Red River Basin Overview

Considerations for Basin Friendly
Flood Damage Reduction Alternatives

Flood problems are widespread within the Red River Basin

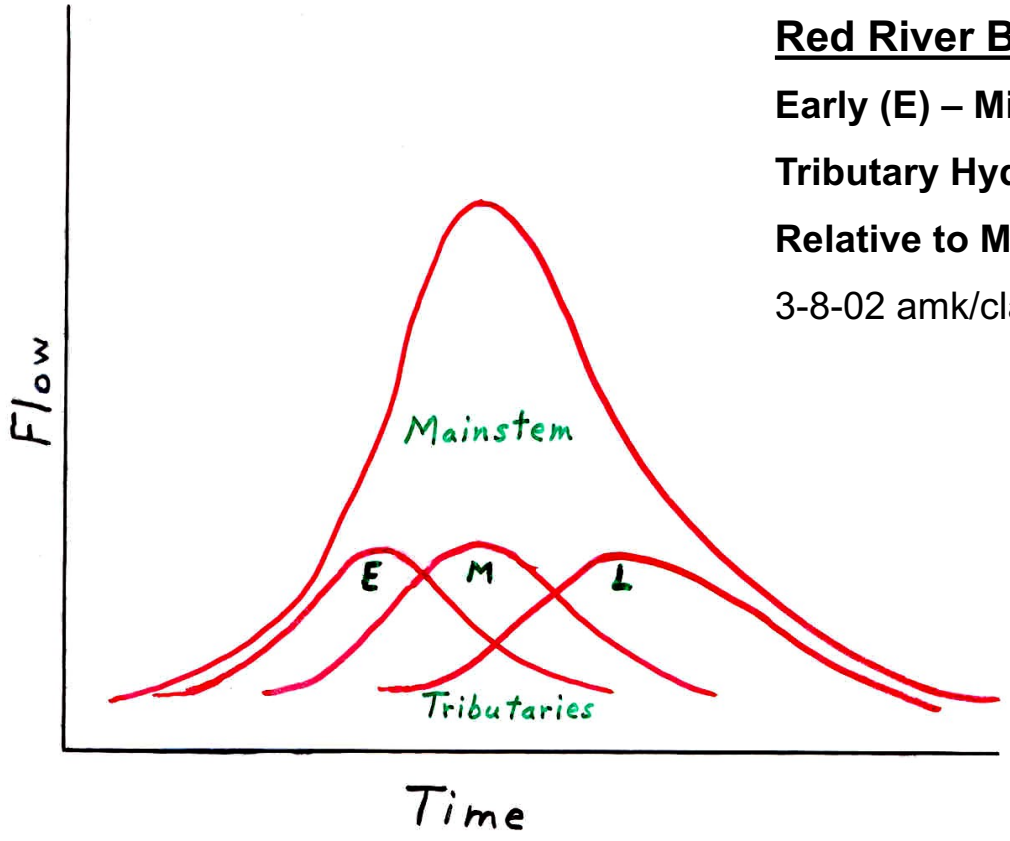
- Throughout the basin, people try to solve their own local flood problems
- These efforts range from small projects on private lands to large public works projects
- Large or small, they can add up to very significant changes in basin hydrology
- It makes a big difference what measures are implemented to solve local flood problems
- It also matters where in the basin the measure is being implemented

Flood Damage Reduction Measures

- TSAC Technical Paper 11 – Flood Damage Reduction Framework, 2004 (a product of the MN Flood Damage Reduction Workgroup) (After Adoption of Mediation Agreement)
  - Identified the common flood damage reduction measures.
  - Characterized the impact that these measures are likely to have on basin outflows, which is dependent on their location within the basin.
  - The underlying purpose of TP11 is to guide selection toward measures that address both local and mainstem flood damage reduction goals

Critical Concept #1 - Timing

The concept of “**Early**”, “**Middle**” and “**Late**” runoff areas within the basin, relative to mainstem flood hydrographs, substantially assists selection of FDR measures for local benefits that take into account downstream impacts.



Red River Basin FDR Strategy

Early (E) – Middle (M) – Late (L)

Tributary Hydrographs

Relative to Mainstem Hydrograph

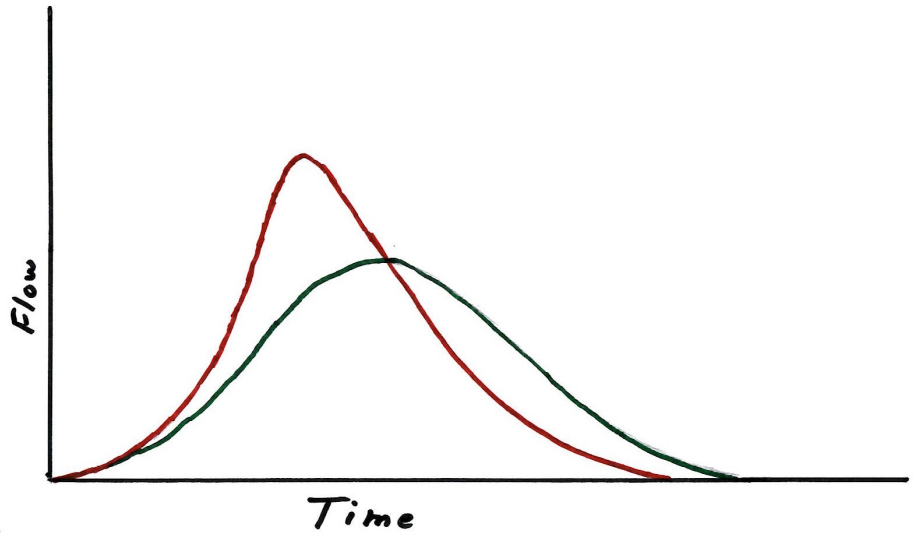
3-8-02 amk/cla

Note: From a Basin perspective, the Red River at Fargo is a tributary. From a Fargo Perspective, Bois de Sioux, Otter Tail, and Wild Rice ND are tributaries.

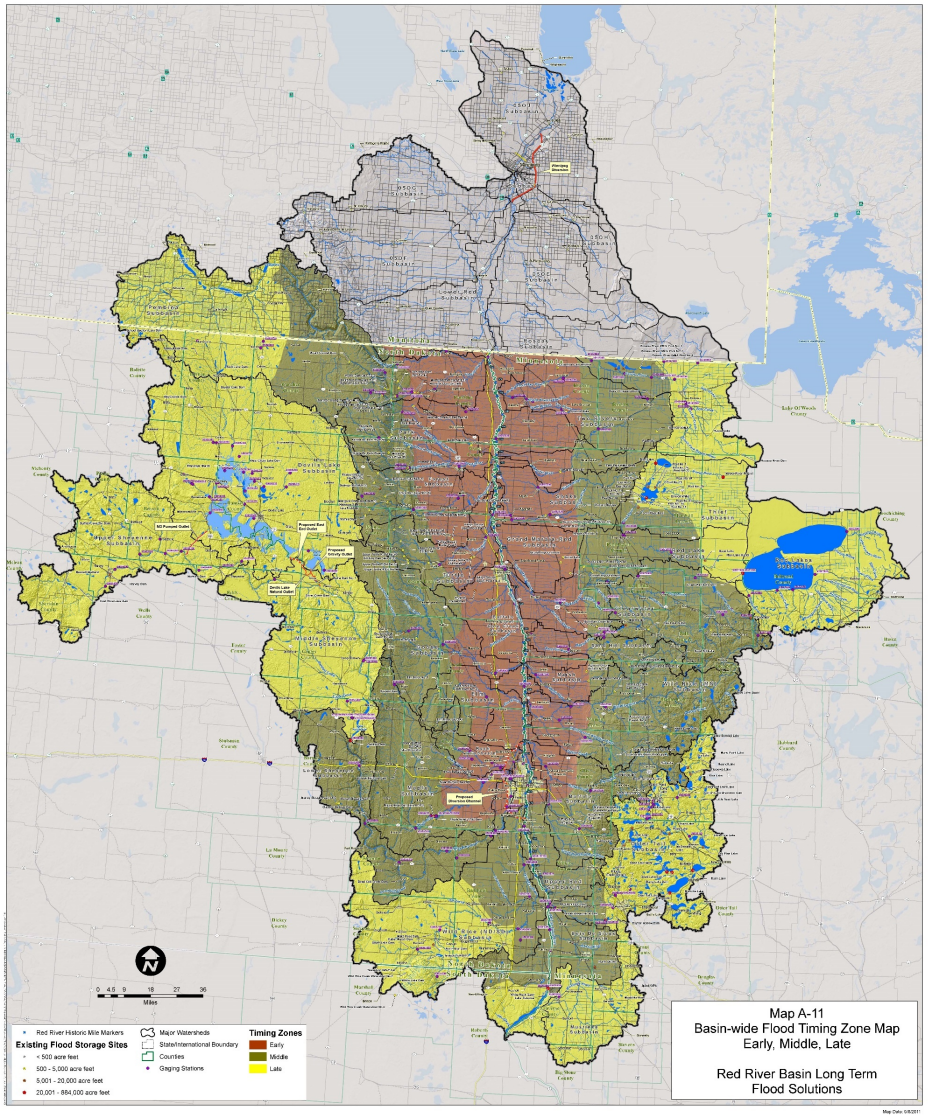
Critical Concept #2 – Storage defines the shape of a watershed's hydrograph

- Within any given watershed, the shape of the hydrograph (its peak and duration) is defined by the amount and location of flood storage within the watershed
- The storage can be artificial (impoundments, etc.) or natural (flood plains, etc.)
- The impacts of an FDR measure can be predicted by how that measure increases or decreases flood storage

Effect of Flood Storage

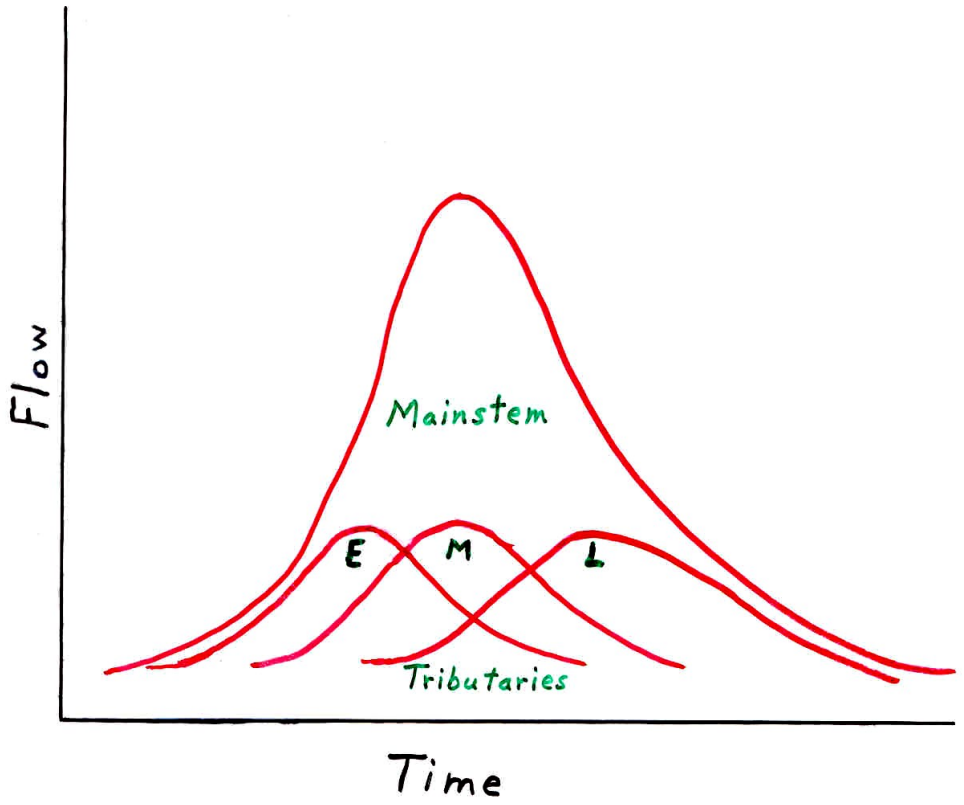


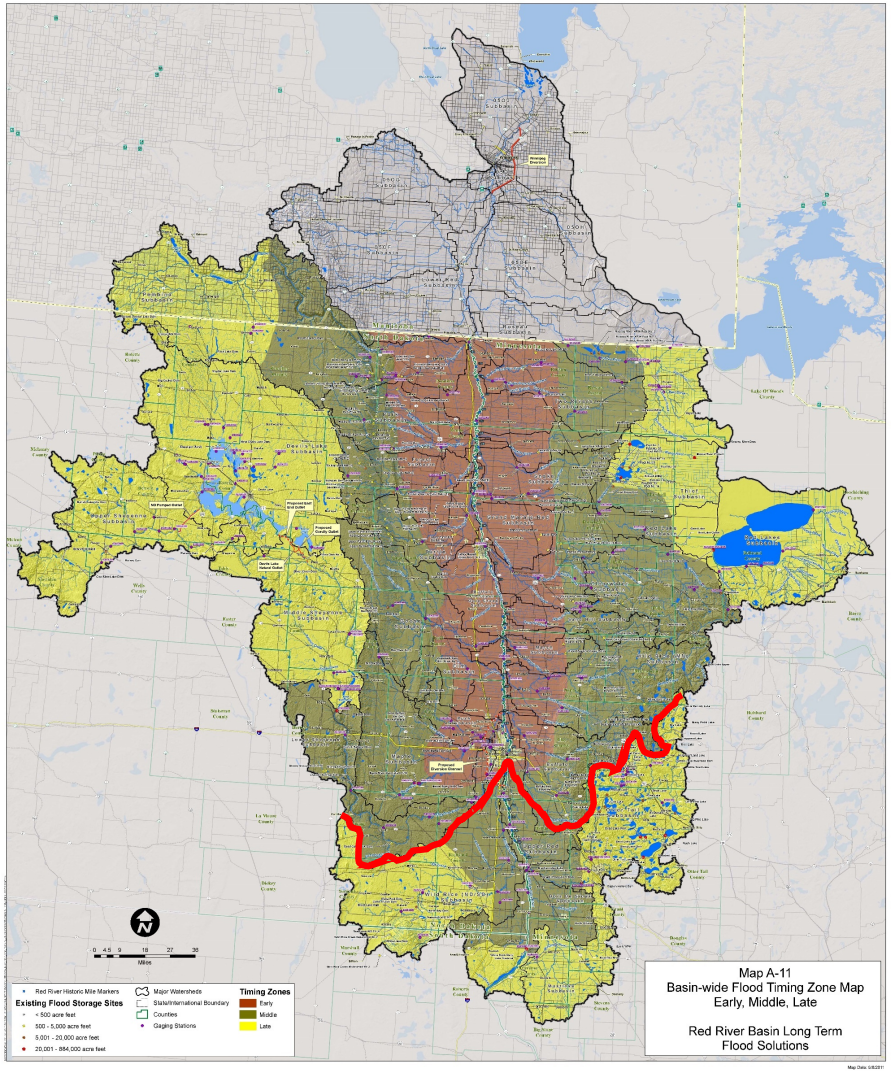
- Reduces and delays peak flow
- Increases the overall duration
- Add storage to go from red to green
- Take away storage to go from green to red



Basin Timing Map

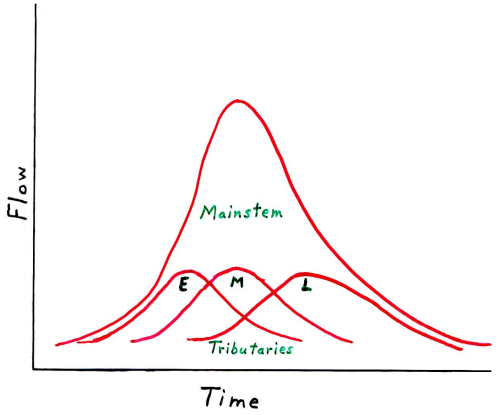
Timing is affected by storage, travel time, and snowmelt progression





Red River @ Fargo Drainage Area within the Red River Basin

- The Red River Watershed Upstream of Fargo
  - ~75% within the Basin Late Zone
  - ~25% within the Basin Middle Zone



Flood Damage Reduction Strategies

1. Reduce Flood Volume
2. Increase Conveyance Capacity
3. Increase Temporary Flood Storage
4. Protection/Avoidance

There are several individual measures within each of the broad strategy catagories shown above

A Basin Approach to Flood Damage Reduction

- All of the aforementioned strategies can be used to provide local FDR benefits
  - Primary consideration should be given to measures that also work toward achieving basin flood damage reduction goals
  - Measures that work against meeting basin flood damage reduction goals should be minimized or avoided, if possible
  - Unavoidable adverse basin impacts should be mitigated

Downstream Impacts of FDR Measures Applied in Early, Middle, and Late Areas Upstream

Flood Damage Reduction Measure	Early Upstream Area	Middle Upstream Area	Late Upstream Area
1) Reduce Flood Volume	+	++	++
a) Wetlands	+	+	++
b) Cropland BMPs	+	++	++
c) Conversion to grassland	+	++	++
d) Conversion to forest	+	++	++
e) Other beneficial uses of stored water	+	++	++
2) Increase Conveyance Capacity	+	-	- -
a) Channelization	+	-	- -
b) Drainage	+	-	- -
c) Diversion	+	Variable	-
d) Setting back existing levees (to increase conveyance capacity)	+	-	- -
e) Increasing bridge capacity	+	-	-
3) Increase Temporary Flood Storage	Variable	++	+
a) Gated impoundments	+	++	++
b) Ungated impoundments	-	+	+
c) Restored or created wetlands	-	+	+
d) Drainage	-	+	++
e) Culvert sizing	-	+	+
f) Setting back existing levees (to increase floodplain storage)	+	++	+
g) Overtopping levees	++	+	Variable
4) Protection/Avoidance	Variable	Variable	Variable
a) Urban levees	-	-	-
b) Farmstead levees	-	-	-
c) Agricultural levees	-	-	-
d) Evacuation of the floodplain	0	0	0
e) Floodproofing	0	0	0
f) Warning and emergency response	0	0	0

Downstream Impacts of FDR Measures Applied in Early, Middle, and Late Areas Upstream

Flood Damage Reduction Measure	Early Upstream Area	Middle Upstream Area	Late Upstream Area
1) Reduce Flood Volume	+	++	++
a) Wetlands	+	+	++
b) Cropland BMPs	+	++	++
c) Conversion to grassland	+	++	++
d) Conversion to forest	+	++	++
e) Other beneficial uses of stored water	+	++	++
2) Increase Conveyance Capacity	+	-	- -
a) Channelization	+	-	- -
b) Drainage	+	-	- -
c) Diversion	+	Variable	-
d) Setting back existing levees (to increase conveyance capacity)	+	-	- -
e) Increasing bridge capacity	+	-	-
3) Increase Temporary Flood Storage	Variable	++	+
a) Gated impoundments	+	++	++
b) Ungated impoundments	-	+	+
c) Restored or created wetlands	-	+	+
d) Drainage	-	+	++
e) Culvert sizing	-	+	+
f) Setting back existing levees (to increase floodplain storage)	+	++	+
g) Overtopping levees	++	+	Variable
4) Protection/Avoidance	Variable	Variable	Variable
a) Urban levees	-	-	-
b) Farmstead levees	-	-	-
c) Agricultural levees	-	-	-
d) Evacuation of the floodplain	0	0	0
e) Floodproofing	0	0	0
f) Warning and emergency response	0	0	0

Diversion Project components

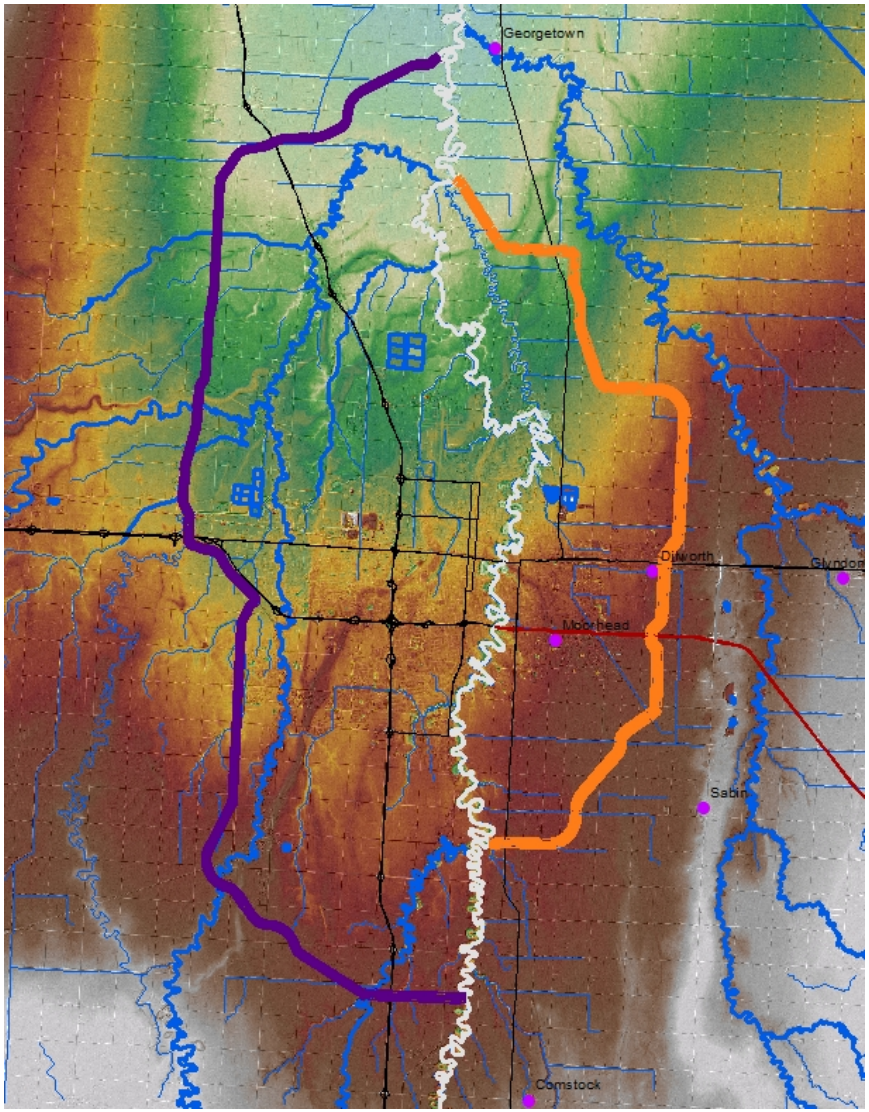
- Diversion Channel
  - Original Stand-Alone Measure and Still the Signature Feature
  - Works Very Well Locally
  - Has Adverse Downstream Impacts
- Levees
  - Traditional/Existing FDR Measure
  - Has Adverse Downstream and Upstream Impacts
- Staging Area
  - Included to Mitigate the Adverse Downstream Impacts of the Diversion and Levees

Diversion Channel Impacts

- Preliminary analysis considered:
  - Various channel capacities
  - Minnesota and North Dakota Alignments
- North Dakota Alignment has Significantly Greater Downstream Impacts than Minnesota Alignment of the Same Capacity (nearly twice the stage increase)
- Why? - There would have to be a difference in storage effects

ND & MN Diversion Alignments

- The ND Diversion flows through a low floodplain area thus draining floodplain and also isolating existing floodplain areas, by levees along its alignment, resulting in excessive loss of floodplain storage.
- The MN Diversion flows through higher ground generally not within the floodplain thereby having minimal effect on floodplain storage along the alignment.
- This is the primary reason that downstream impacts were found to be much greater for the ND Diversion.



Levees

- Levees reduce flood storage by isolating the interior area from the floodplain
- The larger the levee protected area, the greater the loss of floodplain storage

Staging Area

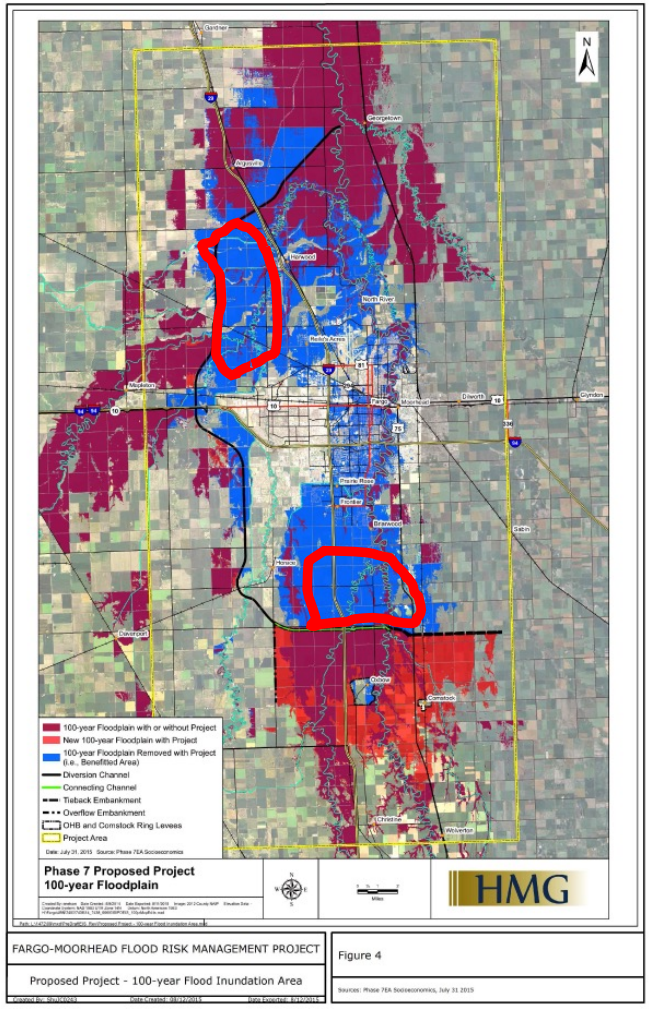
- The Staging Area was Added to the original project primarily To Mitigate the Adverse Downstream Impacts of the Diversion and Levees
- Therefore, the Size of Staging Area is Determined by the Magnitude of those Downstream Impacts which, in turn, is determined by the loss of floodplain storage

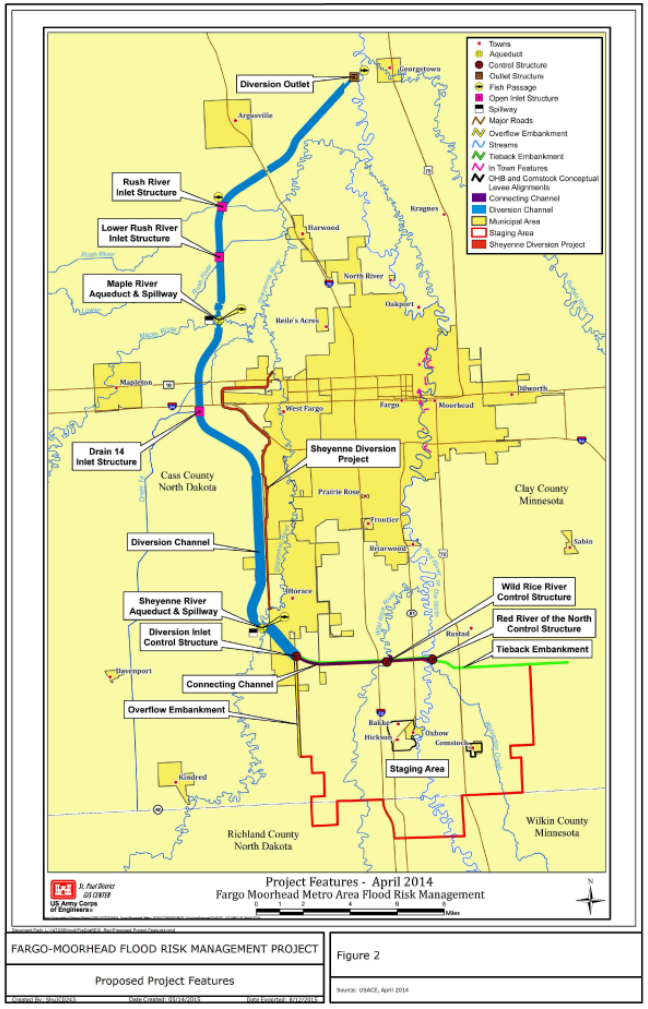
Minimize the Downstream Impacts by Minimizing the Loss of Floodplain Storage

- Diversion
  - Change the Location to the Minnesota Side
  - Move the ND Alignment to East
  - Redesign the Dikework and Structures along the Channel to Restrict Inflows From the Tributaries and Allow Water to Enter the Floodplain Area on the West Side
- Staging Area
  - Move the Dam North (about 4 Miles)
  - The Dam Alignment Should Follow the Edge of the Developed Area as close as practical
- Protected/Benefited Area would be Reduced but that Area is generally Outside of Developed Urban Areas

Primarily Undeveloped Areas Losing Protection

- Northwest of Fargo
- South of Fargo





Summary

- The above suggestions for reducing the project impact can be implemented without eliminating any of the basic project features
- The reduced project would still protect the core urban areas
- Reduced benefits would be to primarily undeveloped lands within the existing floodplain
- Additional protection will be added as distributed storage is implemented upstream as part of the basinwide 20% flow reduction strategy
  - Note that 20% flow reduction simply reduces the magnitude of a given frequency flood
  - Changes the peak flow of a 100-yr flood to about that of a 50-yr flood and the peak flow of a 200-yr to about that of a 100-yr flood