Purpose: This document describes procedures that can be used to evaluate antecedent precipitation using climate data and tools available in Minnesota.

Audience: Those involved in jurisdictional wetland delineation, restoration, mitigation, regulation, or any other activity requiring the use of hydrologic data, observations, or imagery.

Use: These accepted methods can be used to compare antecedent precipitation conditions between different dates for sites in Minnesota. They make the best use of data and tools readily available via the web from the Minnesota State Climatology Office. The ability to compare antecedent precipitation conditions is often relevant to assessing wetland hydrology.

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1. Introduction

The publications *Accessing and Using Meteorological Data to Evaluate Wetland Hydrology* (Sprecher and Warne, 2000), and USDA-NRCS Engineering Field Handbook – Chapter 19 – Hydrology Tools for Wetland Determination (NRCS, 1997 and draft update 2011), are important resources for nationwide application. They describe techniques for evaluating the precipitation preceding a particular date to determine whether observations made on that date are representative of relatively normal, wet, or dry conditions.

In Minnesota, we have the additional resource of an outstanding State Climatology Office, whose web-available climate data and tools greatly enhance the application of these procedures. Together with the capabilities of spreadsheet programs, these data and tools make the procedures accessible and straightforward.

The first method uses monthly precipitation data and the WETS Tables (or their Minnesota equivalents) and is derived from the method presented in Hydrology Tools for Wetland Determination (NRCS, 1997). The State Climatology Office web site has a built-in tool for applying this method. The second method evaluates daily precipitation data on the basis of 30-day rolling totals. These methods can also be combined as a 3rd “hybrid” method.

2. Three-Prior-Month Method for Evaluating Antecedent Precipitation

2.1. Background

This method, commonly referred to as the “NRCS method,” has long been used for interpreting wetland signatures on air photos (Figure 1). The method considers precipitation data from the three months prior to the date of interest and weighs those data for length of time since the precipitation contributed to the water budget (Figure 2). Several assumptions are made when using the method:

- Rain was evenly distributed for the month of observation.
- Three months is the proper length of time to evaluate antecedent precipitation even though hydrologic systems vary considerably in their “lag time.”
- Snowmelt contributes to wetland hydrology in the same way as rainfall.

*Figure 1: Examples of aerial images showing wetland hydrology signatures.*
The method can be used in two ways:

- **With the tool available on State Climatology Office website.** For older observation or photo dates, the procedure is completely automated on the website. The tool populates a table like Figure 2. It uses geostatistical interpolation to derive precipitation data from surrounding gauge sites, thereby negating the need to select the “closest” precipitation gauging station; and

- **Without the tool** - manually or with a spreadsheet. There are several reasons you may need to do this - for example for recent hydrologic observation dates for which the appropriate monthly precipitation data have not yet been updated to the built-in tool. In this case you still make use of the data on the State Climatology Office website, but you must put the precipitation data in a table yourself.

![Completed Rainfall Documentation Worksheet for the Three-Prior-Month method, as used for photo interpretation.](image)
2.2. Three-Prior-Month Method Using the State Climatology Office Monthly Precipitation Data Retrieval Web Tool for Wetland Delineation

a. Go to http://climate.umn.edu. Select: **Retrieve Past Climate Data**

![Figure 3](image1)

b. Select: **Monthly**.

![Figure 4](image2)
c. Select: **Monthly Precipitation Data from Gridded Database (for Wetland Delineators)**

![Past Climate Data for Minnesota](image)

Figure 5

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d. Choose select a wetland location.

![Wetland Delineation Precipitation Data Retrieval from a Gridded Database](image)

**Wetland Delineation Precipitation Data Retrieval from a Gridded Database**

Obtaining a long-term precipitation data time-series for wetland delineation efforts can be a difficult and time-consuming process. Locating the nearest precipitation monitoring station to the wetland often proves challenging. Once a nearby monitoring location is identified, retrieving the data, accounting for gaps in the record, and generating the summary statistics can provide further challenges.

By offering access to "synthetic" data, this application assists users in overcoming some the challenges inherent in assembling a precipitation data set. The synthetic data are made up of regularly-spaced grid nodes whose values were calculated using data interpolated from Minnesota’s outstanding, but spatially and temporally irregular, precipitation data base. [More Information](#) ...
e. Click to continue to zoom in to your location. If desired, the map settings can be adjusted to display different background layers, including USGS 1:24K topo maps at appropriate scales.

f. When you’ve zoomed in to the desired location, click CREATE PRECIPITATION DATA TABLE.
The result will be tables showing the range of normal monthly precipitation for the site based on Period-of-record statistics, 1971-2000 summary statistics, and 1981-2010 summary statistics (Figure 8). These are derived by geostatistical interpolation between precipitation data from surrounding gages. Below these is a year-to-year table of monthly precipitation data for the site. These are derived from precipitation data from surrounding gage sites, also using geostatistical interpolation techniques. They are color-coded for wet, normal, and dry months.

To create a precipitation documentation worksheet using USDA-NRCS methodology, select the date of the site visit or aerial photograph and click on “create worksheet.”

![Table of data](image)

**Figure 8**

To generate a completed Rainfall Documentation Worksheet using the Three-Prior-Month (“NRCS”) method, select the date of the site visit or aerial photo, and then select create worksheet. The result will be two Precipitation Documentation Worksheets, one using the 1971-2000 normal period and one using the 1981-2010 normal period (Figure 9). There is a several-month delay in data entry for the monthly precipitation data. To evaluate recent months you may need to use the procedure described in Section 2.3 below.

**Unless specifically required by policy, use the 1981-2010 normal period.**
Minnesota Climatology Working Group

Precipitation Worksheet Using Gridded Database

Precipitation data for target wetland location:
- county: Stearns
- township number: 123N
- range number: 30W
- nearest community: Cold Spring
- section number: 16

Aerial photograph or site visit date:
- Tuesday, July 01, 2014

Score using 1971-2000 normal period

<table>
<thead>
<tr>
<th>(values are in inches)</th>
<th>first prior month: June 2014</th>
<th>second prior month: May 2014</th>
<th>third prior month: April 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>estimated precipitation total for this location:</td>
<td>6.90</td>
<td>6.10</td>
<td>4.24</td>
</tr>
<tr>
<td>there is a 30% chance this location will have less than: *</td>
<td>3.02</td>
<td>2.28</td>
<td>1.13</td>
</tr>
<tr>
<td>there is a 30% chance this location will have more than: *</td>
<td>5.98</td>
<td>3.73</td>
<td>2.47</td>
</tr>
<tr>
<td>type of month: dry</td>
<td>normal</td>
<td>wet</td>
<td>wet</td>
</tr>
<tr>
<td>monthly score:</td>
<td>3 * 3 = 9</td>
<td>2 * 3 = 6</td>
<td>1 * 3 = 3</td>
</tr>
<tr>
<td>multi-month score:</td>
<td>18 (Wet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score using 1981-2010 normal period

<table>
<thead>
<tr>
<th>(values are in inches)</th>
<th>first prior month: June 2014</th>
<th>second prior month: May 2014</th>
<th>third prior month: April 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>estimated precipitation total for this location:</td>
<td>6.90</td>
<td>6.10</td>
<td>4.24</td>
</tr>
<tr>
<td>there is a 30% chance this location will have less than: *</td>
<td>2.91</td>
<td>2.28</td>
<td>1.38</td>
</tr>
<tr>
<td>there is a 30% chance this location will have more than: *</td>
<td>5.74</td>
<td>3.74</td>
<td>3.02</td>
</tr>
<tr>
<td>type of month: dry</td>
<td>normal</td>
<td>wet</td>
<td>wet</td>
</tr>
<tr>
<td>monthly score:</td>
<td>3 * 3 = 9</td>
<td>2 * 3 = 6</td>
<td>1 * 3 = 3</td>
</tr>
<tr>
<td>multi-month score:</td>
<td>18 (Wet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 9: Resulting Precipitation Documentation worksheets.

Unless specifically required by policy, use the 1981-2010 normal period.
2.3. Three-Prior-Month method using the State Climatology Office monthly precipitation data and Filling out the Rainfall Documentation Worksheet manually or with a spreadsheet

You may need to do this for recent observations, or if you want instead to use the USDA-NRCS WETS data rather than the geostatistically-derived monthly range of normal precipitation.

a. Follow all the steps outlined in Section 2.2 above to get the normal monthly precipitation range information for the three months prior to the observation date.

If you want to use the USDA-NRCS WETS data for the monthly range of normal precipitation rather than that from the State Climatology Office, there is a link (view USDA-NRCS WETS data) at the bottom of the precipitation documentation worksheets (Figure 9). Alternatively you can go to http://www.wcc.nrcs.usda.gov/climate/wetlands.html.

b. Transfer the appropriate “normal range” numbers for the prior months to the appropriate boxes on a blank Rainfall Documentation Worksheet – OR – use the [NRCS method] sheet in the Excel spreadsheet tool available here: http://www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls

c. For recent observations you will need to retrieve recent monthly precipitation data. From climate.umn.edu Select: Retrieve Past Climate Data; then Select: Monthly as in Section 2.2 (Figures 3, 4).

d. There are several options for retrieving precipitation data. For data from the Minnesota Volunteer Precipitation Observing Program (“MNGage”) Select: Monthly MNGage Precipitation by Target Location (Figure 10).

e. Select click to select target location. Zoom in to your site as described above. When you have the location in the cross-hairs, click on DONE/return to application. Choose the year(s) and select retrieve monthly data (Figure 11). Daily data are also available.
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Figure 11

f. Transfer the precipitation data from the prior months of interest to the appropriate boxes on a blank Rainfall Documentation Worksheet (Appendix).

OR:

Use the [NRCS method] sheet in the Excel spreadsheet tool available here: www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls (Figure 12).
<table>
<thead>
<tr>
<th>Date</th>
<th>Weather Station</th>
<th>State</th>
<th>County</th>
<th>Growing Season</th>
<th>Photo/obs Date</th>
<th>Soil Name</th>
<th>2nd Prior Month*</th>
<th>3rd Prior Month*</th>
<th>Condition</th>
<th>Condition Value</th>
<th>Month Weight Value</th>
<th>Product of Previous 2 Columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/15/2015</td>
<td>Cold Spring, MN</td>
<td>MN</td>
<td>Stearns</td>
<td>4/20 - 10/15</td>
<td>7/1/2014</td>
<td>Soil Name</td>
<td>2.28</td>
<td>4.24</td>
<td>W</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 12:** Example application of Three-Prior-Month method using the Excel spreadsheet tool.
3. Method of Rolling Totals

3.1. Background

The Three-Prior-Month method compares actual precipitation with monthly ranges of normal. Precipitation patterns within a particular month are not reflected in monthly totals. Monthly totals are reset to zero at the beginning of each month and may not accurately reflect antecedent precipitation in the middle of the month. Because the period of continuous inundation required for wetland hydrology is less than a month, it is often desirable to evaluate higher frequency (daily) precipitation data.

The 30-day Rolling Total method is particularly useful. It involves summing the prior 30-day precipitation totals for each day and plotting this “rolling total” on a daily basis. By overlaying a plot of the normal precipitation range on the daily plot, you can evaluate whether antecedent precipitation was greater or less than normal throughout a month rather than just at the beginning or end.

The method is especially easy using spreadsheet software and data from the State Climatology office. An example Microsoft Excel spreadsheet (30Day_Rolling_Total_Spreadsheet.xls) is available here: http://www.bwsr.state.mn.us/wetlands/wca/30Day_Rolling_Total_Spreadsheet.xls.

A spreadsheet such as this can be used as a template by cutting and pasting data into the appropriate spreadsheet cells. This guidance is geared toward web-available data and Microsoft Excel®. Other spreadsheet programs will work but the format of commands and formulas will be different.

3.2. Procedure

The 30-day rolling totals procedure consists of these basic steps:

- Get daily precipitation data and monthly ranges of normal for your site from the State Climatology office.
- Put the data into appropriate places in a spreadsheet.
- Calculate and plot 30-day rolling totals for the time period of interest.
- Plot monthly ranges of normal on the plot of 30-day rolling totals.
- Compare the rolling 30-day sums to the monthly ranges of normal to determine whether antecedent precipitation was within the range of normal.

3.2.1. Get Precipitation Data

a. From climate.umn.edu Select: Retrieve Past Climate Data; then Select: Daily. For data from the Minnesota Volunteer Precipitation Observing Program select: Daily MNGage Precipitation by Target Location (Figure 13).
b. Select **click to select target location**. Zoom in to your site as described above. When you have the location in the cross-hairs, click on **DONE/return to application**. Choose the year(s) and select **retrieve daily data** (Figure 14).
Minnesota’s precipitation data archive is searched for data closest to a selected target location for each month. Values from the site closest to the target location are returned below after clicking the retrieve monthly data or retrieve daily data buttons. The precipitation data are made up of measured rainfall and the measured liquid content of snowfall.

Temperature, snowfall, and snow depth data from National Weather Service reporting stations are no longer retrieved from this application. To obtain those data, see our newest data retrieval tool (May 2014). National Weather Service precipitation data continue to be available from this application.

The data will appear on the bottom of the screen. Highlight the data you want and copy, and paste it into the spreadsheet (Figure 15).
d. Do a “text-to-columns” conversion. In Excel, highlight the entire column containing the pasted data. Select “Data”, then “Text to Columns”. Choose “Fixed Width.” Then use break lines to delineate 2 columns, one for date and one for precipitation (Figure 16).

e. Change the “Column data format” for the date column to “Date: MDY.” The column data format for the data after the precipitation column can be set to “skip” (Figure 16).
Figure 16: Text-to-columns conversion
You now have a two-column spreadsheet. For ease of use, insert a new row at the top and label the columns. Then go to the 1st column, 2nd row and click “Window” > “Freeze panes.” Also, use “Edit-Find-Replace” to replace all the ‘T’ values in the precipitation column with zeros.

Create a third column and label it “30-day rolling total”. The value in this column for each day will be the sum of the precipitation amounts for that day and the preceding 29 days. The calculation is easily automated in the spreadsheet by copying and pasting the first instance of the formula into the other rows of the third column. An example Microsoft Excel formula is =SUM(B153:B182). It is also helpful to create a monthly total precipitation column by totaling the daily precipitation values for each month (Figure 17).

3.2.2. Get Normal Monthly Precipitation Range Data

a. Follow all the steps outlined in Section 2.2 above to get the normal monthly precipitation range information for the location.

If you want instead to use the USDA-NRCS WETS data for the monthly range of normal precipitation rather than that from the State Climatology Office, there is a link (view USDA-NRCS WETS data) at the bottom of the precipitation documentation worksheets (Figure 9). Alternatively you can go to www.wcc.nrcs.usda.gov/climate/wetlands.

b. Transfer the appropriate “normal range” values (Figure 8) for the months of interest to the spreadsheet. For ease of use put the data in a new spreadsheet tab. Create another column with the last dates of the month for the months of interest. Why the last dates? We will be plotting the ranges of normal for each month at the end of that particular month, rather than the beginning or middle, because the range of normal is for the preceding 28/29, 30, or 31 days of the month (Figure 18).
3.2.3. Plot the Data

There are many options for plotting and many ways to approach formatting dates, curves, axes, etc. Here are the basics, assuming some familiarity creating graphs using spreadsheet software. These directions are based on Microsoft Excel®; other spreadsheet or graphing programs will have different formatting of commands.

- Create an X-Y (Scatter) plot with date as the X-axis and precipitation as the Y.
- Select the source data (Figure 19). The source data series will be:
  - 30-day rolling total plotted as a curve (column ‘C’ against column ‘A’, Figure 17)
  - Upper and lower boundaries of the range of normal, plotted at the end of each month as lines (Columns ‘C’ and ‘D’ against column ‘B’ in Figure 18).
- Don’t forget to format the X and Y axes, specifying maximum, minimum, and units for each so that the desired data plot the way you want!
- It is also helpful to plot:
  - Daily precipitation “spike graph” to provide details of the distribution of rainfall within the months of interest (column ‘B’ against column ‘A’, Figure 17).
  - Monthly precipitation totals as points (column ‘D’ against column ‘A’, Figure 17).
Figure 19: Selecting source data

Figure 20: Formatting Axes.
3.2.4. Determine Whether Precipitation Was Within Range of Normal

Deviation from the range of normal precipitation is determined by using the superimposed plots of 30-day rolling totals and ranges of normal precipitation for the period of interest (Figure 21). Including daily precipitation data on the plot helps show how the 30-day rolling totals evolved.

In the example in Figure 21, we see that in 2014, rainfall events at the end of April caused the 30-day total to rise from below normal to well above normal.

The strength of the method of 30-day rolling totals can be seen by comparing it to the monthly totals. The monthly totals indicate that April was significantly wetter than normal. However, the more detailed method of 30-day rolling totals detected that the heavy rains did not occur until the end of April. Detailed knowledge of rainfall distributions in early- to mid-April could have been important as that is at the beginning of the regulatory growing season (Sprecher and Warne, 2000).

3.3. Remarks on the Method

The method of 30-day rolling totals provides a more accurate assessment of antecedent moisture conditions at a site than do monthly totals, which artificially zero rainfall totals at the beginning of each month. However, the method of rolling sums also artificially zeroes rainfall after 30 days (Sprecher and Warne, 2000).
4. Combining the 30-Day Rolling Total and Three-Prior-Month Methods: “Hybrid Method”

The 30-Day Rolling Total and Three-Prior-Month methods can be effectively combined. This is particularly useful when the observation date or date of interest falls later in the month – in this case the Three-Prior-Month method alone would ignore the precipitation in the early part of the month.

a. On the plot of 30-day rolling totals, mark off 30-day blocks starting backward from the observation date or date of interest (Figure 22).

![Figure 22: Three 30-day periods prior to the observation date or October 15, 2014.](image)

b. Decide whether the 30-day blocks reflect normal, drier than normal, or wetter than normal precipitation by comparing the 30-day rolling totals with the ranges of monthly normal. This will require professional judgment!

c. Record your decisions for the 30-day blocks in the Rainfall Documentation Worksheet in the column labeled “Condition dry, wet, normal” (Figure 2). Use these decisions to complete the Three-Prior-Month method as
described above. The [Hybrid method] sheet in the Excel spreadsheet available here: [www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls](www.bwsr.state.mn.us/wetlands/wca/NRCS_%20Hybrid_Methods_Spreadsheet.xls) automates the calculation—requiring inputs to the “Condition dry, wet, normal” column for the 3 prior 30-day periods (Figure 23).

**Figure 23: Example Application of Hybrid Method Using the Excel Spreadsheet Tool**

The “Hybrid Method” may rate the three-months’ precipitation prior to the observation date differently than the Three-Prior-Month method, depending on professional judgment. The difference is the ability to calculate 30-day increments starting on any date rather than only at the beginning of the calendar month.
5. Observation on Assessments of Antecedent Precipitation (Sprecher and Warne, 2000)

- Using the Normal Monthly Precipitation Range data alone is quickest and OK for simple generalizations about long-term trends.

- The simple method of 30-day rolling totals is readily used with long sets of monitoring well data because of ease of plotting information. These plots, when superimposed on a daily precipitation spike graph, provide a powerful tool for explaining water well fluctuations.

- The hybrid method is useful for making decisions regarding individual dates of observation at a site. Whenever feasible, the monthly analyses should be interpreted using the daily data from which the monthly summaries were aggregated.

- The Three-Prior-Month and rolling total methods can be used in conjunction with indices of longer term hydrologic input, such as the Palmer drought indices.

- The Normal Monthly Precipitation Range data evaluate the range of normal precipitation in monthly increments. Antecedent precipitation probably does not affect wetland hydrology in monthly or 30-day increments.

- Antecedent precipitation is only one part of the water budget. The other parts of the water budget need to be considered when interpreting observed levels of ground or surface water.

- The duration of impact of antecedent precipitation typically varies with the seasons. In the early spring, when evapotranspiration (ET) is low, there is probably a longer duration impact of prior precipitation than later in the summer when ET is high.

- The duration of influence of antecedent precipitation on wetland hydrology can be quite site-specific. NRCS hydrologists chose three months as a reasonable length of time to evaluate antecedent precipitation for Food Security Act programs. In the absence of site-specific information to the contrary, three months preceding a date of site monitoring seems to be a reasonable length of time to evaluate whether precipitation was within the range of normal.

- There is no way to remove professional judgment in borderline situations. The limits of the range of normal (30th and 70th percentiles) are themselves professional judgments. Moreover, when antecedent precipitation levels are close to thresholds of normal, uncertainties about other parts of the water budget become major considerations.

6. References
