INITIAL ASSESSMENT OF THE AGRICULTURAL RISK OF TEMPORARY WATER STORAGE FOR FM DIVERSION

Department of Agribusiness and Applied Economics
North Dakota State University

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FM Diversion Authority

NDSU NORTH DAKOTA STATE UNIVERSITY

Research Question and Scope

- Issue: How would temporary water storage affect crop production and agricultural revenues?

- Study Focus: Examined planting delays caused by Diversion
  - Frequency—likelihood or probability of planting delays
  - Magnitude—what would be the revenue losses
  - Geography—how effects vary among storage areas

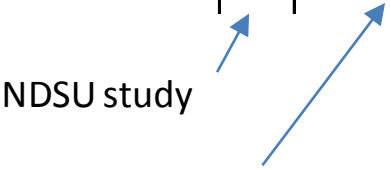
Scope of Analysis

Total Revenue from Crop Sales in Non-flood Years

Total Revenue from Crop Sales in Flood Years (without Diversion)

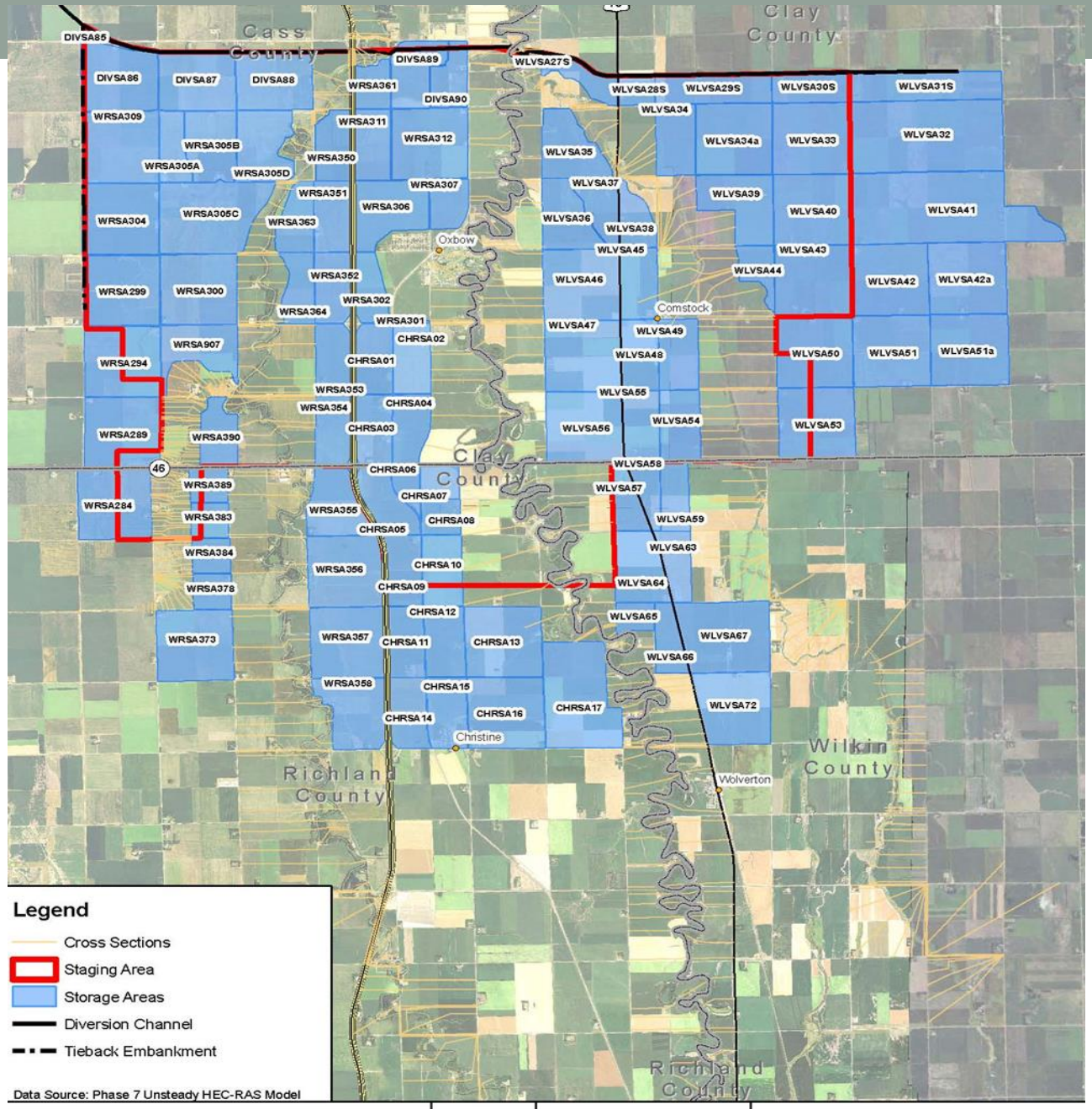
Total Revenue from Crop Sales in Flood Years (with Diversion)

Historically, approximately 60%-80% of losses in a flood event have been covered by Federal Crop Insurance. Uncertainty remains regarding the potential effects of man-made water storage on Federal crop insurance.



NDSU study

Uncertainty related to Federal Crop Insurance



Geographic Scope of Study (blue areas)

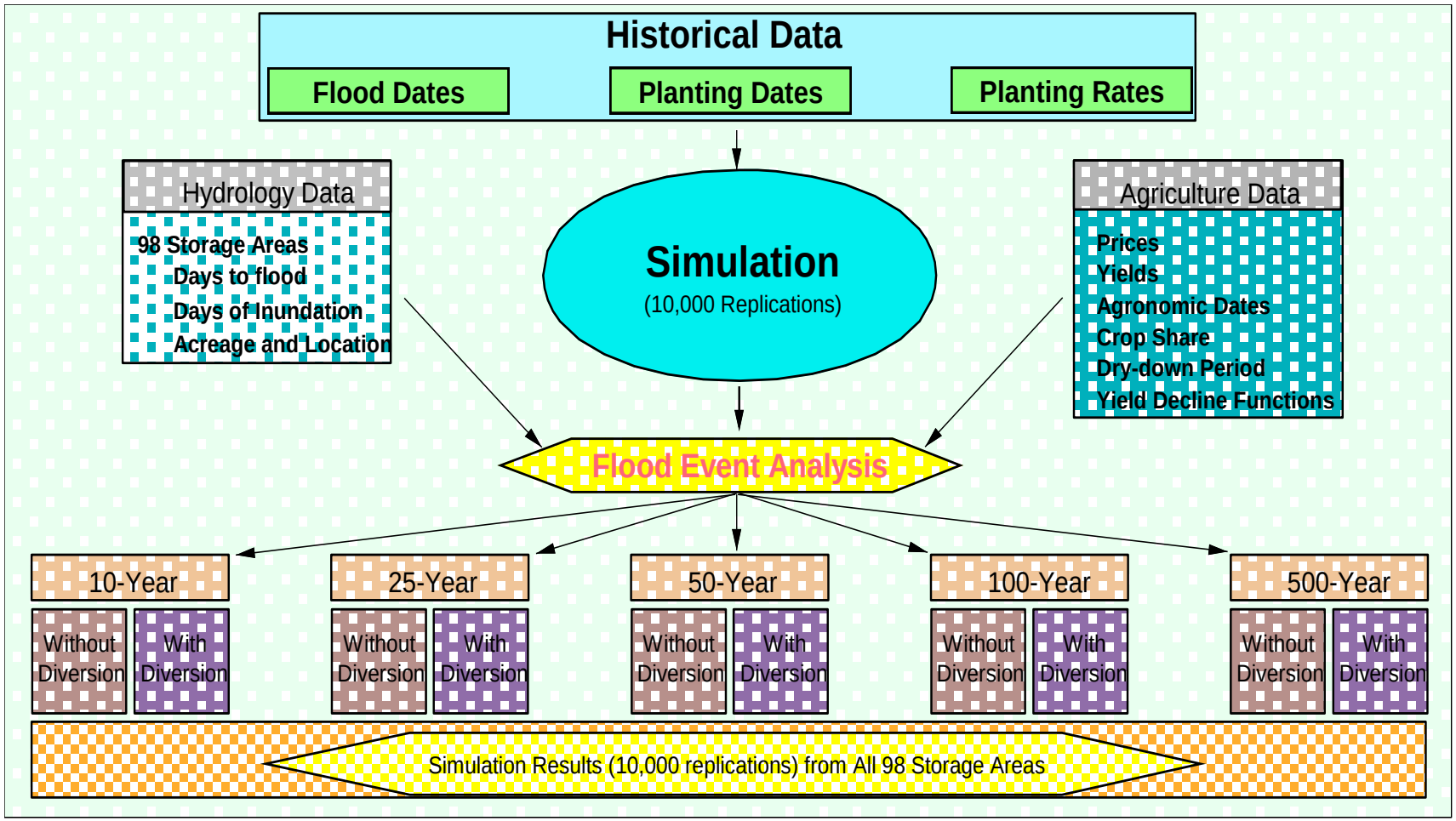
98 individual storage areas totaling 44,285 acres

Exceeds the designation of the staging area provided by USACE (32,500 acres of inundated lands)

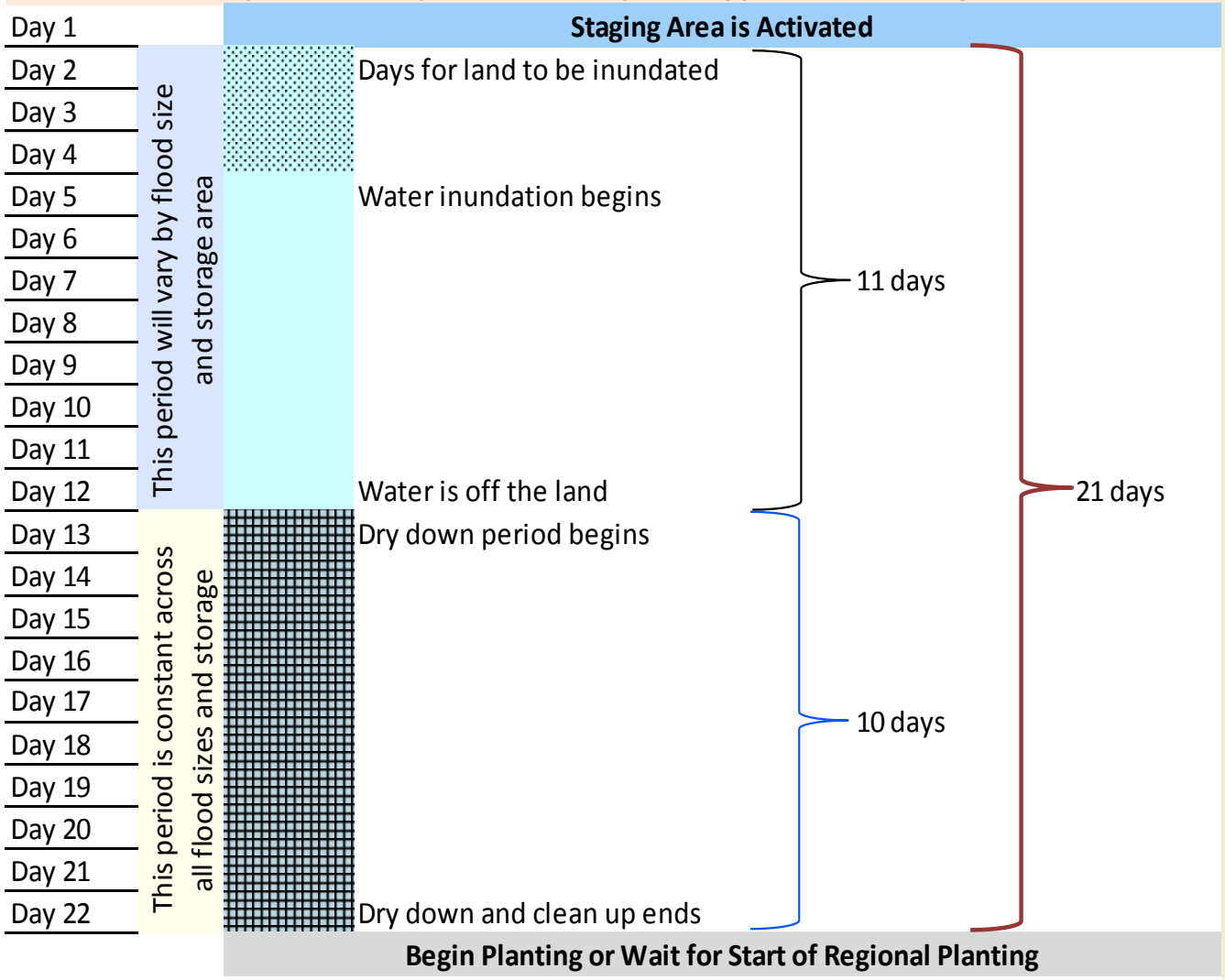
Data from HEC-RAS 7.2 hydrology model provided by FM Diversion Authority

Study used entire acreage of a storage area if any portion of the area was inundated

Analytical Outline



Conceptual Example of How Hydrology Data was Organized



Timeline

NDSU study links hydrology data from staging activation, with a **Dry Down Period**, to estimate when the effects of inundation are gone.

Separate timelines developed for Without and With Diversion conditions.

Move onto Results

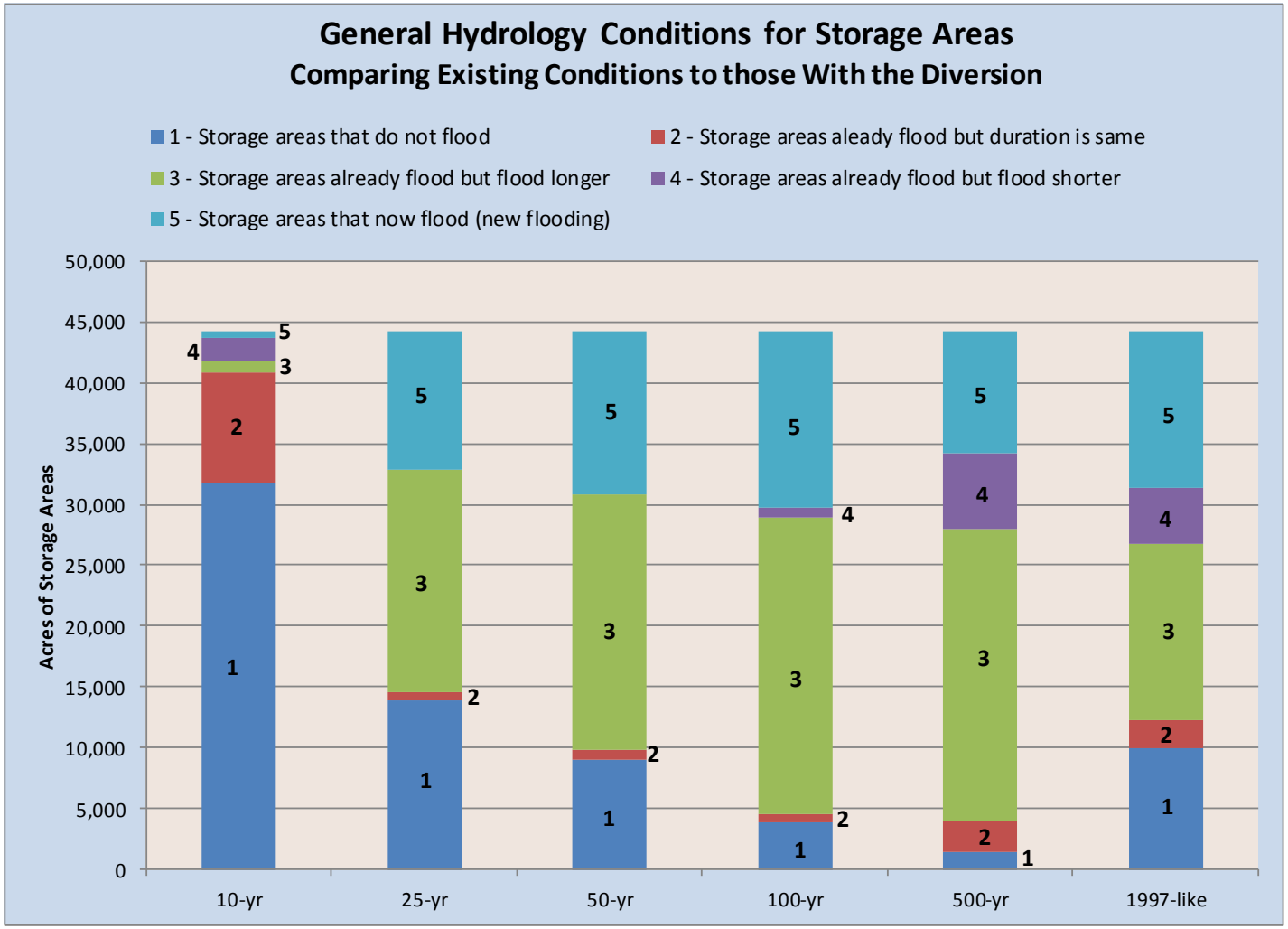
Hydrology Effects

- Hydrology effects vary by storage area and by flood size
  - Group 1 - Land that does **not flood** with or without Diversion
  - Group 2 - Land already floods, but **floods same duration** with Diversion
  - Group 3 - Land already floods, but **floods longer** with Diversion**
  - Group 4 - Land already floods, but **floods shorter** with Diversion
  - Group 5 - Land that would not flood, **but now floods (new flooding)** with Diversion**

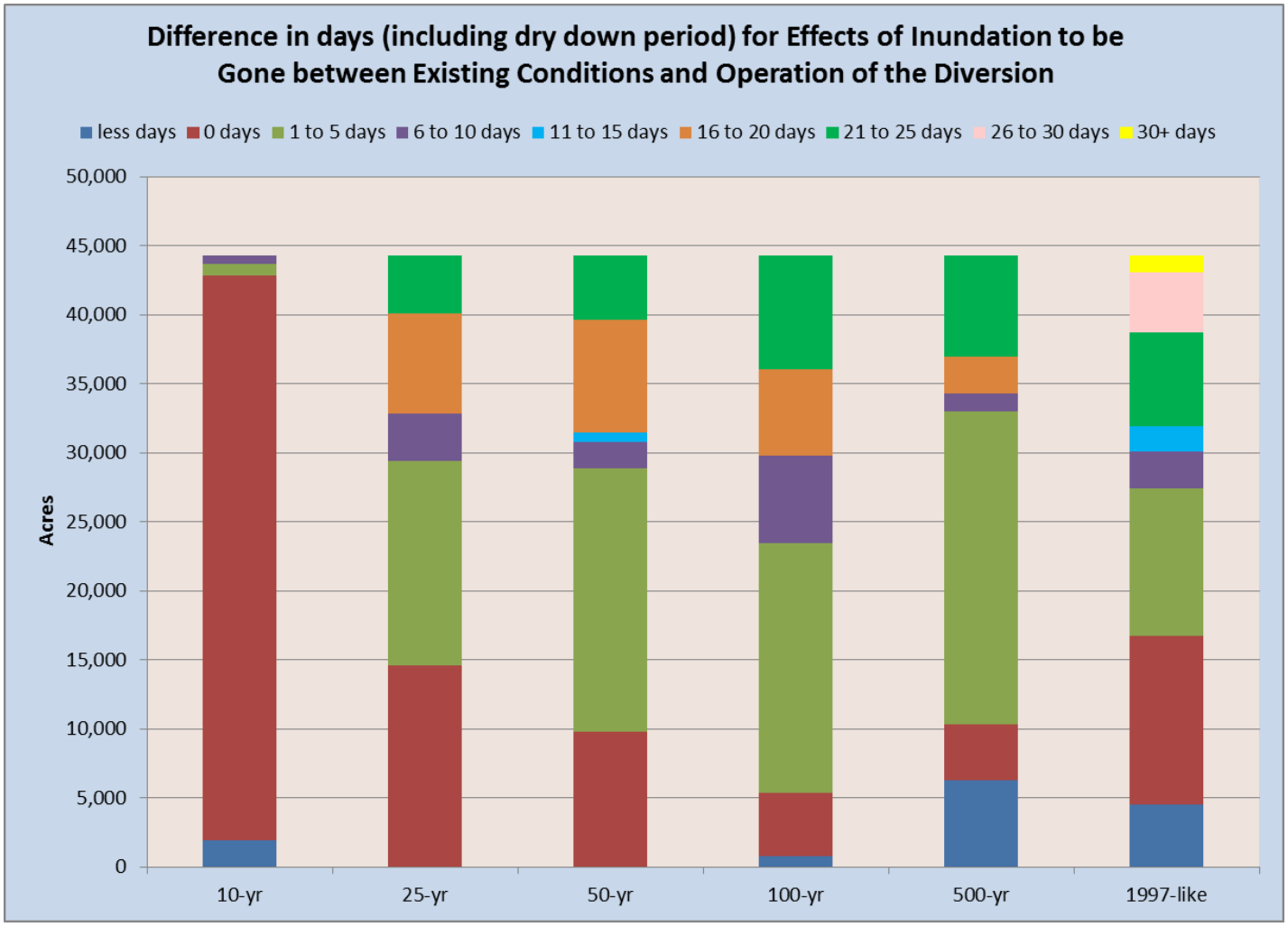
The mix of different types of hydrology effects varied across all 5 simulated flood events -- complicates reporting of results.

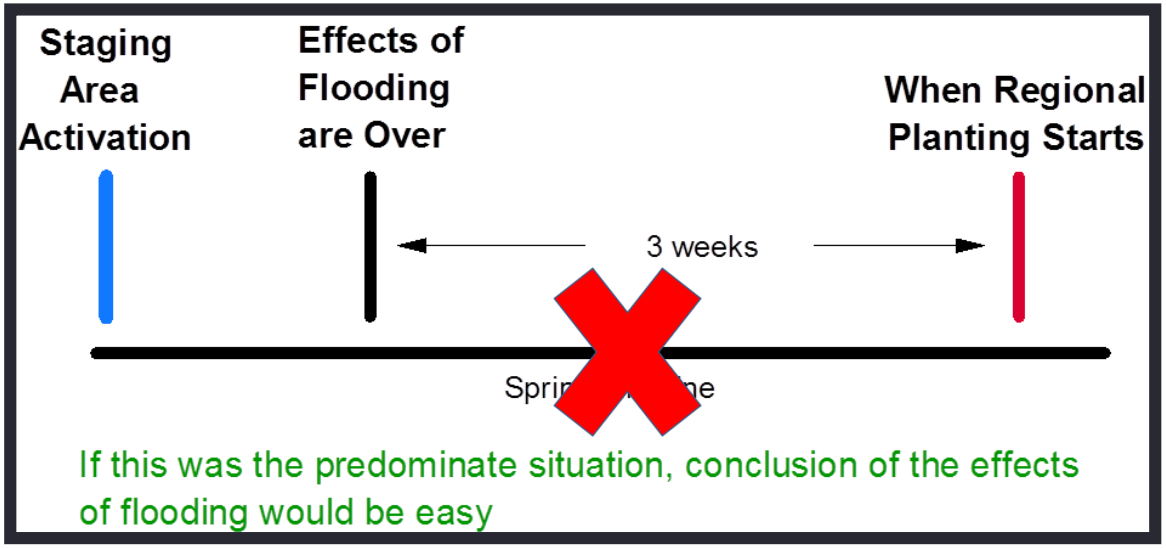
** Storage areas adversely impacted by FM Diversion

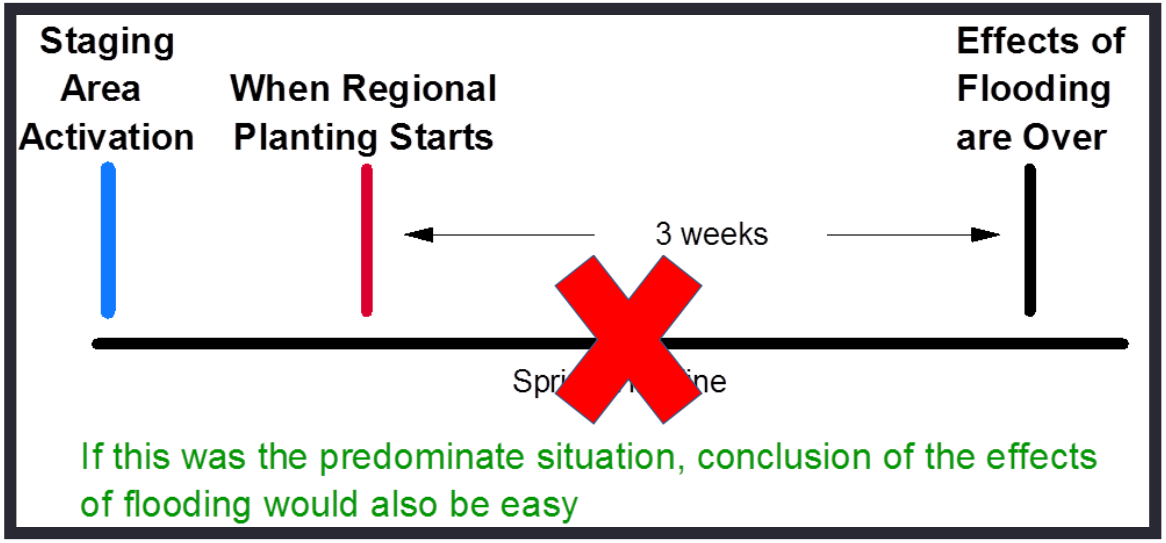
Summary of General Hydrology Effects



Summary of Additional Time for Effects of Diversion Flooding to be gone



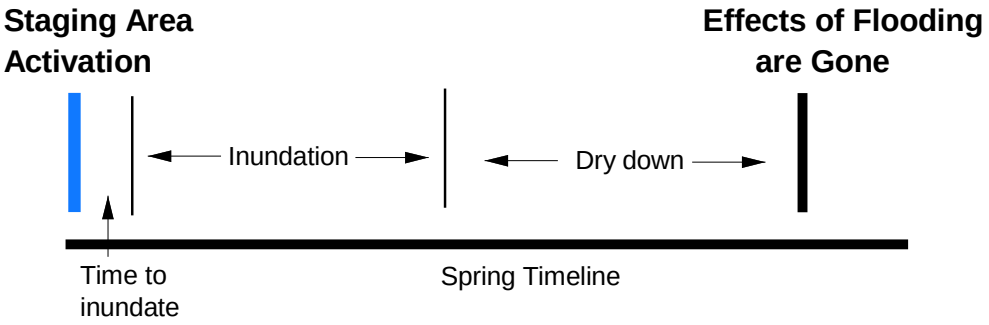




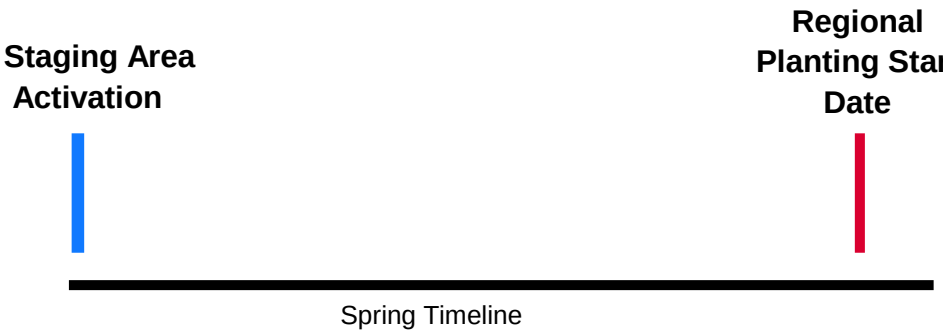
The **two situations demonstrated in the graphics were NOT observed with current data**.

One situation would suggest few planting delays and the other situation would suggest substantial planting delays.

Key Time Periods



Majority of acres will require 16-30 days for effects of temporary water storage to be over.
Determined by Hydrology Data



Majority of conditions indicate regional planting starts 16-35 days after activation of staging.
Determined by NDSU model, using historical data

Take Away

These two time periods are very similar in length. The likelihood (probability) of a planting delay will be sensitive to factors affecting those periods.

Probability of Revenue Loss due to Delayed Planting from Operation of the Diversion, Average of All Crops

		Average of Storage Areas within the Hydrology Group by Size of Flood Event (based on 10,000 simulations)					
		10-Year	25-Year	50-Year	100-Year	500-Year	1997-like
Storage Areas that Flood Longer with the Diversion (Group 3)							
	Any Revenue Loss	33%	64%	67%	75%	75%	91%
	$1 to $25 per acre	33%	64%	67%	75%	75%	91%
	More than $25 per acre	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Storage Ares that now Flood with the Diversion but would not Flood under Existing Conditions (Group 5)							
	Any Revenue Loss	29%	50%	56%	60%	60%	78%
	$1 to $25 per acre	28.5%	45%	48%	48%	46%	52%
	More than $25 per acre	0.5%	5%	8%	12%	14%	26%

Per-Acre Revenue Losses, by Crop, due to Diversion

(High and Low 5% of observations, Hydrology Group 3)

	10-year	25-year	50-year	100-year	500-year	1997-Like
	---------- Corn ----------					
Least (5%)	$0	$0	$0	$0	$0	$0
Average	-$0.75	-$5.46	-$6.16	-$9.16	-$5.54	-$12.61
Max (5%)	-$5.08	-$21.65	-$22.66	-$28.68	-$18.23	-$29.64
	---------- Wheat ----------					
Least (5%)	$0	$0	$0	$0	$0	-$0.01
Average	-$1.35	-$8.72	-$9.63	-$13.21	-$8.60	-$16.63
Max (5%)	-$6.66	-$23.47	-$24.13	-$30.06	-$20.06	-$29.34
	---------- Sugarbeets ----------					
Least (5%)	$0	$0	$0	$0	$0	-$0.02
Average	-$0.44	-$18.25	-$20.61	-$28.65	-$18.95	-$36.68
Max (5%)	-$2.61	-$51.81	-$53.84	-$68.22	-$44.73	-$64.73
	---------- Soybeans ----------					
Least (5%)	$0	$0	$0	$0	$0	$0
Average	$0	-$0.01	-$0.02	-$0.07	-$0.03	$0.56
Max (5%)	$0	-$0.30	-$0.45	-$1.33	-$0.63	-$7.04

Interpretation

The table shows the range of per-acre values observed given study data and averaging techniques of the statistical output from 10,000 simulations.

Average values mask the variability observed in the analysis.

Five percent average of minimum and maximum observations controls for low probability events

Per-Acre Revenue Losses, by Crop, due to Diversion

(High and Low 5% of observations, Hydrology Group 5)

	10-year	25-year	50-year	100-year	500-year	1997-Like
	---------- Corn ----------					
Least (5%)	$0	$0	$0	$0	$0	$0
Average	-$2.99	-$6.94	-$6.84	-$8.96	-$9.81	-$18.03
Max (5%)	-$29.98	-$49.60	-$48.73	-$57.66	-$61.10	-$79.77
	---------- Wheat ----------					
Least (5%)	$0	$0	$0	$0	$0	$0
Average	-$5.89	-$12.76	-$12.06	-$15.76	-$17.22	-$27.63
Max (5%)	-$51.07	-$76.23	-$73.12	-$84.10	-$88.28	-$102.45
	---------- Sugarbeets ----------					
Least (5%)	$0	$0	$0	$0	$0	$0
Average	-$1.81	-$27.25	-$25.60	-$33.67	-$36.75	-$58.81
Max (5%)	-$16.77	-$163.08	-$156.50	-$179.97	-$188.08	-$219.31
	---------- Soybeans ----------					
Least (5%)	$0	$0	$0	$0	$0	$0
Average	$0	$0	$0	-$0.01	-$0.01	$0.09
Max (5%)	$0	-$0.05	-$0.07	-$0.14	-$0.16	-$1.73

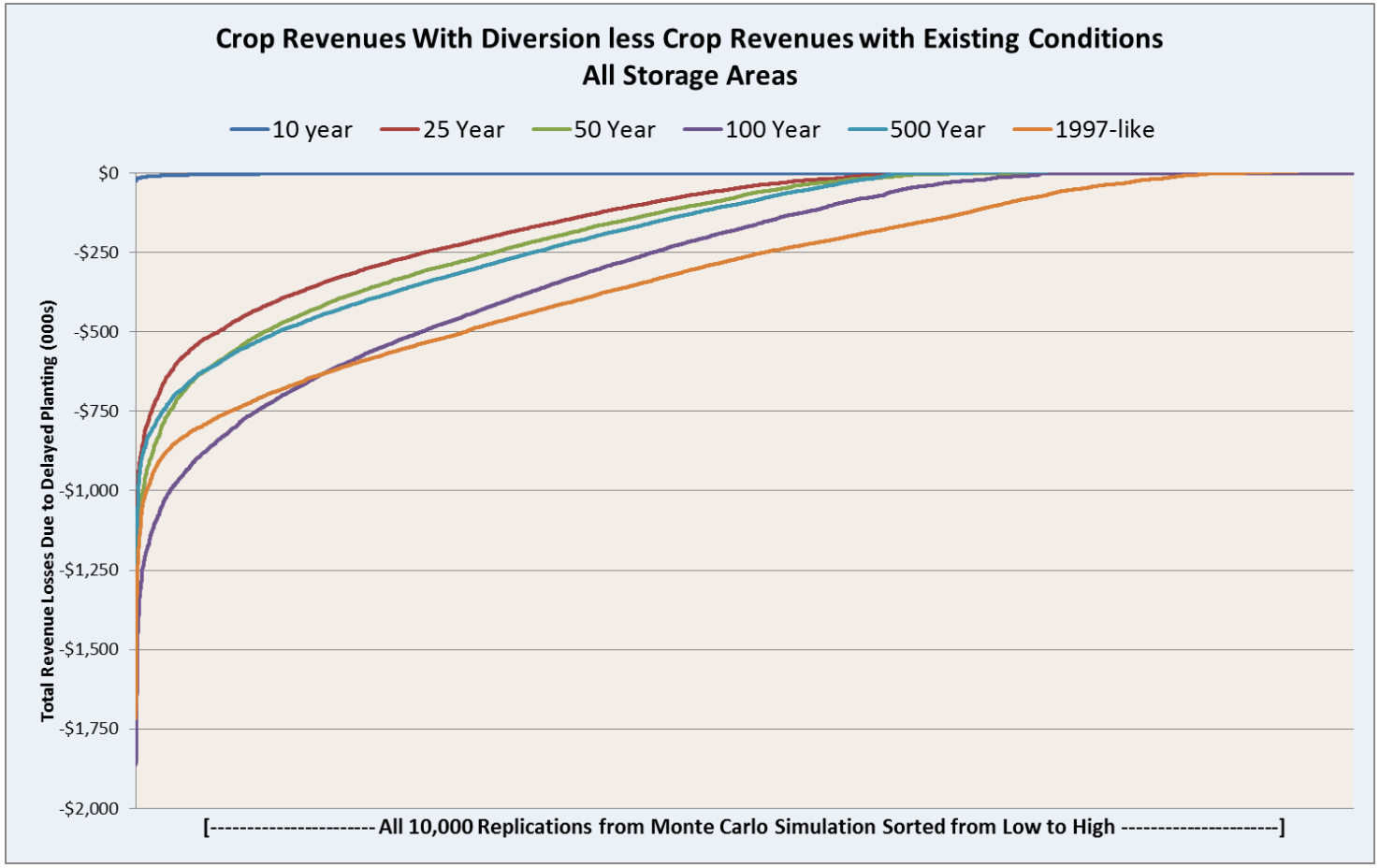
Interpretation

The table shows the range of per-acre values observed given study data and averaging techniques of the statistical output from 10,000 simulations.

Average values mask the variability observed in the analysis.

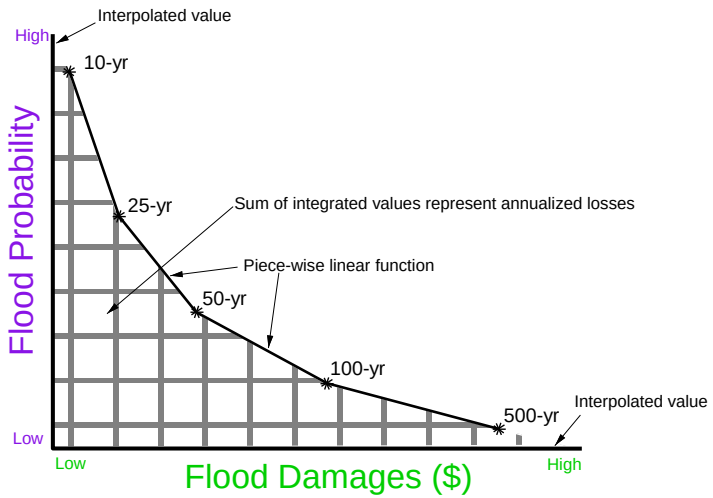
Five percent average of minimum and maximum observations controls for low probability events

Magnitude and Frequency of Total Crop Revenue Losses



Annualization

Combines event-level damages with annual probabilities



$$\exp(losses) = \int_{n=1}^{N} prob_n * loss_n$$

where n = five flood scenarios (10-, 25-, 50-, 100- and 500-year events)

Hypothetical Tornado Damages*					
Size	F1	F2	F3	F4	F5
Annual Chance	10%	4%	2%	1%	0.2%
Damages	$20	$40	$60	$80	$100

*Would not include probabilities of more than one storm in any given season.

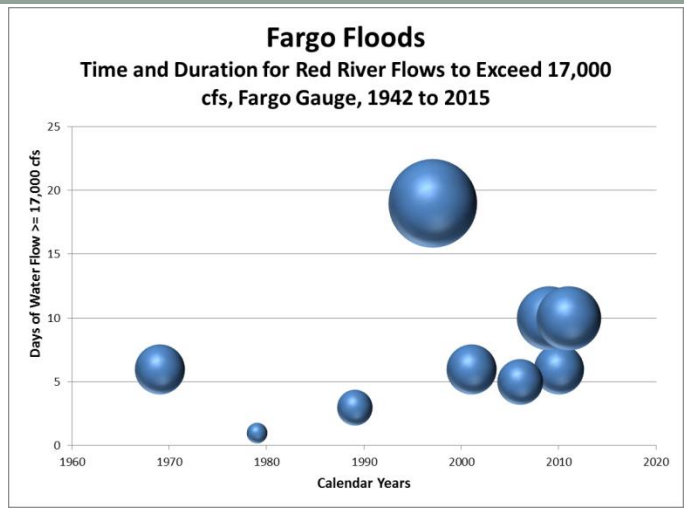
Hypothetical annualized tornado losses = $11.70

Annualized values for floods will always be smaller than event-level damages because in most years there is no flood event.

Data necessary to estimate annualized values is incomplete due to uncertainty relating to insurance issues.

Conclusions

Hydrology



- Most studied drainage system in the U.S. Very detailed hydrology data revealed:
  - Much clearer understanding of the duration of flooding.
  - Diversion operations results in less than a week of additional time for effects of flooding to be over on majority of lands.
  - Data reveals considerable variability within the staging area.
  - Data reveals not all storage areas adversely affected by Diversion operations.

- Diversion will only be operated when flows exceed 17,000 cfs in Fargo (~35ft crest), and only be used for spring flood events

Conclusions

Modeling

- Combining hydrology with historical data revealed:
  - 85% chance that the Diversion will not operate in any given year
  - Effects of flooding will be over for a majority of lands approximately the same time regional planting starts (historical data).

- Better understanding of how the effects of flooding align with regional planting, which increases our understanding of how Diversion may impact planting delays

- Stochastic variability of flood duration was not part of the hydrology data – However, the 1997-like flood hydrology demonstrates *flood-event duration* to be an important driver of potential planting delays and revenue losses

Conclusions

Losses Associated with Planting Delays

- During a 25-yr or larger flood event, high probability (60% chance) of modest ($1 to $25/acre average within a storage area) revenue losses due to planting delays
- During a 25-yr or larger flood event, low probability (10% chance) of greater losses ($25 to $75 per acre)
- Overall losses sensitive to effects on soybeans
  - 50% of acreage
  - Over the planting window used in this study, least sensitive to planting delays

Recommendations

- Impacted lands along the rivers should be evaluated
- Examine implications of Federal crop insurance
- FM Diversion Authority continue to evaluate alternative compensation and mitigation strategies
- This study is an initial assessment. Study highlighted complexity of the issue, some issues remain unquantified

Acknowledgements and Study Documentation

- The research team gratefully acknowledges the contributions from several organizations and individuals:
  - AE2S; Eric Dodds, Rocky Schneider, Dustin Dale
  - Houston Engineering; Greg Thompson, Gregg Theilman
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  - US Army Corps of Engineers: Aaron Buesing, Terry Williams, Brett Coleman

- Two Reports available to public: http://ageconsearch.umn.edu/
  - Main report, highly technical, large (>300 pages)
  - Summary report, highlights findings, small (25 pages)

- Presentation posted on FM Diversion Web Site http://www.FMDiversion.com

- Research Team – contact information

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