Degradation in the Papillion Creek Watershed: Predicting, Preventing, and Planning

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Presented to: Omaha Sediment and Erosion Control Seminar

Date: 10 February 2022

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STUDY BACKGROUND

Goals

- Assess the level of stream degradation that has occurred since the streams were originally classified by USACE and USGS in the 1990s; and
- Develop a comprehensive strategy document that identifies level of stream degradation, which assets are at greatest risk (i.e., bridges, utilities, residential and commercial development, and ecosystem), and identifies priority construction projects.

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STUDY BACKGROUND

Objectives

- Conduct Basin Assessment to determine status of watershed.
- Identification and categorization of sites according to type, risk and issue.
- Evaluate the current state and trends of degradation and channel change in select watersheds
- *Provide the FluvialGeomorph ArcGIS tool and files from the analysis for future use by the sponors
- Identify local solutions with watershed/regional benefits
- *Create a Solutions Matrix that connects three specific areas of concern to application of solutions throughout the watershed
- Develop a list of projects with a determined priority identification.
- Develop conceptual (30%) site designs for three sites.
- Evaluate the regulatory and environmental consideration of the proposed designs.

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PAPILLION CREEK BASIN ASSESSMENT

- Through meetings with PCWP members, ‘areas of concern’ were identified
- April 2019 Site visit cataloged most of these sites – Primarily on Cole Creek, West Papio Creek, and South Papio Creek.
- Additional Site visits in 2020 and 2021 expanded the number of sites visited – Thomas Creek, Hell Creek, Big Papio Creek, Little Papio Creek
- FluvialGeomorph Analysis completed on multiple Creeks
- For three ‘focus’ creeks, Cole, West Papio, and South Papio, a toolbox of bed degradations centered around ‘Engineering with Nature’ were developed.
- Each toolbox suggest solutions that have wide applicability across the watershed.
- Cole Creek – Mature Watershed
- West Papio – Actively Adjusting Watershed
- South Papio – Developing Watershed

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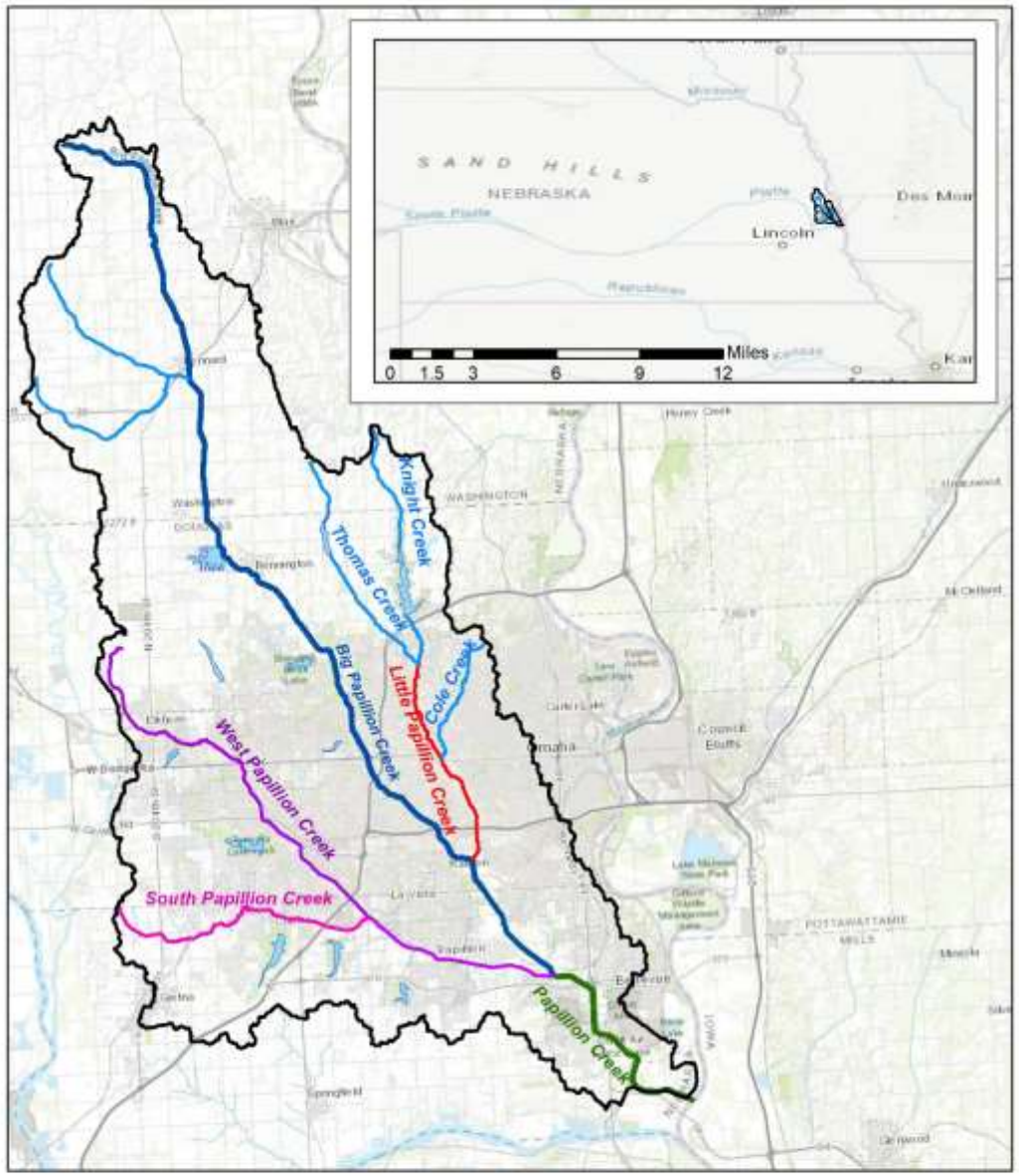

Map of Study Area: Papillion Creek Basin

Papillion Creek Basin

Exsiting Dams & Lakes

Jan 2021

N

0 2 4 8 12 16 Miles

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WHAT IS FLUVIALGEOMORPH?

FluvialGeomorph (FG): is a rapid watershed assessment toolkit developed by the Corps of Engineers to assess stream channel stability.

- uses existing high-resolution terrain data-Light Imaging Detection and Ranging (LiDAR) or other available data sets to measure and compare channel morphology.
- channel morphology is then mapped and compared against representative stable channel dimensions (empirical relationships) to identify locations within the watershed where channel instability exists.
- Assessments are completed on a single data set or multiple years depending on the availability of data.
- Geomorphic mapping and the associated metrics provide a basis to identify and assess priority locations within the watershed for further data collection and study or concentrated restoration.

Advantages to Using FG Analysis:

1. Cover large areas of the watershed
2. Identifies area showing degradation or channel migration with remotely sensed data (minimizing field verification)
3. Changes in metrics through time can be used a predictor of future areas of concern
4. Can easily be update when a new LiDAR data set is available
5. Public Access (FREE!)

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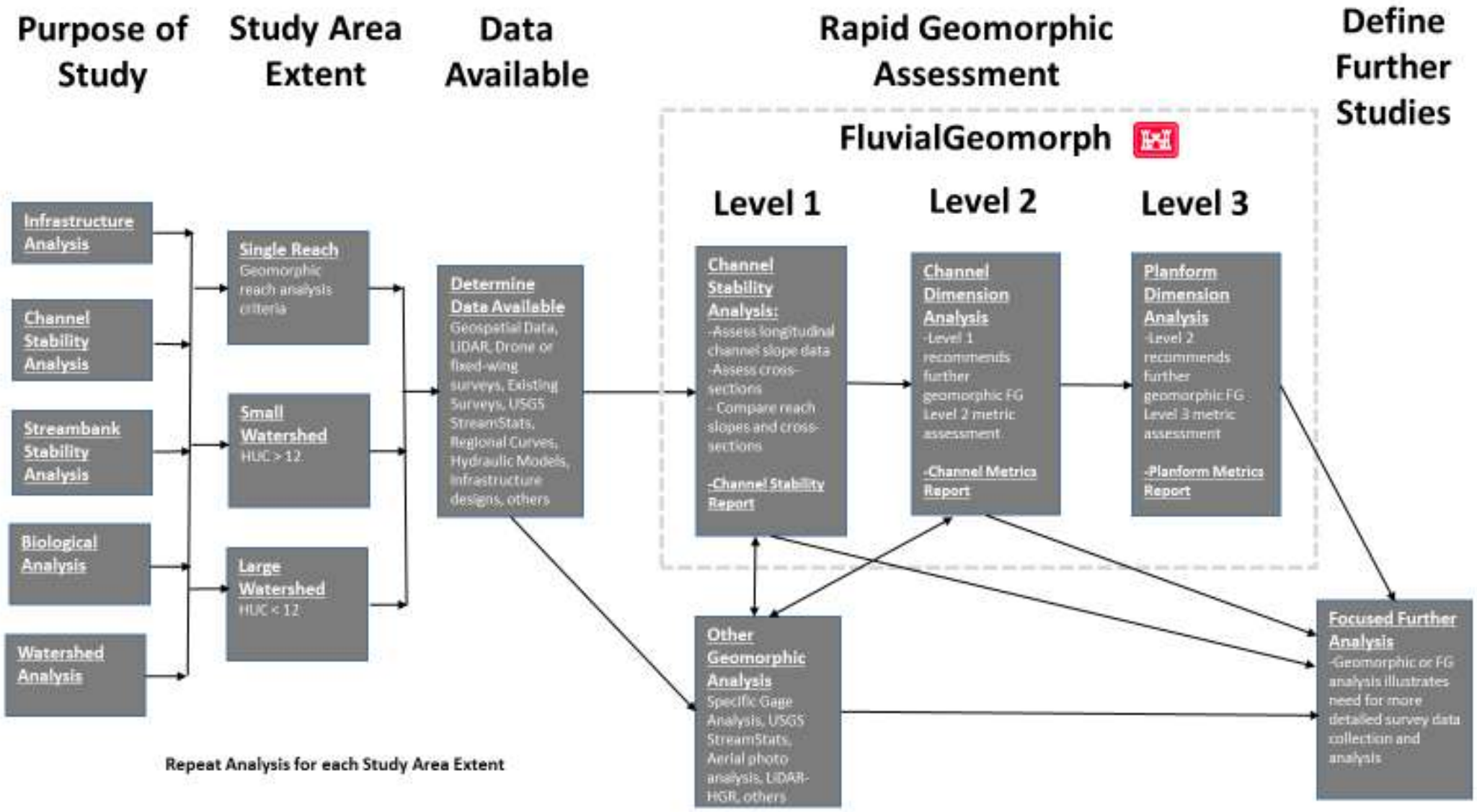
FLUVIALGEOMORPH WORKFLOW



WHAT CAN FLUVIALGEOMORPH TELL US?

- The analysis uses GIS to blend LiDAR change analysis (2004, 2010, 2016) with incremental volume changes and hydraulic modeling to develop relationships between channel geometry and hydraulics
- These relationships can be based on:
  - bankfull width (if using FEMA WSP's)
  - mean depth
  - cross section area
  - channel/valley (left/right) reach slopes
  - sinuosity
  - meander/beltwidth patterns
  - floodplain access for reaches
  - width-depth ratios
  - entrenchment ratios
  - stream power
  - shear stress

Level 1 & 2 Analysis (bed change + morphology metrics)

- Cole Creek
- South Papillion Creek
- West Papillion Creek

Level 1 Analysis (bed change only)

- Thomas Creek
- Little Papio to Washington County line
- Big Papio to Washington County line
- Hell Creek

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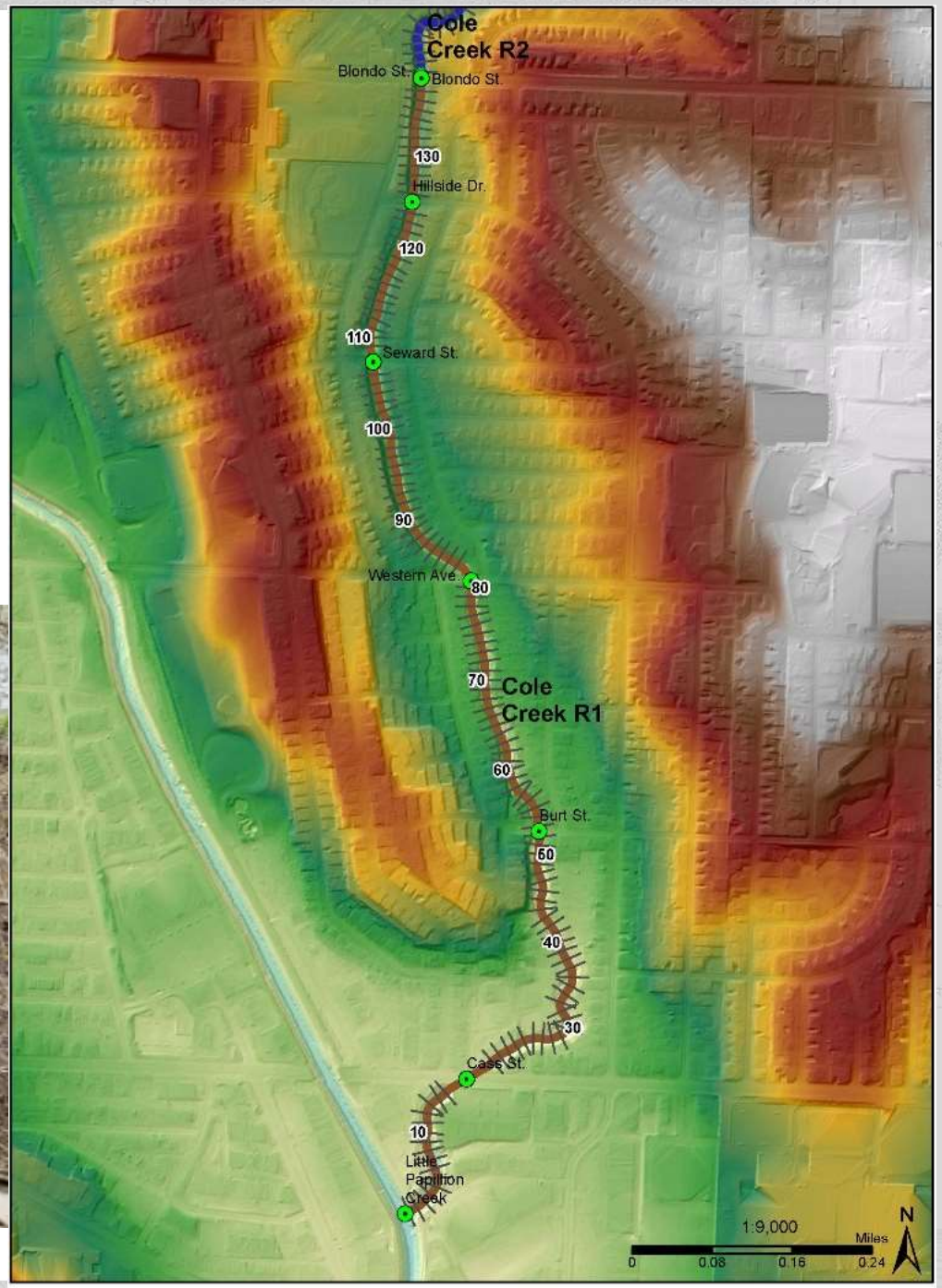
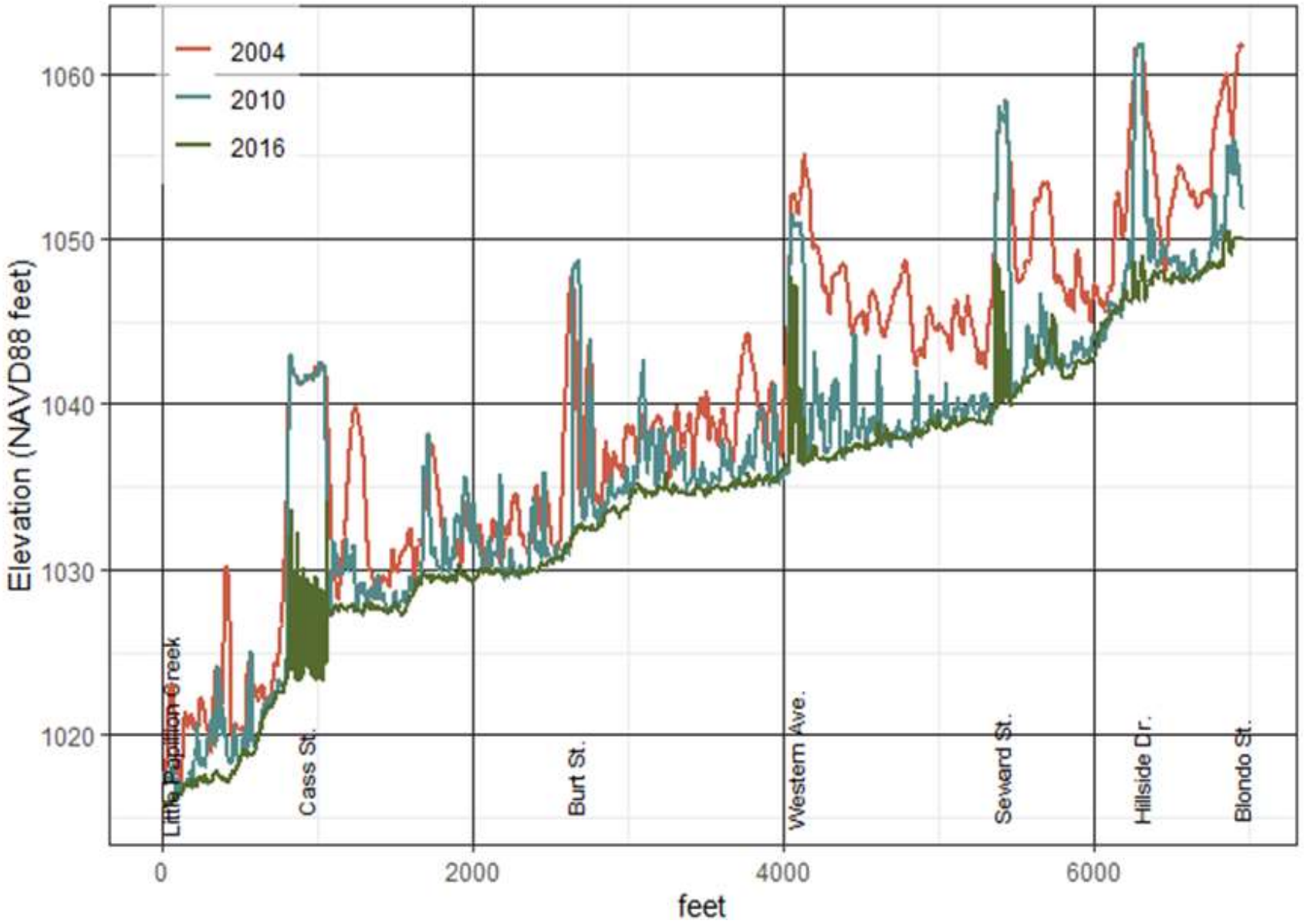
COLE CREEK ANALYSIS

Primary Area of Concern – Western Ave to Blondo Street, with Seward St. and Hillside Dr.



COLE CREEK REACH 1 – MOUTH TO BLONDO ST.



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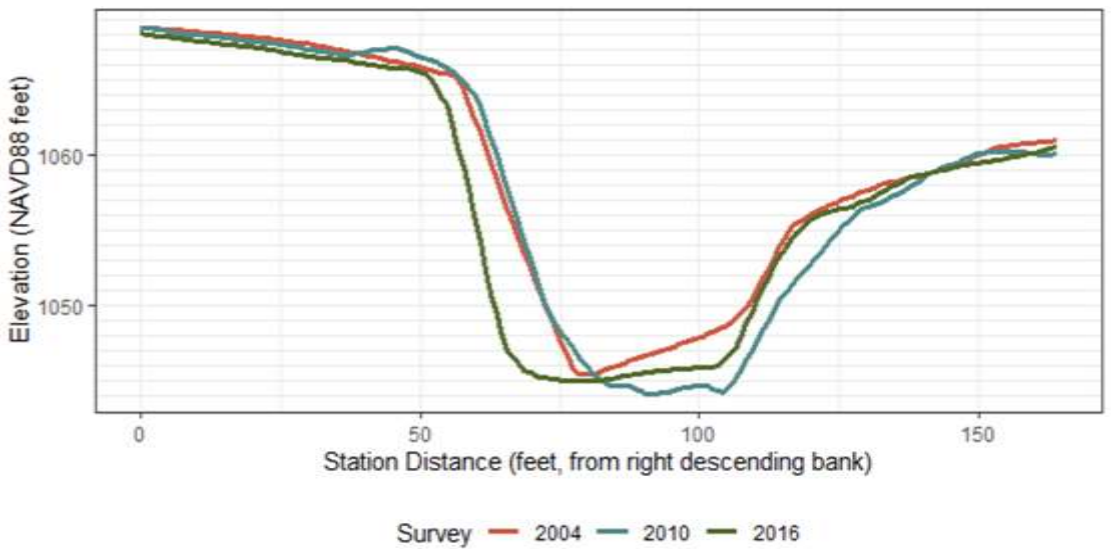
COLE CREEK BELOW HILLSIDE DRIVE



COLE CREEK DESIGN SCREENING

Alternative	Planning Objectives?		Planning Constraints			Screening Result
	Meets Purpose and Need [	Sustainable	Technically Feasible	Includes beneficial environmental opportunities	Level of structural bank protection	
Alt 1 - No Action	No	No	NA	No	NA	**Does not meet the need of the project**
Alt 2 – Steel Sheet Pile Wall	Yes	Minimal maintenance	Yes	No, no vegetation components and unnatural in appearance	Total	**Not environmentally beneficial, likely not the least cost alternative**
Alt 3 – Retaining Wall	Yes	Minimal to moderate maintenance	Yes	No, no vegetation components	Partial to Total	**Environmentally beneficial, Not least cost alternative**
Alt 4 – Riprap Blanket w/Toe	Yes	Minimal to moderate maintenance	Yes	Yes, vegetation component above blanket	Partial	**Environmentally beneficial, not least cost alternative**
Alt 5 – EWN LPSTP/LFSTP w/bioengineering	Yes	Minimal to moderate maintenance	Yes	Yes, potential to incorporate vegetation and contribute to viewshed aesthetic value	Partial: up to half bank height based on final design	**Environmentally beneficial, likely a component of least cost alternative.**
Alt 6 – Full Bank Rock Wall	Yes	Minimal to moderate maintenance	Yes	Yes, majority of wall covered with topsoil and vegetation contributing to viewshed aesthetic value	Total	**Environmentally beneficial, not least cost, but long life with minimal maintenance**
Alt 7 – GCS	Yes	Minimal to moderate maintenance	Yes	Yes, stone facing; potential to incorporate vegetation and contribute to viewshed aesthetic value	Partial: provided limited toe protection, does prevent channel deepening & widening	**Environmentally beneficial, likely a component of least cost plan**
Alt 8 – Buyouts	Yes	Moderate to significant maintenance	Yes	No	NA	**Environmentally and economically unacceptable**

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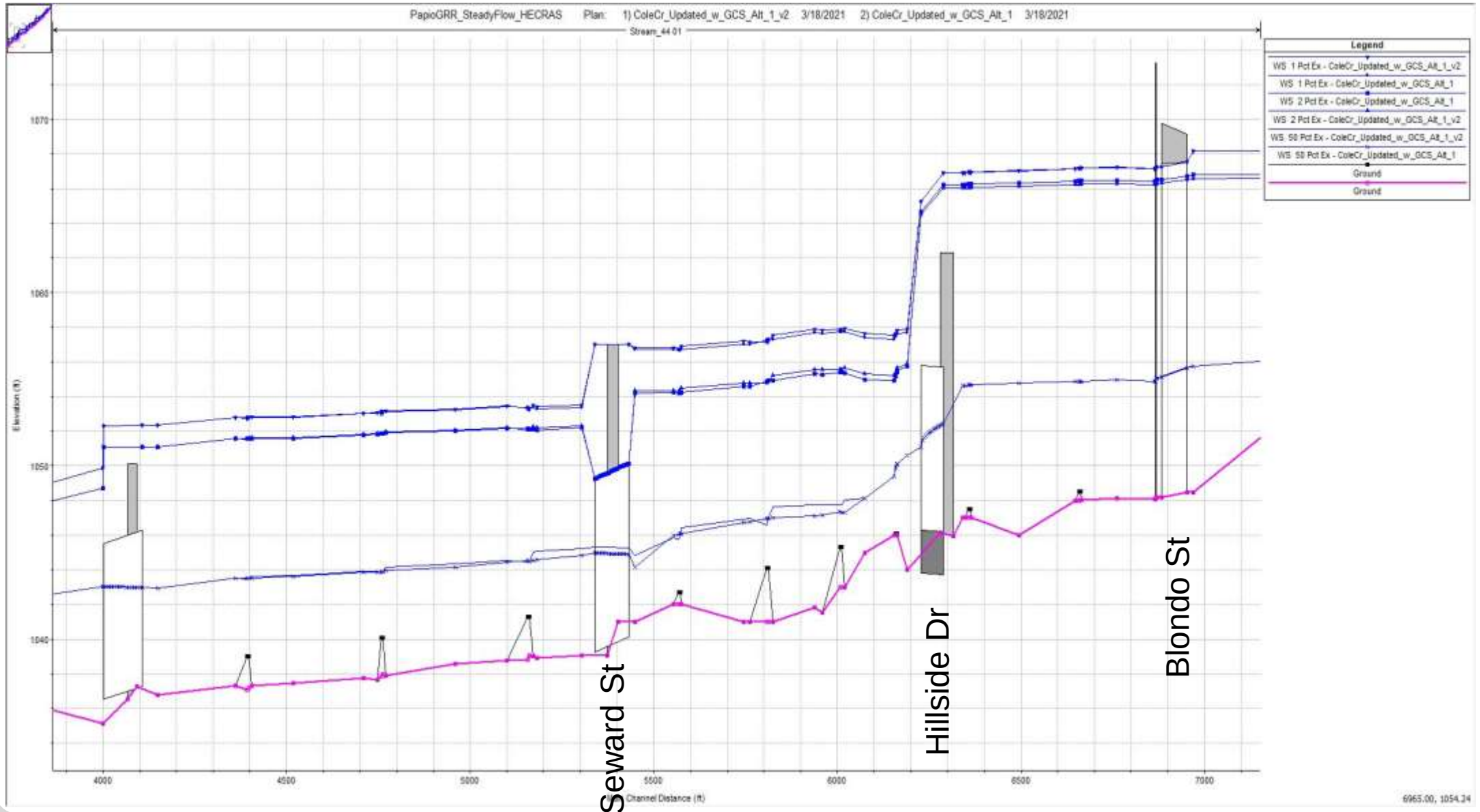
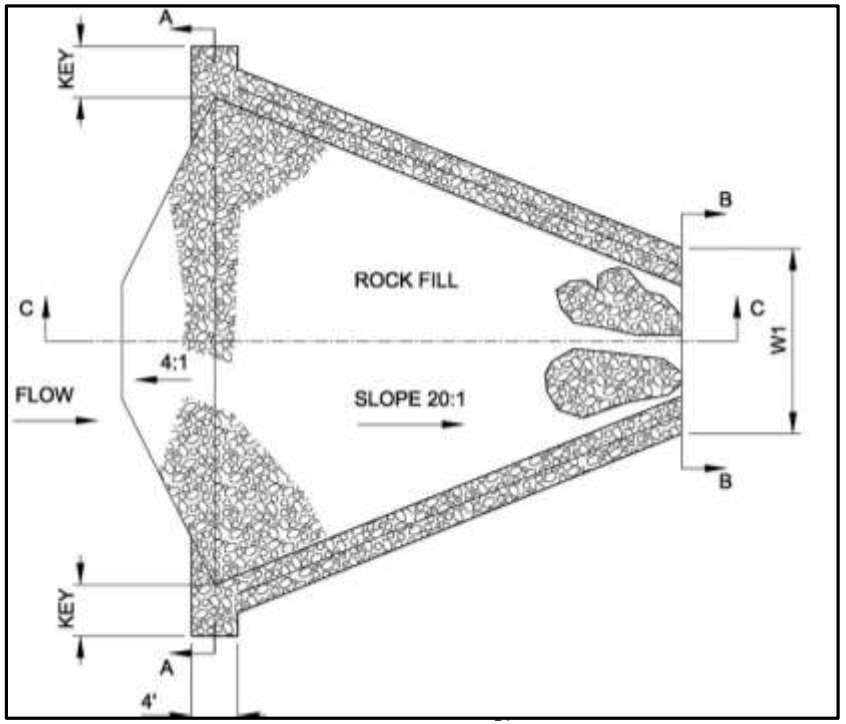
PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

COLE CREEK DESIGN



EXAMPLE QUANTITIES AND LAYOUT –
COLE CREEK RIFFLES – HILLSIDE DR TO SEWARD ST. – EXPANDED TO WESTERN TO BLONDO

	Station (ft)	Elev (ft)	InRoads Fill Volume (CY)	Tonnage Volume (TON)	Foundation Thickness (FT)	Foundation Tonnage (TON)	Key Tonnage (TON)	Total Tonnage (TON)	$/ton	$
GCS #1	5610	1043.2	30	49.5	3	194	18	262	80	$20,973
GCS #2	5850	1044.6	140	231	3	411	18	660	80	$52,800
GCS #3	6050	1045.8	120	198	3	528	18	744	80	$59,547
GCS #4	6200	1046.6	10	16.5	3	70	18	105	80	$8,360
							SUM	1771		$141,680



- Concept Quantities developed utilizing available .dtm and 3D modeling.
- Less robust data sources in other reaches will require more empirical estimates

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PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

- Site B – 132nd Street Bridge at West Papio Creek

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WEST PAPIO CREEK AT 132ND STREET

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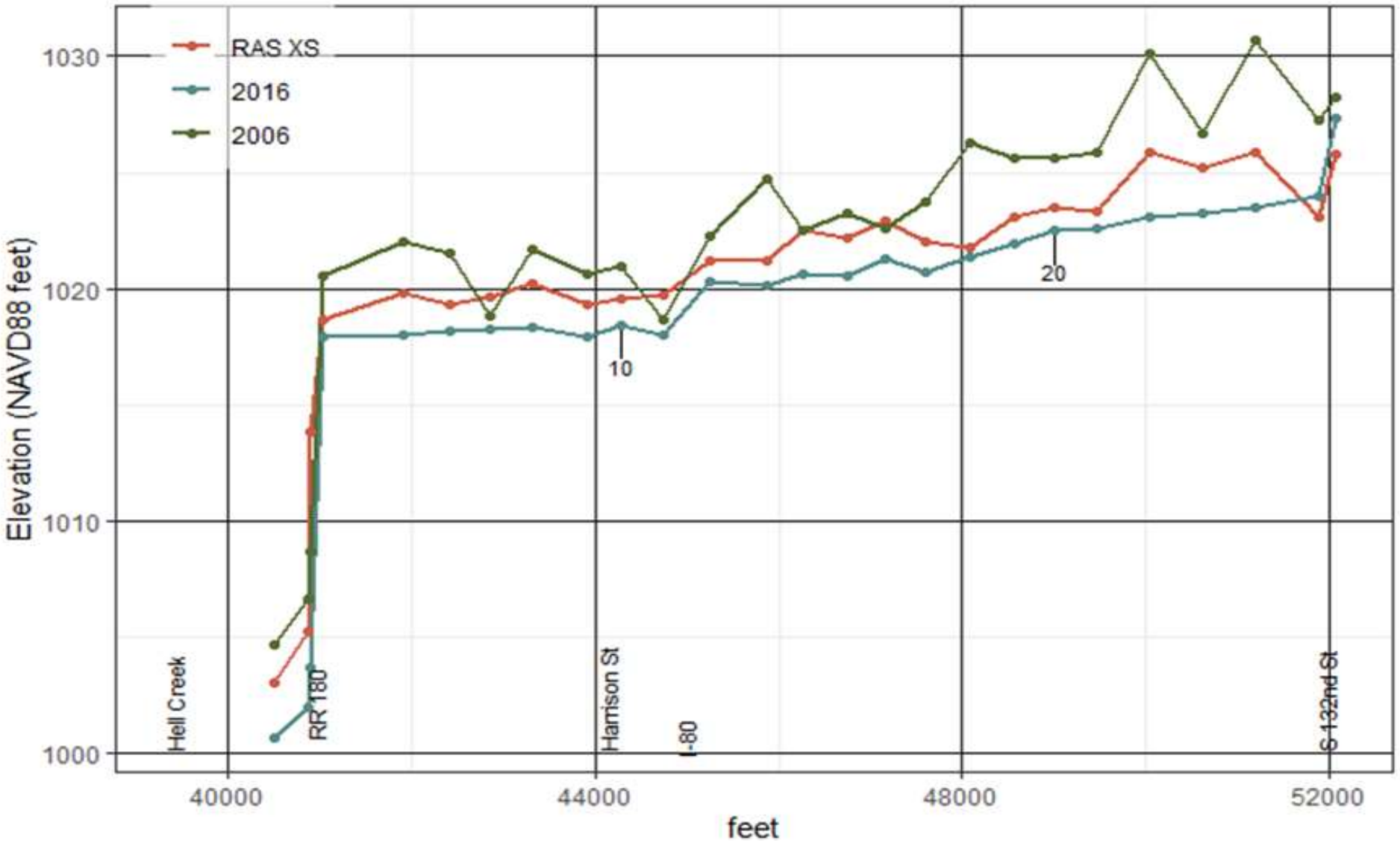
WEST PAPIO BED DEGRADATION



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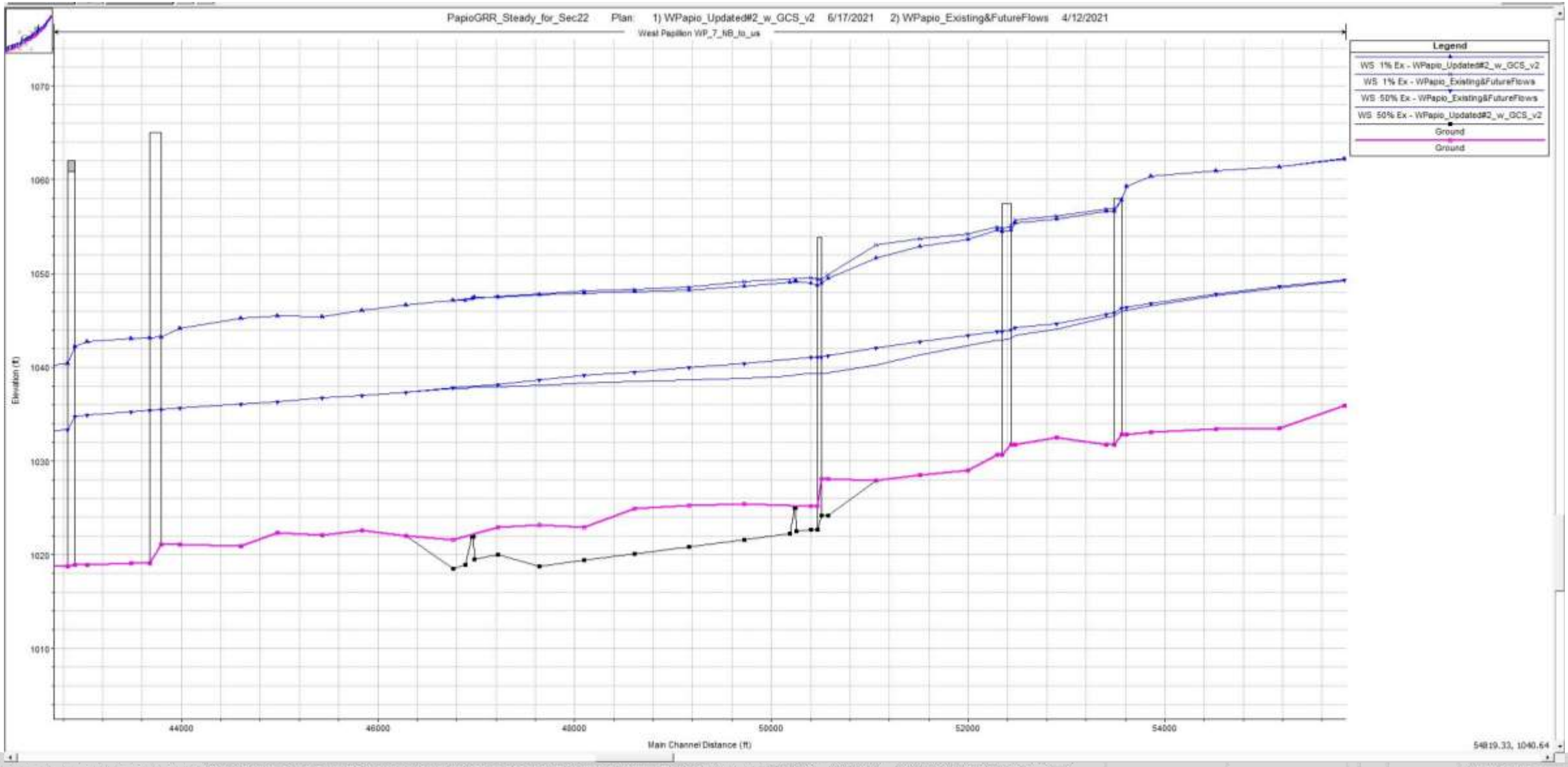
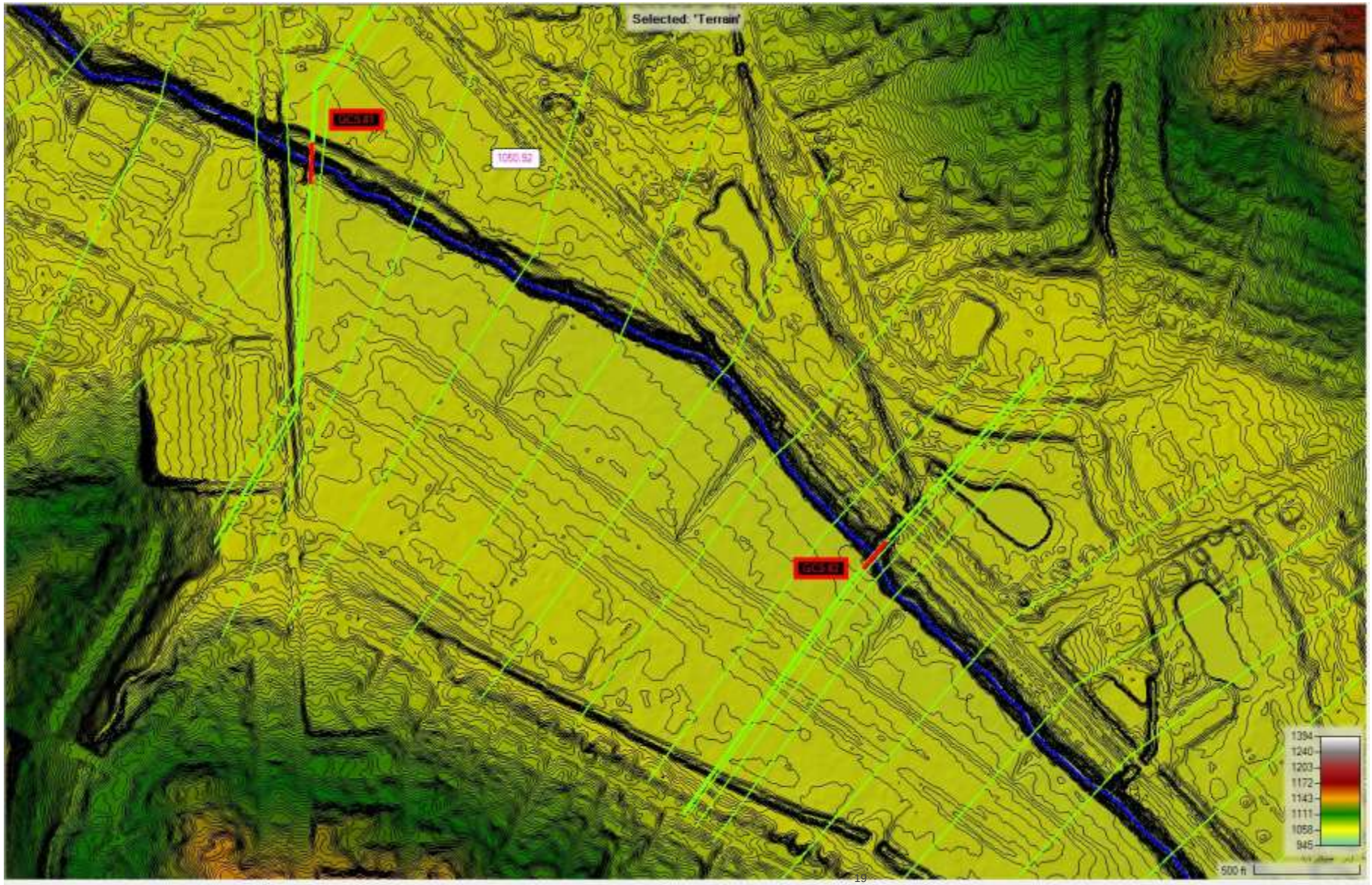
PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

WEST PAPIO @ 132ND STREET DESIGN



DOWNSTREAM ROCK SERVING AT GRADE CONTROL



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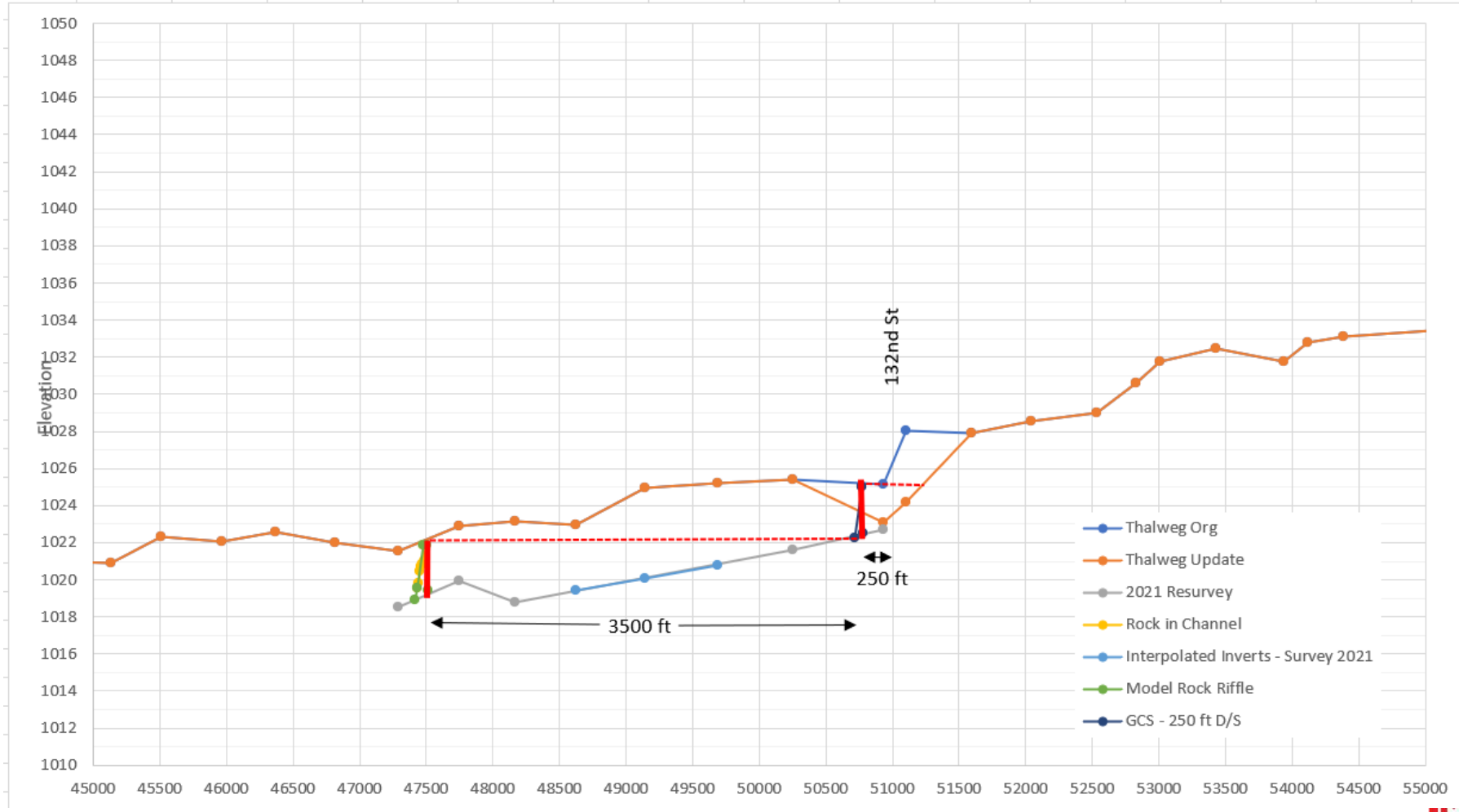
UPDATED CHANNEL SURVEY – WEST PAPIO AT 132ND ST



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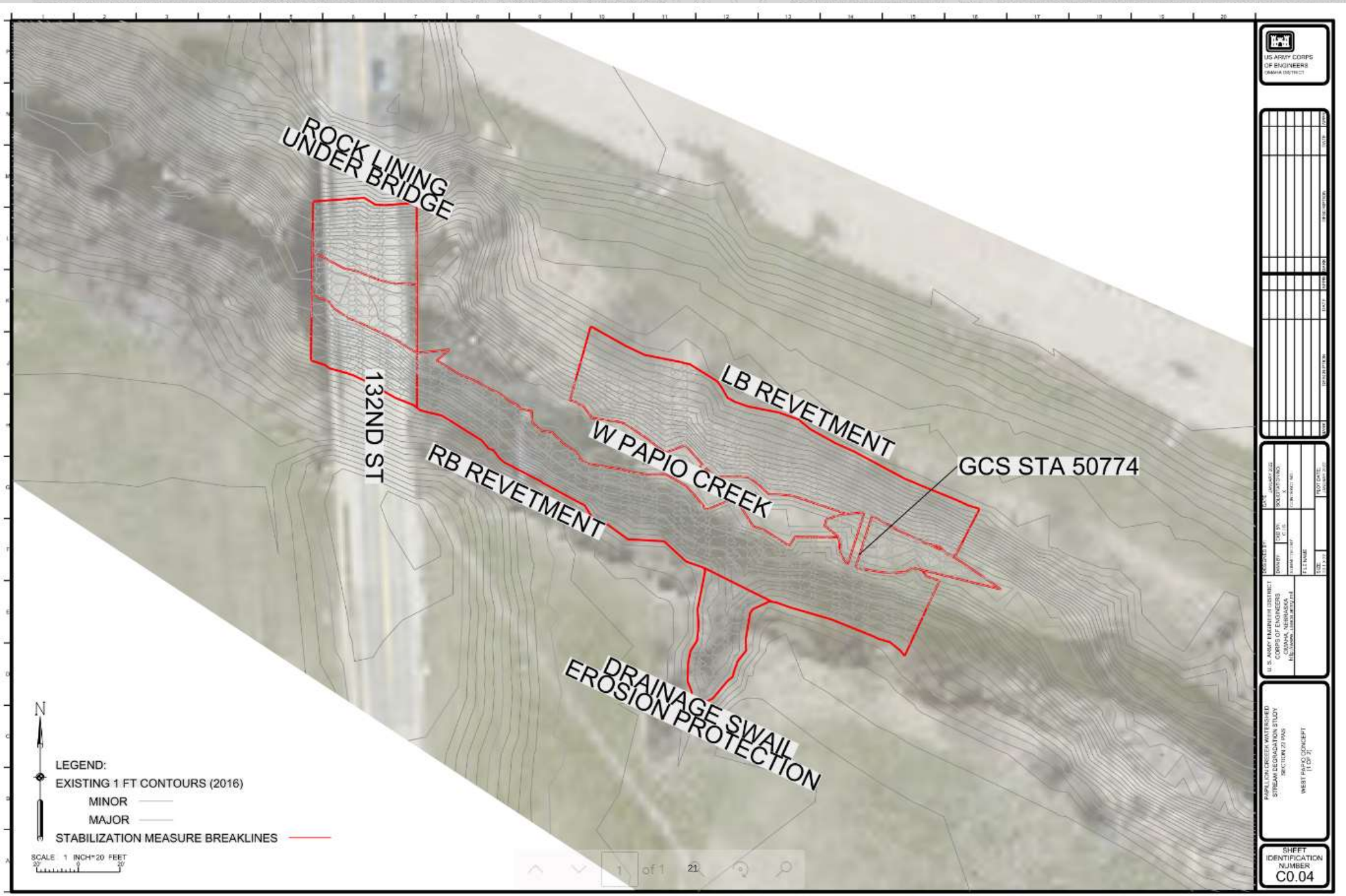
ROCK LINING UNDER BRIDGE
132ND ST
LB REVETMENT
W PAPIO CREEK
RB REVETMENT
GCS STA 50774
DRAINAGE SWALE EROSION PROTECTION
N
LEGEND:
EXISTING 1 FT CONTOURS (2016)
MINOR
MAJOR
STABILIZATION MEASURE BREAKLINES
SCALE 1 INCH=20 FEET
US ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS OMAHA, NEBRASKA
PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY SECTION 22 PAS
WEST PAPIO CONCEPT (1 OF 2)
SHEET IDENTIFICATION NUMBER
C0.04
1 of 1
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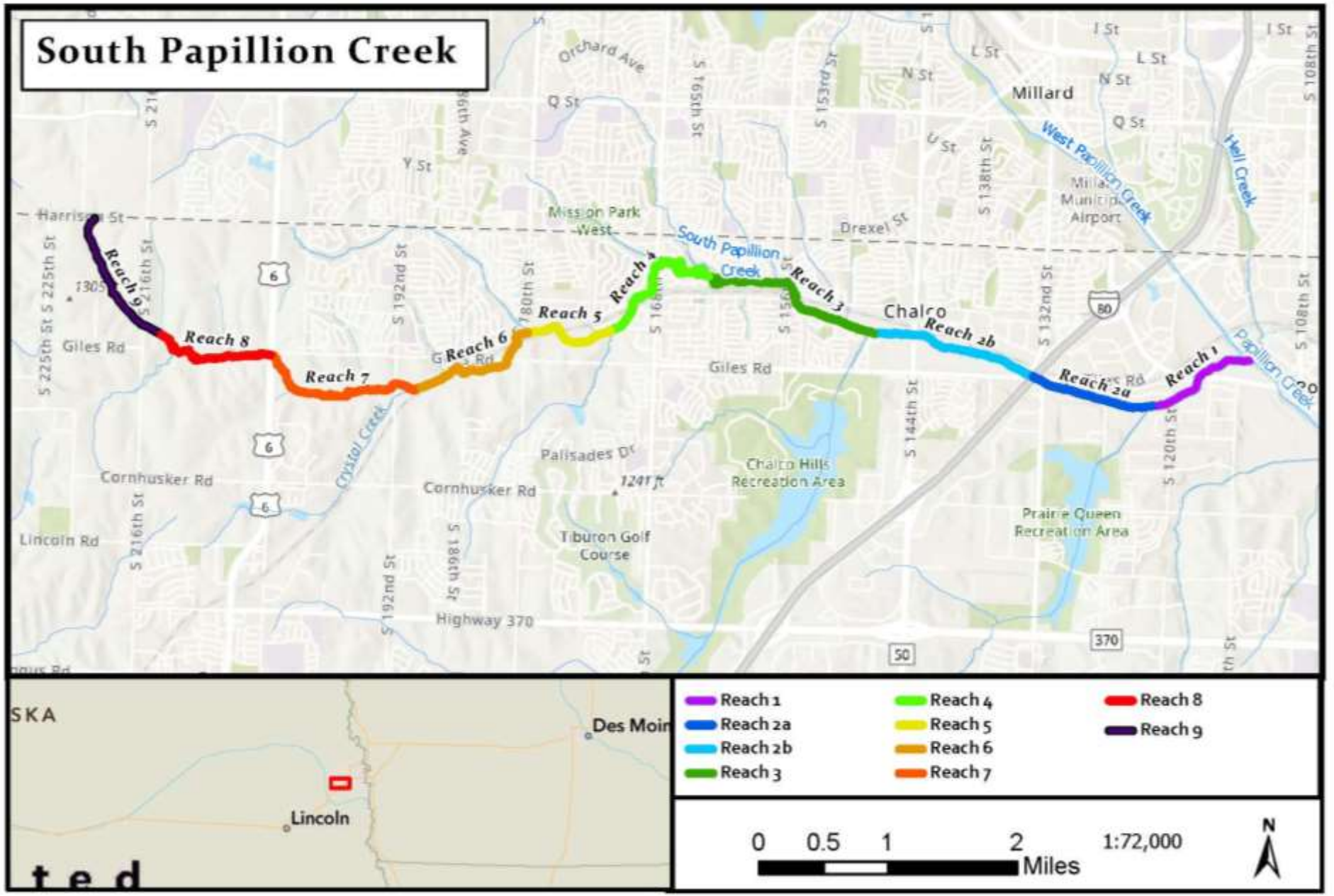
PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

- **Site C – South Papio Creek from Confluence to Giles Rd (above Beedle Creek)**



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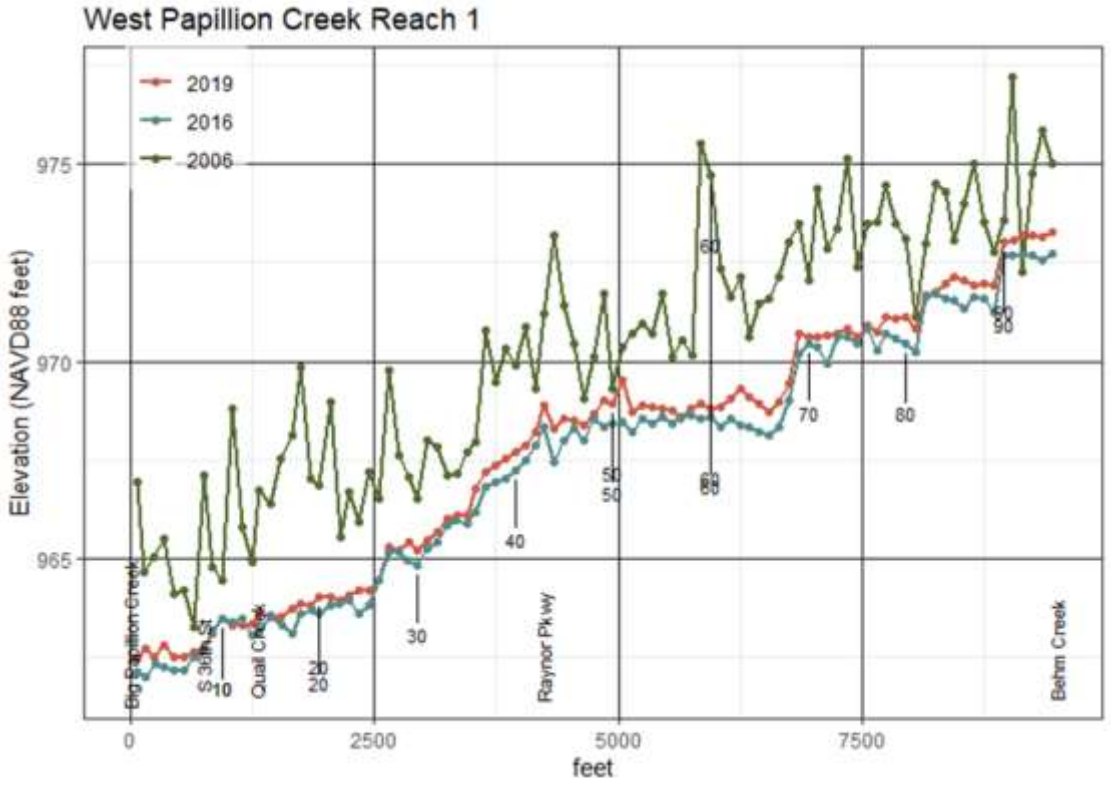
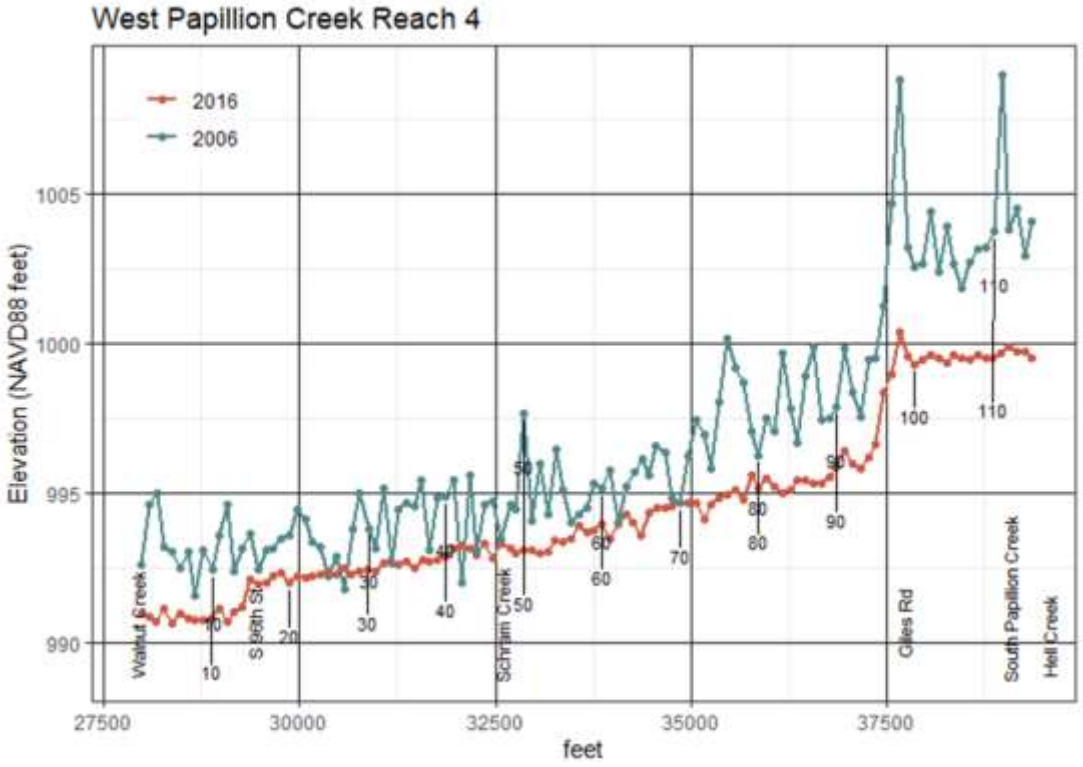
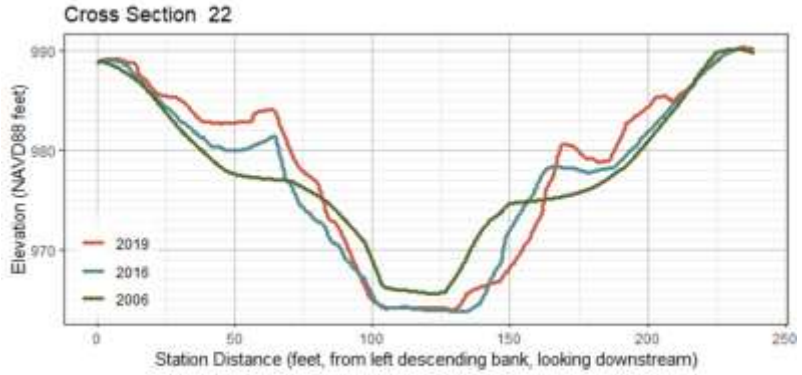
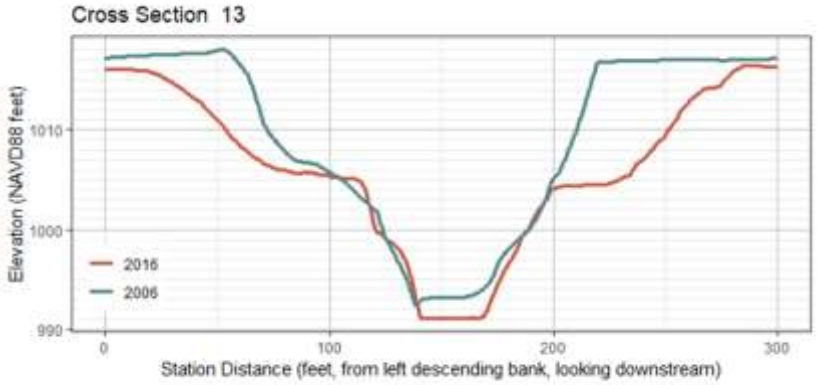
WEST PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

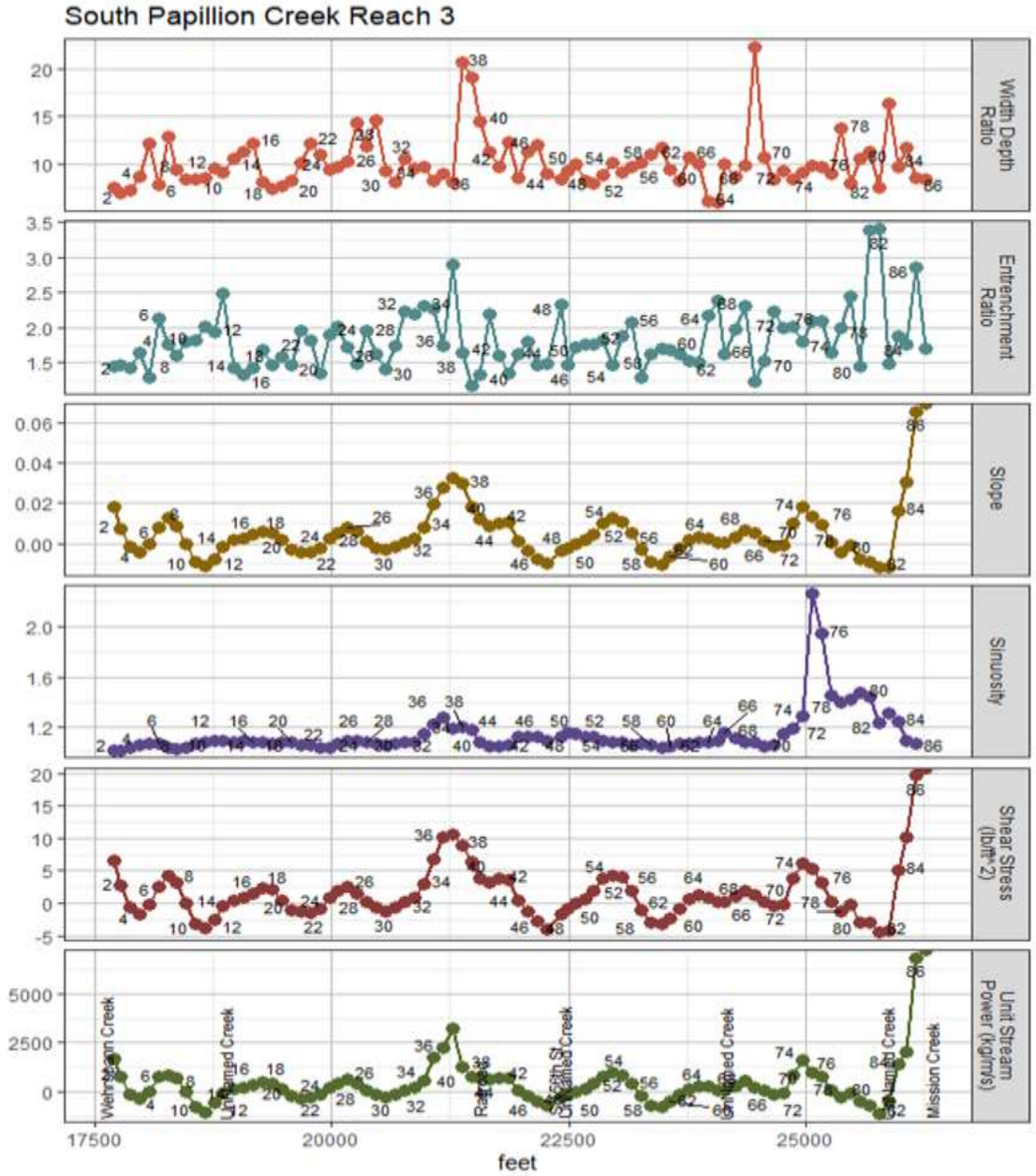


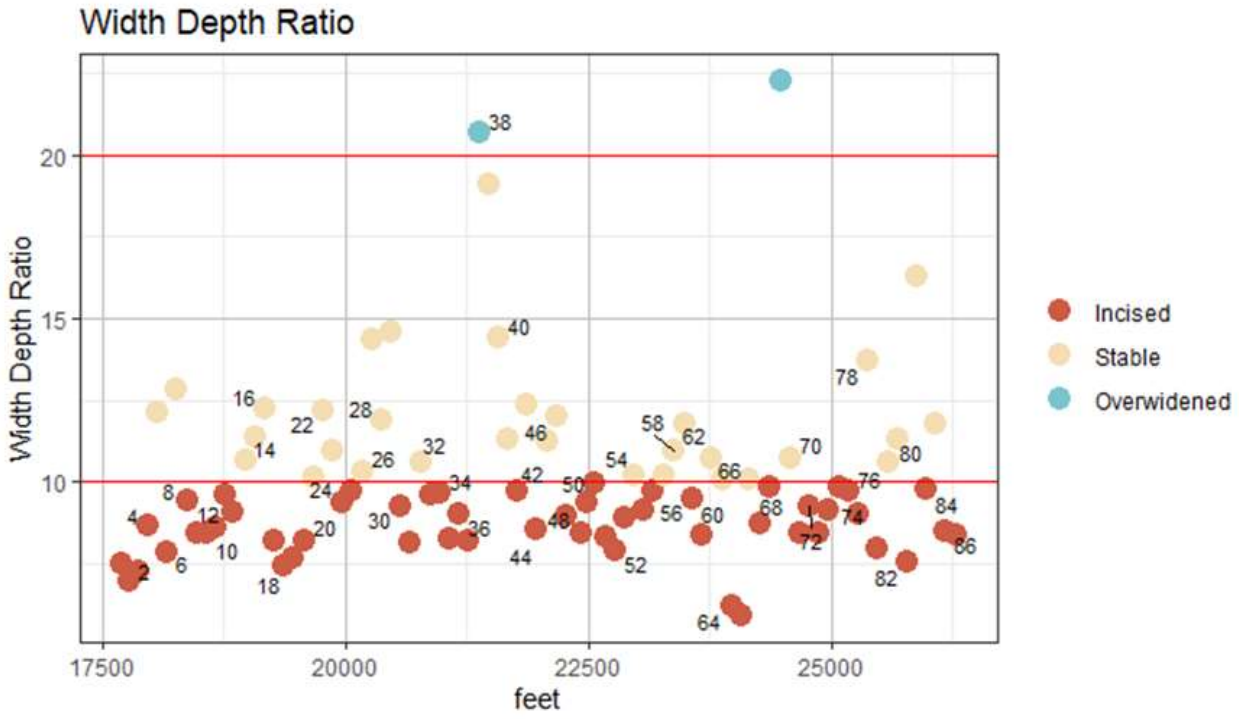






WHAT ELSE CAN FLUVIALGEOMORPH TELL US?





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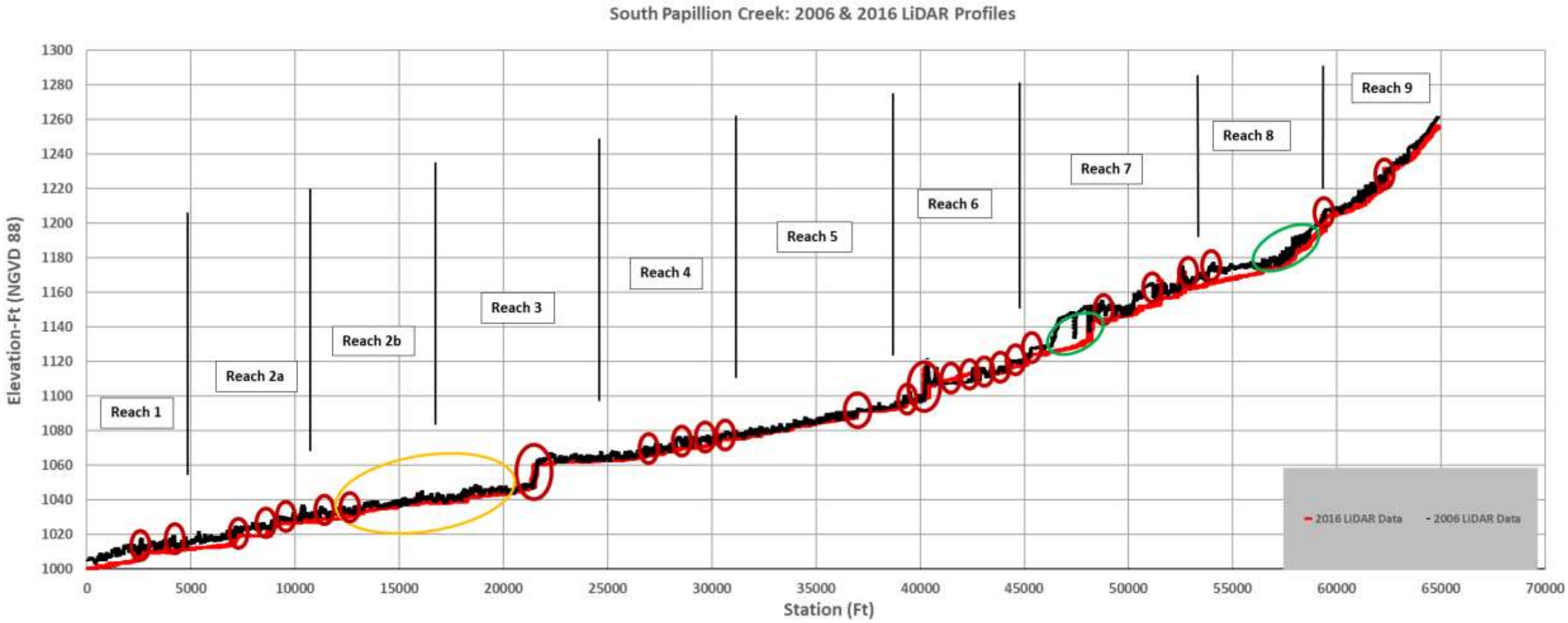
PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY



Report will include locations of suggested additional grade control in South Papio Creek to the source (west of Hwy 31 N. of Gretna)

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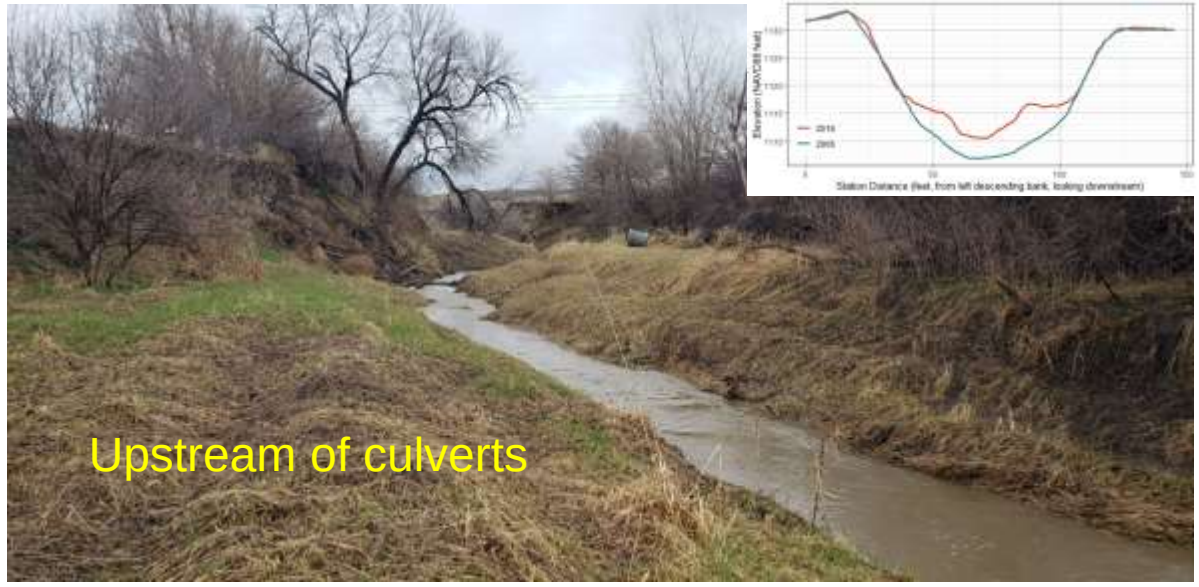
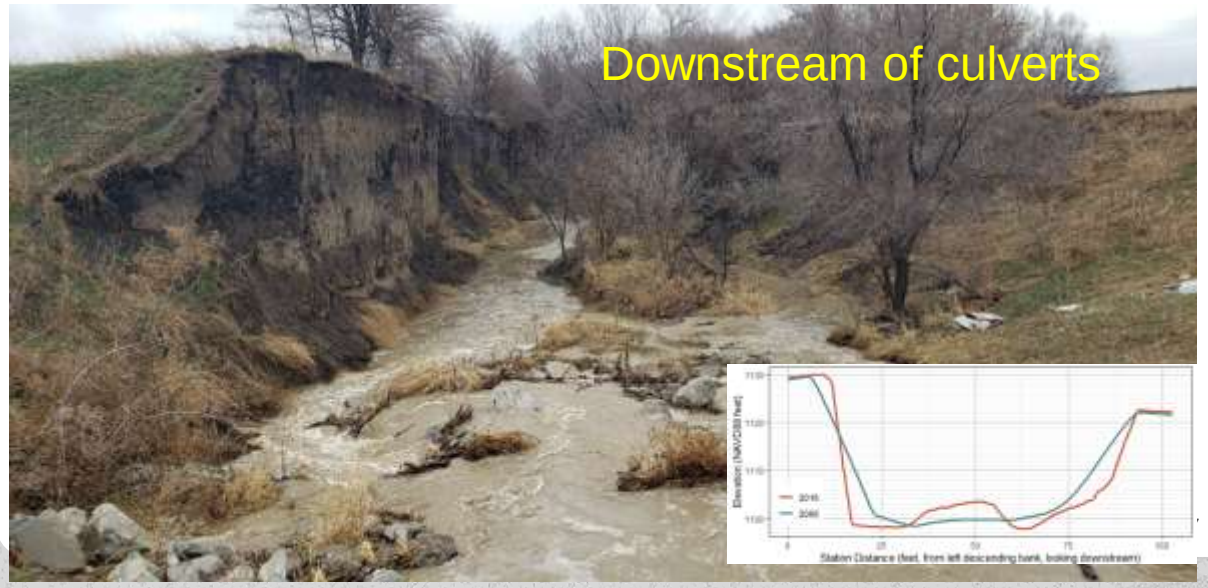
PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY
SOUTH PAPIO FLUVIALGEOMORPH UPDATE

Channel Degradation

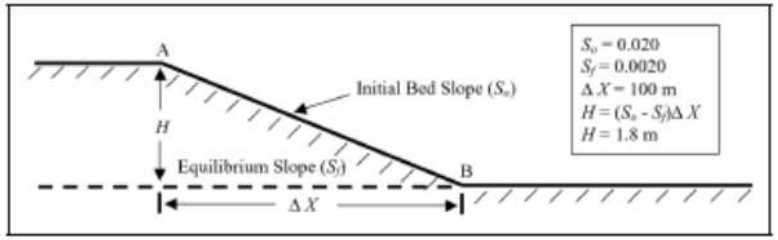
Reach 9: Reach 6-Giles Road culverts



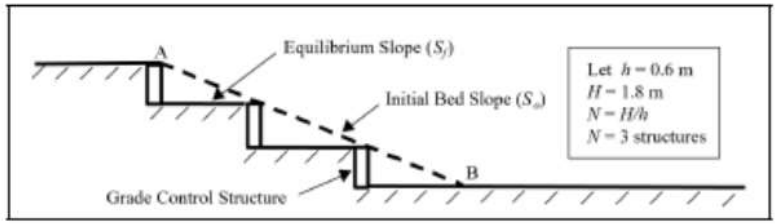


South Papillion FG Assessment Summary

Summary of Recommendations: The summary is based on FG Level I and Level II analysis and field reconnaissance completed in March 2021.



a. Initial condition of streambed showing degradational zone between points A and B. Total anticipated drop in reach is calculated to be 1.8 m



b. Stabilization of degradational zone using three bed control structures. Each structure has a design drop of 0.6 m

Priorities:

- **Use existing GCS locations to continue to stabilize the channel.**

- **Grade control should be expanded in the areas where there is active bed degradation, reaches 7, 8 and 9.**

- **Develop a comprehensive plan to monitor general watershed development and infrastructure enhancements.**

- **Target low width to depth ratio areas for additional bed and bank erosion control.**

- **Target low channel sinuosity and entrenchment ratio (ER) sections for bank erosion protection.**

- **Cross-reference public infrastructure with existing FG identified stabilization priority areas.**

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PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

REGULATORY & ENVIRONMENTAL PERMITTING

To make the permitting process manageable a few strategies should be employed:

a. *Utilize pre-application meetings with the Nebraska State Regulatory Office of USACE.* Pre-application meetings will allow for feedback from regulatory staff on concerns that might arise in the formal permit review process, allowing for modification before submittal.

b. *Ensure that permit applications are complete.* If pertinent information is omitted from the permit application, it will be returned with a request that the information be added, extending the preparation and review timeline. The NRD and Cities/Counties in the watershed should encourage developers to provide complete applications and can possibly serve as a quality control check before submittal.

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PAPILLION CREEK WATERSHED STREAM DEGRADATION STUDY

- *Conclusion #1 – Existing structures are having a significant impact on the morphology of the channels in the Papillion Creek watershed.*

- *Conclusion #2 – Continued Urbanization of the Watershed will alter the hydrology and sediment supply.*

- *Conclusion #3 – Urbanization shows no signs of slowing, so the speed at which grade control can be designed, permitted, and constructed is on the critical path to successfully preventing degradation in the watershed.*

- ***Next steps:***
  - **Update analysis when new LiDAR is available and look for continued trends**
  - **Examine possibilities for expanded Regional General Permit or Programmatic Permit for GCS to create regulatory efficiencies**

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QUESTIONS?

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