

**Analysis of Red River of the North
FMM VE13A-Bundled
vs
Record Flood
or
FEMA 100 year - July 2012 Study**

All gage elevations adjusted to VERTCON 1988 NAVD

VERTCON: is a computer program that computes the modeled difference in orthometric height ("height above sea level") between the North American Vertical Datum of 1988 (NAVD 88) and the National Geodetic Vertical Datum of 1929 (NGVD 29) for a location in the contiguous United States.

The parameters required are the latitude and longitude of the location.

All "Gage 0" Datum displayed as "Converted to NAVD 88 height", which represents the base elevation of the river gage .

Link to VERTCON

http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl

This analysis includes Red River of the North Gages

USGS 05092000 RED RIVER OF THE NORTH AT DRAYTON, ND
USGS 05083500 RED RIVER OF THE NORTH AT OSLO, MN
USGS 05082500 RED RIVER OF THE NORTH AT GRAND FORKS, ND
USGS 05070000 RED RIVER OF THE NORTH NEAR THOMPSON, ND
USGS 05064500 RED RIVER OF THE NORTH AT HALSTAD, MN
USGS 05054000 RED RIVER OF THE NORTH AT FARGO, ND
USGS 05051522 RED RIVER OF THE NORTH AT HICKSON, ND

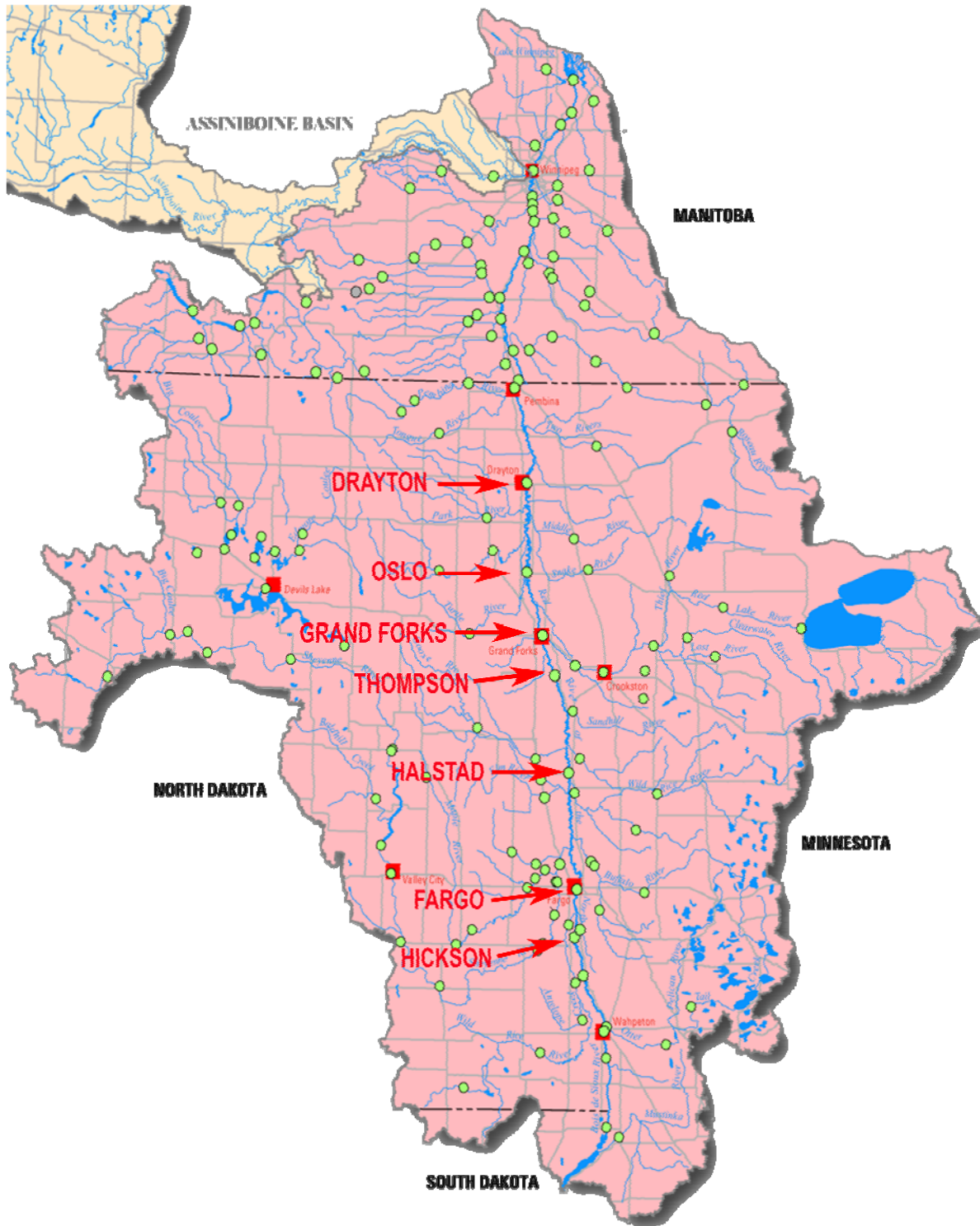
Cited sources:

USGS, NGS.NOAA, Federal Emergency Management Agency Flood Insurance Study Number 38017CV000A (July 27th, 2012) and Grand Forks Letter of Map Revision (LOMR) effective August 2nd, 2007.

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RED RIVER USGS RIVER GAGE LOCATIONS



Intent: To evaluate impacts caused by the Fargo-Moorhead Metropolitan Area Flood Risk Management Project (FMM) to entities along the Red River main stem.

Rejected Assumptions: The U.S. Army Corps of Engineers conducted an EOE (Expert Opinion Elicitation) during the SDEIS (Supplemental Draft Environmental Impact Study) and is summarily rejected in this analysis for the follow reasons:

- 1) Inconsistent with FEMA 100 yr and historical data.
- 2) The EOE was conducted after the FMM EIS commenced, compromising the integrity of the initial DEIS (Draft Environmental Impact Study).
- 3) The EOE disproportionally weights historical gage data to establish an artificial benchmark that supports the FMM.
- 4) The EOE suppresses impacts by disregarding historical USGS observations by comparing EOE based "existing conditions" with EOE projections.
- 5) The EOE was utilized to establish a more favorable cost benefit ratio than using existing non-weighted historical river data.
- 6) The EOE attempts to theorize precipitation conditions beyond any rational or scientific basis of accuracy.

Summary: The proposed FMM project creates significant impacts up to 22.5 miles upstream of Fargo and beyond Drayton, ND. The U.S. Army Corps of Engineers was unable to minimize impacts downstream and solicited an EOE study to increase the theorized hydraulics and hydrology modeling of the Red River of the North. This alteration relies heavily upon a disproportionate increase of CFS discharge flows and gage elevation to reduce impacts in relation to FMM project objectives and related reduction of natural flood plain development for development purposes.

Any net reductions in flood levels are in relation to EOE benchmarks and require all components to work in unison for timing of crests and to provide the stated reduction benefit. The proposed project has primarily three component phases. **NOTE** relocation of flood water capacity from the natural flood plain occurs with each phase of construction.

- 1) northern reach from I-94 to Red River outlet capturing the Sheyenne, Maple and Rush rivers.
- 2) Western reach from Sheyenne aqueduct to the northern reach crossing at I-94.
- 3) Southern reach from the Sheyenne aqueduct eastward 12.5 mile, 5.5 miles of that reach into MN.

Bad Scenario: A problematic scenario for populations downstream of Fargo, ND would be the construction of the northern reach prior to the lawsuit and the DNR issues being resolved, as there are no control structures to limit discharge of captured water from the Sheyenne, Maple and Rush rivers into the Red River mainstem.

Worst Case Scenario: If only the northern reach and southern reach components are constructed, populations downstream of Fargo, ND would experience full discharge of the staging/storage area immediately upstream of Fargo to preserve the metro area. Combining full discharge of flood water upstream of Fargo and uncontrolled discharge of the northern reach, populations downstream of Fargo could realize impacts greater than those stated in the Supplemental Environmental Assessment.

Net Effects: Populations downstream of Fargo, ND could experience an increase in water impacts and a reduction of existing rated level of protection, which could initiate and increase in requirement for flood insurance coverage.

Drayton

USGS 05092000 RED RIVER OF THE NORTH AT DRAYTON, ND
Pembina County, North Dakota
Hydrologic Unit Code 09020311
Latitude 48°34'20", Longitude 97°08'50" NAD27
Drainage area 34,800 square miles
Gage datum 755.0 feet above NGVD29

VERTCON

Latitude: 48 34.20
Longitude: 097 08.50
NAVD 88 height: 755.00 ft
Datum shift (NAVD 88 minus NGVD 29): 1.178 feet
Converted to NAVD 88 height: 756.178 feet

Benchmark

USGS 05092000
Date: 1997-04-24
CFS : 124000
Gage: 45.55

756.178 feet (1988 NAVD)
45.55 record crest

801.728 feet (1988 NAVD)
803.14 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

1.412 feet higher than 1997 record
16.944 inches higher than 1997 record

Drayton Summary: USGS gage 05092000 located at Drayton, ND has a base elevation of 756.178 feet when converted to NAVD 88 datum. The USGS recorded an April 24, 1997 peak crest of 45.55 feet at 124,000 CFS of discharge reflecting 801.728 feet at the gage. The proposed VE13A alignment of the FMM indicates projected impacts could reach 803.14 feet, which exceeds the 1997 record crest of 801.728 feet by 1.412 feet (16.944 inches).

Oslo

USGS 05083500 RED RIVER OF THE NORTH AT OSLO, MN
Marshall County, Minnesota
Hydrologic Unit Code 09020306
Latitude 48°11'38", Longitude 97°08'25" NAD27
Drainage area 31,200 square miles
Contributing drainage area 27,400 square miles
Gage datum 772.65 feet above NGVD29

VERTCON

Latitude: 48 11.38
Longitude: 097 08.25
NGVD 29 height: 772.65 ft
Datum shift(NAVD 88 minus NGVD 29): 1.119 feet
Converted to NAVD 88 height: 773.769 feet

Benchmark

USGS 05083500
Date: 1997-04-23
CFS : 120000
Gage: 38.00

USGS 05083500
Date: 2009-04-01
CFS : 80600
Gage: 38.37

773.769 feet (1988 NAVD)
38.37 record crest

812.139 feet (1988 NAVD)
813.26 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

1.121 feet higher than 2009 record
13.452 inches higher than 2009 record

Oslo Summary: USGS gage 05083500 located at Oslo, MN has a base elevation of 773.769 feet when converted to NAVD 88 datum. The USGS recorded an April 1, 1997 peak crest of 38.37 feet at 80,600 CFS of discharge but also an April 23, 1997 crest of 38.00 feet at 120,600 CFS of discharge. Although the CFS discharge reading was lower on the April 1, 1997 the higher gage crest was used. The proposed VE13A alignment of the FMM indicates projected impacts could reach 813.26 feet, which exceeds the 1997 record crest of 812.139 feet by 1.121 feet (13.452 inches).

Grand Forks

USGS 05082500 RED RIVER OF THE NORTH AT GRAND FORKS, ND
Grand Forks County, North Dakota
Hydrologic Unit Code 09020301
Latitude 47°55'37", Longitude 97°01'44" NAD27
Drainage area 30,100 square miles
Contributing drainage area 26,300 square miles
Gage datum 779.0 feet above NGVD29

VERTCON

Latitude: 47 55.37
Longitude: 097 01.44
NGVD 29 height: 779.0 ft
Datum shift(NAVD 88 minus NGVD 29): 1.070 feet
Converted to NAVD 88 height: 780.070 feet

Benchmark

USGS 05082500
Date: 1997-04-18
CFS : 137000
Gage: 52.04

Date: 1997-04-22
Gage: 54.35

780.070 feet (1988 NAVD)
54.35 record crest

834.42 feet (1988 NAVD)
833.40 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

-1.02 feet lower than 1997 record
-12.24 inches lower than 1997 record

Alternate Benchmark

832.2 feet 2003 FEMA 100 yr (1988 NAVD)
833.40 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

1.2 feet higher than FEMA 100 yr
14.4 inches higher than FEMA 100 yr

833.3 feet 2010 FEMA 100 yr (1988 NAVD)
833.40 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

.10 feet higher than FEMA 100 yr
1.2 inches higher than 2010 FEMA 100 yr

Alternate Benchmark

USGS 05082500
Date: 2011-04-14
CFS : 87500
Gage: 49.86

780.070 feet (1988 NAVD)
49.86 highest crest since floodwall completion

829.93 feet (1988 NAVD)
833.40 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

3.47 feet higher since floodwall completion
41.64 inches higher since floodwall completion

Grand Forks Summary: USGS gage 05082500 located at Grand Forks, ND has a base elevation of 780.070 feet when converted to NAVD 88 datum. Grand Forks presents issues that are unique and systemic. There is historical gage data prior to implementation of flood walls as well as historical crests since flood wall completion. The Grand Forks location also experienced two BFE (base flood elevation) changes since 2003. The first occurred in 2003 when FEMA requested the U.S. Army Corps of Engineers to evaluate the Grand Forks region and another in December 2010 after the FMM EIS had commenced. ** NOTE ** Any raise of the BFE decreases the maximum efficacy rating of related flood protection measures. When comparing the upstream Thompson, ND gage and downstream Oslo, MN gage to the Grand Forks, ND gage data - the 2010 BFE revision is inconsistent with conditions in the region.

The USGS recorded an April 22, 1997 peak crest of 54.35 feet at 137,000 CFS of discharge. The proposed VE13A alignment of the FMM indicates projected 100 year impacts could reach 833.40 feet, which is below the 1997 record crest of 834.42 feet by 1.02 feet (12.24 inches). This data suggests that the 1997 event was considerably higher than a 100 year flood event.

The 100 year BFE adopted in 2003 of 832.2 feet when compared to the proposed VE13A alignment of the FMM indicates projected impacts could reach 833.40 feet, which exceeds the 1997 record crest of 832.2 feet by 1.2 feet (14.4 inches).

The 2010 revision of the 100 year BFE to 833.3 feet was rejected in this analysis because it reduces the 250 year rating of Grand Forks flood protection and occurred during the FMM EIS to reduce impacts related to the U.S. Army Corps of Engineers EOE modeling.

Grand Forks Summary – with Flood Wall: USGS gage 05082500 located at Grand Forks, ND has a base elevation of 780.070 feet when converted to NAVD 88 datum. The highest recorded crest since flood wall completion occurred April 14, 2011 with a peak crest of 54.35 feet at 87,500 CFS of discharge. The proposed VE13A alignment of the FMM indicates projected impacts could reach 833.40 feet, which exceeds the 2011 record crest of 829.93 feet by 3.47 feet (41.64 inches).

Thompson

USGS 05070000 RED RIVER OF THE NORTH NEAR THOMPSON, ND
Latitude 47°45'32", Longitude 96°56'37" NAD27
Grand Forks County, North Dakota, Hydrologic Unit 09020301
Drainage area: 24,010 square miles
Datum of gage: 779 feet above NGVD29.

VERTCON

Latitude: 47 45.32
Longitude: 096 56.37
NGVD 29 height: 779.00 ft
Datum shift(NAVD 88 minus NGVD 29): 1.076 feet
Converted to NAVD 88 height: 780.076 feet

Benchmark

USGS 05070000
Date: 2011-04-13
CFS : 72000
Gage: 65.18

780.076 feet (1988 NAVD)
65.18 record crest

845.256 feet (1988 NAVD)
847.58 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

2.324 feet higher than 2011 record
27.888 inches higher than 2011 record

Thompson Summary: USGS gage 05070000 located at Thompson, ND has a base elevation of 780.076 feet when converted to NAVD 88 datum. The USGS recorded an April 13, 2011 peak crest of 65.18 feet at 72,000 CFS of discharge reflecting 845.256 feet at the gage. The proposed VE13A alignment of the FMM indicates projected impacts could reach 847.58 feet, which exceeds the 1997 record crest of 845.256 feet by 2.324 feet (27.888 inches).

Halstad

USGS 05064500 RED RIVER OF THE NORTH AT HALSTAD, MN
Traill County, North Dakota
Hydrologic Unit Code 09020107
Latitude 47°21'07", Longitude 96°50'36" NAD27
Drainage area 21,800 square miles
Gage datum 826.65 feet above NGVD29

VERTCON

Latitude: 47 21.07
Longitude: 096 50.36
NGVD 29 height: 826.65 ft
Datum shift(NAVD 88 minus NGVD 29): 1.089 feet
Converted to NAVD 88 height: 827.739 feet

Benchmark

USGS 05064500
Date: 1997-04-19
CFS : 71500
Gage: 40.74

827.739 feet (1988 NAVD)
40.74 record crest

868.479 feet (1988 NAVD)
869.09 FMM VE13A-Bundled 100 yr Event (1988 NAVD)

.611 feet higher than 1997 record
7.332 inches higher than 1997 record

Halstad Summary: USGS gage 05064500 located at Halstad, ND has a base elevation of 780.076 feet when converted to NAVD 88 datum. The USGS recorded an April 19, 1997 peak crest of 40.74 feet at 71,500 CFS of discharge reflecting 868.479 feet at the gage. The proposed VE13A alignment of the FMM indicates projected impacts could reach 869.09 feet, which exceeds the 1997 record crest of 868.479 feet by .611 feet (7.332 inches).

Fargo

USGS 05054000 RED RIVER OF THE NORTH AT FARGO, ND
Cass County, North Dakota
Hydrologic Unit Code 09020104
Latitude 46°51'40", Longitude 96°47'00" NAD27
Drainage area 6,800 square miles
Gage datum 861.8 feet above NGVD29

VERTCON

Latitude: 46 51.40
Longitude: 096 47.00
NGVD 29 height: 861.8 ft
Datum shift(NAVD 88 minus NGVD 29): 0.942 feet
Converted to NAVD 88 height: 862.742 feet

Benchmark

USGS 05054000
Date 2009-03-28
CFS: 29500
Gage: 40.84

862.742 feet (1988 NAVD)
40.84 record crest

903.582 feet (1988 NAVD)
903.59 FMM Existing Condition as of March 2013 (1988 NAVD)

.008 feet higher than 2009 record
.096 (less than 1/10 inch higher than 2009 record using EOE data)

Alternate Benchmark

862.742 feet (1988 NAVD)
40.84 record crest

903.582 feet (1988 NAVD)
902.64 FEMA July 2012 Cass County Flood Study (1988 NAVD)

.942 feet - 2009 crest exceeded new FEMA 100 yr flood elevation
11.304 inches - 2009 crest exceeded new FEMA 100 yr flood elevation

Fargo Summary: USGS gage 05054000 located at Fargo, ND has a base elevation of 780.076 feet when converted to NAVD 88 datum. The USGS recorded an March 28, 2009 peak crest of 40.84 feet at 29,500 CFS of discharge reflecting 903.582 feet at the gage. FEMA released a Cass County Study in July 2012 indicating a 100 year BFE of 902.64 feet, which is below the 2009 record crest of 903.582 feet by .942 feet (11.304 inches).

This data suggests that Fargo, ND has exceeded both the previous and most recent 100 year FEMA BFE.

Information provided by CH2MHill, FMM project manager, indicated that the disparity between a 100 year and 500 year event approximately 2.25 miles upstream of the Red River and Wild Rice confluence at the Lower Wild Rice & Red River Cemetery (LWRRRC) 1500 feet south of the intersection of Hwy 81 and Cass 16 to be 1.1 feet (13.2 inches). During the 2009 flood event water reached a lidar elevation of 913.4 feet with the 2012 FEMA 100 year BFE being 912.2 feet LWRRRC.

It would be inconsistent with available data to apply a flood rating in the 2009 flood event at Fargo to be lower than a 100 year flood event considering the 100 year BFE was exceeded at the Fargo and LWRRRC locations.

This further supports that any application of EOE data was used to downgrade the Fargo, ND 2009 historic flood and will subsequently downgrade existing flood protection(s) downstream placing considerably higher numbers of property below the 100 year BFE.

Hickson

Cass County, North Dakota
Hydrologic Unit Code 09020104
Latitude 46°39'35", Longitude 96°47'44" NAD27
Drainage area 4,300 square miles
Gage datum 876.38 feet above NGVD29

VERTCON

Latitude: 46 39.35
Longitude: 096 47.44
NGVD 29 height: 876.38
Datum shift(NAVD 88 minus NGVD 29): 1.053 feet
Converted to NAVD 88 height: 877.433 feet

Benchmark

USGS 05051522
Date: 2009-03-26
CFS : 23,700
Gage: 39.04

877.433 feet (1988 NAVD)
39.04 record crest

916.473 feet (1988 NAVD)
915.8 FEMA 100 yr Event (1988 NAVD)

.673 feet higher than 1997 record
8.076 inches higher than 1997 record

Hickson Summary: USGS gage 05051522 located at Hickson, ND has a base elevation of 877.433 feet when converted to NAVD 88 datum. The USGS recorded a March 26, 2009 peak crest of 39.04 feet at 23,700 CFS of discharge reflecting 916.473 feet at the gage, which exceeded the FEMA 500 year flood rating. The FEMA 100 year flood BFE from the July 2012 FEMA Flood Insurance Number 38017CV000A (Cass County) is 915.8 feet, which is lower than the 2009 record crest of 916.473 feet by .673 feet (8.076 inches).