More on Flooding

by John P. Bluemle

Most of the remarks about flooding that follow are taken from an NDGS publication, the third edition of "*The Face of North Dakota*," just recently published. In view of the preceding article by Julie LeFever on floodplain insurance, it seems appropriate to include some information about the causes and kinds of flooding we experience in North Dakota.

This article will not be an exhaustive treatment of floods; more detailed information is included in a 1999 NDGS publication, "*Flooding in the Grand Forks - East Grand Forks, North Dakota and Minnesota Area*."

The geologic situation in the Red River Valley lends itself in a unique way to serious flooding. Basically, the geologic component of the flooding problem in the Red River Valley relates mainly to the fact that the area is so extremely flat, a consequence of the fact that the area formed as the floor of Glacial Lake Agassiz.

Several factors affect the severity of flooding in the Red River Valley. They include several "constant factors," which remain the same from year to year, as well as several "variable factors," which change annually.

Constant factors may be natural or man-made (the list that follows was compiled for the Red River and is not necessarily complete):

a. Direction of river flow;
b. Gradient on the river; flow velocity;
c. Obstructions (bridges, dikes, etc.);
d. Micro-relief on the floodplain;
e. Drainage ditches;
f. Urbanization of the land/floodplain;
g. Road network.

Variable factors (these change from year to year—additional factors are possible):

a. Condition of the soil prior to freeze-up and during the thaw;
b. Severity of the winter;
c. Snow accumulation and precipitation during the thaw;
d. River-ice thickness and location of ice jams;
e. Timing of the thaw;
f. Thaw rate and other weather conditions;
g. Timing of the crests on the Red and Red Lake rivers;
h. Sedimentation in the river channel.

Obviously, some of the things in the above lists are geologic, some relate to long- or short-term weather conditions, and others are the result of ways people have changed the original landscape. In any given year, the relative severity of the flood depends upon several "worst-case" circumstances. That is, a "worst possible" flood can result from:

a. Exceptionally wet fall;
b. Exceptionally cold winter;
c. Exceptionally heavy winter snow accumulation;
d. Exceptionally late, cool spring followed by sudden warming;
e. Widespread, heavy, warm rain during the thaw.

The more of these conditions that coincide, the worse will be the flood. As bad as the 1997 flood was in Grand Forks, it could have been much worse.

Long-Term Floods – The floods on Devils Lake and on so many of the smaller lakes and sloughs in eastern North Dakota have been particularly frustrating because they have no apparent end point. As I write this, Devils Lake has exceeded its 1999 maximum and is now at the highest level ever "officially" recorded (it has been much higher in the geologic past). Floods like the one on Devils Lake are the result of an ongoing and poorly understood "wet-cycle." The current wet cycle, which climatologists believe began about 1980, has filled Devils Lake and many of the sloughs in eastern North and South Dakota to overflowing. It is typical of innumerable similar, natural cycles that have occurred in the geologic past. Devils Lake, and nearly all of the small lakes and sloughs that dot North Dakota's glaciated terraine, have risen and fallen – overflowed or dried up completely – dozens of times in response to these climatic cycles. The problem is that many areas that were flooded in the recent geologic (but prehistoric) past are now developed (the towns of Devils Lake, Minnewaukan, and Churchs Ferry are situated on the old lake plain). As the lake rises, it floods land that has not been flooded in human memory.

Flash Floods – *Flash floods* are most commonly associated with headwater streams (small valleys, rather than large rivers, which take more time to receive water). They are most common in desert regions, but they do occur in North Dakota. Flash floods usually result from thunderstorms that may drop several inches of rain in a very short time.

Flash floods can occur anywhere in North Dakota, but they are most common in the western part of the state because the drainage system there is better developed than in the eastern part, and rainfall runs off quickly. Even a very rapid snow melt can result in flash flooding. Furthermore, the thinner soils over parts of western North Dakota make infiltration of precipitation less effective there than in the east where soils are thicker.

Flash floods happen nearly every summer somewhere in North Dakota. A typical example is a thunderstorm that produced up to 10 inches of rain and hail in a couple of hours in the area between New Salem and Mandan in 1998. The result was flash flooding on several small creeks (Square Butte Creek, Sweet Briar Creek, Fish Creek, and others). The flows caused intense erosion in just a few minutes time.

Jökulhlaups are a kind of "flash flood." The word is an Icelandic one that translates to "glacier outburst flood." Iceland, with its extensive glaciers, many of them on volcanoes, has to contend with jökulhlaups when the volcanoes beneath the ice erupt, quickly melting the glaciers. Jökulhlaups can be catastrophic flash floods in the extreme. They can form when the natural upward flow of heat melts a large portion of the base of a glacier. They can also be caused by the damming of a river by a glacier causing a large lake to form. Then, when the glacier dam is breached as the lake grows too large, all the water in the lake may be released, nearly instantaneously.

The best-known North American jökulhlaups were the Glacial Lake Missoula floods, which happened between 15 and 13 thousand years ago. The floods, which poured volumes of water approaching cubic miles across northern Idaho, formed the channeled scablands of central Washington. The water then flowed down the Columbia River to the Pacific Ocean.

In North Dakota, we know that we had periodic jökulhlaups at the end of the Ice Age when glaciers dammed Glacial Lake Regina in Saskatchewan. Each time the glacier dam there failed, huge amounts of water flowed southeastward across North Dakota. The result was the nearly instantaneous carving of the entire Sheyenne River Valley, which flowed, brim full of water—a river several times larger than the modern Mississippi River at New Orleans.

Discussion - Why do we continue to suffer so much flood damage when geologists and other scientists have a clear understanding of what causes floods and other geologic hazards, engineers know how to reduce damage from these occurrences, and hundreds of billions of dollars have been spent on flood control? Why do losses from flooding continue to increase?

The explanation is complex, but relates mainly to the fact that measures taken in response to flood hazards, whether in the form of adjustments, abatement or protection, encourage further development of flood-prone areas. When, <u>inevitably</u>, the flood-hazard response eventually proves inadequate, the resulting losses are much greater than they would have been if that sense of security hadn't been encouraged. Each renewed response to the flood hazard, therefore, adds an increment to subsequent flood damages. Even without this factor, the increasing pressure on land resources would result in some intensification of land use in flood-prone areas which, in itself, would result in considerable additional future damages.

The most instructive local case history is Grand Forks-East Grand Forks, which suffered a disastrous flood in 1997 following a severe winter with record snowfall and heavy spring precipitation. The unfortunate fact is that the two-city area (Winnipeg, Fargo-Moorhead, Wahpeton-Breckenridge and other areas along the Red River of the North are in similar situations) was developed on a flood plain, an area that has been flooded in the past. The area has experienced much larger floods in the past, although no one living today "remembers" them. The flood in 1997 was inevitable. Even-more-serious floods are inevitable in the future. The problem is, no one knows when they will happen.

The typical response to a flood is nearly always to build ever-more massive forms of protection, higher levees, bigger dams, etc. Because it is much too late to completely evacuate the Red River flood plain, the most prudent response would be to be certain that sufficient room is allowed so that, the next time there is a flood, with runoff equal, double, or triple that which occurred in 1997, the river will have an unimpeded and clear route to flow through the cities. This would involve removing obstacles from the floodplain, removing anything that people would prefer didn't get wet, and relocating structures and people from harm's way. And, since it appears that levees are the preferred solution to the flooding problem in Fargo, Grand Forks, and other cities along the Red River, it would also involve placing those levees at sufficient distances from the river.

The prudent response might also involve expansion of upper-basin storage or utilization of the existing road network (making use of the raised road grades and culvert system to control how fast water runs off the land into the river – the so-called "waffle plan"). It might involve restoration of drained wetlands. It might involve reconsideration of the timing of releases of water from reservoirs in the basin. But the unfortunate fact is that none of these mechanisms, even if they are all implemented, will be effective when the inevitable, truly massive flood, with double or triple the 1997 flow, occurs. The Red River flood of 2001 should be a warning. The flood this spring was somewhat unexpected and occurred following a hard, but not exceptional winter. The 2001 flood on the Red River could easily have been far worse with only a few, slight changes, such as a heavy rainfall event at exactly the wrong time.

Is it ever possible to justify developing land where water is certain to flow? Unfortunately, local governments nearly always cave in to local pressure to develop land, irrespective of its suitability for that purpose. Land developers profit by developing land and local governments appreciate the increased tax base. The big loser is the person who buys a home on the floodplain, over a reclaimed landfill, on an old landslide, or in any number of geologically hazardous areas. The company that builds its office or plant at the edge of a river valley has a great view — until it slides into the river. The other loser is the taxpayer, who subsidizes the federal flood insurance payments to cover the mistakes made by others. Unfortunately, too many unsuspecting prospective home buyers have the misconception that, because a house has been built, all geologic hazards must have been considered ("if it was built, everything must be all right"). This is seldom the case.

When a river levee is proposed, pressure is nearly always intense to move it closer to the river so this person's home or that company's business will be protected. After all, no one can recall the area ever being flooded ("it's never flooded in my lifetime"). Unfortunately, an area remaining dry for what city planners or developers may consider a long time — 20 or 30 or over a hundred years for example— to a geologist is only a very short time — just a 'brief interlude between floods.'