TO:	**Permitting and I&E Personnel**
SUBJECT:	**Determination of Precipitation Total for Design Storms**
DATE:	**February 23, 2018**
APPROVAL:	**Harold D. Ward, Director**

INTRODUCTION

This policy memorandum sets forth acceptable procedures and practices for determining rainfall precipitation amounts for various frequency Design Storms that are used to perform drainage structure design calculations, Storm Water Runoff Analysis, and/or any other hydrologic calculations that may be required under the West Virginia Surface Mining Reclamation Rule, 38 CSR 2. This policy was developed to provide consistency by establishing permitting design procedures that coincide with other permitting policies, procedures, and guidance and to encourage consistency with current prudent and standard engineering practices.

Because National Oceanic and Atmospheric Administration (NOAA) precipitation frequency estimates have replaced United States Weather Bureau data, as referenced in 38 CSR 2 §2.42, NOAA Atlas 14 (or the most recent Atlas version) is to be used to determine Precipitation Frequency Estimates for all applicable Design Storms specified in the Reclamation Rule.

This policy is prospective and only applies to new permit actions submitted after the above effective date.

BACKGROUND

Per 38 CSR 2 §2.42, "Design Storm means predicted precipitation of given intensity, frequency and duration based on United States Weather Bureau data." These design storms are utilized to determine the "Peak Runoff" used in various hydrology designs, analyses, and calculations for permit applications and certifications. Per 38 CSR 2 § 2.86, "Peak Runoff means the maximum flow in a specified geographic location resulting from a given design storm."

United States Weather Bureau precipitation data can be found in the Technical Handbook of Standards and Specifications for Mining Operations in West Virginia, 1984 (the Technical Handbook)[1]. The Technical Handbook includes tables of 24-hour precipitation totals for various storm frequencies by West Virginia county. The tables are based upon the U. S. Weather Bureau Rainfall-Frequency Atlas of the United States, Technical Paper No. 40, which was published in 1961.

In 1970, the U.S. Weather Bureau, the U.S. Coast and Geodetic Survey, and the U.S. Commission of Fish and Fisheries were brought together to establish the National Oceanic and Atmospheric Administration or NOAA. NOAA is now the federal agency responsible to estimate, maintain and

[1]West Virginia Department of Natural Resources Division of Reclamation, Technical Handbook of Standards and Specifications for Erosion and Sediment Control, Excess Spoil Disposal, and Haulageways for Mining Operations in West Virginia, revised 04/84.

update precipitation frequency data for the United States. Current precipitation frequency data is published in NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 3.0 (revised 2006). The Atlas states that:

> "The Atlas is intended as the official documentation of precipitation frequency estimates and associated information for the United States... The Atlas supersedes precipitation frequency estimates contained in Technical Paper No. 40 'Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years' (Hershfield, 1961), NWS HYDRO-35 'Five- to 60-minute precipitation frequency for the eastern and central United States' (Frederick et al., 1977) and Technical Paper No. 49 'Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States' (Miller et al., 1964)."

NOAA precipitation frequency data is available online from the Precipitation Frequency Data Server that was developed and published in tandem with NOAA Atlas 14 to allow delivery of the results and supporting information in multiple forms via the internet.[2]

APPLICATION OF POLICY

Precipitation frequency totals for applicable Design Storms are to be obtained from:

- NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 3.0 (or most recent Atlas version, if subsequently updated).
- The "geographic location" used in determining the Point Precipitation Frequency Estimate – based upon the judgment of the registered professional engineer or licensed land professional surveyor certifying the design calculations - shall be the coordinates for either the approximate center of the permit or the approximate center of the sub-watershed in which the drainage or runoff design calculations are being conducted.
- The Point Precipitation Frequency Estimate to be utilized as the Design Storm total shall be the 90% confidence value estimate (in inches) based on the appropriate Average Recurrence Interval (such as 10, 25, 100-year, etc.) and Storm Duration (such as 6-hour, 24-hour, etc.).
    - It is not intended that the upper limit of the 90% confidence interval estimate be utilized – unless the registered professional engineer or professional surveyor performing the design calculations deems a higher value should be used in order to be consistent with standard or prudent engineering practices.
- All site-specific printouts, tables, and backup data from Atlas 14 are to be included in the permit and drainage calculation documentation.
- Precipitation Frequency Estimates from the Technical Handbook may continue to be used, so long as the precipitation estimate (in inches) is no less than the corresponding 90% confidence value indicated by Atlas 14 for the same approximate location, Average Recurrence Interval, and Storm Duration.

[2]Current url: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

Example from NOAA Atlas 14, October 2017

Precipitation Total (inches) for a 25-year/24-hour Design Storm

NOAA Atlas 14, Volume 2, Version 3
Location name: Charleston, West Virginia, USA*
Latitude: 38.3366°, Longitude: -81.5277°
Elevation: 1015.58 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.338 (0.310–0.371)	0.402 (0.367–0.441)	0.481 (0.440–0.528)	0.540 (0.493–0.592)	0.615 (0.560–0.672)	0.672 (0.610–0.733)	0.724 (0.654–0.788)	0.776 (0.699–0.844)	0.842 (0.754–0.914)	0.890 (0.794–0.965)
10-min	0.526 (0.481–0.576)	0.627 (0.574–0.689)	0.748 (0.684–0.821)	0.834 (0.762–0.914)	0.941 (0.856–1.03)	1.02 (0.925–1.11)	1.09 (0.985–1.19)	1.16 (1.04–1.26)	1.24 (1.11–1.34)	1.30 (1.16–1.41)
15-min	0.644 (0.590–0.706)	0.767 (0.702–0.842)	0.918 (0.840–1.01)	1.03 (0.937–1.13)	1.16 (1.06–1.27)	1.26 (1.15–1.38)	1.35 (1.22–1.47)	1.44 (1.30–1.57)	1.55 (1.38–1.68)	1.62 (1.45–1.76)
30-min	0.853 (0.781–0.934)	1.03 (0.939–1.13)	1.26 (1.15–1.38)	1.42 (1.30–1.56)	1.64 (1.49–1.79)	1.80 (1.64–1.97)	1.95 (1.77–2.13)	2.10 (1.89–2.29)	2.29 (2.05–2.49)	2.43 (2.17–2.63)
60-min	1.04 (0.953–1.14)	1.26 (1.15–1.38)	1.58 (1.44–1.73)	1.81 (1.66–1.99)	2.13 (1.94–2.32)	2.37 (2.16–2.59)	2.61 (2.36–2.85)	2.85 (2.57–3.10)	3.17 (2.83–3.44)	3.41 (3.04–3.70)
2-hr	1.21 (1.10–1.31)	1.46 (1.33–1.60)	1.82 (1.66–1.99)	2.10 (1.91–2.29)	2.48 (2.25–2.69)	2.77 (2.50–3.01)	3.08 (2.77–3.33)	3.38 (3.02–3.65)	3.79 (3.37–4.09)	4.11 (3.63–4.43)
3-hr	1.27 (1.16–1.39)	1.54 (1.41–1.69)	1.92 (1.75–2.10)	2.21 (2.02–2.41)	2.61 (2.38–2.84)	2.93 (2.66–3.19)	3.26 (2.94–3.53)	3.60 (3.22–3.89)	4.05 (3.60–4.37)	4.41 (3.90–4.76)
6-hr	1.51 (1.40–1.64)	1.80 (1.67–1.97)	2.23 (2.06–2.43)	2.57 (2.36–2.79)	3.04 (2.79–3.30)	3.42 (3.12–3.70)	3.82 (3.46–4.12)	4.23 (3.82–4.55)	4.79 (4.29–5.15)	5.24 (4.65–5.61)
12-hr	1.78 (1.66–1.92)	2.12 (1.98–2.29)	2.59 (2.41–2.79)	2.97 (2.76–3.20)	3.52 (3.25–3.77)	3.96 (3.64–4.23)	4.42 (4.04–4.72)	4.91 (4.45–5.22)	5.59 (5.02–5.92)	6.14 (5.46–6.49)
24-hr	2.16 (2.03–2.31)	2.57 (2.42–2.75)	3.11 (2.92–3.33)	3.55 (3.33–3.79)	4.16 (3.89–4.44)	4.66 (4.35–4.96)	5.18 (4.81–5.50)	5.71 (5.29–6.07)	6.45 (5.95–6.84)	7.04 (6.46–7.46)
2-day	2.59 (2.43–2.75)	3.07 (2.89–3.27)	3.68 (3.46–3.91)	4.17 (3.91–4.43)	4.83 (4.53–5.13)	5.37 (5.02–5.69)	5.92 (5.51–6.27)	6.48 (6.01–6.86)	7.24 (6.69–7.66)	7.83 (7.21–8.28)
3-day	2.80 (2.64–2.97)	3.32 (3.13–3.52)	3.95 (3.73–4.20)	4.46 (4.20–4.74)	5.15 (4.84–5.46)	5.69 (5.33–6.03)	6.24 (5.83–6.61)	6.80 (6.33–7.20)	7.55 (7.00–7.98)	8.12 (7.51–8.58)
4-day	3.01 (2.84–3.19)	3.56 (3.37–3.78)	4.23 (4.00–4.49)	4.76 (4.49–5.04)	5.47 (5.14–5.79)	6.02 (5.65–6.37)	6.57 (6.15–6.95)	7.12 (6.66–7.53)	7.86 (7.31–8.30)	8.42 (7.81–8.89)
7-day	3.62 (3.42–3.84)	4.27 (4.03–4.53)	5.00 (4.72–5.31)	5.57 (5.25–5.91)	6.30 (5.94–6.68)	6.87 (6.45–7.27)	7.41 (6.96–7.85)	7.95 (7.44–8.41)	8.63 (8.07–9.14)	9.14 (8.52–9.68)
10-day	4.19 (3.97–4.42)	4.92 (4.67–5.21)	5.71 (5.41–6.04)	6.32 (5.98–6.67)	7.09 (6.70–7.48)	7.66 (7.24–8.09)	8.22 (7.75–8.67)	8.75 (8.24–9.23)	9.42 (8.85–9.94)	9.91 (9.29–10.5)
20-day	5.86 (5.58–6.16)	6.86 (6.53–7.22)	7.85 (7.47–8.26)	8.59 (8.16–9.03)	9.51 (9.03–10.0)	10.2 (9.67–10.7)	10.8 (10.3–11.4)	11.4 (10.8–12.0)	12.1 (11.5–12.8)	12.7 (11.9–13.3)
30-day	7.37 (7.03–7.75)	8.62 (8.22–9.04)	9.74 (9.28–10.2)	10.6 (10.1–11.1)	11.6 (11.0–12.2)	12.4 (11.7–13.0)	13.0 (12.4–13.7)	13.7 (13.0–14.3)	14.4 (13.6–15.1)	14.9 (14.1–15.7)
45-day	9.42 (9.01–9.87)	11.0 (10.5–11.5)	12.3 (11.7–12.8)	13.2 (12.6–13.8)	14.4 (13.7–15.1)	15.2 (14.5–15.9)	16.0 (15.2–16.7)	16.6 (15.8–17.4)	17.4 (16.6–18.2)	17.9 (17.1–18.8)
60-day	11.4 (10.9–11.9)	13.2 (12.6–13.8)	14.6 (14.0–15.3)	15.7 (15.0–16.4)	17.0 (16.2–17.7)	17.8 (17.1–18.6)	18.6 (17.8–19.5)	19.3 (18.5–20.2)	20.2 (19.2–21.1)	20.7 (19.7–21.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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