

The Great Flood of 2011
Narrative by Brad Lawrence

The Great Flood of 2011 will go down in history as one of the most devastating natural disasters of all time. The following narrative depicts the key events that shaped my perception of the flood from a Fort Pierre, SD perspective. I want to provide a little background about the author. I am a graduate Mechanical Engineer from the South Dakota School of Mines and Technology. I have worked in the engineering field for a little more than 17 years. My focus has primarily been pavement, water, sewer and electric infrastructure associated with public works.

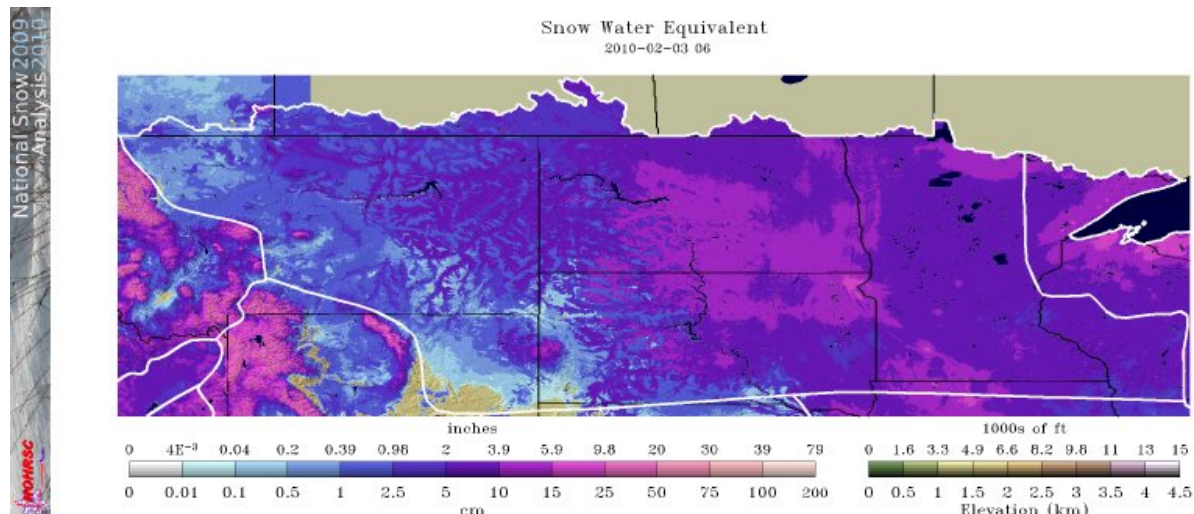
My first exposure to the possible threat that loomed due to the Missouri River came in the spring of 1997 (200% of normal flow year). Heavy plains snowpack had accumulated during the winter as a result of several strong blizzards that plagued the plains states that winter. As a result, the runoff from the plains snowpack filled the main stem reservoirs to near capacity in early April. This caused the US Army Corps of Engineers (Corps) to open one of the powerhouse bypass tubes in the Stilling Basin. Lake Oahe peaked less than two feet from maximum pool that year. The higher than normal discharges ran through the majority of the summer. This led to the observation that the plains snowpack can create a significant amount of runoff.

Since that first exposure, I have monitored and been intrigued by the amount of plains snow that has accumulated and the runoff associated with it. In 2009 I witnessed Lake Oahe raising five feet in seven days. That was an astonishing event considering we were just coming out of a nearly decade long drought. I again watched in 2010 as the combined runoff of the plains and mountain snowpacks converged to fill Lake Oahe to nearly the same elevation as it was in 1997. The very interesting thing about this was that the system had nearly 3 million acre feet (MAF) carry over drought storage that year to keep the lakes inside their maximum pools.

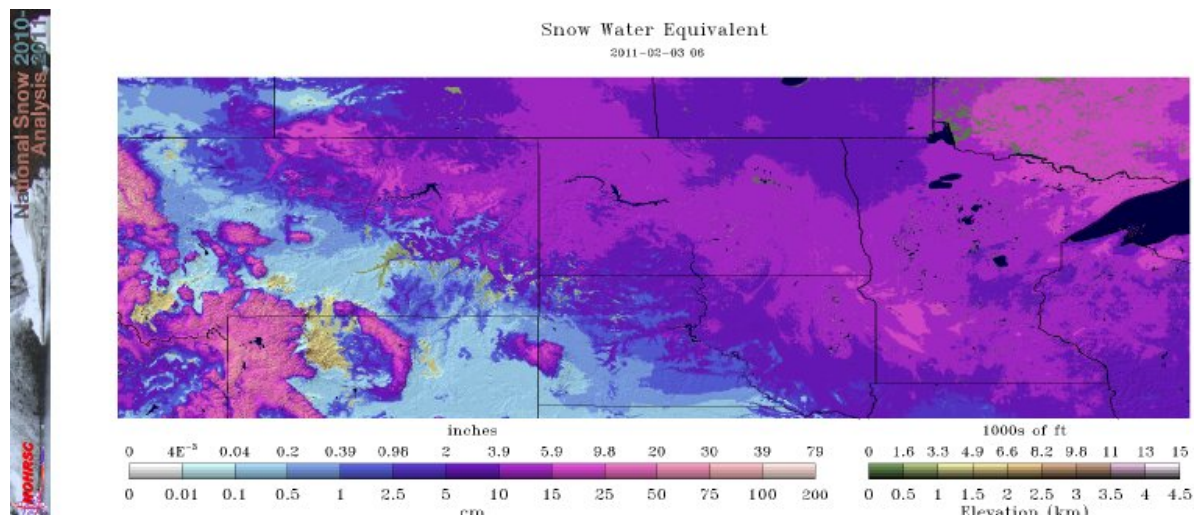
On February 3, 2011 I was asked to speak at the South Dakota Rural Water Managers Meeting in Fort Pierre. At that meeting some questions came up about the amount of snow on the plains and the anticipated runoff. I offered my opinion that the entire upper United States was primed for flooding. This included nearly every major river system east of the Missouri River and I included the Missouri river at that time. The reason was that the Corps had failed up to that point to remove the necessary water to reach the multiple use flood control storage requirement. That storage is required on March 1, 2011 the start of the runoff year. At that time, the Corps was 100,000 acre feet shy of the minimum required flood control pool.

On that same day I sent an e-mail (Ref. 1) to Kevin Morely with the American Water Works Association who is the coordinator the National Water and Waste Water Agency Response Network (NationalWARN) in Washington, DC. In that now infamous e-mail I warned of the increased possibility of (biblical) flooding across the entire upper plains east to the East coast. My intention was to warn the downstream states that the odds of a flood occurring this year were substantially increased. The reason for issuing this warning was to bring attention to the extreme amount of water stored in our plains and

mountain snow packs. At that time, the plains snow pack contained about 3.1" of water. This was according to the National Weather Service's (NWS) National Operational Hydrologic Remote Sensing Center (NOHRSC). This first pictograph shows the plains snow pack in 2010, when the total annual Missouri River runoff was determined to be approximately 150% of normal. The snow water equivalent on February 3, 2010 was listed at 2.4". The key thing to note here is where the higher concentrations of snow fell. The lighter colors of pink indicate more water. The higher concentrations were east of the Missouri River basin.



This second pictograph shows the snow water equivalent for the same date in 2011. As you can see there is much more pink on the western plains and the pink is covering much more of the Missouri River Basin.



I should note that comparing just one day from one year to the next can be misleading since one good snow storm or one good melt might bias the total amounts significantly. I compared day over day for

the entire month of January prior to this date to determine that this was a trend and not an isolated occurrence.

So our 3.1" compared to the 2.4" of snow water equivalent, yields a 129% increase over 2010 which was 150% of normal runoff. If you assume that the 2010 runoff was due to equal parts of mountain and plains snow pack, then the anticipated total annual runoff on February 3, 2011 was 194% of normal or a nearly 50% increase of normal over the previous year.

I also was looking at the two mountain snow packs that contribute runoff to the Missouri River Basin for water content. They were 7.4" in the Northern Rockies in 2010 compared with 9.3" in 2011 on that same date. I also had looked at the trend for these areas and they were consistent. In the Central Rockies it was similar with 3.3" in 2010 and 5.2" in 2011.

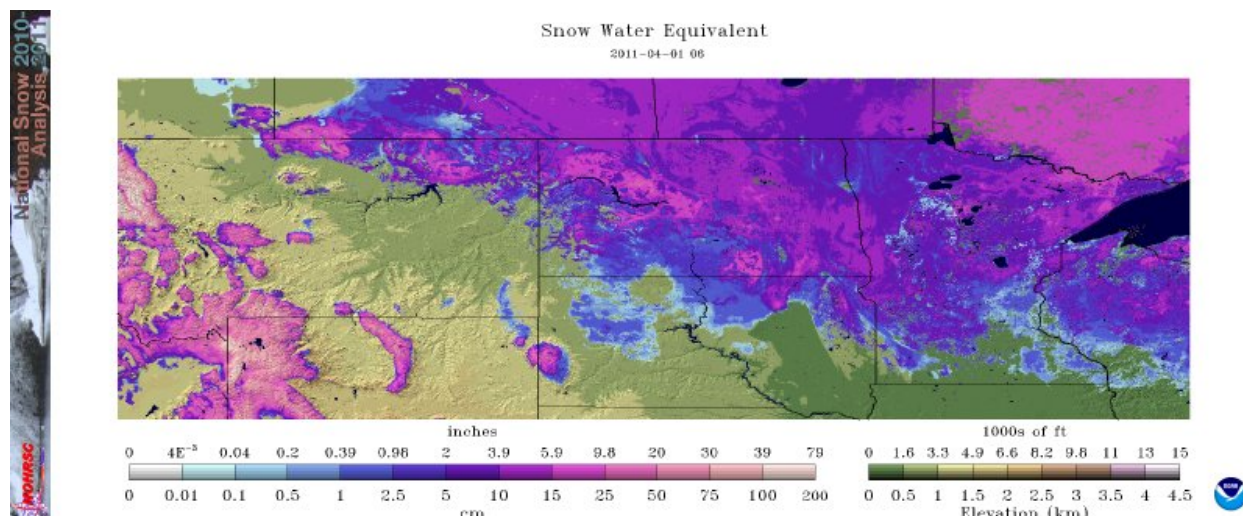
So any way that you look at it, we were in for a substantial increase in the amount of runoff in February of 2011 over the large runoff of 2010.

When I sent this information to Kevin Morely, he disseminated it to two federal agencies, EPA and Homeland Security. The information also was sent to all 50 state WARNs for their use and information. We did not try to hide this information. I did not send this information to the CORPS, as they (should) have a legion of people looking at this same or better information.

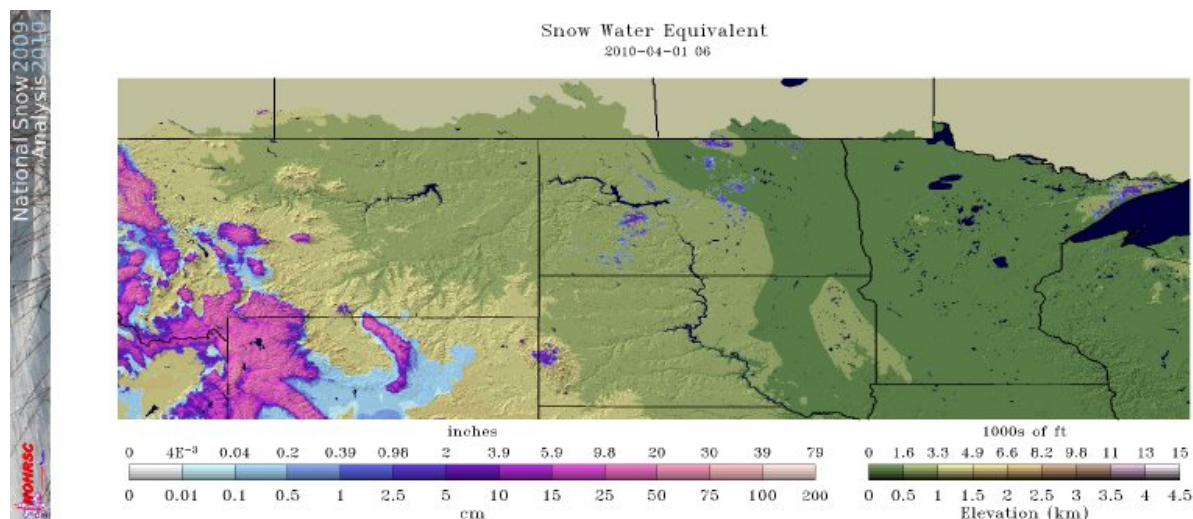
On February 22, 2011 the NWS issued its Spring Flood Risk Forecast. In that forecast the predictions by the NWS mirrored the statements in my February 3, 2011 e-mail. The only difference was the NWS didn't mention any increased risk for the Missouri River at that time.

During the month of February 2011 there was a significant melt that occurred. That melt ran off into the system and reduced the already below standard flood control pool by another 700,000 acre feet by the critical March 1, 2011 storage check. That means we entered the runoff year 800,000 acre feet below the required (Master Manual) flood control storage total of 16.3 million acre feet (MAF).

As I tracked this trend in snow water equivalency it increased consistently as we went farther into the spring months. This following pictograph shows the SWE for the plains snowpack on April 1, 2011. This is the date that the Corps chief of the Reservoir Control Center (RCC) claimed that the plains snow pack was overestimated and that the mountain snowpack was "nothing to write home about." The plain's SWE was 1.5" on that date or nearly 50% of the total on the ground on February 3, 2011. Note the significant light pink shades by Lake Sacagawea and just north and east of Fort Peck Reservoir. That water runs off into the Missouri River System.



As you can see from the following pictograph, contrast this to the plains snowpack for 2010.



The SWE totals for the “nothing to write home about” Northern Rockies and Central Rockies snowpacks on April 1, 2011 were 14.4” and 7.1” respectively. On April 1, 2010 those same SWE’s were 8.4” and 4.3”. I won’t even do the math as it is very easy to see the marked difference between 2010, a 150% runoff year, and the 2011 totals. Obviously nothing to write home about!

We prepared in earnest for spring flooding. We sought out sandbag suppliers, faster filling methods and started planning for what appeared to be a long term flood event with a magnitude of around 85,000 to 100,000 cubic feet per second (CFS). It would have been a minor flood and one that would be fought with sand bags and minor storm drain work.

I received a call from Eric Stasch with the Oahe Project office on May 18th. He said that the Corps was anticipating trouble with holding back all the runoff from particularly heavy rains in Montana in the past week. He indicated that the Corps wanted to run the Oahe powerhouse at full capacity and partially open one tube in the Stilling Basin to achieve 60,000 cfs to see if we had any consequences from that

discharge. On Thursday the 19th, the Corps ran Oahe at 65,000 cfs for the entire afternoon. We didn't experience any problems.

On Monday May 23rd we were called to a joint meeting with the Corps, SD Office of Emergency Management personnel and local emergency management officials to include the two cities of Pierre and Fort Pierre. At that meeting the Corps announced that they felt they would need to increase the discharges from Oahe to 85,000 cfs in the near future. While at that meeting I had calculated and written in my notes that we would be at or above 110,000 cfs by June 10. I showed my prediction to Mr. Stasch and he asked how I came up with that number.

On May 24th at 5 PM we were called back again to another conference call with the Corps. The information they were disseminating was the latest flow prediction of 110,000 cfs. Our 100 year flood plain for the Missouri river was 70,000 cfs and would not have been that big of an event had it occurred. Now with a monster flood on the horizon, all thoughts shifted to how can we save our town.

For the first several days I didn't eat. I couldn't eat. It was all I could do to hold back the gag reflex. You see this was my hometown. This is where I went to school and graduated from high school. I knew early on that this was going to be a dance with the Devil. It would be proven just how difficult a dance it was going to be in a few short days.

On May 27th the Corps awarded a contract to construct protective measures for the cities of Fort Pierre and Pierre. The only issue was they left out all of Fort Pierre north of US Highway 14. The project started in earnest on Saturday May 28. The required completion date was June 1 at midnight. The project proceeded at an absolutely astonishing pace. However on date of award for the project we got the bad news that the levees would have to be increased another two feet to accommodate the newly anticipated 150,000 cfs discharges from Oahe. That was a cannon ball to the mainsail.

During this time we were working to increase the elevation of some of our roads that were inundated with water already. This effort provided a stable road network for the levee construction. Without the grade raises the task would have fallen short. We were simultaneously creating sandbag sites, providing elevation benchmarks for all areas along the river and providing as much information as possible to the public. There wasn't much sleep during this period, but I finally was able to eat.

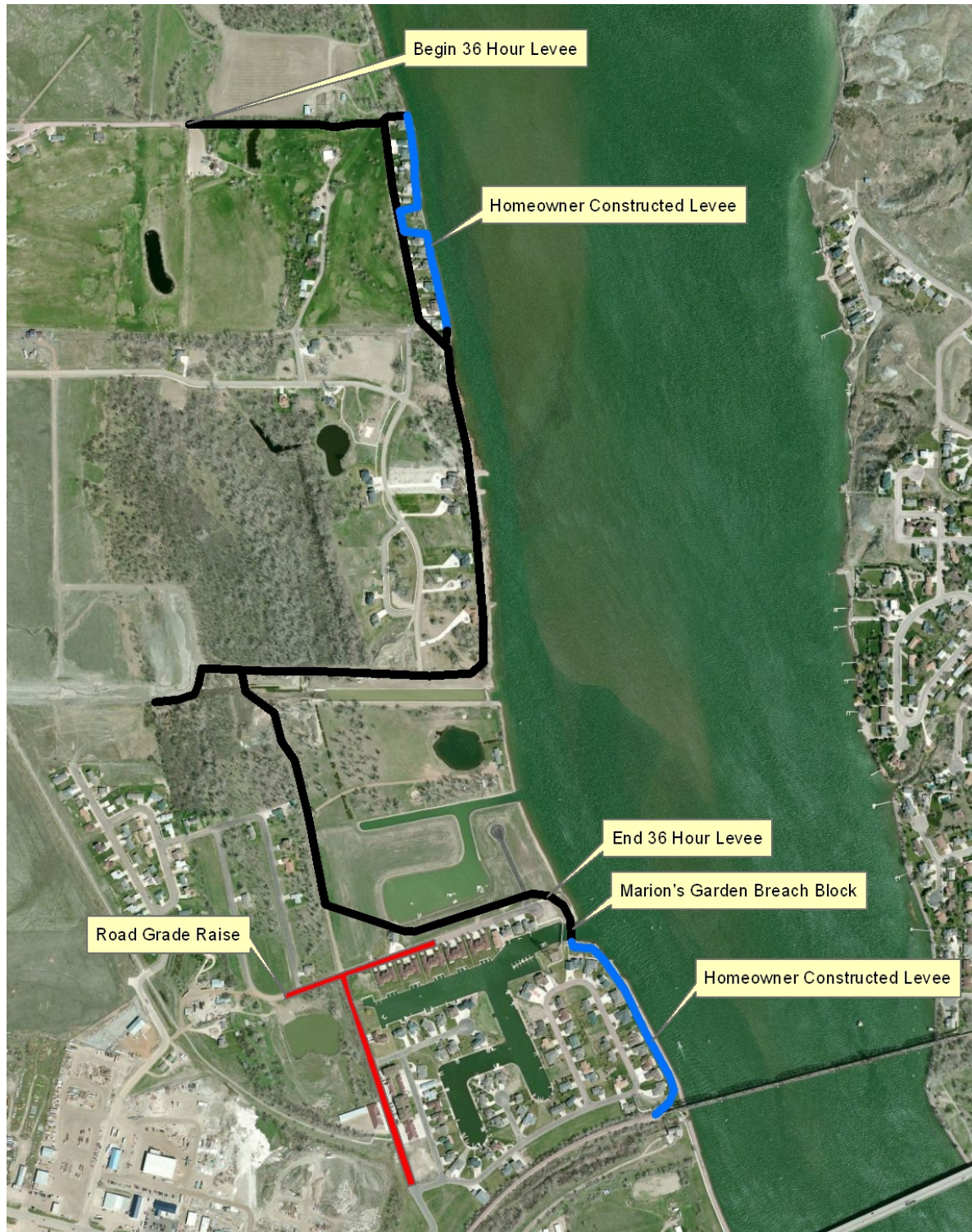
We received an incredible amount of support during these days from all over the US. People were donating food and having the local businesses bring it to us. It was incredible and very a humbling experience. There were days a person would wonder if we were worthy of such selfless and incredible support. We can never repay those that donated other than to pay it forward helping the next area of the nation that is in trouble.



There was one task that was still gnawing at us. That was how to protect the remaining half of the city left unprotected by the Corps levee. The main issue was plugging the three large canal breaches of the riverbank. The southernmost one was over 100' wide and fairly deep.

I worked with Scott Schweitzer from Brosz Engineering to devise a plan to capture as much of the northern segment of town as possible. We devised a plan to create a levee that would cover over half of the exposed area north of HWY 14. Simultaneously and unbeknownst to us was a plan being made by the Marion's Garden Homeowner's Association to plug their breach and build a levee along their riverfront. As that plan moved forward, we devised a plan and route to construct another 10,000' of levee. There were just a few issues: we didn't have any plans; second we didn't have time to go to bids; the water elevation was rising now every day and we had to race the water increases to completion.

We completed closure about hour 30 of the construction. It was a grueling task as 3,000' of the levee had to be constructed in sections of ground already underwater. By hour 36 we had made completion and were ahead of the water enough to take a short break. We returned and put a finish on the new levee system over the next few days.



While the levee system was being constructed, a pressing need for storm water pumping supplies and plans were needed. Brosz Engineering provided to us the plan to create 12 runoff basins and several more pumping sites. We used a 2.5" rain over a 24 hour period with high runoff coefficients as our base storm. Our first real test came when over 5" of rain fell in a little over 70 hour period starting on June 19th; so much for our plan. Our planning saved us by dictating where the largest amount of runoff would concentrate and where we needed to increase our pumping capacity the most. In the end we had 73 pumps and a monthly cost for storm water pumping of \$200,000.

That first large event triggered localized flooding due to storm water backup. This was compounded by the fact that not all of our 37+ storm sewers outlets into the river were plugged. We worked feverishly to plug the storm sewers and pump all the runoff from the massive rain out. Then it rained again on June 24th, only this time it was only about 2". This caused the Bad River to reach flood stage and start to leave the banks along the city of Fort Pierre. The river crested a little over bank full in the unprotected areas of Fort Pierre. The flooding left significant amounts of sediment in our park areas by the mouth of the Bad River.



Coincidentally during this same time, the Corps announced on their Friday June 17 5 PM conference call that they were increasing the discharges from Oahe to 155,000 cfs at 8 AM Saturday morning. They were then going to increase the discharge again on Monday morning to 160,000 cfs. This was an attempt to utilize the extra(?) storage available at Fort Randall Dam to keep a foot of free board on Oahe. The significant rains of June 19 through June 24 erased all hope that this tactic would work. The Corps abandoned the plan after only about 72 hours of running at 160,000 cfs.

Then on June 30 the hardest rain I have ever witnessed fell when over 2" of rain came down in less than an hour. For the third time in two weeks we were swamped. I was ready to quit. Between the increased discharges and the relentless rain we were beat. Mercifully the last significant rain fell on July 4th.

Things finally began to become what we termed "Flood Normal". We went about our daily lives working about 16-20 hours a day most of the time just keeping our heads above water. Finally the news came that the water would start to recede in mid August. There was a light at the end of the tunnel.

Since the drawdown began we have been working again at feverish pace. We are in a race with old man winter now. Levee removal is in full swing these days and so is the documentation phase with FEMA.

Many of us city workers were impacted either directly or through family members that were directly impacted by the flood. I had to evacuate my parent's home the week prior to the flood. I could see it coming and there wasn't going to be an opportunity to get their stuff out after the flood started. They came up to my house and lived there until late August when their home was reclaimed from the impact of flooding.

In summary the Corps is predicting a total runoff of around 60 million acre feet (MAF) or 220% of normal. If you take this flow and convert it to a 24 hours a day rate, it comes out to 82,877 cubic feet per second (cfs). What that means is that when winter operations are taken into consideration, we would have had to operate at something around the 120,000 cfs range for a long time to pass that much water. It would be longer than the 90 days we ran at 150/160 kcfs.

The real issue in my mind is that the Corps totally blew it when it came to understanding the amount of risk (water) the snowpacks contained. Additionally, because of that they never communicated what preparations and to what level were needed until it was too late. Earlier in my narrative when I reference the April Fool's Day e-mail that Jody Farhat sent out saying "it was nothing to write home about." She showed a total of lack of recognition of the pending disaster.

The other thing that is vitally important is that we were going to flood no matter what happened with the "Perfect Storm" in May up in Montana. Did it have an effect? Yes. But at the 160,000 cfs we were ultimately running, that "Perfect Storm" water passed through the system in less than 20 days. That leaves us to wonder what caused the rest of the 90 days of flooding; that was the mountain snowpack.

As I said in my narrative, we (I) were anticipating something in the 85-110 kcfs range for an event. I think the system could have been able to keep it in that range without the heavy rains in Montana. I haven't done any of the math to prove that out, but it seems that if we had that extra 3 to 5 MAF of storage, lost to the "perfect Storm" rains, coming into the mountain snowpack runoff; we could have reduced the peak amount by 25% or about down to 120,000 cfs. That would have put us in the 110,000 cfs range.

We also anticipated that the flood would become an issue in mid June rather than late May. The Montana rains did change the time frame for this event by moving it up earlier, increasing the peak flow rate and lengthening the duration of the event.

One other item that the Corps has read into my e-mail when I warned that the Corps would hold back waters due to downstream flooding is that I was talking about Mississippi flooding. In fact I only mention downstream. I did not limit it or otherwise indicate that it was the Mississippi that I was worried about. The Corps has indicated that they did indeed have concerns in the lower Missouri River basin during the

time that they should have been increasing discharges to keep pace with the plains snowpack runoff. It appears that the reference to the Mississippi River flooding is a red herring to throw us off the fact that they did indeed reduce discharges to avert flooding downstream.

In the end we may never know just what improvements could be made to the response. The reason is that the Corps response to the threat of flooding was so poorly conducted that drawing any plausible conclusions may prove impossible.

Respectfully Submitted,

Brad Lawrence
Director of Public Works

Reference #1

I hear ya

Kevin M. Morley
Security & Preparedness Program Manager
American Water Works Association
1300 Eye Street, NW Suite 701W
Washington, DC 20005

O: [REDACTED]

D: [REDACTED]

E: [REDACTED]

Check out the new J100 RAMCAP Standard for Risk and Resilience @
www.awwa.org/j100ramcap

From: Brad Lawrence [REDACTED]
Sent: Thursday, February 03, 2011 2:14 PM
To: Kevin Morley
Subject: Re: Monitoring WinterStorm Aftermath

Kevin,

You certainly may. I don't want to be a chicken little and claim that the sky is falling. I want to be a realist and notice that there is a large amount of snow to melt and runoff. I also wanted to point out to the states that missed this big event that they still have their bacon in the fire!

Thanks,

Brad

----- Original Message -----

From: [Kevin Morley](#)
To: [Brad Lawrence](#)
Sent: Thursday, February 03, 2011 12:59 PM
Subject: RE: Monitoring WinterStorm Aftermath

Excellent points Brad...Mind if I repackage this message while provide full credit to you?

Kevin M. Morley
Security & Preparedness Program Manager
American Water Works Association
1300 Eye Street, NW Suite 701W
Washington, DC 20005

O: [REDACTED]

D: [REDACTED]

E: [REDACTED]

Check out the new J100 RAMCAP Standard for Risk and Resilience @
www.awwa.org/j100ramcap

From: Brad Lawrence [REDACTED]
Sent: Thursday, February 03, 2011 12:00 PM
To: Kevin Morley
Subject: Re: Monitoring WinterStorm Aftermath

Kevin,

I met this morning with the rural water managers in SD. One item of concern in the coming days/months is sandbagging supplies. I anticipate significant flooding from the Missouri River to the East Coast on nearly every significant river. This may be one for the record books.

I am including the Missouri River in that tally at this time. The Corps of Engineers has failed thus far to evacuate enough water from the main stem reservoirs to meet normal runoff conditions. This year's run off will be anything but normal. This is compounded by the anticipated flooding downstream. The Corps will hold back water to help alleviate the downstream flooding; filling the reservoirs to capacity in the process. Once full, they will pass everything that comes in. In April 2009 the inflow to Oahe was 140,000 cfs. That would be a flood of biblical proportions here and downstream.

I would also anticipate that those states that are downstream and not affected directly by all this moisture will become affected when the runoff reaches them.

I will guarantee that the James River and Big Sioux River in SD will flood. The Red and James in ND along with many tributaries to the Missouri River will flood. Everything in MN including the Mississippi looks like it is primed to flood; especially the Minnesota River.

It looks like this most recent storm went right down the Ohio River Valley. That can't be good for that system.

There are some significant events that could preclude this and those are slow thaws with intermittent freezes and a general lack of precipitation for the rest of February and March.

So I would be working the flood preparation supply chain to see what is available and be ready. It is a high probability that a large scale flooding event(s) will occur this year.

Historic Fort Pierre	
Brad Lawrence <i>Director of Public Works, Chair SDWARN</i>	City of Fort Pierre 08 E 2nd Ave PO Box 700 Fort Pierre, SD 57532
[REDACTED] www.fortpierre.com	tel: [REDACTED] fax: [REDACTED] mobile: [REDACTED]
Want to always have my latest info?	Want a signature like this?

----- Original Message -----

From: Kevin Morley

To: [REDACTED]; [Alan Barefield](#); [Andrea Powers](#); [Arnold, Colleen](#); [Bieber, Steven](#); [Biederman, Terry](#); [Brad Brooks](#); [Brad Murphy](#); [Broussard, Don](#); [REDACTED]; [Carr, Bill](#); [Chaplik, Tom](#); [Chris Taylerson](#); [Daniel Rayfield](#); [REDACTED]; [Dougherty, Laurie](#); [Eric Melcher](#); [Gerwin, Steve](#); [Greg McKnight](#); [Howe, Mike](#); [Howlett, Rick](#); [Jacobson, Mike](#); [Jason Barrett](#); [Jim Brummer](#); [John Wiltout](#); [REDACTED]; [Kelly, Scott](#); [Kirk Medina](#); [Lamb, Patti](#); [Lawrence, Brad](#); [Leslie Shurtleff](#); [Luther, Thad](#); [Lynch, Dan](#); [Mark Nicely](#); [Matthew Holmes](#); [McKenna, Johnna](#); [Michael Knox](#); [Michael Richardson](#); [Montressa 'Monty' Elder](#); [REDACTED]; [Morgan, Buddy](#); [Moulton, Pete](#); [Pat Credeur](#); [REDACTED]; [Pierson, Dale](#); [Randy Norden](#); [Riordan, Raymond](#); [Robin Halperin](#); [Schreppel, Connie](#); [Segal, Martha](#); [Sharon Williams](#); [Shaun Fielder](#); [Smith, Sandy](#); [Steve Shepard](#); [Stuhr, Michael](#); [Talley, Richard](#); [Ted Corrigan](#); [Titzmann, Paul](#); [Warnstaff, Clarence](#); [Wavra, Greg](#)

Sent: Thursday, February 03, 2011 8:34 AM

Subject: Monitoring WinterStorm Aftermath

I am sure many of you from Texas to Maine have your hands and bucket loaders full in the aftermath of this severe winter event.

I have not seen or been made aware of any specific WARN activations and/or responses. But just remember that there is a big family out here that is poised to provide assistance if called upon.

Please advise if I can be of any assistance in facilitating conference calls or making contact with other agencies to provide status updates etc as we have done in the past.

Kevin M. Morley

Security & Preparedness Program Manager

American Water Works Association

1300 Eye Street, NW Suite 701W

Washington, DC 20005

O: [REDACTED]

D: [REDACTED]

E: [REDACTED]

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American Water Works Association

The Authoritative Resource on Safe Water (R)

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