Waterway Management Program Hydraulic Performance Update

Troy Barnhart
tbarnhart@co.slo.ca.us

Lower AG Creek
~3:45 PM 1/10/2023

Outline

Background

Definitions

WMP

Watershed & Data

Floods of 2023

Hydrology

Hydraulics

What's Next?

Questions

Notes:
Became involved in project *following* 2023 floods.
This analysis spawned out of emergency planning effort: modeled 2023 floods to calibrate experimental flood forecasting models.

Background – Definitions

- Hydrology
- Recurrence
- Hydraulics
- Stage
- Discharge/Flow/Q
- Rating Curve
- Roughness

Background – WMP (1/2)

Channel abv UPRR
8/20/2007

Public Works
Water Resources

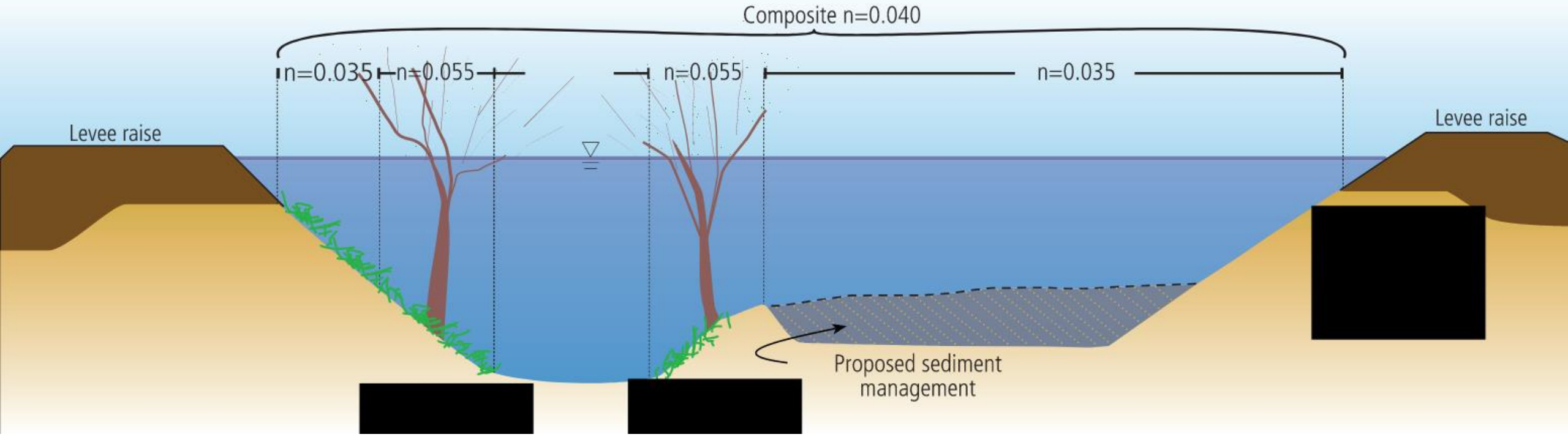
Notes:
1961 as-built (clear scraped) channel likely had 10- to 20-year flood capacity.
Sediment and vegetation accumulation reduced to 2- to 5-year capacity in 2006 (pre-WMP).

Background – WMP (2/2)

Design standards

North: 20-year / 5% annual chance

South: 10-year / 10% annual chance



Notes:
Illustration from preliminary study, not final WMP plan

Key WMP components:
(1) levee raise, (2) sediment removal, (3) vegetation maintenance

Background – Watershed & Data (1/2)

Rain Stations

Lopez Area (x3)

- Upper Lopez
- Lopez Dam

Arroyo Grande Area (x3)

- Arroyo Grande

Los Berros Area

- Los Berros

Stream Gages

Lopez Area

- Lopez Creek (USGS)

Arroyo Grande Creek (x4)

- Arroyo Grande
- 22nd Street

Los Berros Creek (x3)

- Los Berros – Stream

Notes:
Gaging network (credit Tech Unit) is robust in AG watershed.
Primary data gap is Tar Springs Creek.
All listed data sources considered/incorporated into hydrologic modeling. Key gages specifically noted.

Background – Watershed & Data (2/2)

Arroyo Grande Creek Gage

Los Berros – Stream Gage

Notes:
Entire analysis relies on calibration to rating curve-derived discharge estimates at these two stations.
AGAG est. 1939
Los Berros est. 1968
USGS discharge measurements until 1980s

Disclaimer

All results presented are preliminary and subject to change.

Uncertainty is unavoidable due to the inherent complexities of discharge measurement.

Limited QA/QC to date due to technical complexities.

Upper Lopez Canyon Rd abv Lake Lopez
1/31/2023

Hydrology (1/2)

Rain Station	January 9, 2023		March 10, 2023	
	3 hr	24 hr	3 hr	24 hr
Lopez Dam	2.2” [40-yr]	6.3” [75-yr]	0.9” [1-yr]	4.3” [9-yr]
Arroyo Grande	1.4” [10-yr]	3.8” [17-yr]	0.8” [1-yr]	3.1” [6-yr]
Los Berros	1.2” [2-yr]	4.2” [12-yr]	0.8” [1-yr]	3.2” [4-yr]

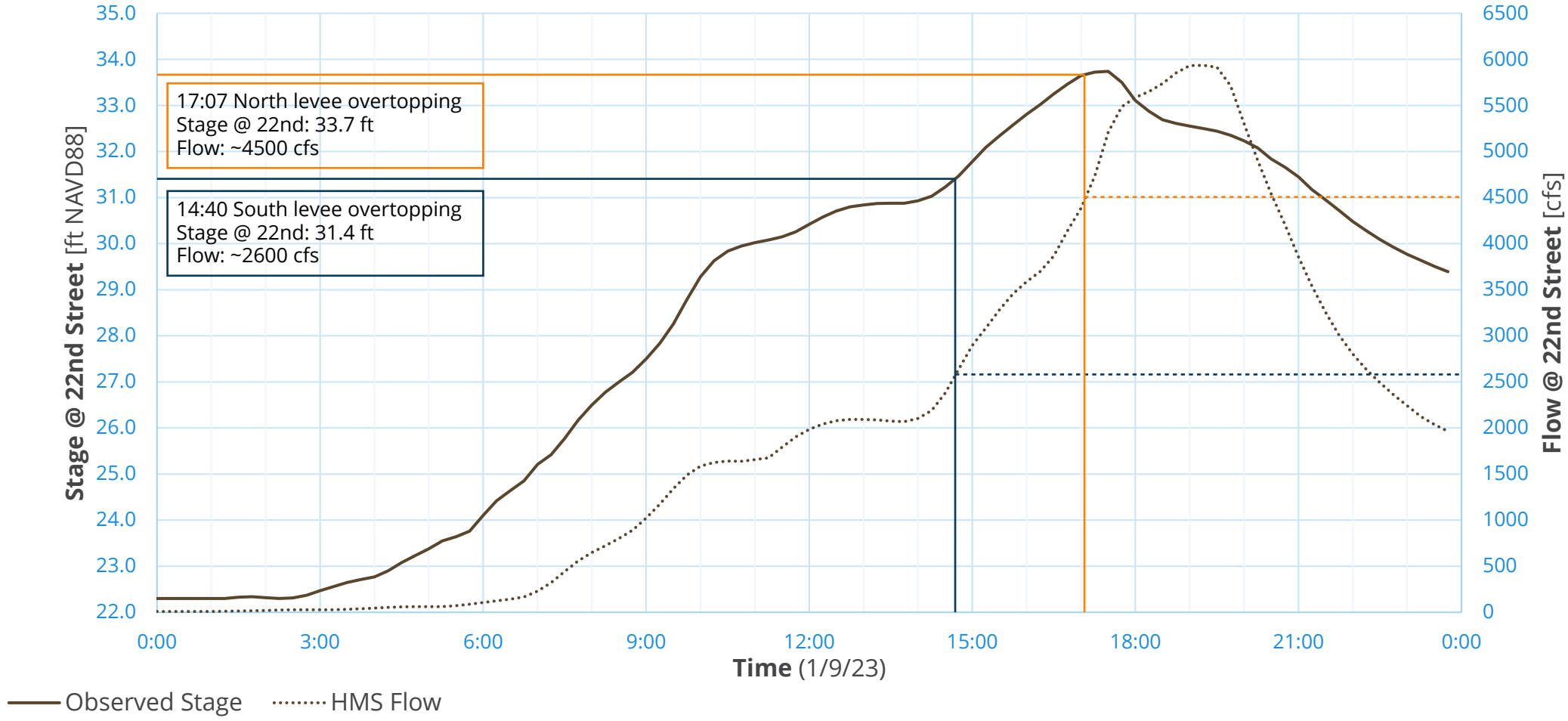
Notes:
3-hr peak most important to flooding on AG Creek.
24-hr more representative of total storm.
1/9/23: Upper watershed (Tar Springs & above Lopez) swamped. Less extreme rain below.
3/10/23: Modest storm but watershed already saturated.

Hydrology (2/2)

Event	Peak Flow	Recurrence
January 9, 2023	~6,000 cfs	12-year
March 10, 2023	~2,700 cfs	5-year

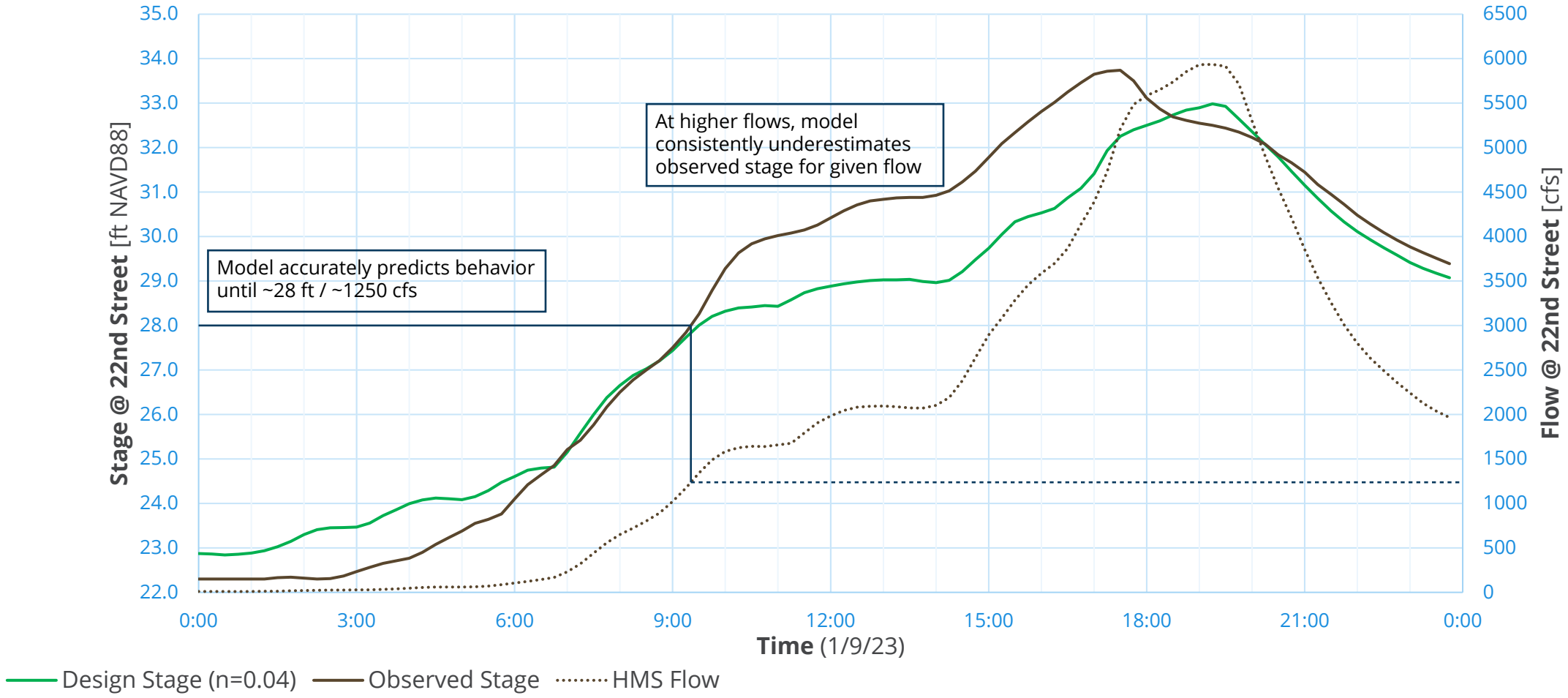
Notes:
Flow estimates from routed flow at stream gages + calibrated hydrologic model for watershed below gages.
Recurrence from 1999 USACE analysis. Recurrence applicable whether or not Lopez is discharging during flood.
Overtopping of north levee not expected behavior 1/9/23.

Hydraulics



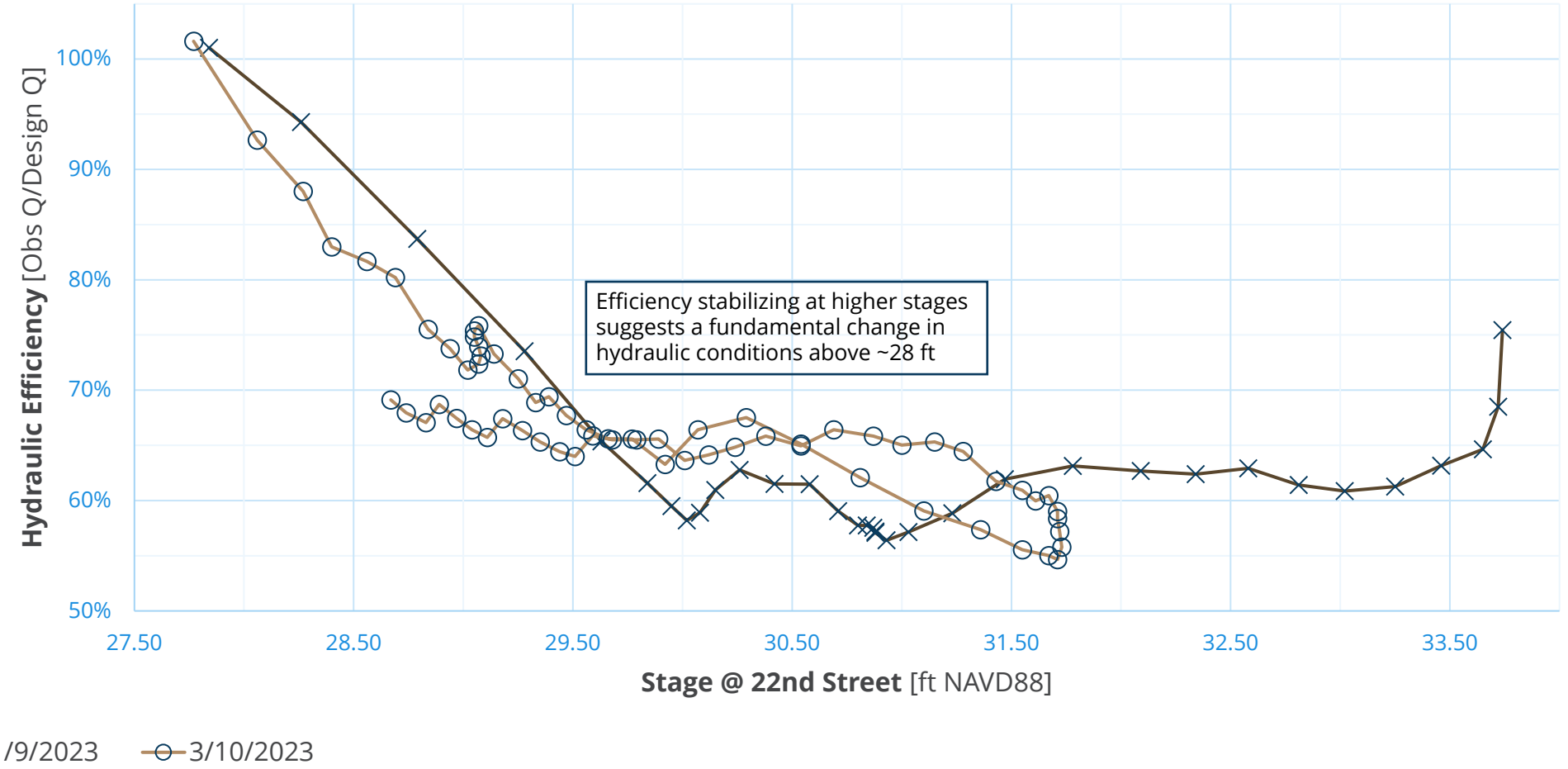
Notes:
5-year recurrence flow = 2800 cfs
10-year recurrence flow = 5400 cfs
Peak >10-year, but levee failure at ~17:30 caused stage to drop prior to peak flow.

Hydraulics



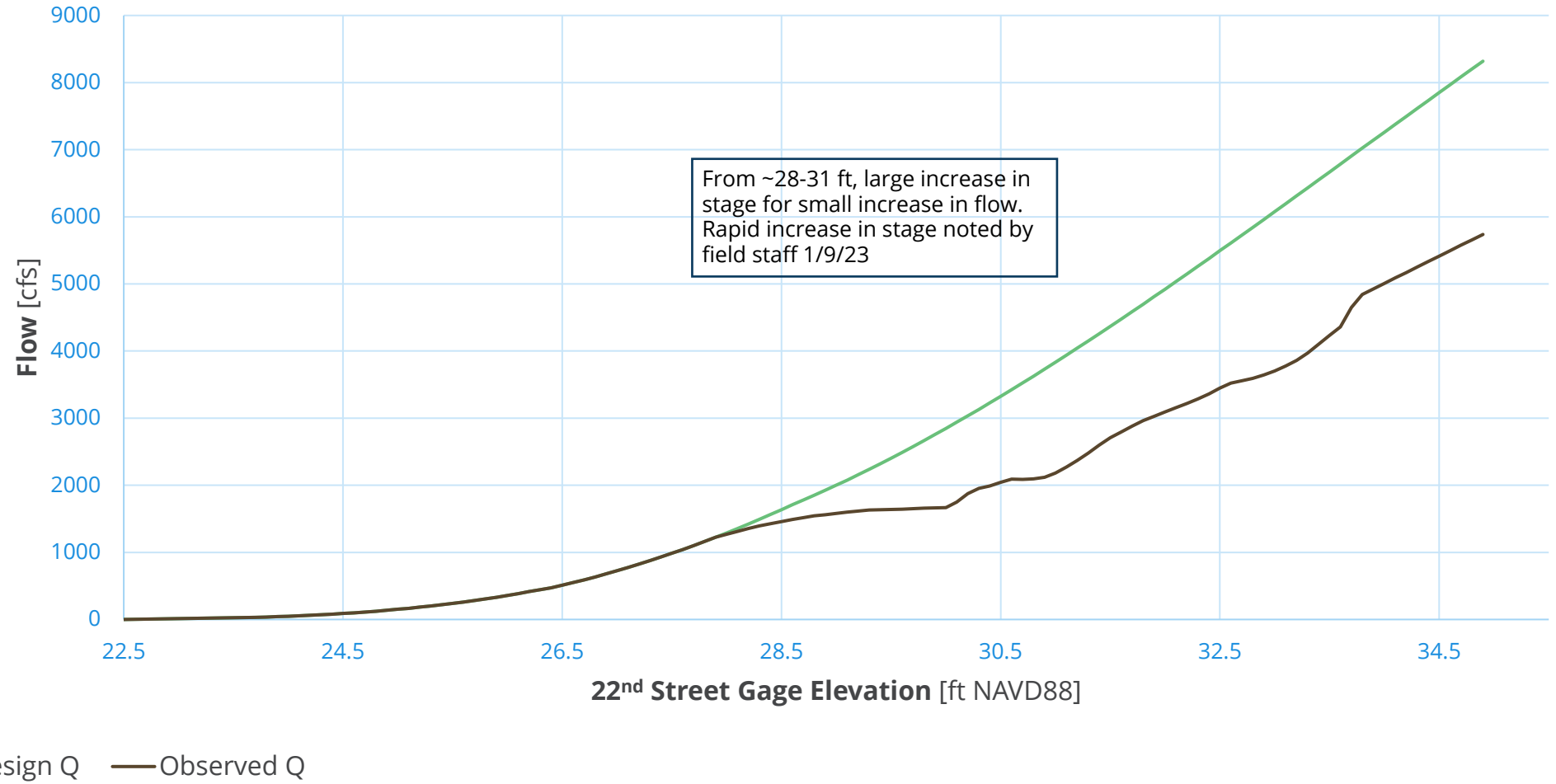
Notes:
Design Stage represents HMS hydrograph run through design hydraulic model.
Overprediction at <100s cfs expected – different hydraulics at low flows.
3/10/23 not shown but same pattern present.

Hydraulics



Notes:
1/9/23 values only include data points prior to levee failure. Increase in apparent efficiency at stages >33 due to flow exiting channel.
3/10/23 values 'loop' back and differ at stages due to different hydraulics on rise and fall of hydrograph.

Hydraulics

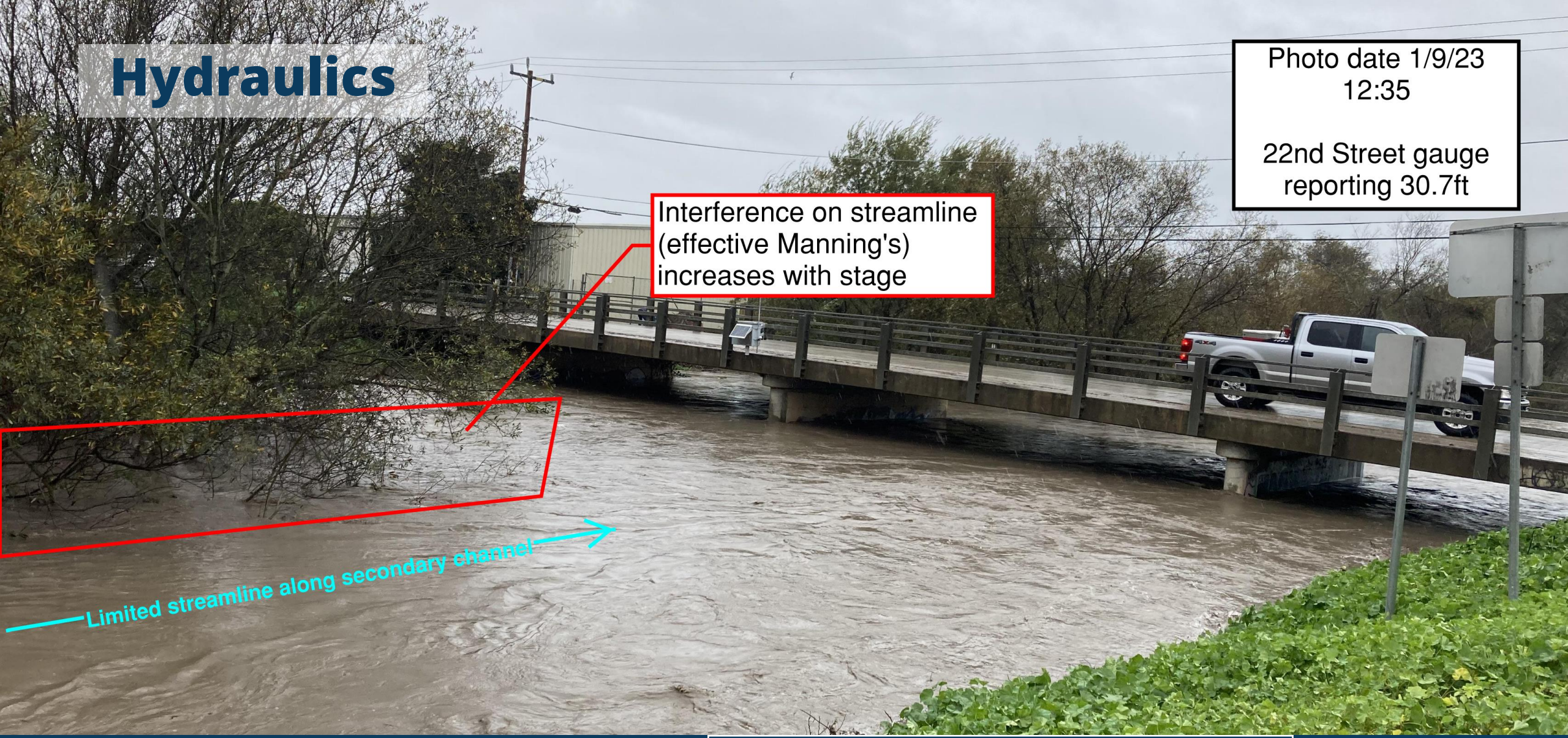


Notes:
Observed curve assumes design behavior <1250 cfs.

Hydraulics

Notes:
Reviewed design docs, event logs and photos, etc. to investigate discrepancy at high stages. Instream tree canopy drew attention.
This is a relatively open reach along the creek. Note minimal vegetation below stage drawn in blue.

Hydraulics



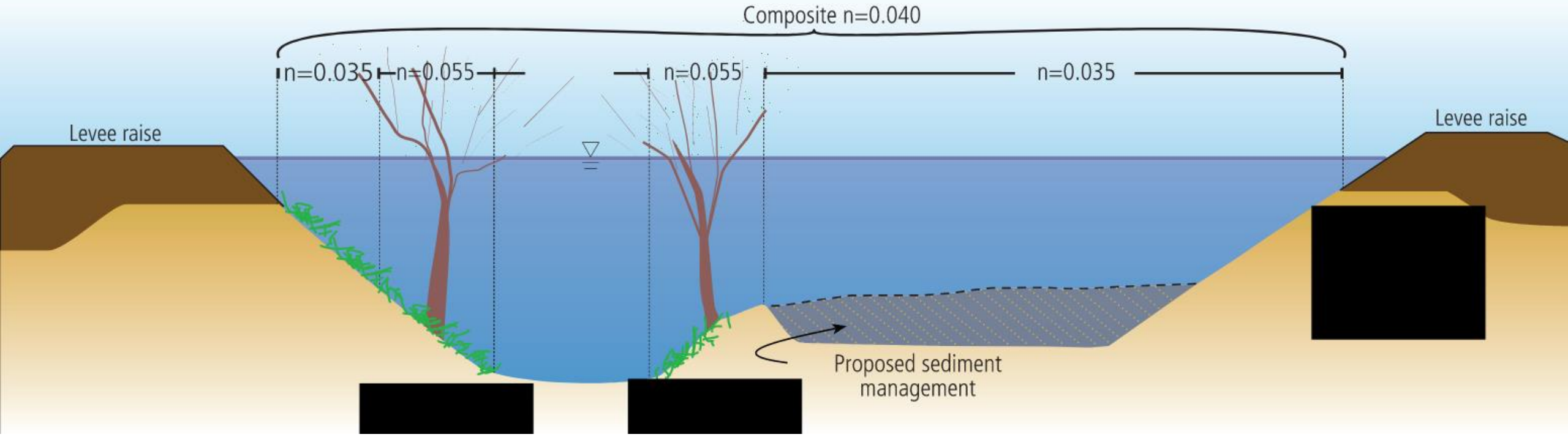
Notes:
Effective Manning's = roughness

Hydraulics

Notes:
Note difference in water elevation at right pier vs middle pier.

Design hydraulic model does not account for varying conditions that can cause differences like this across the channel.

Hydraulics



Notes:
Design documents assume minimal canopy exposed to flow.
Canopy influence is more significant within 'buffer' areas than design assumed.
Canopy below levee crowns extends beyond buffer areas– not assumed in design.

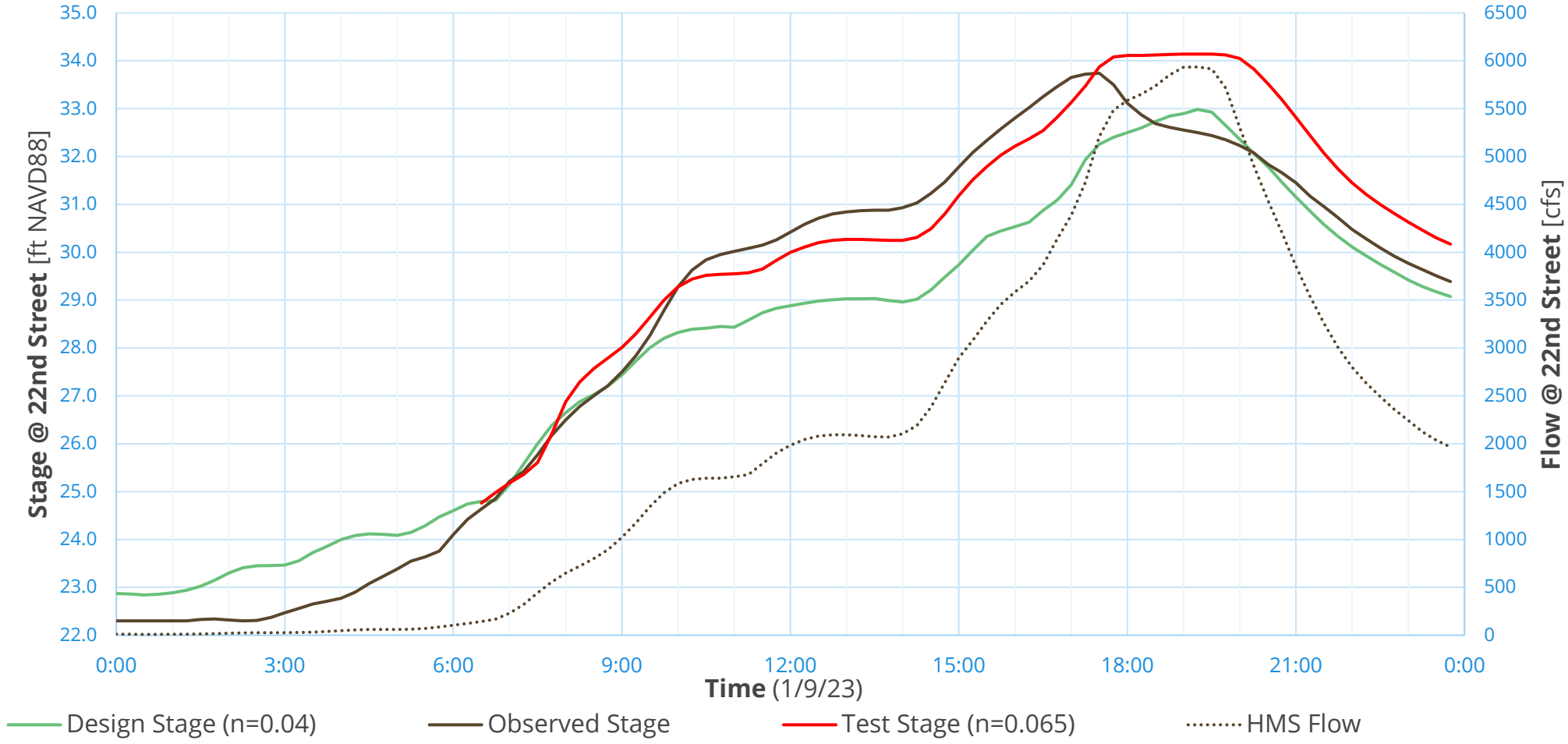
Hydraulics

Channel abv UPRR
8/20/2007

Public Works
Water Resources

Notes:
Compared to pre-WMP conditions, much lower roughness in lower channel elevations.
However, at high stages, tree canopy is more developed/rough.
Design engineer estimated roughness c. 2005 as n=0.057.

Hydraulics



Notes:
Test Stage represents HMS hydrograph run through design hydraulic model with estimated, higher roughness.

Residual discrepancy appropriate for freeboard considerations (debris jams, sediment deposition, etc.)

Summary

- Sediment removal and levee raise beneficial
- Permitted vegetation maintenance not in accordance with design assumptions
- Assumed performance

  North: 10-year / 10% annual chance (from 20-year / 5%)

  South: 5-year / 20% annual chance (from 10-year / 10%)

Notes:
Despite vegetation issue, net improvement from pre-WMP. Moreover, in absence of WMP, sediment & vegetation accumulation would have further reduced conveyance capacity.

What Now?

- **Internal**
  - Emergency response planning & flood forecasting
  - Tar Springs data coverage
- **WMP**
  - Consultant Review of modeling & vegetation
  - Survey to characterize vegetation by location
- **Future**
  - Potential re-engagement with regulatory agencies
  - Grant to study other alternatives

Questions?