current flow. High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/wri/wri994142/pdf/wri99-4142.pdf.

Update Frequency

Hourly

Methodology

High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/wri/wri994142/pdf/wri99-4142.pdf. NWM streamflow values are compared to these AEPs and classified accordingly. "High water" conditions are approximated by the 50% AEP.

Short-Range Forecast

Service	Brief Description
High Water Arrival Time Forecast	Depicts the forecast arrival and end time of high water over the next 18 hours. This service is derived from the short-range configuration of the NWM over the contiguous U.S.
High Water Arrival Time Forecast - Hawaii	Depicts the forecast arrival time of high water over the next 48 hours. This service is derived from the short-range configuration of the NWM over Hawaii.
High Water Arrival Time Forecast - Puerto Rico/U.S. Virgin Islands	Depicts the forecast arrival time of high water over the next 48 hours. This service is derived from the short-range configuration of the NWM over Puerto Rico and the U.S. Virgin Islands.
High Water Probability Forecast	Depicts the probability of forecast high water over the next 12 hours using a time-lagged ensemble from the short-range forecast of the NWM over the contiguous U.S.
Maximum High Flow Magnitude Forecast	Depicts the magnitude of the peak NWM streamflow forecast over the next 18 hours where the NWM is signaling high water. This service is derived from the short-range configuration of the NWM over the contiguous U.S.
Maximum High Flow Magnitude Forecast - Hawaii	Depicts the magnitude of the peak NWM streamflow forecast over the next 48 hours where the NWM is signaling high water. This service is derived from the short-range configuration of the NWM over Hawaii.
Maximum High Flow Magnitude Forecast - Puerto Rico/U.S. Virgin Islands	Depicts the magnitude of the peak NWM streamflow forecast over the next 48 hours, where the NWM is signaling high water. This service is derived from the short-range configuration of the NWM over Puerto Rico and the U.S. Virgin Islands.
Rapid Onset Flooding Forecast	Depicts forecast rapid onset flooding using the short-range configuration of the NWM over the contiguous U.S.
Rapid Onset Flooding Probability Forecast	Depicts the probability of forecast rapid onset flooding over the next 12 hours using a time-lagged ensemble from the short-range configuration of the NWM over the contiguous U.S.

High Water Arrival Time Forecast
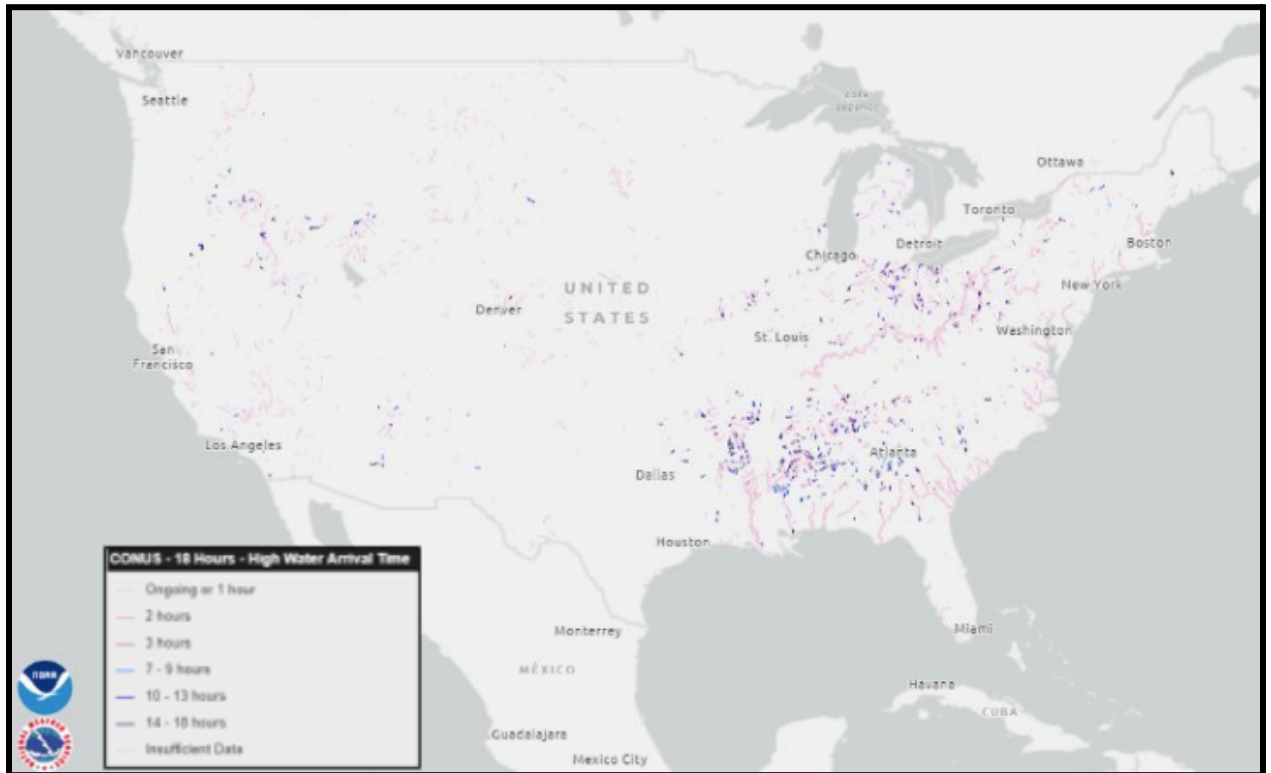
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_18hr_high_water_arrival_time/MapServer/

Description

This service contains two layers: High water arrival time and high water end time.

High water arrival time: Depicts the forecast arrival time of high water over the next 18 hours. Reaches are colored by the time at which they are forecast to reach high water.

High water end time: Depicts the forecast end time of high water over the next 18 hours. Reaches are colored by the time at which they are forecast to drop below high water.

Both services are derived from the short-range configuration of the National Water Model (NWM) over the contiguous U.S. Shown are reaches that are expected to have flow at or above the high water threshold over the next 18 hours.   High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency
Hourly

Methodology
The arrival and end times are calculated by comparing the forecast streamflow to the estimated "high water" condition. The time at which forecast streamflow first exceeds the "high water" condition is considered the arrival time and the time at which the forecast streamflow first falls below the "high water" condition is considered the end time. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

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High Water Arrival Time Forecast - Hawaii

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_48hr_high_water_arrival_time_hi/MapServer/

Description

This service contains two layers: High water arrival time and high water end time.

High water arrival time: Depicts the forecast arrival time of high water over the next 48 hours. Reaches are colored by the time at which they are forecast to reach high water.

High water end time: Depicts the forecast end time of high water over the next 48 hours. Reaches are colored by the time at which they are forecast to drop below high water.

This service is derived from the short-range configuration of the National Water Model (NWM) over Hawaii. Shown are reaches that are expected to have flow at or above the high water threshold over the next 48 hours. High water flows were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf.

Update Frequency

Every 12 hours

Methodology

The arrival and end times are calculated by comparing the forecast streamflow to the estimated "high water" condition. The time at which forecast streamflow first exceeds the "high water" condition is considered the arrival time and the time at which the forecast streamflow first falls below the "high water" condition is considered the end time. High water thresholds were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf. "High water" conditions are approximated by the 50% annual exceedance probability.

High Water Arrival Time Forecast - Puerto Rico/U.S. Virgin Islands
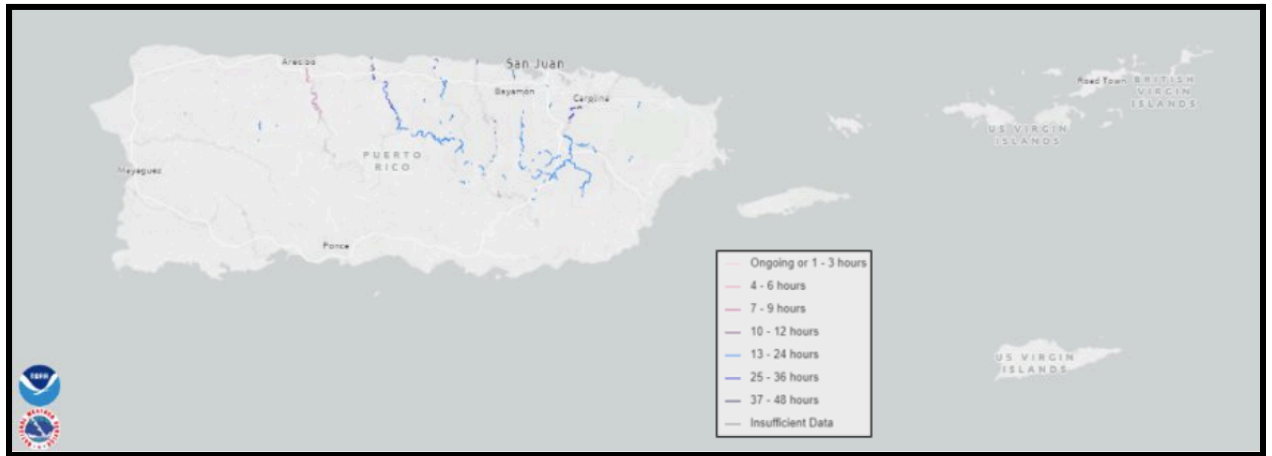
Service URL
https://maps.water.noaa.gov/server/rest/services/nwm/srf_48hr_high_water_arrival_time_prvi/MapServer/

Description
This service contains two layers: High water arrival time and high water end time.

High water arrival time: Depicts the forecast arrival time of high water over the next 48 hours. Reaches are colored by the time at which they are forecast to reach high water.

High water end time: Depicts the forecast end time of high water over the next 48 hours. Reaches are colored by the time at which they are forecast to drop below high water.

This service is derived from the short-range configuration of the National Water Model (NWM) over Puerto Rico and the U.S. Virgin Islands. Shown are reaches that are expected to have flow at or above the high water threshold over the next 48 hours.   High water flows were derived from USGS regression equations found at https://pubs.usgs.gov/wri/wri994142/pdf/wri99-4142.pdf.

Update Frequency
Every 12 hours

Methodology

The arrival and end times are calculated by comparing the forecast streamflow to the estimated "high water" condition. The time at which forecast streamflow first exceeds the "high water" condition is considered the arrival time and the time at which the forecast streamflow first falls below the "high water" condition is considered the end time. High water thresholds were derived from USGS regression equations found at https://pubs.usgs.gov/wri/wri994142/pdf/wri99-4142.pdf. "High water" conditions are approximated by the 50% annual exceedance probability.

High Water Probability Forecast

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_12hr_max_high_water_probability/MapServer/

Description

This service contains two layers: High water probability and average high water probability hotspots.

High water probability: Depicts the probability of forecast high water over the next 12 hours using a time-lagged ensemble from the short-range forecast of the National Water Model (NWM) over the contiguous U.S. Shown are reaches that are forecast to have flow at or above high water within the next 12 hours of at least one of the last 7 forecasts. Reaches are colored by the probability that they will meet or exceed the high water threshold across the last 7 forecasts. Probabilities are derived by counting the number of forecasts that meet the high water condition within the next 12 hours, equally weighted. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Average high water probability hotspots:

USGS HUC10 polygons for basins with greater than 50% of NWM features with flow expected to be at or above high water over the next 12 hours, symbolized by the average probability.

Update Frequency

Hourly

Methodology

Shown are reaches or hotspots (USGS HUC10 basins) that are expected to have forecast streamflow at or above "high water" conditions within the next 12 hours. Probabilities are computed as the % agreement across 7 "ensemble members", in this case represented by the last 7 short-range forecasts. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Maximum High Flow Magnitude Forecast
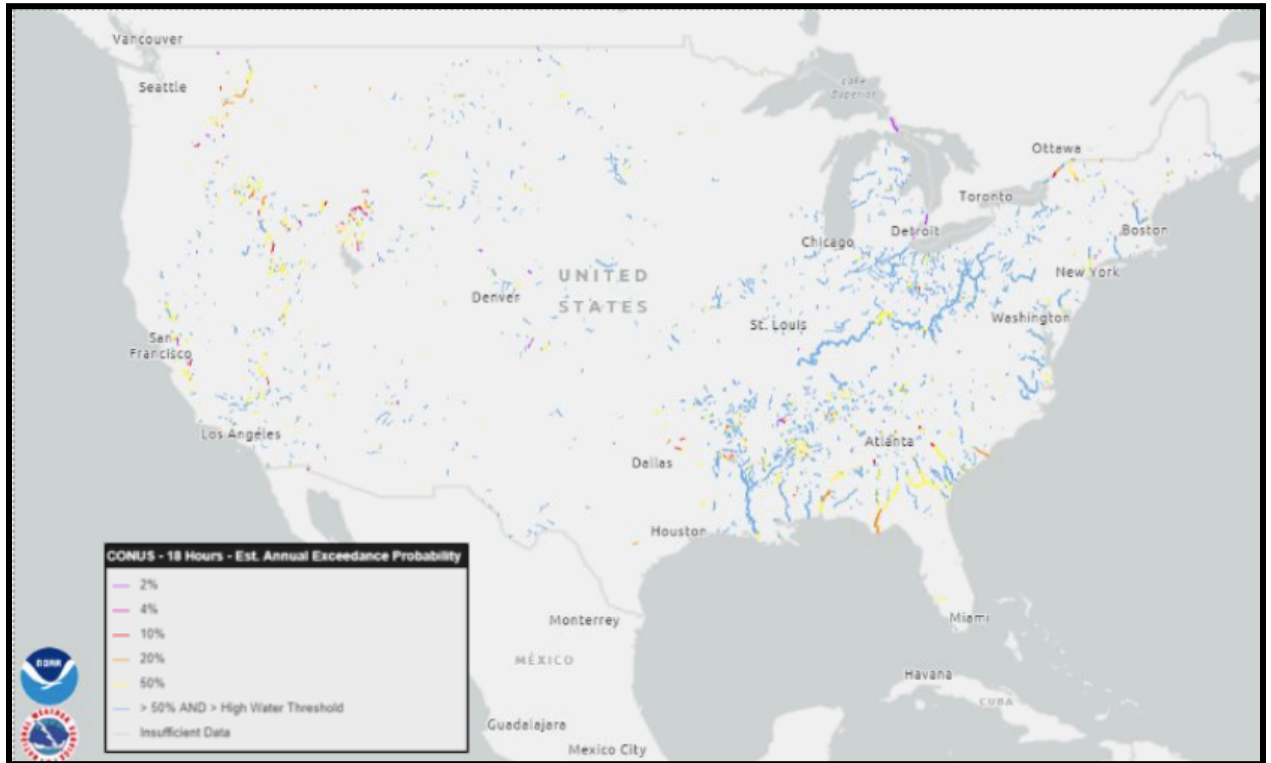
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_18hr_max_high_flow_magnitude/MapServer

Description

Depicts the magnitude of the peak National Water Model (NWM) streamflow forecast over the next 18 hours where the NWM is signaling high water. This service is derived from the short-range configuration of the NWM over the contiguous U.S. Shown are reaches with peak flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their forecast peak flow. High water thresholds (regionally varied) and AEPs were derived using the 40-year NWM v2.1 reanalysis simulation.
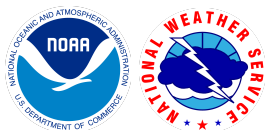
Update Frequency

Hourly

Methodology

AEPs were derived from the 40-year NWM v2.1 reanalysis simulation, utilizing a multi-decade flood frequency analysis and guidance from the Bulletin 17C guidelines developed by the Subcommittee on Hydrology of the Advisory Committee on Water

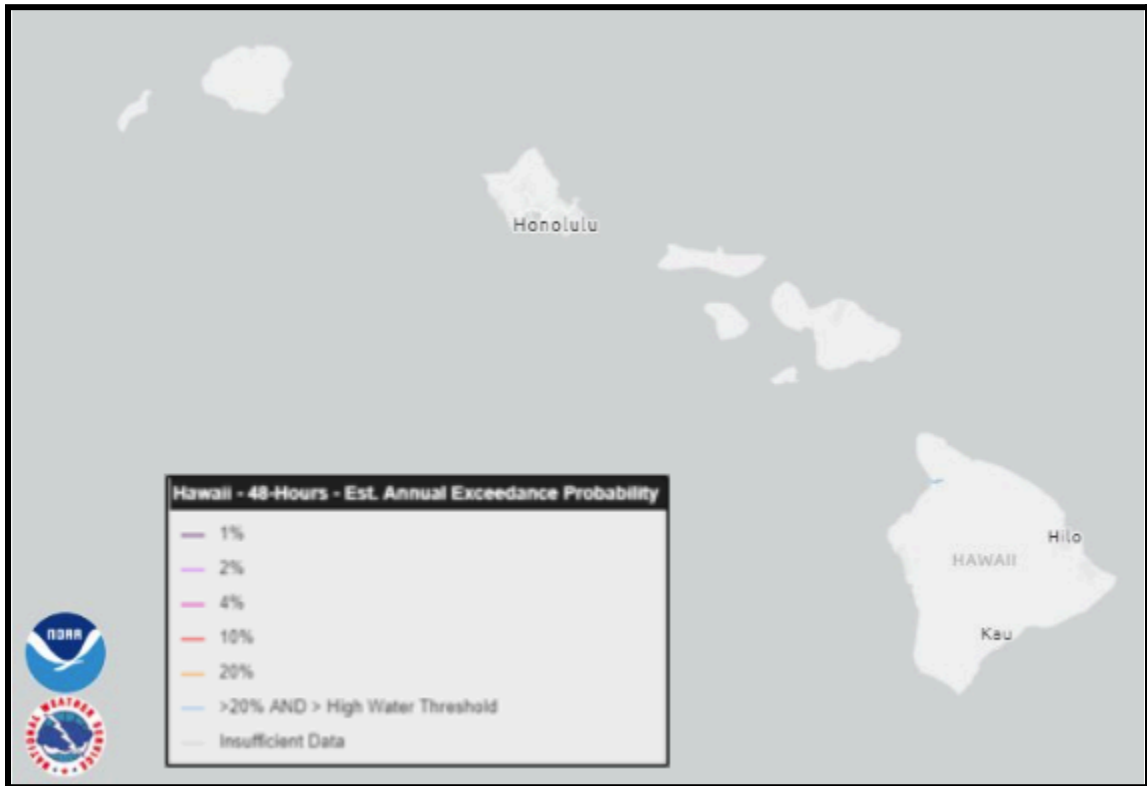Information (ACWI). NWM streamflow values are compared to these AEPs and classified accordingly. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Maximum High Flow Magnitude Forecast - Hawaii

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_48hr_max_high_flow_magnitude_hi/MapServer

Description

Depicts the magnitude of the peak National Water Model (NWM) streamflow forecast over the next 48 hours where the NWM is signaling high water. This service is derived from the short-range configuration of the NWM over Hawaii. Shown are reaches with peak flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their peak flow. High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf.

Update Frequency

Every 12 hours

Methodology

High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf. NWM streamflow values are compared to these AEPs and classified accordingly. "High water" conditions are approximated by the 50% AEP.

Maximum High Flow Magnitude Forecast - Puerto Rico/U.S. Virgin Islands

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_48hr_max_high_flow_magnitude_prvi/MapServer

Description

Depicts the magnitude of the peak National Water Model (NWM) streamflow forecast over the next 48 hours where the NWM is signaling high water. This service is derived from the short-range configuration of the NWM over Puerto Rico and the U.S. Virgin Islands. Shown are reaches with peak flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their peak flow. High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/wri/wri994142/pdf/wri99-4142.pdf.

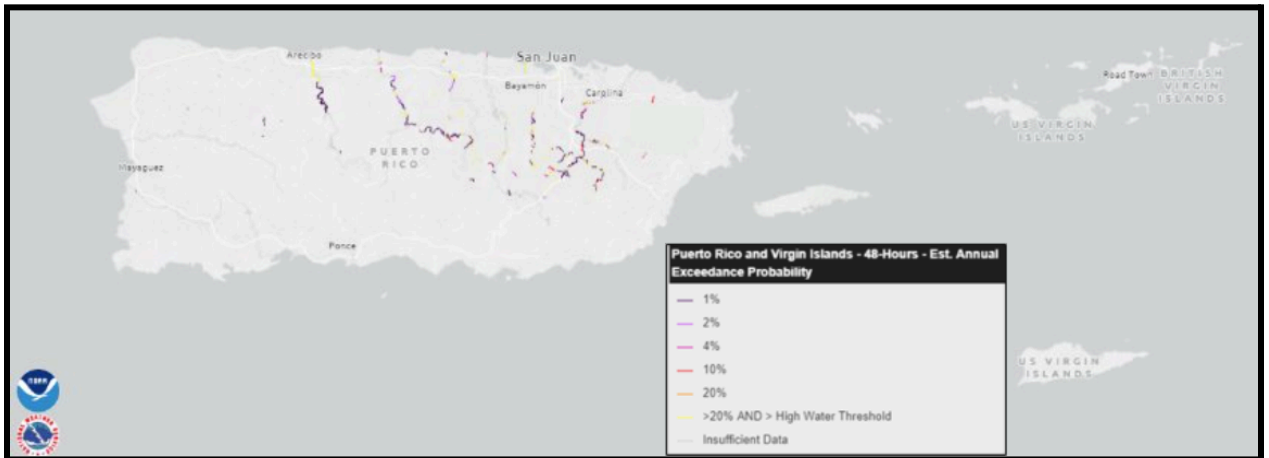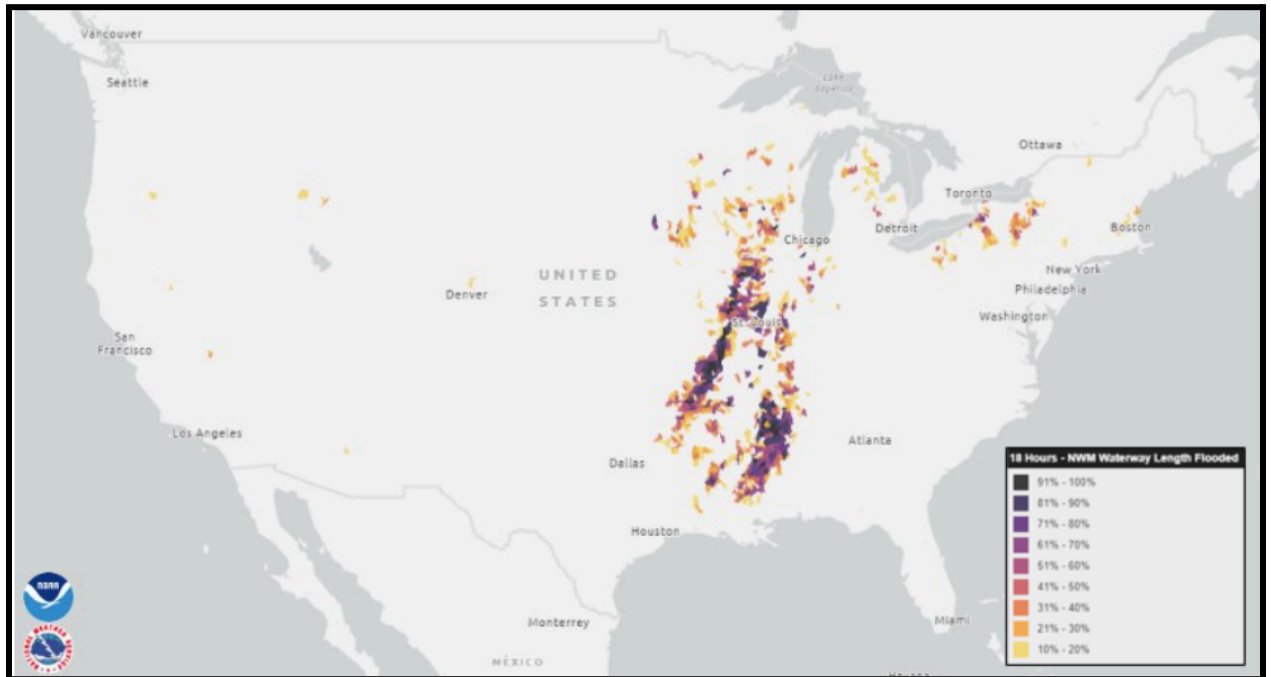## Update Frequency

Every 12 hours

Methodology

High water thresholds and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf. NWM streamflow values are compared to these AEPs and classified accordingly. "High water" conditions are approximated by the 50% AEP.

Rapid Onset Flooding Forecast

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_18hr_rapid_onset_flooding/MapServer

Description

This service contains 3 sublayers: Rapid Onset Flooding Arrival Time, Rapid Onset Flooding Duration and NWM Waterway Length Flooded

Rapid Onset Flooding Arrival Time: This sublayer colors reaches by the time at which they are expected to reach "high water" conditions and fall within the rapid onset criteria.

Rapid Onset Flood Duration: This sublayer colors reaches by the length of time between when the streamflow increases above the high water threshold and the streamflow decreases below the high water threshold. If the streamflow never decreases below the high water threshold within the forecast period, the length will be "ongoing".

NWM Waterway Length Flooded: This sublayer colors the HUC10 basin polygons by the percentage of the NWM waterway length (within each HUC10) that is expected to meet the rapid onset flood criteria

Forecast rapid onset flooding uses the short-range configuration of the National Water Model (NWM) over the contiguous U.S. **Rapid Onset Criteria** are as follows: when a river reach (stream order 4 and below) has a forecast flow increase of 100% or greater within an hour, and which are expected to be at or above the high water threshold within 6 hours of that increase. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency

Hourly

Methodology

Forecast rapid onset flooding uses the short-range configuration of the National Water Model (NWM) over the contiguous U.S. **Rapid Onset Criteria** are as follows: when a river reach (stream order 4 and below) has a forecast flow increase of 100% or greater within an hour, and which are expected to be at or above the high water threshold within 6 hours of that increase. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Rapid Onset Flooding Probability
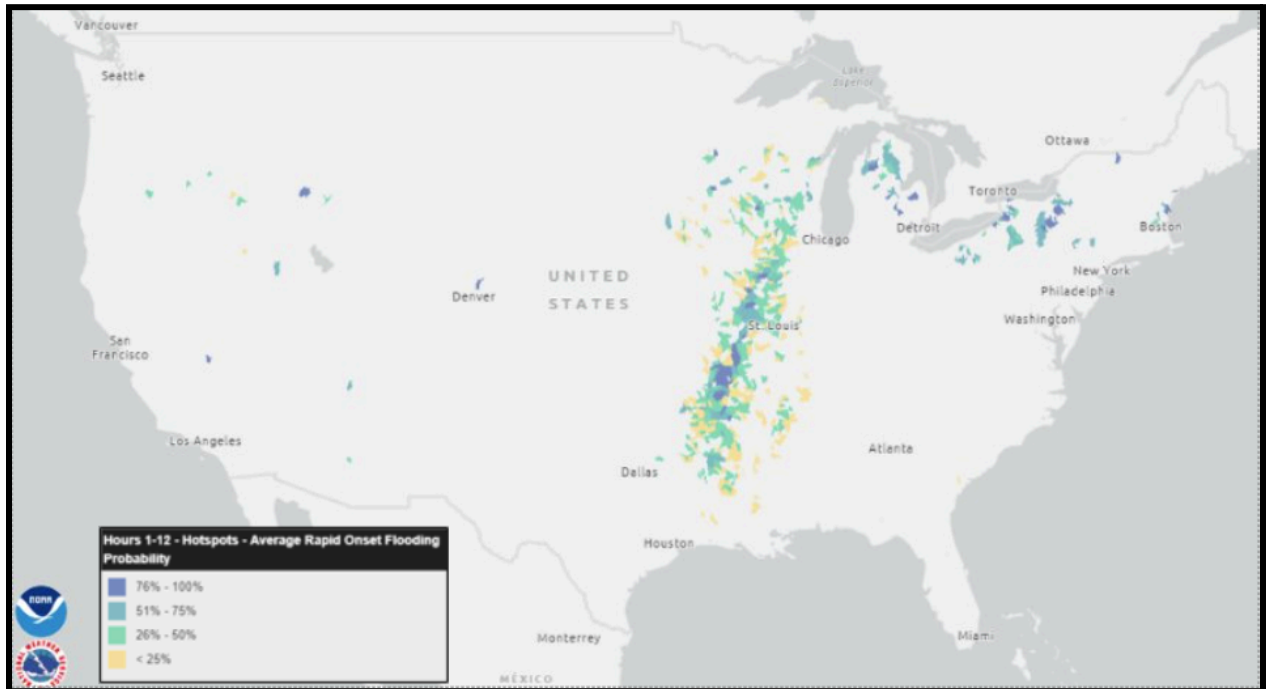
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/srf_12hr_rapid_onset_flooding_probability/MapServer

Description

This service contains 4 sublayers based on time: Rapid Onset Flooding Probability for hours 1-6, Rapid Onset Flooding Probability for hours 7-12, Rapid Onset Flooding Probability for hours 1-12, and Average Rapid Onset Flooding Probability Hotspots.

Depicts the probability of forecast rapid onset flooding over the next 12 hours using a time-lagged ensemble from the short-range configuration of the National Water Model (NWM) over the contiguous U.S. Shown are reaches (stream order 4 and below) that are expected to meet rapid onset flooding criteria (flow increase of 100% or greater within one hour and high water threshold conditions within 6 hours) using the most recent 7 forecasts. Reaches are colored by the probability that they will meet or exceed rapid onset conditions within hours 1-6, 7-12, and 1-12. Probabilities are computed as the % agreement across the 7 ensemble members that a given reach will meet rapid onset criteria at some point during the time period of interest. Hotspots show the average 1-12 hour rapid onset flooding probability, weighted by reach length, for USGS HUC10 basins with greater than 10% of NWM feature length meeting rapid onset criteria in the next 12 hours. High water

thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency
Hourly

Methodology
Probabilities are computed as the % agreement across 7 "ensemble members", in this case represented by the last 7 short-range forecasts. Reaches (stream order 4 and below) that are expected to have a forecast flow increase of 100% or greater within an hour, and which are expected to be at above the high water threshold within 6 hours of that increase, are considered agreeable for the probability calculation. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Medium-Range Forecast

Service	Description
High Water Arrival Time Forecast	Depicts the forecast arrival time of high water over the next 10 days. This service is derived from the medium-range configuration of the NWM over the contiguous U.S.
High Water Probability Forecast	Depicts the probability of forecast high water over the next 5 days using ensembles from the medium-range configuration of the NWM over the contiguous U.S.
Maximum High Flow Magnitude Forecast	Depicts the magnitude of the peak NWM streamflow forecast over the next 3, 5 and 10 days where the NWM is signaling high water. This service is derived from the medium-range configuration of the NWM over the contiguous U.S.
Rapid Onset Flooding Forecast	Depicts forecast rapid onset flooding using the medium-range configuration of the NWM over the contiguous U.S.
Rapid Onset Flooding Probability	Depicts the probability of forecast rapid onset flooding over the next 5 days using ensembles from the medium-range configuration of the NWM over the contiguous U.S.
Peak Flow Arrival Time Forecast	Depicts expected peak flow arrival times over the next 10 days. This service is derived from the medium-range configuration of the NWM over the contiguous U.S.

High Water Arrival Time Forecast
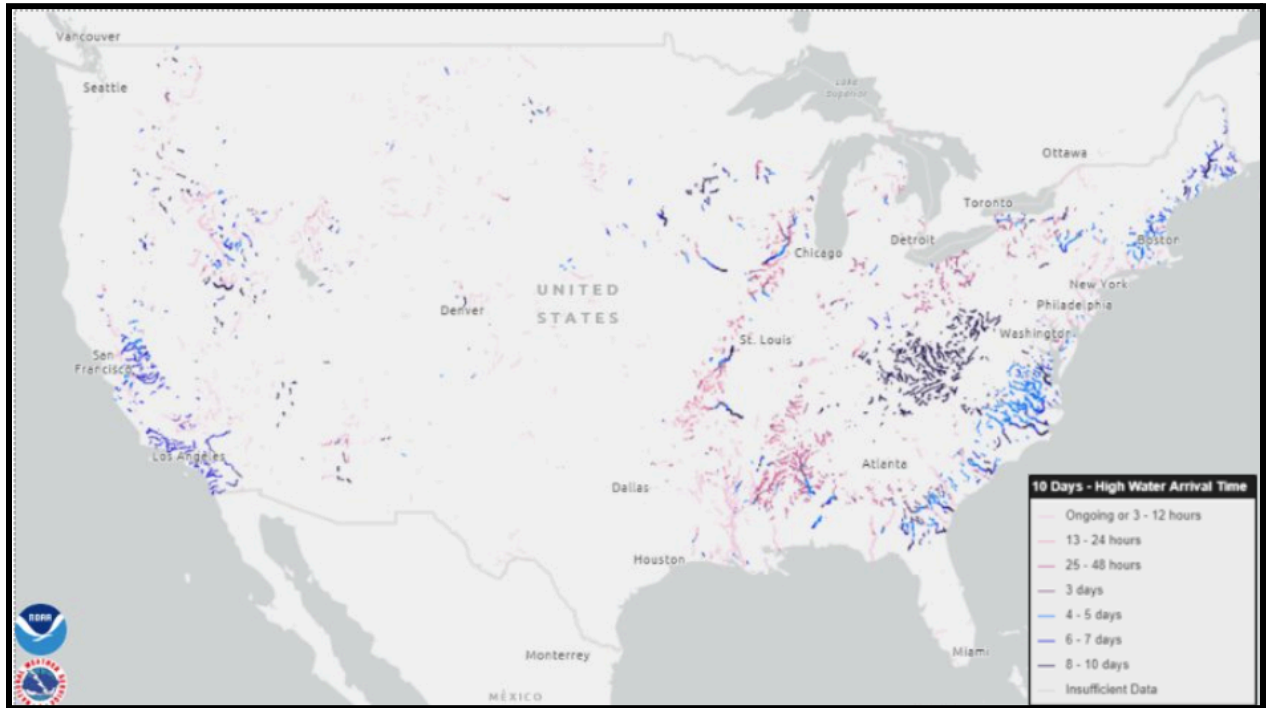
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/mrf_gfs_10day_high_water_arrival_time/MapServer/

Description

This service contains 3 sublayers: High Water Arrival Time for 3 days, High Water Arrival Time for 10 days and High Water End Time for 10 days.

High Water Arrival Time for 3 days: Depicts the forecast arrival time of high water over the next 3 days. Reaches are colored by the time at which they are forecast to reach high water.

High Water Arrival Time for 10 days: Depicts the forecast arrival time of high water over the next 10 days. Reaches are colored by the time at which they are forecast to reach high water.

High Water End Time for 10 days: Depicts the forecast end time of high water over the next 10 days. Reaches are colored by the time at which they are forecast to drop below high water.

This service is derived from the medium-range GFS configuration of the National Water Model (NWM) over the contiguous U.S. Reaches are colored by the time at which they are forecast to reach high water (calculated in 3 hour increments). High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency

Every 6 hours

Methodology

The arrival and end times are calculated by comparing the forecast streamflow to the estimated "high water" condition. The time at which forecast streamflow first exceeds the "high water" condition is considered the arrival time and the time at which the forecast streamflow first falls below the "high water" condition is considered the end time. AEPs were derived from the NWM (v2.1) retrospective, utilizing a multi-decade flood frequency analysis with guidance from the USGS Bulletin 17C. "High water" conditions are approximated with an AEP determined to represent a region, using areas with similar *variability* in water-year runoff efficiency (McCabe and Wolock, 2016).

High Water Probability Forecast
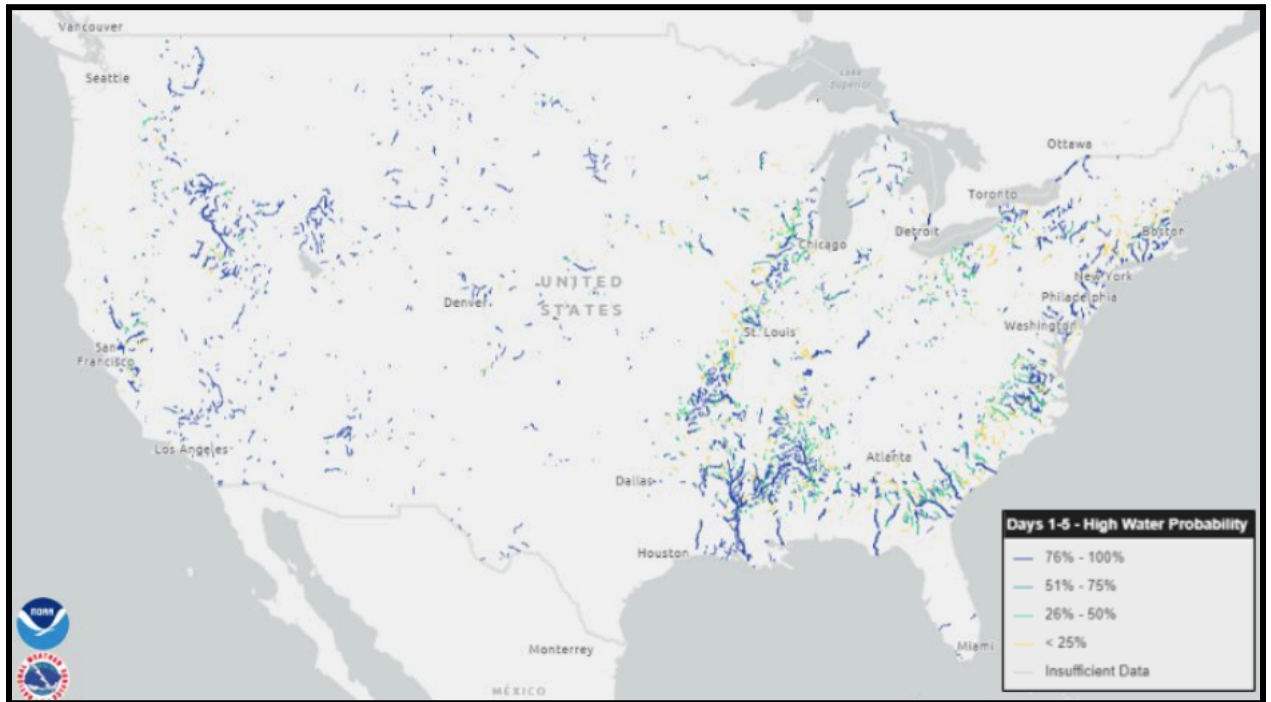
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/mrf_gfs_5day_high_water_probability/MapServer/

Description

This service has 6 sublayers: High Water Probability Day 1, High Water Probability Day 2, High Water Probability Day 3, High Water Probability Day 4-5, High Water Probability Day 1-5, and Average High Water Probability Hotspots.

Depicts the probability of forecast high water over the next 5 days using ensembles from the medium-range configuration of the National Water Model (NWM) over the contiguous U.S. Shown are reaches that are expected to have flow at or above high water on Day 1, Day 2, Day 3, and Days 4-5, using the 7 ensemble members of the medium-range forecast. Reaches are colored by the probability that they will meet or exceed the high water threshold on Day 1, Day 2, Day 3, and Days 4-5. Probabilities are computed as the % agreement across the 7 ensemble members, equally weighted. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency

Every 6 hours

Methodology

Shown are reaches that are expected to have forecast streamflow at or above "high water" conditions on Day 1, Day 2, Day 3, and Days 4-5. Probabilities are computed for Day 1, Day 2, Day 3, and Days 4-5 valid time ranges. For a particular reach, all forecast streamflow values from the 7 ensemble members for the valid time ranges of interest are obtained and considered of equal weight. From these values, the number of times a reach was forecast to be at or above "high water" during each of the valid time ranges is used to compute high water threshold probabilities. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Also shown are the High Water Probability Hotspots which are USGS HUC8 polygons for basins with greater than 50% of NWM features with flow expected to be at or above high water over the next 5 days, symbolized by the average probability. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation. Updated every 6 hours.

Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Maximum High Flow Magnitude Forecast
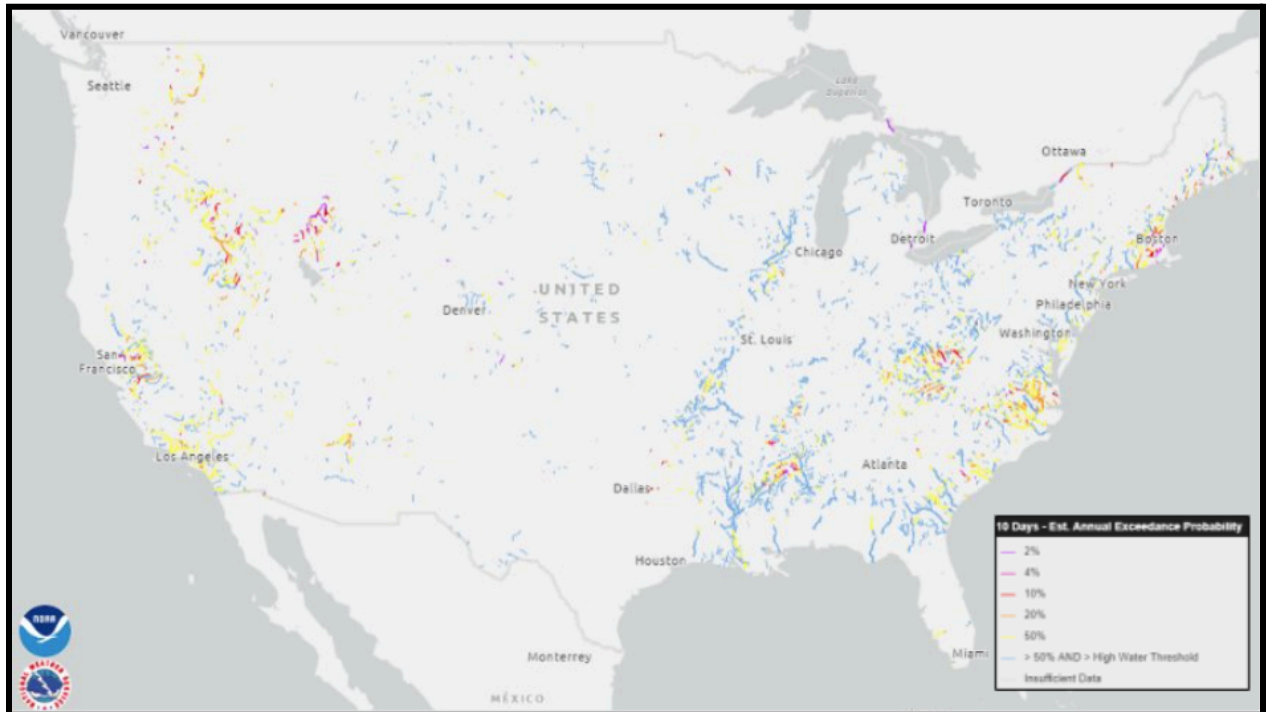
Service URL
https://maps.water.noaa.gov/server/rest/services/nwm/mrf_gfs_10day_
max_high_flow_magnitude/MapServer/

Description
This service has 3 sublayers: Maximum High Flow Magnitude Forecast for 3, 5 and 10 days.

Depicts the magnitude of the peak National Water Model (NWM) streamflow forecast over the next 3, 5 and 10 days where the NWM is signaling high water. This service is derived from the medium-range configuration of the NWM over the contiguous U.S. Shown are reaches with peak flow at or above high water thresholds. Reaches are colored by the annual exceedance probability (AEP) of their forecast peak flow. High water thresholds (regionally varied) and AEPs were derived using the 40-year NWM v2.1 reanalysis simulation.

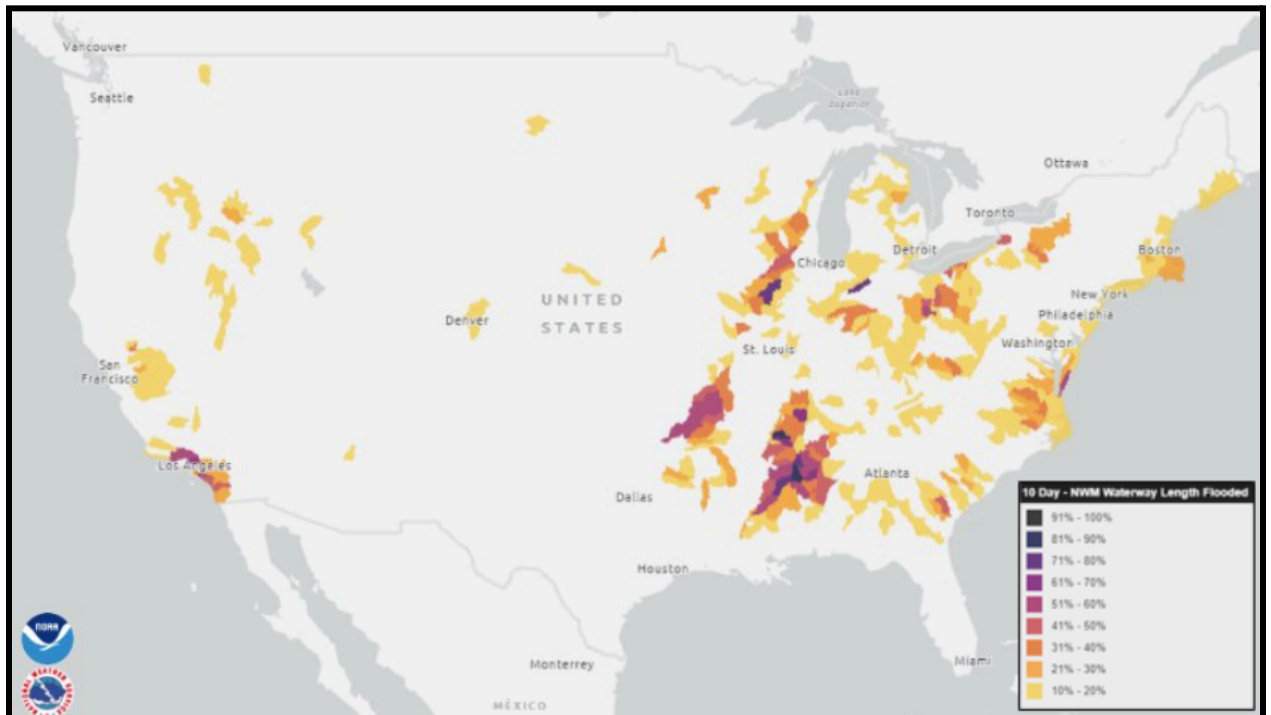### Update Frequency
Every 6 hours

Methodology

AEPs were derived from the 40-year NWM v2.1 reanalysis simulation, utilizing a multi-decade flood frequency analysis and guidance from the Bulletin 17C guidelines developed by the Subcommittee on Hydrology of the Advisory Committee on Water Information (ACWI). NWM streamflow values are compared to these AEPs and classified accordingly. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

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Rapid Onset Flooding Forecast

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/mrf_gfs_10day_rapid_onset_flooding/MapServer/

Description

This service contains 3 sublayers: Rapid Onset Flooding Arrival Time, Rapid Onset Flooding Duration and NWM Waterway Length Flooded

Rapid Onset Flooding Arrival Time: This sublayer colors reaches by the time at which they are expected to reach "high water" conditions and fall within the rapid onset criteria.

Rapid Onset Flood Duration: This sublayer colors reaches by the length of time between when the streamflow increases above the high water threshold and the streamflow decreases below the high water threshold. If the streamflow never decreases below the high water threshold within the forecast period, the length will be "ongoing".

<u>NWM Waterway Length Flooded</u>: This sublayer colors the HUC08 basin polygons by the percentage of the NWM waterway length (within each HUC08) that is expected to meet the rapid onset flood criteria

Forecast rapid onset flooding uses the short-range configuration of the National Water Model (NWM) over the contiguous U.S. **Rapid Onset Criteria** are as follows: when a river reach (stream order 4 and below) has a forecast flow increase of 100% or greater within 3 hours, and which are expected to be at or above the high water threshold within 6 hours of that increase. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency
Every 6 hours

Methodology
Shown are reaches that are expected to have a forecast flow increase of 100% or greater within 3 hours, and which are expected to be at above the high water threshold within 6 hours of that increase. Reaches are colored in two ways. One sublayer colors reaches by the time at which they are expected to reach "high water" conditions. Another sublayer colors reaches by the length of time between when the streamflow increases above the high water threshold and the streamflow decreases below high water. If the streamflow never decreases below "high water" within the forecast period, the length will be "ongoing". HUC8s are also shown and colored based on the percentage of NWM waterway length within that HUC that meets the rapid onset flooding criteria. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Rapid Onset Flooding Probability
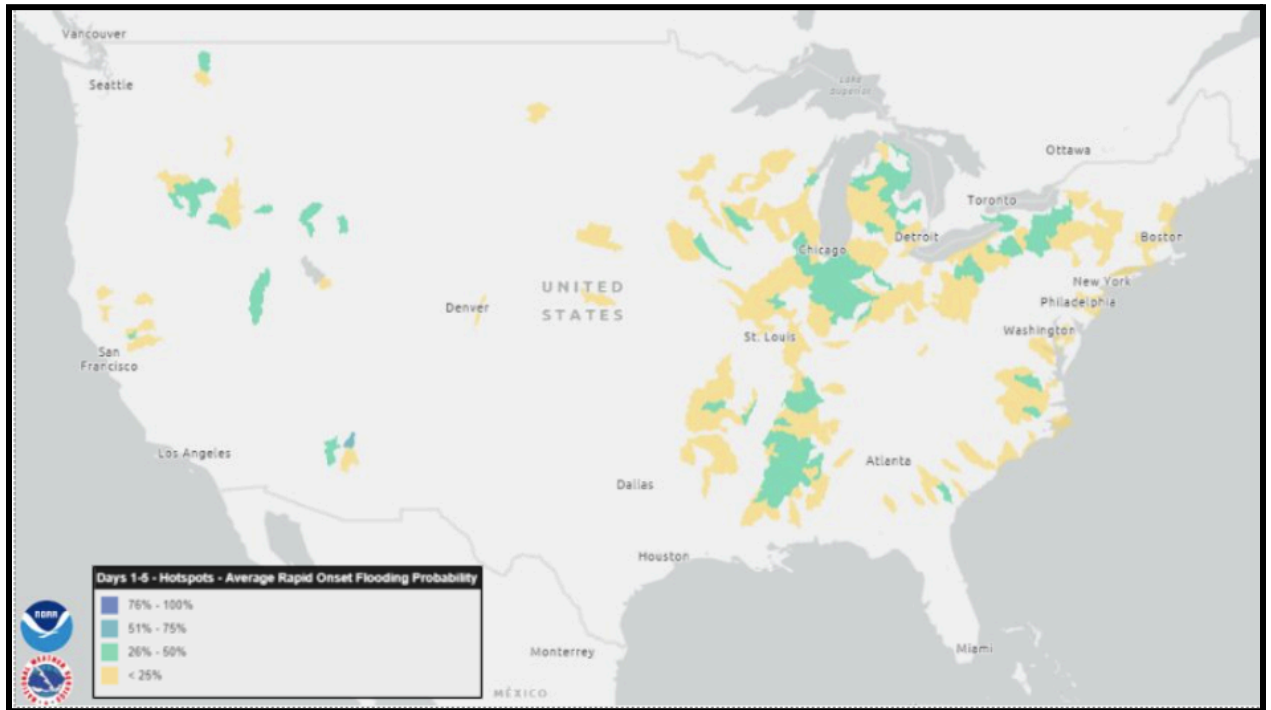
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/mrf_gfs_5day_rapid_onset_flooding_probability/MapServer/

Description

This service contains 6 sublayers: Rapid Onset Flood Probability for Day 1, Day 2, Day 3, Days 4-5, Days 1-5 as well as Average Rapid Onset Flooding Probability Hotspots.

Depicts the probability of forecast rapid onset flooding over the next 5 days using ensembles from the medium-range configuration of the National Water Model (NWM) over the contiguous U.S. Shown are reaches that are expected to have flow at or above high water thresholds on Day 1, Day 2, Day 3, Days 4-5, and Days 1-5 using the 7 ensemble members of the medium-range forecast. Reaches are colored by the probability that they will meet or exceed high water thresholds on Day 1, Day 2, Day 3, Days 4-5, and Days 1-5. Probabilities are computed as the % agreement across the 7 ensemble members, equally weighted. Hotspots show USGS HUC08 basins with greater than 50% of NWM features with flow expected to be at or above high water thresholds over the next 5 days. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency
Every 6 hours

Methodology
Probabilities are computed as the % agreement across all medium-range forecast ensemble members. Reaches (stream order 4 and below) that are expected to have a forecast flow increase of 100% or greater within 3 hours, and which are expected to be at above the high water threshold within 6 hours of that increase, are considered agreeable for the probability calculation. "High water" conditions are approximated regionally with an AEP that aligns with the "Action" flood threshold of the RFC forecast points within each region. Regions are defined by McCabe and Wolock, 2016 based on a spatial analysis of variability in water-year runoff efficiency across HUC8 units.

Peak Flow Arrival Time Forecast
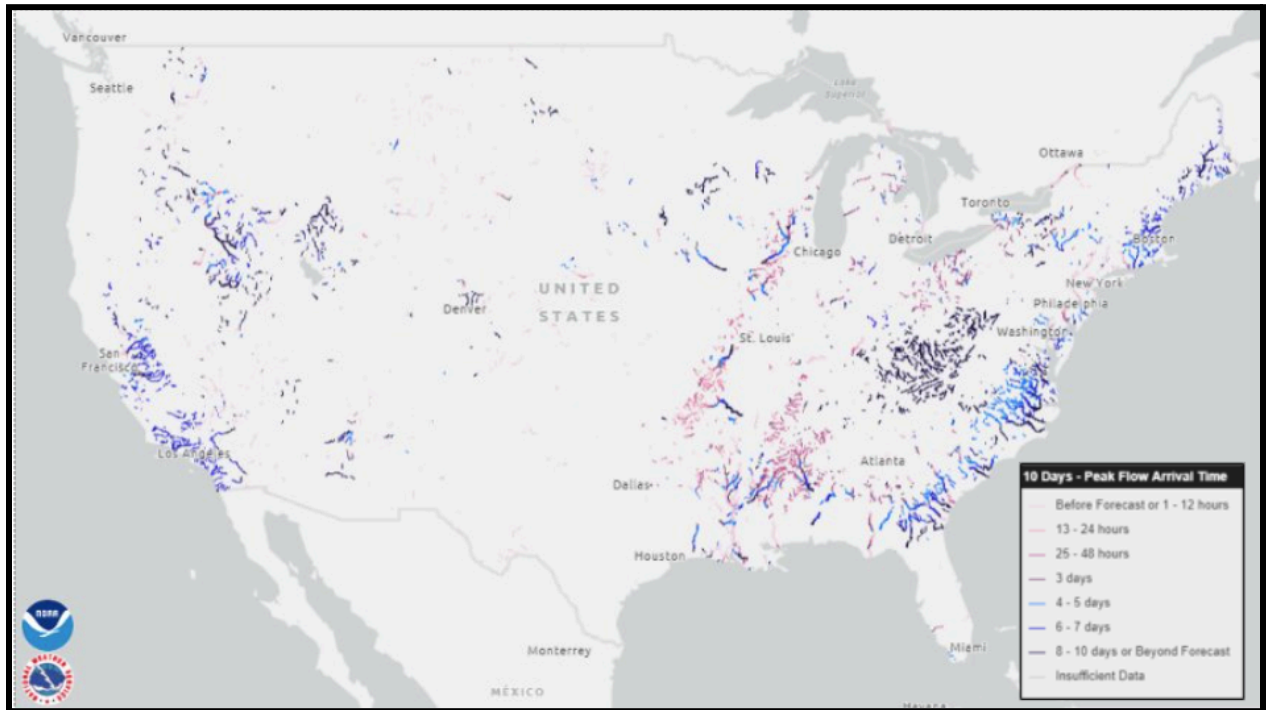
Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/mrf_gfs_10day_
peak_flow_arrival_time/MapServer/

Description

This service has 2 sublayers: Peak Flow Arrival Time Forecast for 3 days and 10 days.

Depicts expected peak flow arrival times derived from the operational NWM medium-range forecast. Shown are reaches that are expected to have flow at or above high water over the next 10 days. Reaches are colored by the time at which they are expected to be at their maximum flow within the forecast period. High water thresholds (regionally varied) were derived using the 40-year NWM v2.1 reanalysis simulation.

Update Frequency

Every 6 hours

Methodology

Shown are reaches that are expected to have forecast streamflow at or above "high water" conditions within the next 10 days. AEPs were derived from the NWM (v2.1) retrospective, utilizing a multi-decade flood frequency analysis with guidance from the USGS Bulletin 17C.

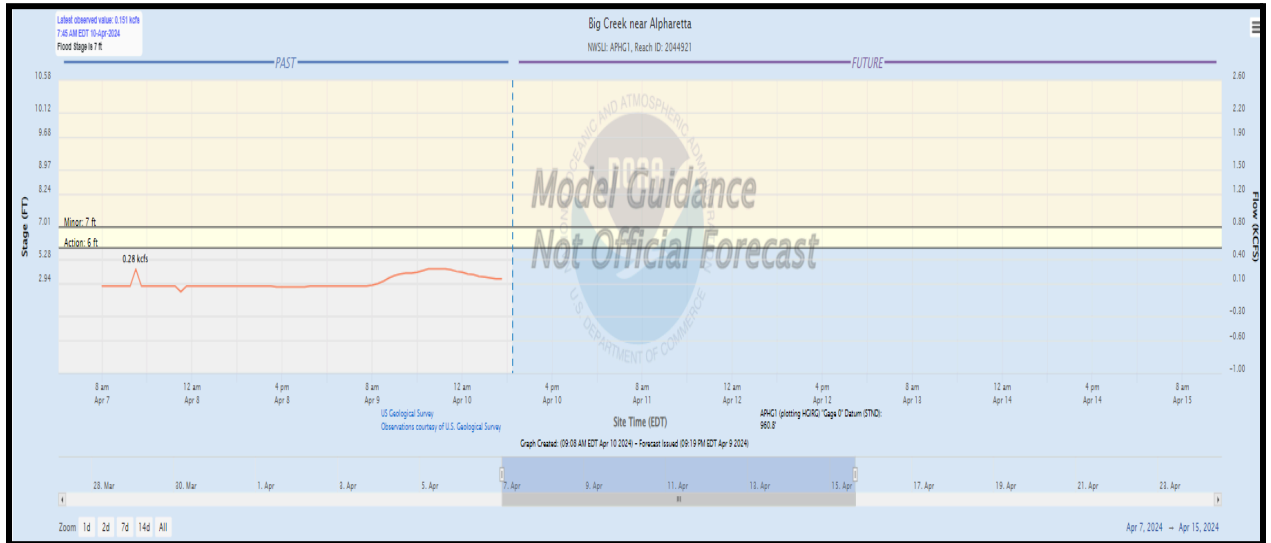# Point-Based National Water Model Services
National Water Prediction Service

Service	Description
Streamflow Analysis	Depicts at the selected site the National Water Model analysis assimilation output.
Short-Range Streamflow Forecast	Depicts at the selected site the National Water Model 18-hour Short-Range streamflow forecast. The Short-Range Forecast uses the HRRR and RAP weather models.
Medium-Range Blend Streamflow Forecast	Depicts at the selected site the 10-Day National Water Model streamflow forecast at the selected site. The Medium Range Blend uses the NBM weather model.
Medium-Range Ensemble Forecasts	Depicts at the selected site the National Water Model Medium-Range Forecasts which present a streamflow forecast using the GFS model including the most recent 10-day medium-range, the 8.5 day 6-member ensemble mean, and the 6 individual medium-range ensemble members each extending out to 8.5 days.
Long-Range Ensemble Forecasts	Depicts at the selected site the suite of streamflow forecasts which include the 30-day long-range ensemble mean and the 4 individual long-range ensemble members each extending out to 30 days.
Categorical Flood Inundation Extent	Depicts at the selected site the inundation extent for each impact flood category using Stage-based Categorical Flood Inundation Mapping: Static map extents available for action, minor, moderate, major and record levels.

For all Point-Based National Water Model Services, please refer to the National Water Prediction Service Product Guide.

Streamflow Analysis (at selected site)

National Water Model
Analysis (ANA)

Service URL

https://maps.water.noaa.gov/server/rest/services/nwm/ana_streamflow_noaa/MapServer **(NOAA Only)**

Selected site data available at the [National Water Prediction Service (NWPS)](#).

For more information on the NWPS Products, go to the [National Water Prediction Service Product Guide](#).
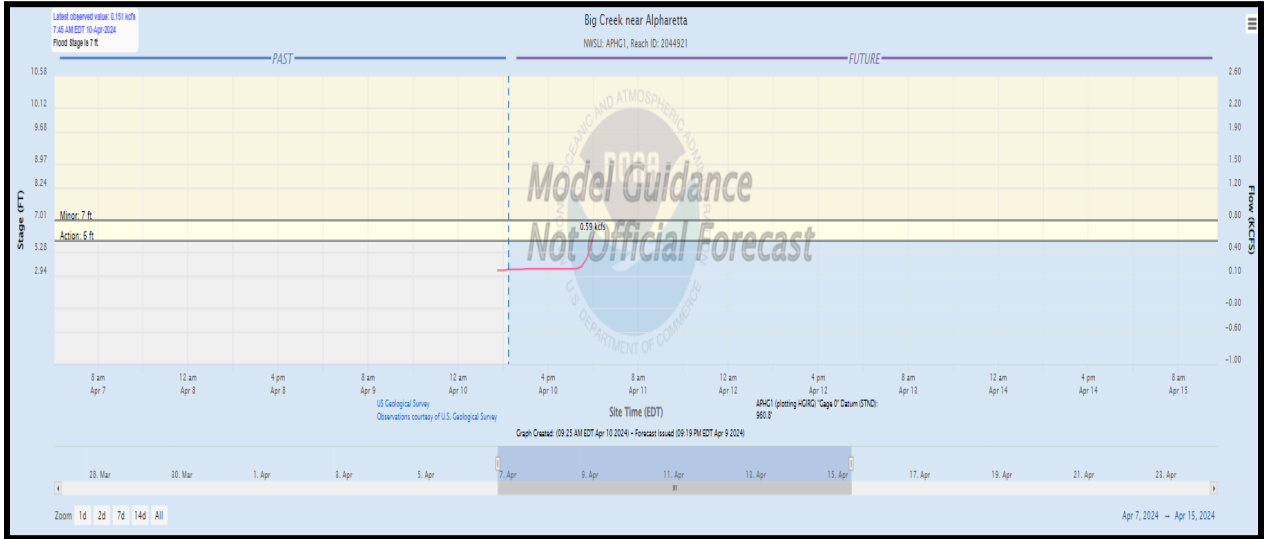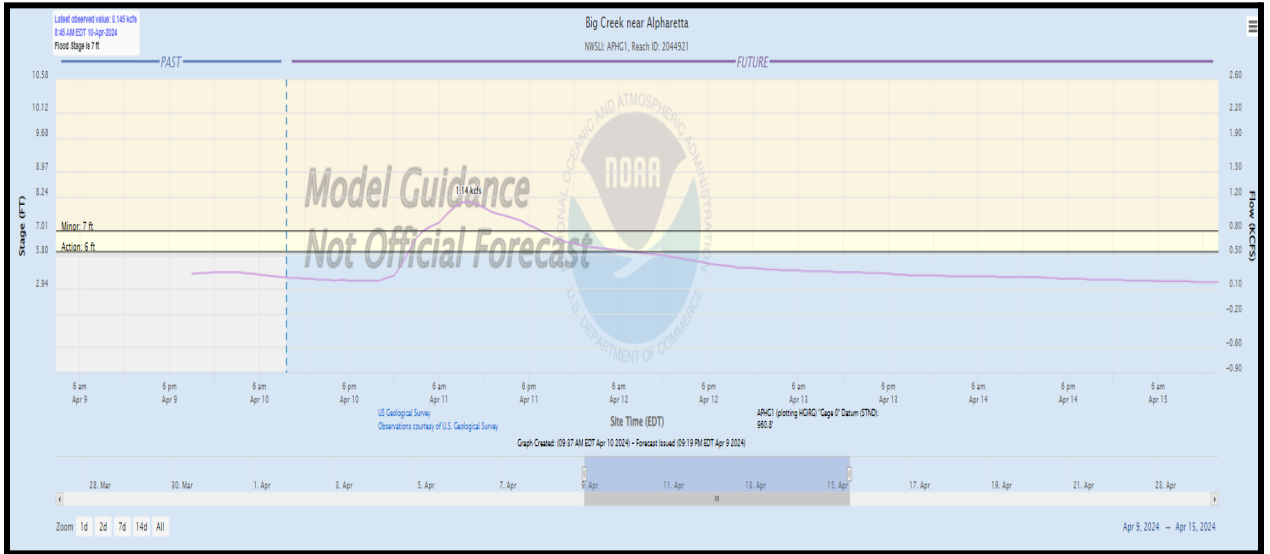
Description

Depicts the streamflow output from the operational National Water Model (NWM) analysis and assimilation for the continental United States.

Update Frequency

Hourly

Short-Range Streamflow Forecast (at selected site)

National Water Model

○ Analysis (ANA)

● Short Range (SR)

Service URL
No data service available

Selected site data available at the [National Water Prediction Service (NWPS)](#).

For more information on the NWPS Products, go to the [National Water Prediction Service Product Guide](#).
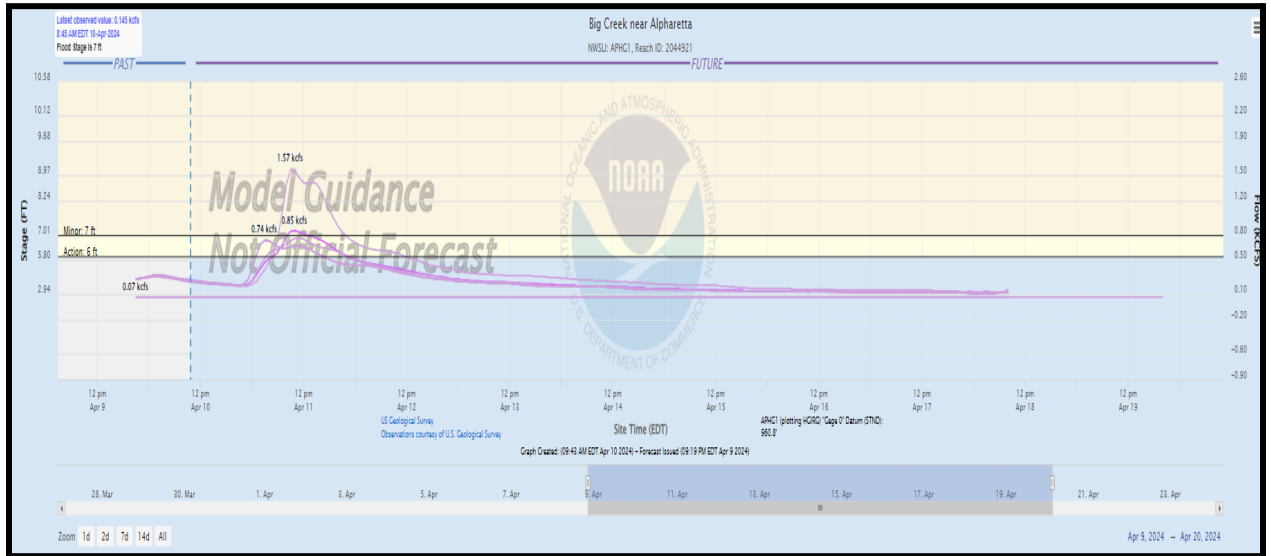
Description

Depicts at the selected site the National Water Model 18-hour Short-Range streamflow forecast. The Short-Range Forecast uses the HRRR and RAP weather models.

Update Frequency

Hourly

Medium-Range Blend Streamflow Forecast (at selected site)

National Water Model

○ Analysis (ANA)

● Medium Range Blend (MRB)

Service URL
No data service available

Selected site data available at the [National Water Prediction Service (NWPS)](#).

For more information on the NWPS Products, go to the [National Water Prediction Service Product Guide](#).

Description
Depicts at the selected site the 10-Day National Water Model streamflow forecast at the selected site. The Medium Range Blend uses the NBM weather model.

Update Frequency
Every 6 Hours

Medium-Range Ensemble Forecasts (at selected site)

Service URL

No data service available

Selected site data available at the [National Water Prediction Service (NWPS)](#).

For more information on the NWPS Products, go to the [National Water Prediction Service Product Guide](#).

Description

Depicts at the selected site the National Water Model Medium-Range Forecasts which present a streamflow forecast using the GFS model including the most recent 10-day medium-range, the 8.5 day 6-member ensemble mean, and the 6 individual medium-range ensemble members each extending out to 8.5 days.

Update Frequency

Every 6 Hours

Long-Range Ensemble Forecasts (at selected site)
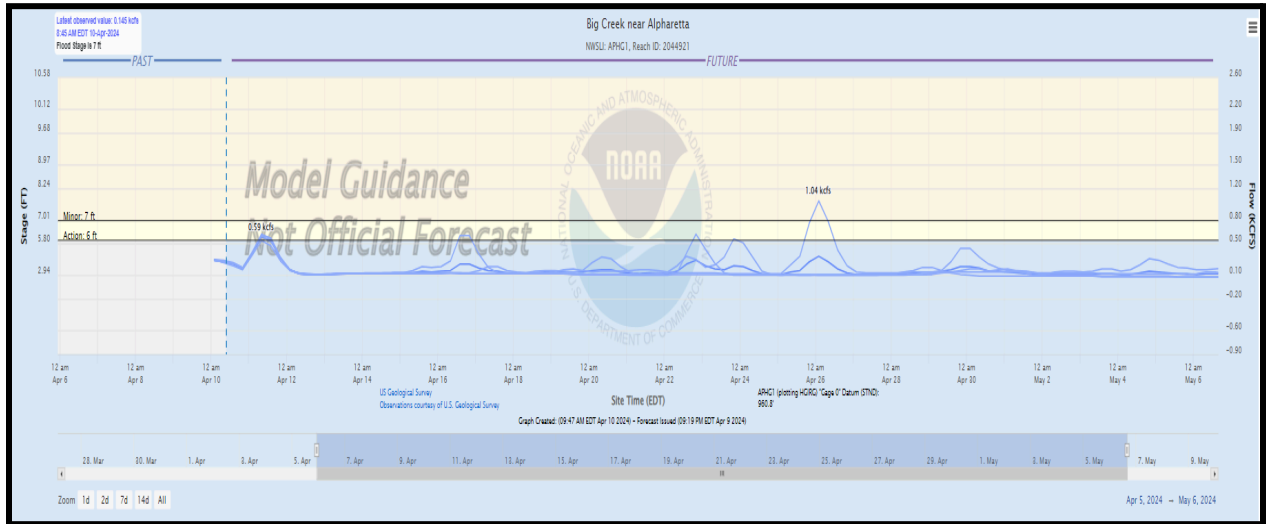
Service URL
No data service available

Selected site data available at the [National Water Prediction Service (NWPS)](#).

For more information on the NWPS Products, go to the [National Water Prediction Service Product Guide](#).
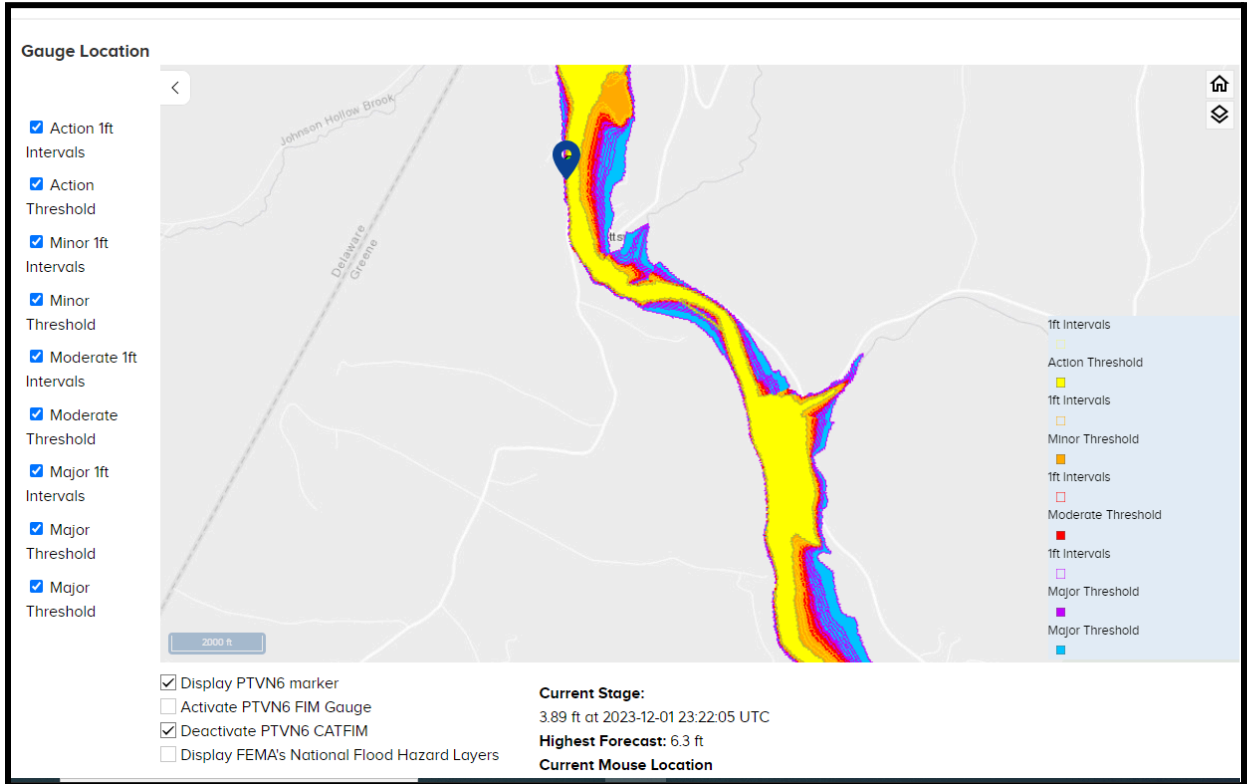
Description
Depicts at the selected site the suite of streamflow forecasts which include the 30-day long-range ensemble mean and the 4 individual long-range ensemble members each extending out to 30 days.

Update Frequency
Every 6 Hours

Categorical Flood Inundation Extent (at selected site)

Service URL

https://maps.water.noaa.gov/server/rest/services/fim_libs/static_stage_based_catfim/MapServer

Description

Depicts at the selected site the inundation extent for each impact flood category using Stage-based Categorical Flood Inundation Mapping: Static map extents available for action, minor, moderate, major and record levels.

Update Frequency

Static