Upper Missouri River Basin
December 2012 Calendar Year Runoff Forecast
December 3, 2012

U.S. Army Corps of Engineers, Northwestern Division
Missouri River Basin Water Management
Omaha, NE

Calendar Year Runoff Forecast

Explanation and Purpose of Forecast

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri River reach above Sioux City. The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

November 2012 Runoff

November runoff was 0.9 MAF (917 KAF) in the Missouri River basin above Sioux City, which is 87% of normal. Rainfall in excess of 150% of normal in the Fort Peck and Garrison reaches were the primary factors leading to increased runoff in November. Previous accumulated monthly runoff volumes above Sioux City included 0.3 MAF (285 KAF) in September and 0.6 MAF (639 KAF) in October.

2012 Calendar Year Forecast Synopsis

The December 1 calendar year runoff forecast above Sioux City, IA is **19.7 MAF** (79% of normal) and **17.8 MAF** (78% of normal) above Gavins Point Dam. This is an increase of 0.5 MAF from the November 1 forecast. Due to the amount of variability in precipitation that can occur over the next month, the expected inflow ranges from the 19.8 MAF upper basic forecast to the 19.6 MAF lower basic forecast. The upper and lower basic forecasts provide a likely range of runoff scenarios that could occur given wetter-than-expected or drier-than-expected conditions. Given that 1 month is being forecasted on December 1 (11 months observed/1 months forecast), the range of greater than normal (upper basic) and lower than normal (lower

basic) runoff is attributed to all 6 reaches for both months. The result is a range or "bracket" for each reach, and thus, for the total runoff forecast.

Current Conditions

Precipitation

November precipitation accumulations ranged from 0.5 to 1.5 inches in the plains region of Montana, northern Wyoming and northern North Dakota. The mountain region of Montana and Wyoming received 2.0 to 4.0 inches of precipitation (Figure 1). These regions received between 150 and 300 percent of normal with some locally greater departures (Figure 2). For the majority of the Missouri River basin, overall precipitation accumulations during the month of November were well below (Figure 2). There was a lack of precipitation in the central area of the basin where accumulations were less than 50% of normal. Portions of Nebraska and South Dakota received less that 25% of the normal November precipitation. During the three-month September-October-November period, precipitation ranged from 75% down to 10% of normal, especially in central Nebraska and central South Dakota (Figure 3).

Year-to-date precipitation has produced some of the driest conditions in the 118-year precipitation record. Among Missouri River basin states, the January-October 2012 precipitation accumulation was the driest on record in Wyoming and Nebraska. South Dakota, Iowa, Kansas and Colorado also ranked much below normal.

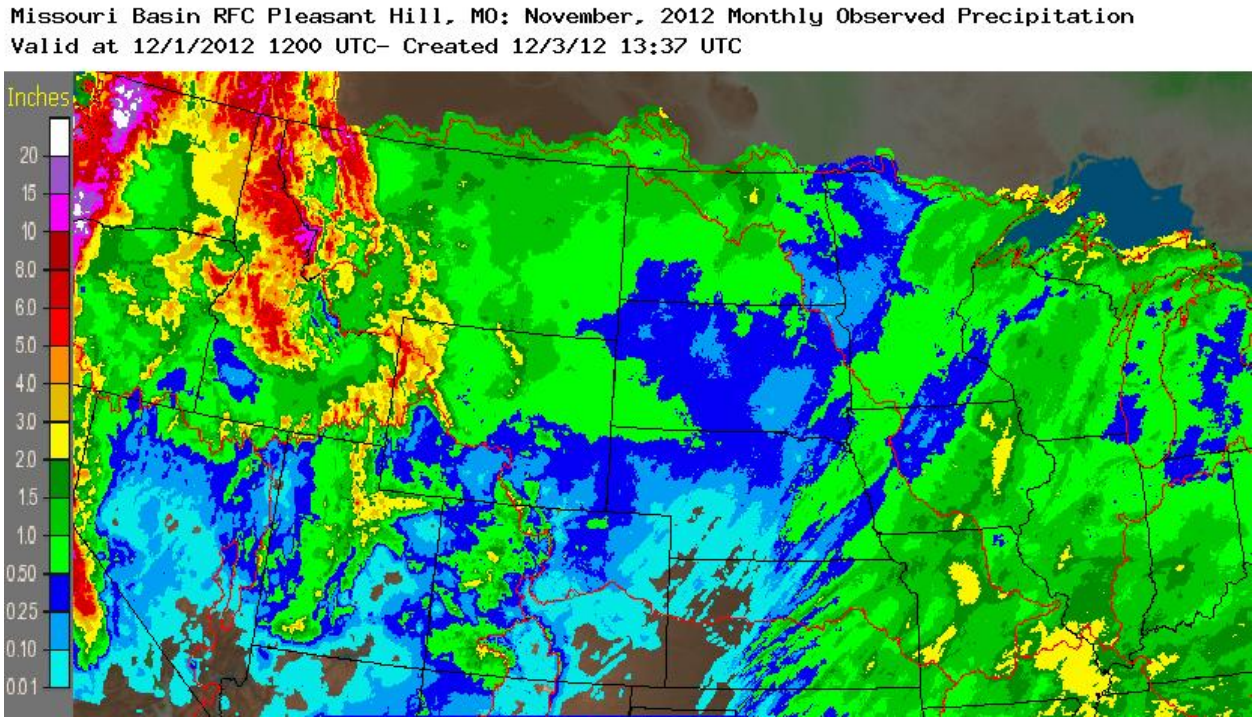

Figure 1. November 2012 Precipitation (inches). Source: National Weather Service.

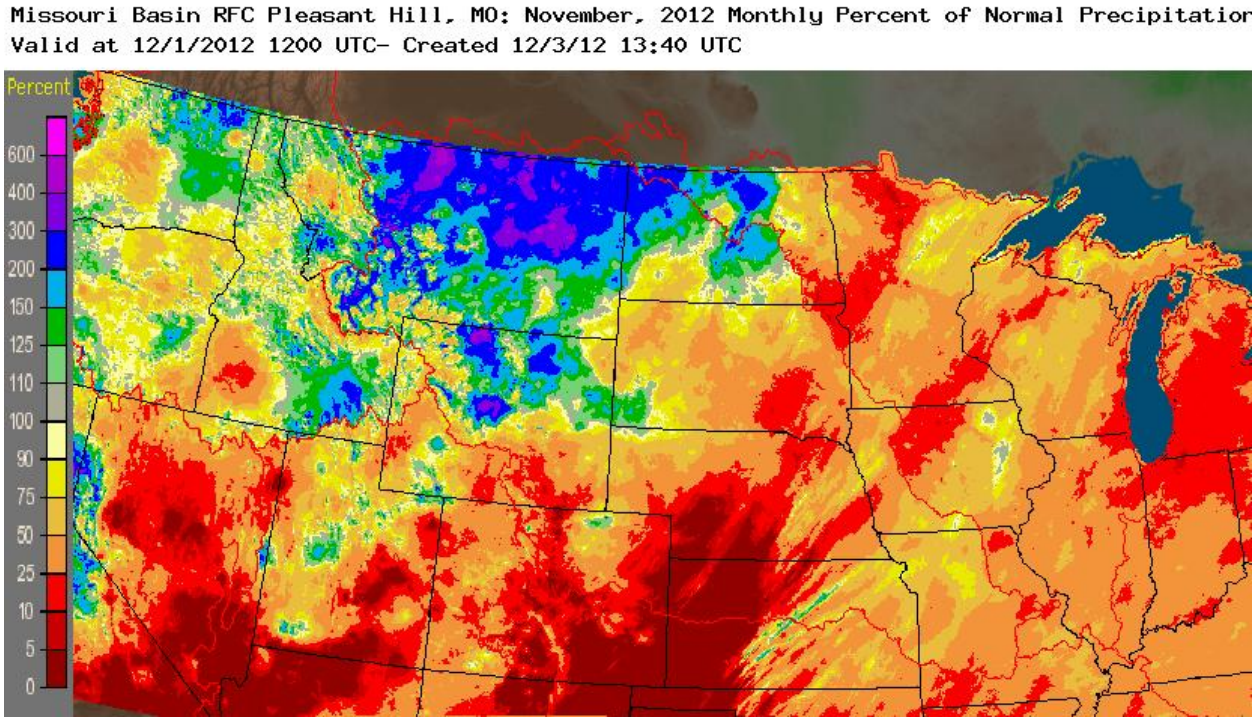

Figure 2. November 2012 Percent of Normal Precipitation. Source: National Weather Service.

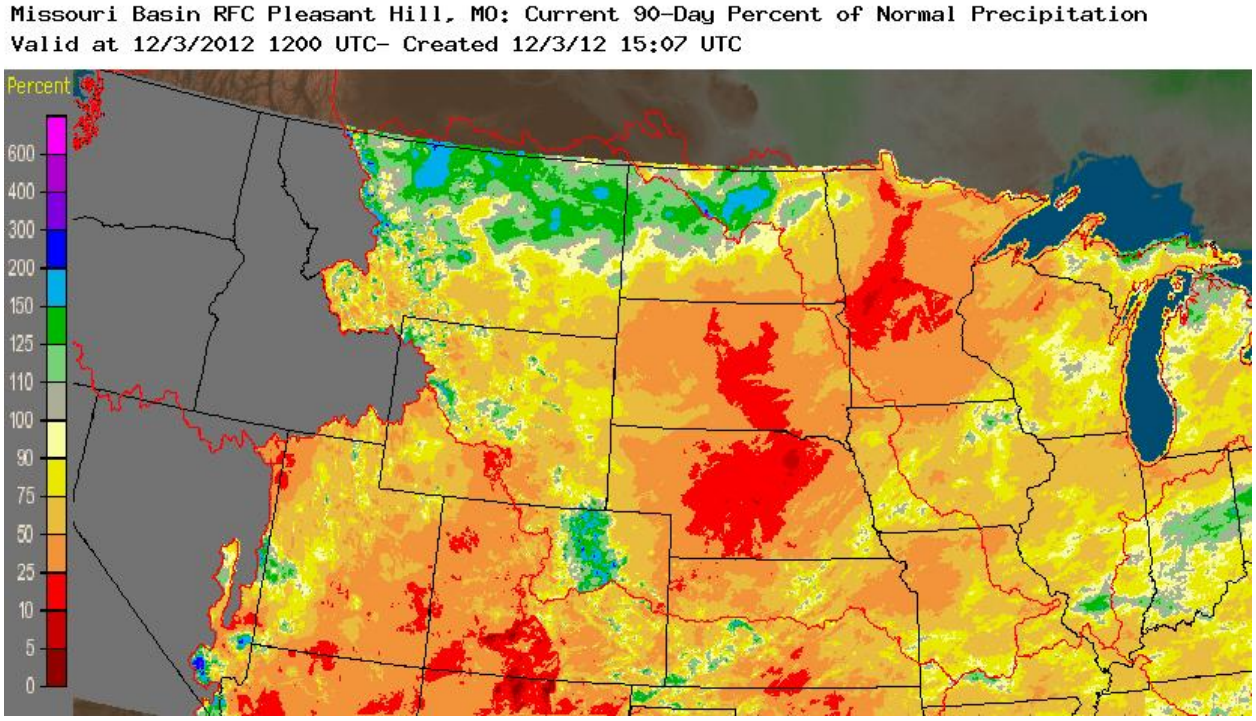

Figure 3. September-October-November 2012 Percent of Normal Precipitation. Source: National Weather Service.

Temperature

November temperatures were 2 to 5 degrees F above normal throughout most of the Missouri River basin (see Figure 4). The greatest departures occurred in the Rocky Mountain regions of Montana and Wyoming. The northern plains of Montana and North Dakota experienced November temperature departures of about 1 degree F. Ninety-day (90-day) temperature departures ending on December 1, 2012 are shown in Figure 5. During this time period, average daily temperatures ranged from normal to 2 degrees F above normal throughout the Missouri River basin.

Year-to-date temperatures have been among the warmest temperatures in the 118-year temperature record. Among Missouri River basin states, the January-October 2012 temperatures were the warmest on record in North Dakota, South Dakota, Wyoming, Iowa, Kansas and Missouri. Temperatures in Montana, Nebraska and Colorado were the 2nd warmest in 118 years of record.

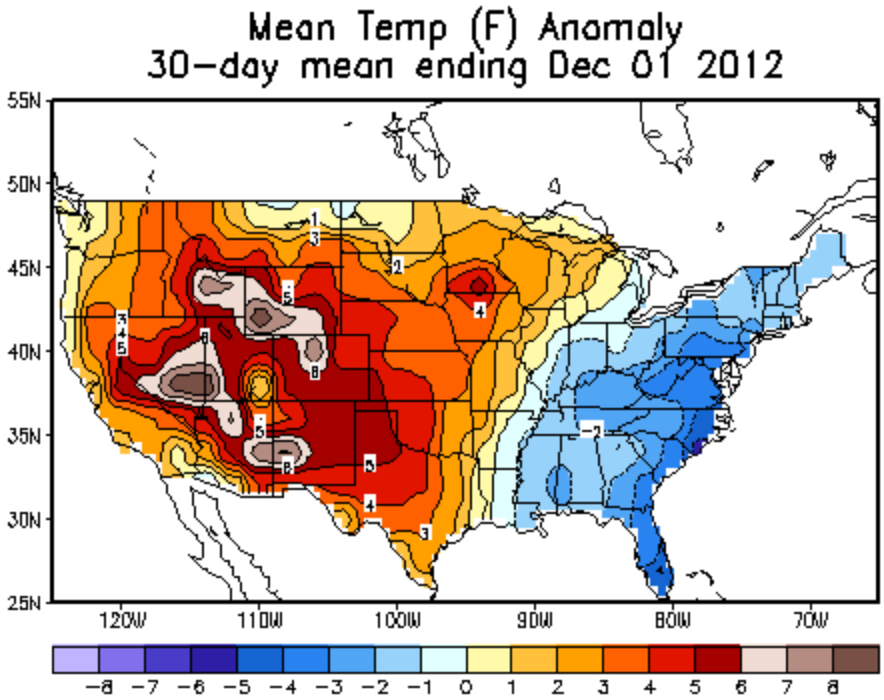

Figure 4. 30-day temperature anomaly (deg F) ending on Nov 28, 2012.

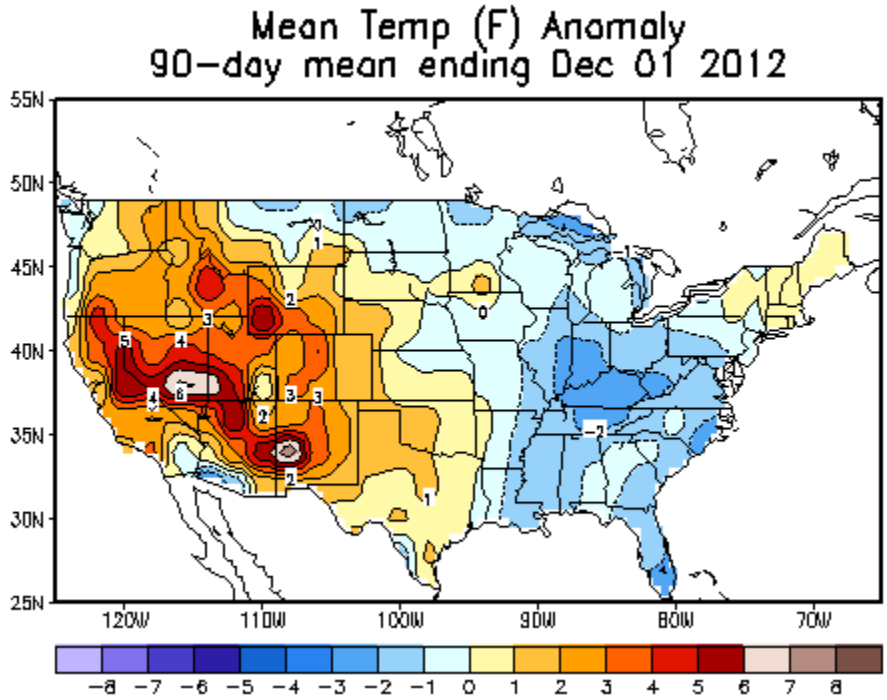

Figure 5. 90-day temperature anomaly (deg F) ending on December 1, 2012.

Soil Moisture Conditions

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future monthly runoff.

Two independent estimates of soil moisture are presented in this report. Figure 6 shows the Climate Prediction Center's calculated soil moisture ranking percentiles for the end of November 2012. Figure 7 shows the Variable Infiltration Capacity model soil moisture percentiles.

Both soil moisture rankings depict very dry soil moisture conditions throughout the upper Missouri River basin, especially in South Dakota, Nebraska, Wyoming and southern Montana. CPC soil moisture conditions in these areas rank from the 5th to the 1st percentile, which are exceptionally dry. In North Dakota and northern Montana, soil moisture ranges from near normal conditions down to the 10th percentile. In comparison, the VIC model depicts very dry soils in the same areas with soil moisture percentiles ranking from the 5th to below the 2nd percentile. In our analysis of the influence of soil moisture on forecast runoff, neither model takes preference over the other. As an indicator of future monthly runoff, soil moisture conditions suggest runoff will be well-below average when considered along with the temperature and precipitation outlooks, which were discussed previously in this forecast discussion.

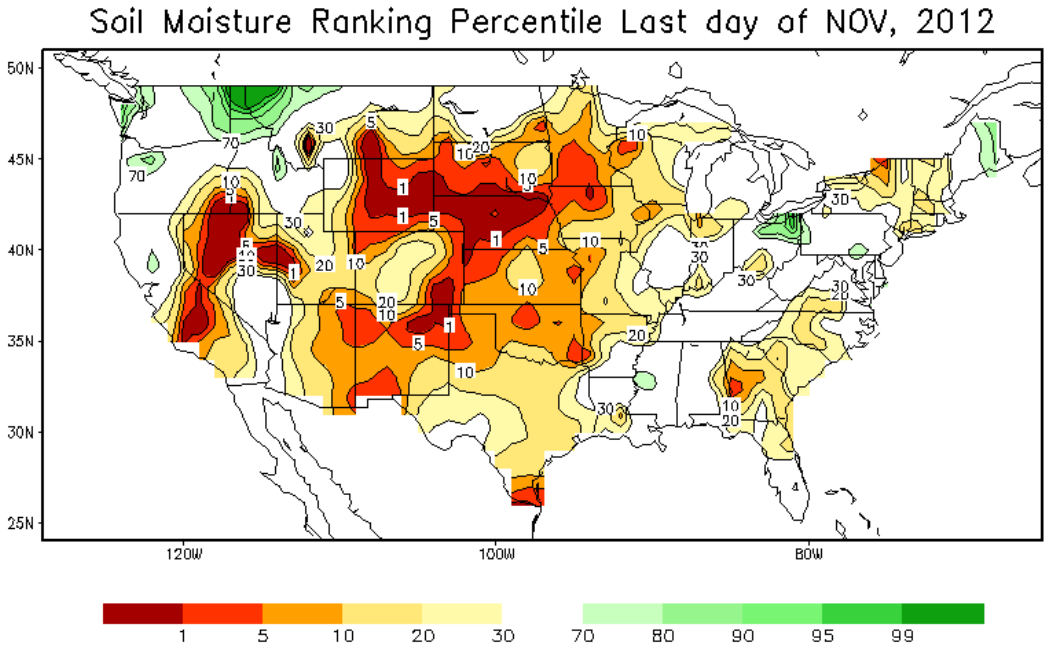

Figure 6. Calculated Soil Moisture Ranking Percentile at the end of November 2012. Source: Climate Prediction Center. http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml

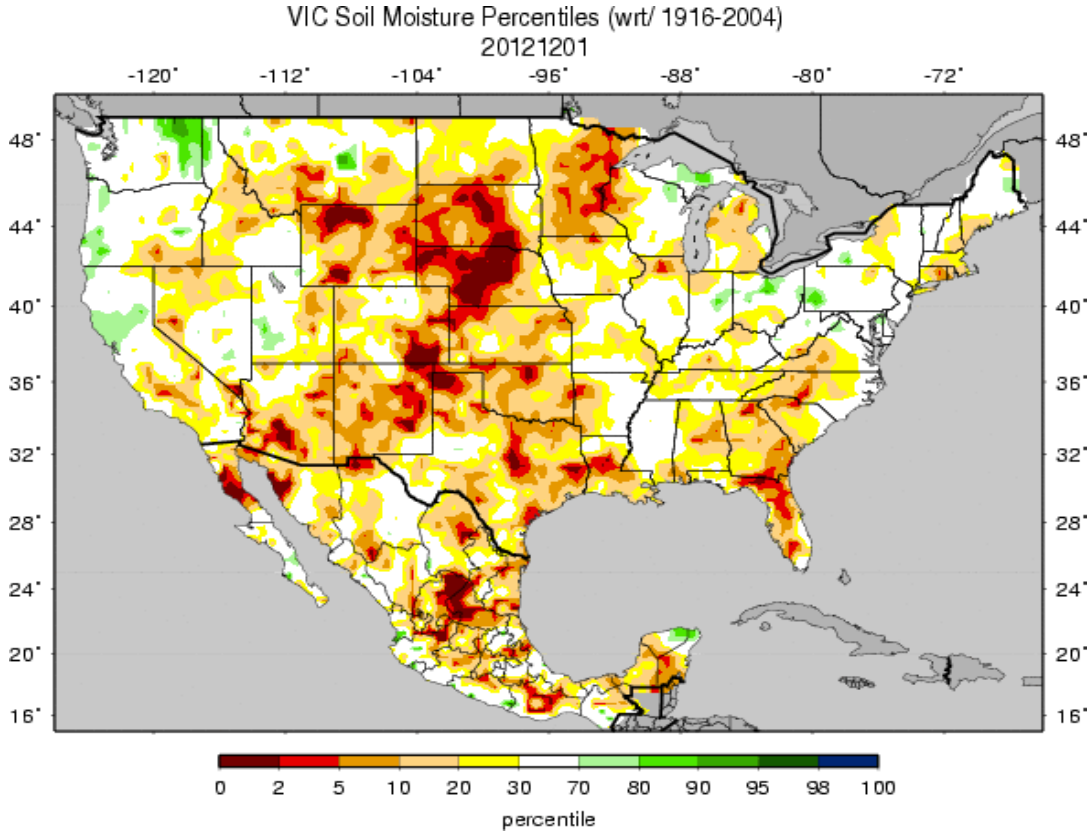

Figure 7. VIC modeled soil moisture percentiles as of December 1, 2012. Source: University of Washington. http://www.hydro.washington.edu/forecast/monitor/curr/conus.mexico/main_sm.multimodel.shtml

Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only, while in actually, about 25% of annual runoff occurs in March and April, due to both plains snow melt and rainfall runoff. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts. A March-April 2013 forecast will not be released until January 1, 2013.

In November, light amounts of SWE had accumulated in the plains; however, warmer than average temperatures melted the snow resulting in some soil moisture recovery and additional November runoff. According to the National Operational Hydrologic Remote Sensing Center (NOHRSC), there is currently a very light layer of snow (trace to 1.0 inches of SWE) over northern Montana and portions of North Dakota (Figure 8).

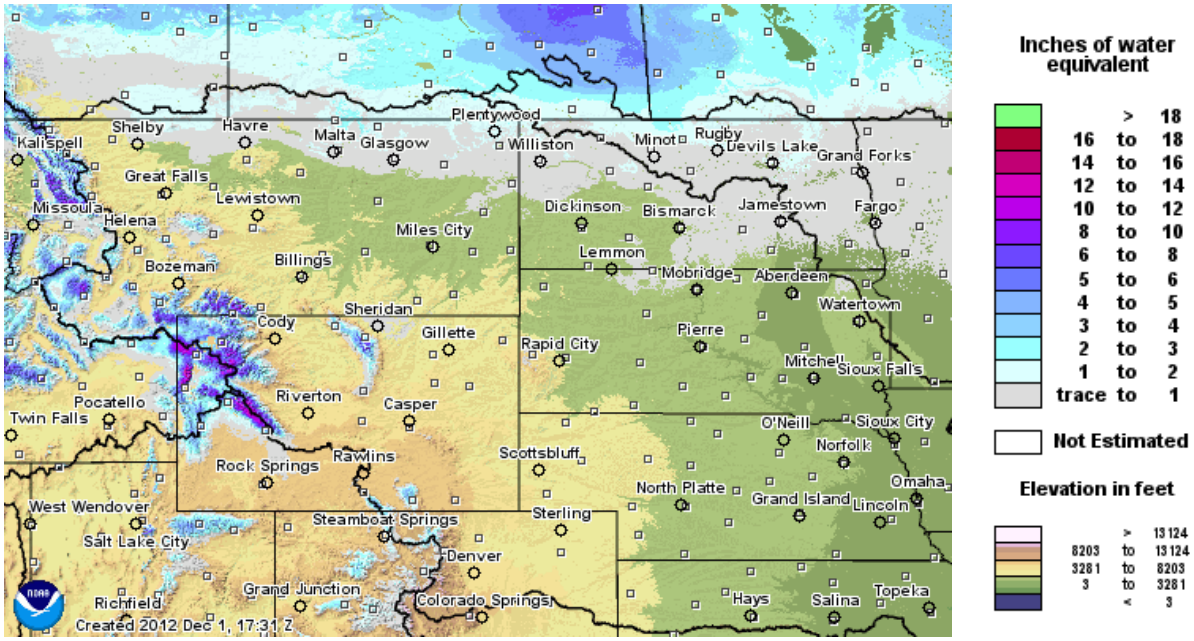

Figure 8. December 1, 2012 NOHRSC modeled plains snow water equivalent. Source: NOAA National Operational Hydrologic Remote Sensing Center. http://www.nohrsc.nws.gov/interactive/html/map.html

Mountain Snow Pack

Mountain snowpack is the primary factor used to predict May-July runoff volumes in the Fort Peck and Fort Peck to Garrison mainstem reaches. During the 3-month May-July runoff period, about 50% of the annual runoff enters the mainstem system as a result of mountain snowmelt and rainfall runoff. Greater than average mountain snow accumulations are usually associated with greater than average May-July runoff volumes, especially when mountain soil moisture

conditions have been wetter than normal as in the past three years. For example, we would expect to see greater than average runoff from an average mountain snowpack this year due to wetter than normal soil moisture conditions. The May-June-July 2013 forecast will not be released until January 1, 2013.

Mountain snowpack is measured by the USDA Natural Resources Conservation Service using a network of Snow Telemetry (SNOTEL) stations in the Rocky Mountains. Mountain snowpack is determined by averaging the snow water equivalent measurements from the SNOTEL stations located in the Fort Peck and Garrison reservoir basins. In the Fort Peck headwater basin, the Corps uses 49 SNOTEL stations to determine the average mountain SWE, while in the Fort Peck to Garrison subbasin, 47 SNOTEL stations are used to determine the average mountain SWE. The current mountain snowpack figure developed by the Corps may be found at: http://www.nwd-mr.usace.army.mil/rcc/reports/snow.pdf. As of December 3, 2012, the Corps of Engineers' assessment of the mountain snowpack was 96% of normal in the drainage area above Fort Peck, and it was 89% of normal in the incremental drainage area between Fort Peck and Garrison.

Drought Analysis

Drought conditions remained relatively the same in November as they did in October according to the National Drought Mitigation Center's (NDMC) drought monitor (Figure 9). The worst classification of drought, Exceptional Drought (D4) persisted in southern South Dakota, eastern Wyoming, and most of Nebraska. Drought in central and western Wyoming is classified as Extreme (D3) Drought, however some recovery occurred in this band of drought impacting northwest Wyoming and southwest Montana. Furthermore, drought impacts have lessened in northern Montana where Abnormally Dry (D0) and Moderate Drought (D1) conditions have been alleviated due to above normal precipitation in November.

The seasonal drought outlook effective from November 15, 2012 to February 28, 2013 is shown in Figure 10. According to the drought outlook, drought is likely to persist or intensify through much of the Missouri River basin, especially southern Montana, Wyoming, South Dakota, Nebraska and Iowa. Some improvement could occur in Montana and North Dakota; however, improvement of more than one drought category is not likely through February 28, 2013.

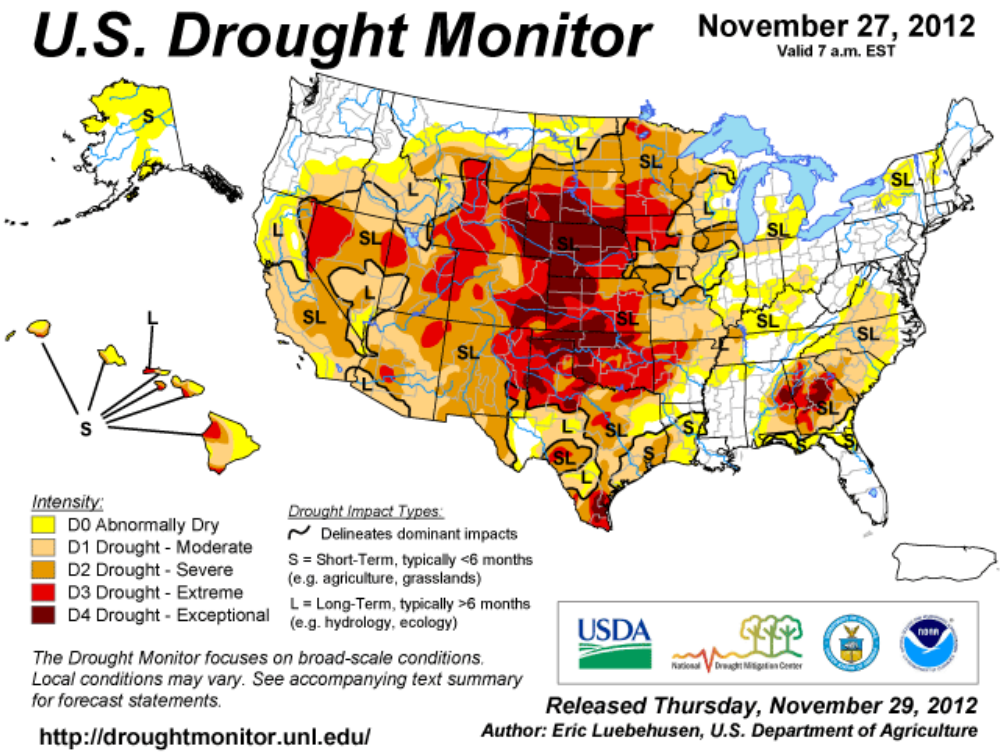

Figure 9. National Drought Mitigation Center U.S. Drought Monitors for November 27, 2012.

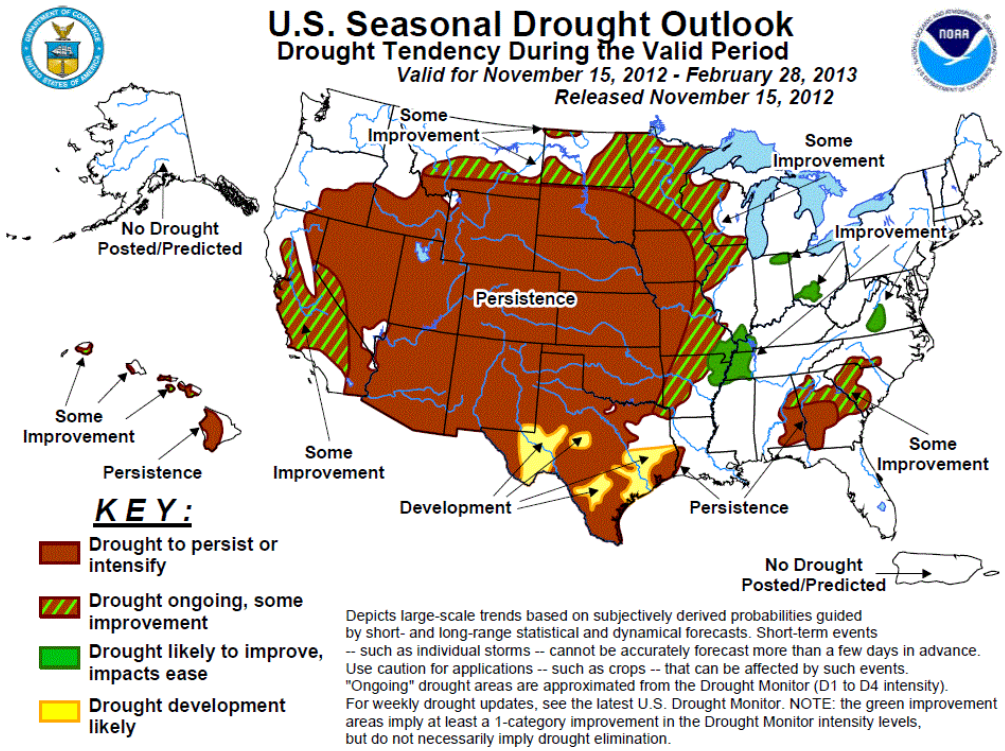

Figure 10. National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook for November 15, 2012 – February 28, 2012

Climate Outlook

ENSO-neutral conditions continue in the equatorial Pacific, though equatorial sea surface temperatures remain above average across the Pacific Ocean. ENSO-neutral conditions are favored in the Northern Hemisphere through the winter of 2012-2013; therefore, there is not a strong indication of future winter temperature and precipitation conditions in the Missouri River basin.

The 8-14 day (Figure 11) CPC climate outlooks, which extend into mid-December, indicate that temperatures are very likely to be below normal in a majority of the upper Missouri River basin. There is also an increased probability for precipitation across Montana, northern Wyoming, North Dakota and South Dakota.

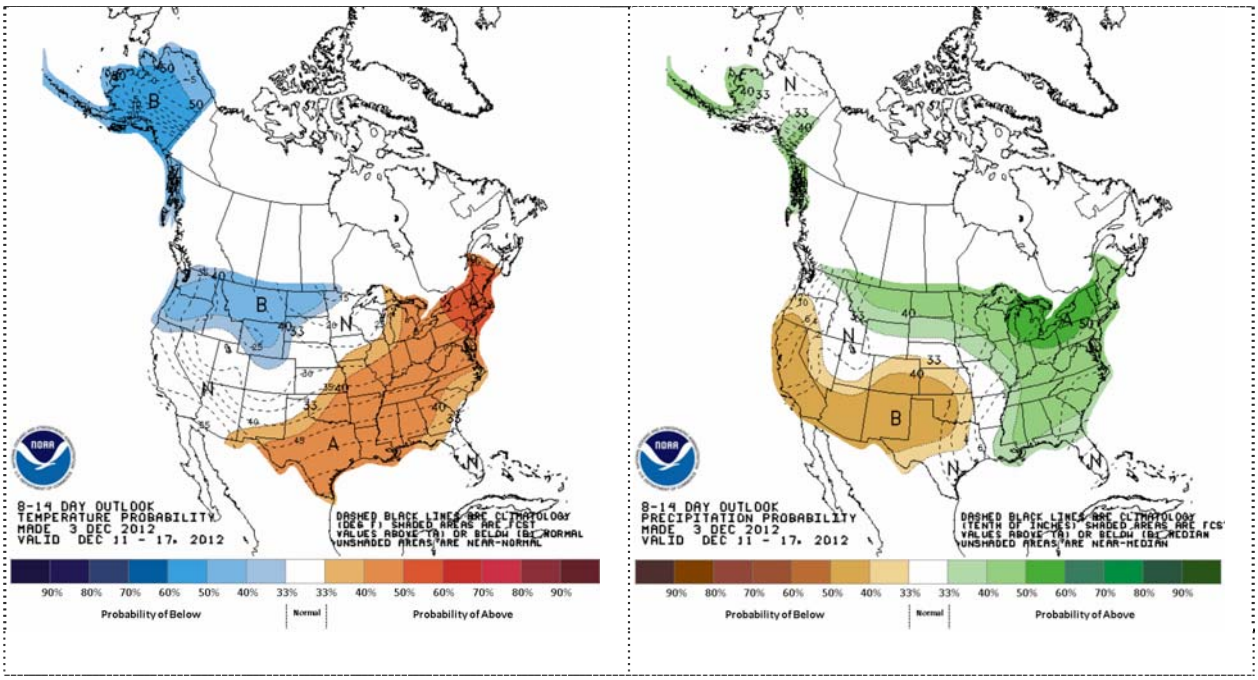

Figure 11. CPC 8-14 day temperature and precipitation outlooks.

During December the Climate Prediction Center is predicting equal chances for above normal, normal and below normal temperatures throughout most of the upper Missouri River basin (Figure 12) with an increased probability for above normal temperatures in the lower basin below Gavins Point Dam. With regard to precipitation, CPC is predicting an increased probability for above-normal precipitation in portions of the upper Missouri River basin covering most of Montana and northwest Wyoming. The CPC 3-month outlook ending in February 2013 is predicting an increased probability for above normal temperatures in upper regions of the Missouri basin over the Rocky Mountains; with equal chances for above, below and normal temperatures in central regions of the basin, and increased chances for below normal temperatures in North Dakota and northeast South Dakota (Figure 13). Precipitation chances through the end of February are forecast to be equal for all regions of the Missouri River basin.

The March-May 2013 CPC Outlook (Figure 14) indicates there is an increased probability for above normal temperatures in the lower Missouri River basin below Gavins Point dam, while there are equal chances for above normal, normal and below normal temperatures in the upper basin. The precipitation forecast indicates equal chances for above normal, normal and below normal precipitation during the March-May 2013 time period.

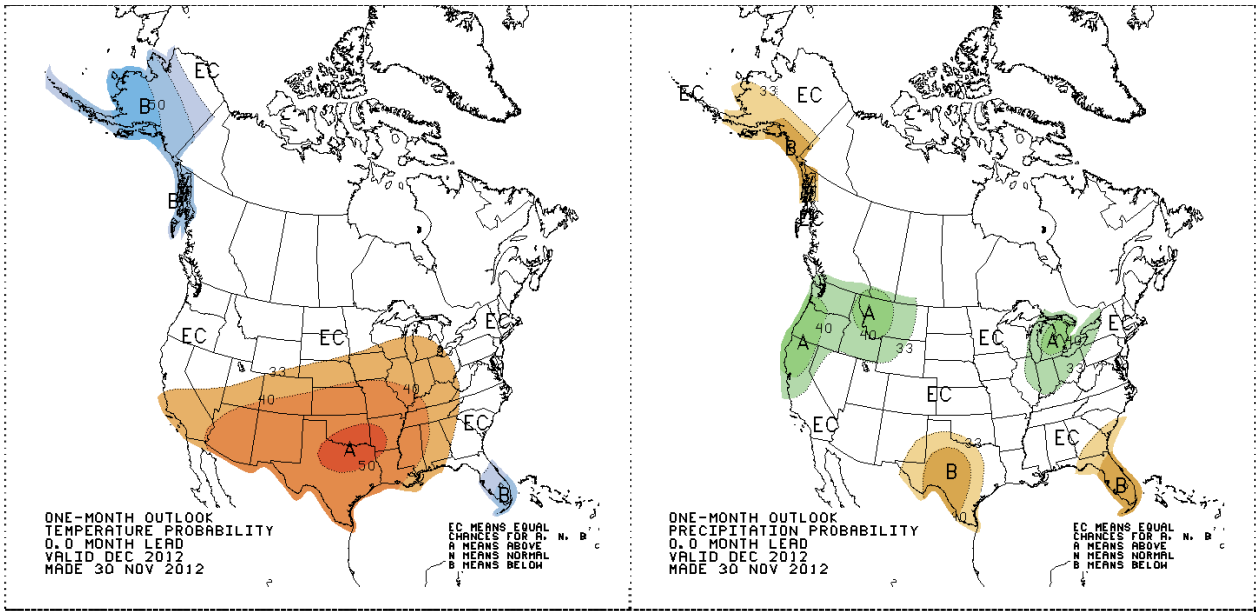

Figure 12. CPC December 2012 temperature and precipitation outlooks.

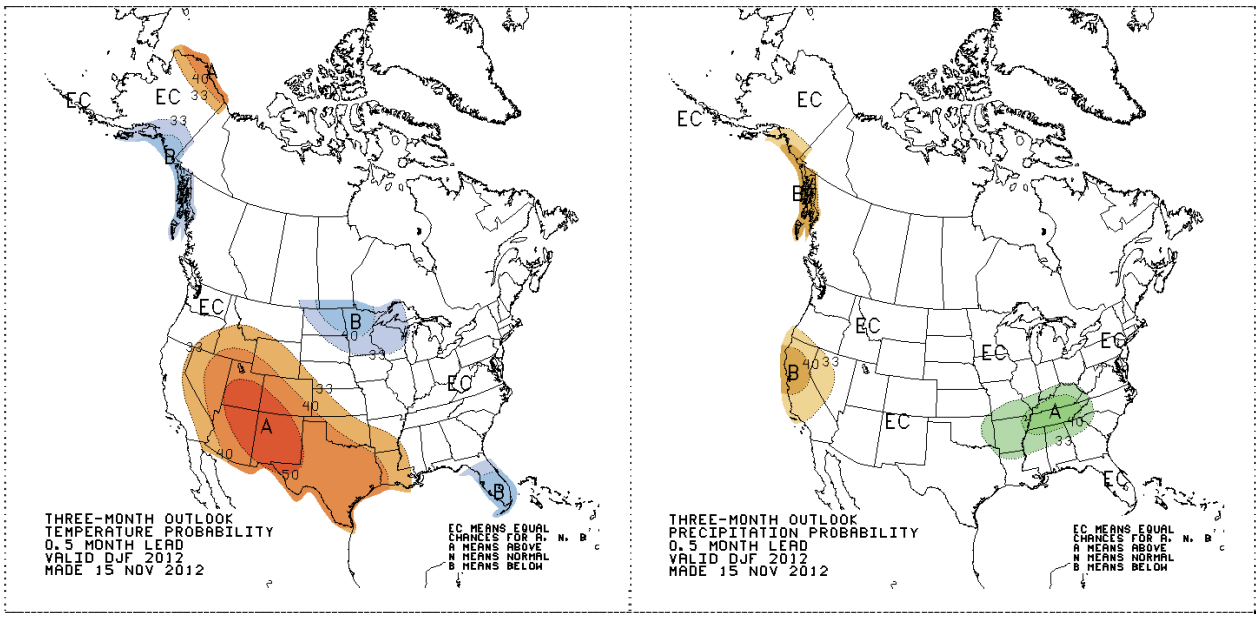

Figure 13. CPC December-January-February 2012/2013 temperature and precipitation outlooks.

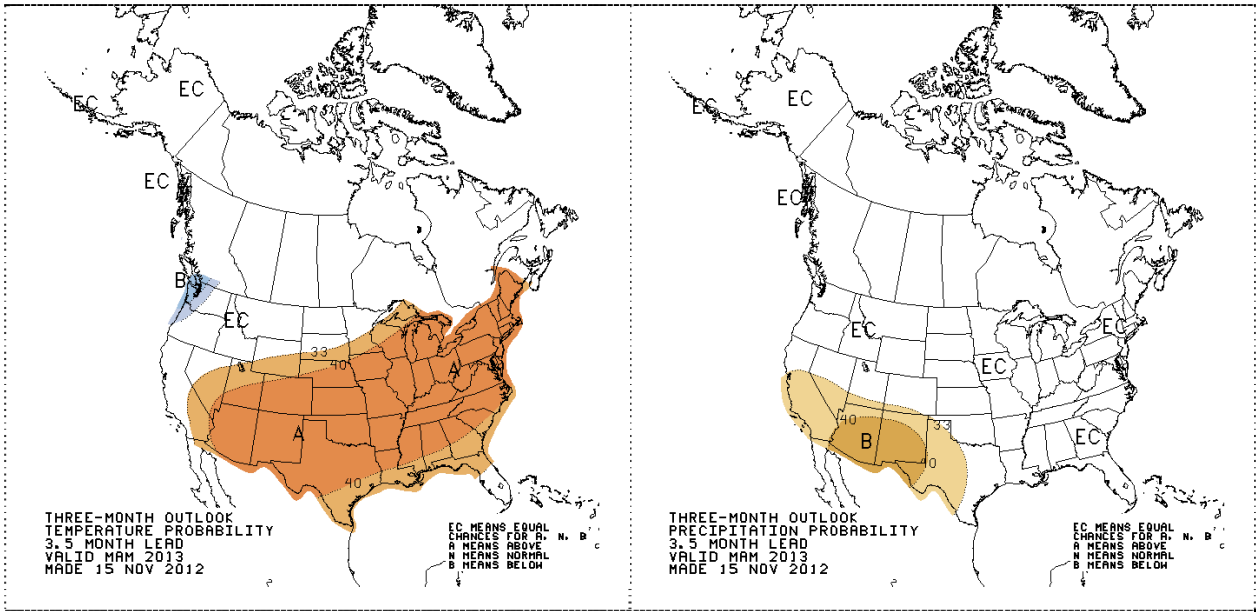

Figure 14. CPC March-April-May 2013 temperature and precipitation outlooks.

Summary – November 2012 Calendar Year Runoff Forecast

The December 1 calendar year runoff forecast above Sioux City, IA is **19.7 MAF** (79% of normal) and **17.8 MAF** (78% of normal) above Gavins Point Dam. This is an increase of 0.5 MAF from the November 1 forecast. Due to the amount of variability in precipitation that can occur over the next month, the expected inflow ranges from the 19.8 MAF upper basic forecast to the 19.6 MAF lower basic forecast.

Since the precipitation outlook is indicating an increased probability for above normal precipitation in the Fort Peck and Garrison reservoir subbasin, some runoff in addition to baseflow is expected to occur. In November precipitation in excess of 150% of normal occurred in the Fort Peck and Garrison reaches resulting in 87% of normal runoff. The December runoff forecast for all reaches is expected to be similar to November runoff due to the increased precipitation probability in approximately the same region. December runoff is expected to be 630 KAF, which is 85% of normal.