



H&H Program Update



April 15, 2025

HELP
#EndTheStreakTX

End the streak of daily deaths on Texas roadways.

TxDOT.gov
#EndTheStreakTX Toolkit



Turn Around, Don't Drown

On average, over 50% of flood fatalities occur in vehicles.



Purpose of the DES H&H Section

The H&H Section leads the statewide practice of hydrology & hydraulics through:

- *development of policy and guidance*
- *providing training and specialized project support*
- *maintaining expertise at the leading edge of the state of practice and the state of knowledge.*
- *cultivating a community of technical collaborators*

The Relationship of Divisions and Districts

Leading TxDOT in providing and growing design and project development expertise, through collaborative efforts and quality customer service, to effectively and efficiently deliver a safer transportation system for Texas.

Ensure the Districts know what they need to know and have what they need to have maximize successful program delivery

The DES H&H Team



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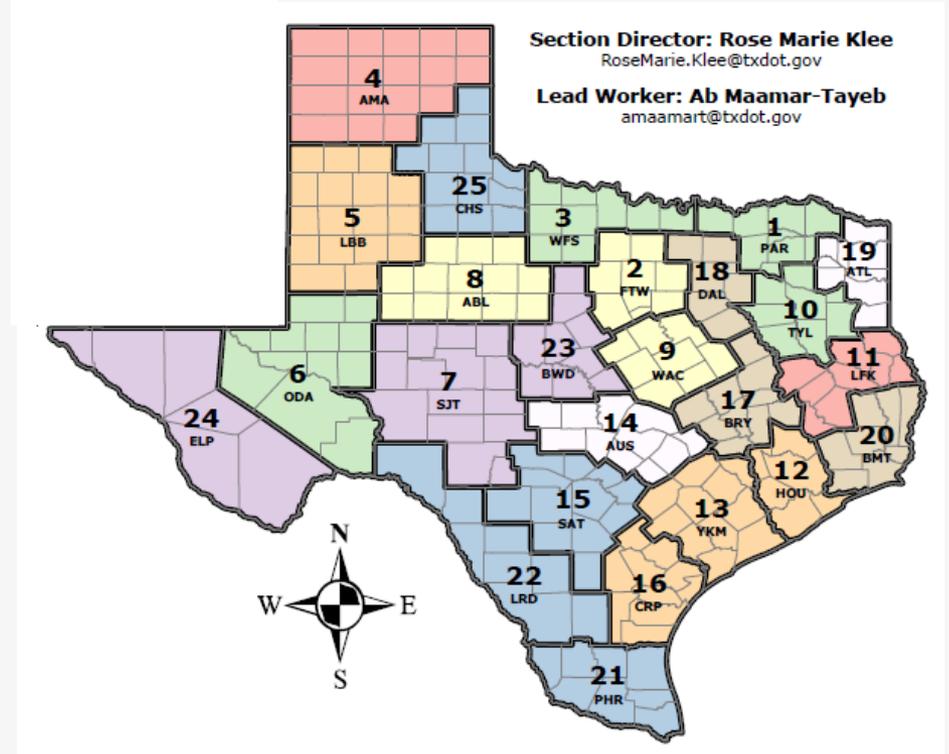
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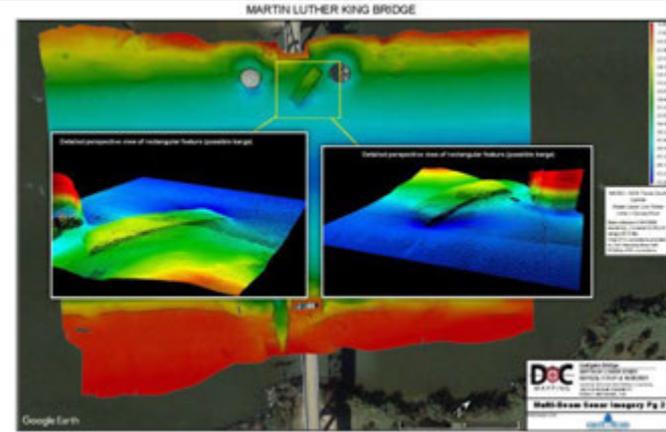
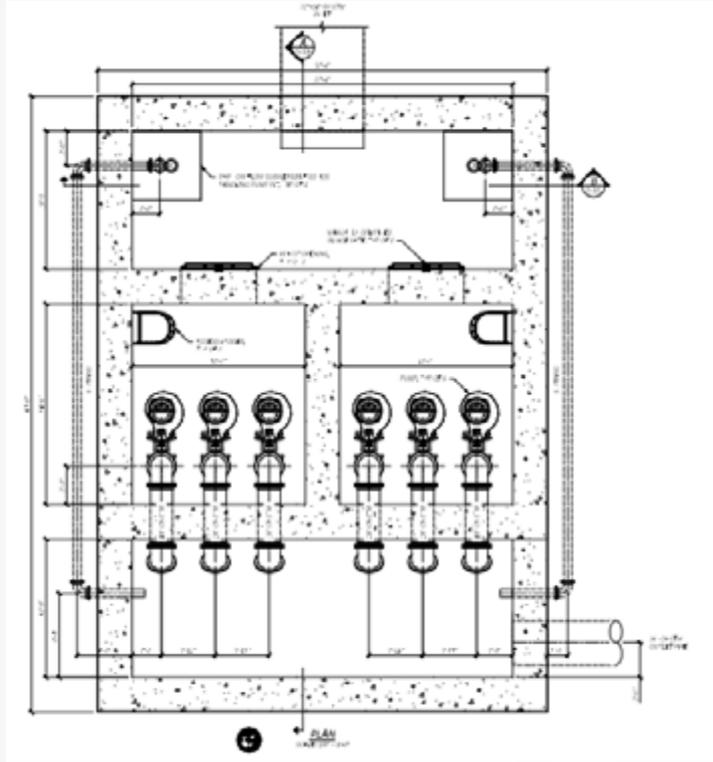


Examples of District Collaborations

Flooding Complaints



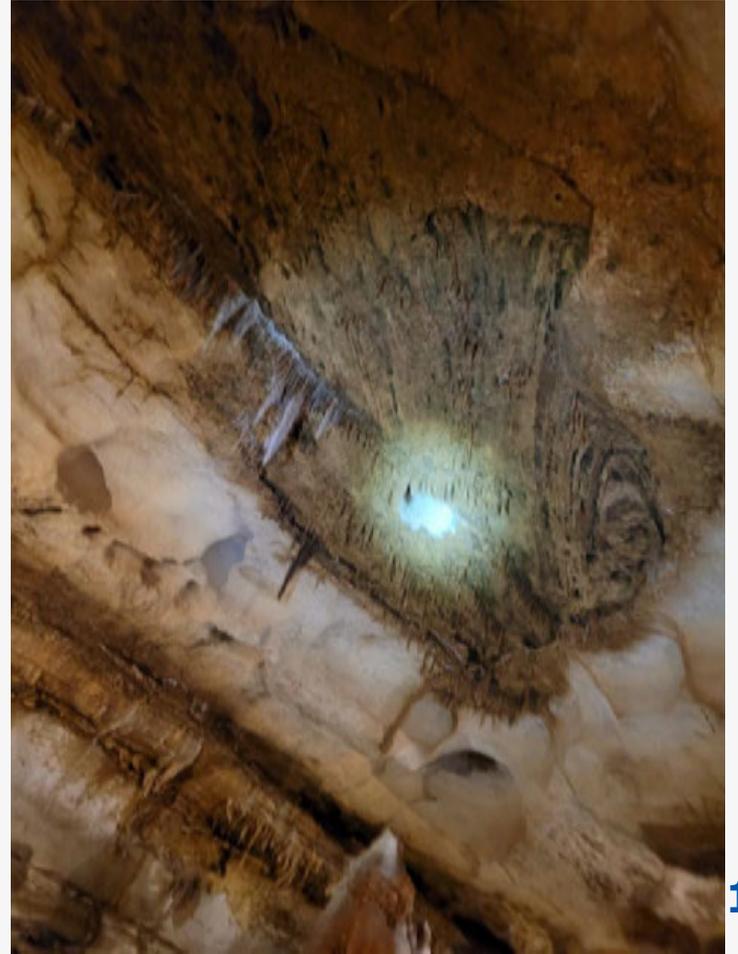
Special Technical Reviews



Fluvial Geomorphology

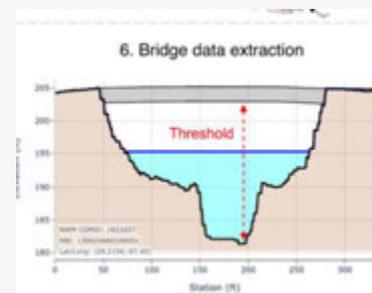
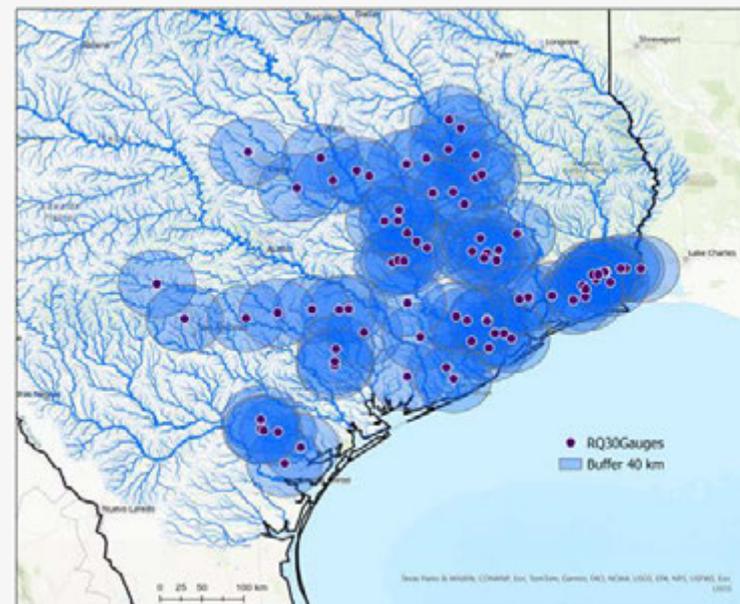


Unique Collaborations



Ongoing and Upcoming Projects

- Research Projects
 - Streamflow III (#Basins and #Gages)
 - Gaps in Scour Knowledge (Cohesive Soils under pressure)
 - Synthesis on Training
 - Nature-Based Solutions



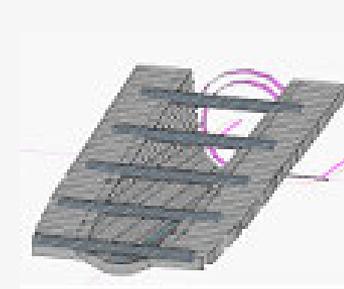
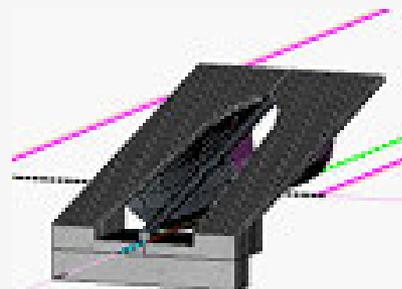
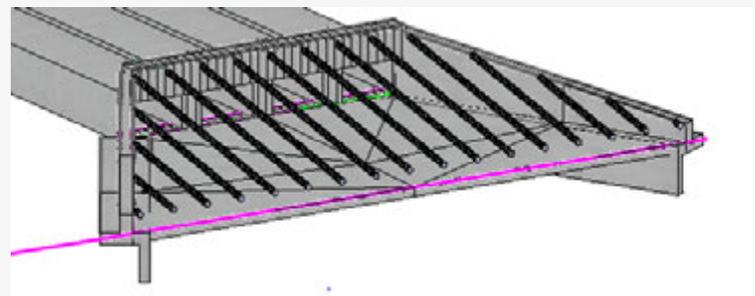
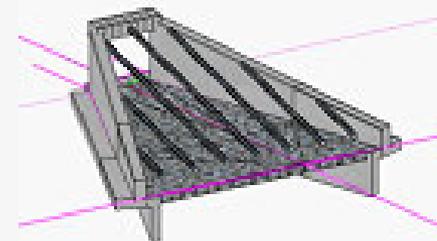
Ongoing and Upcoming Projects

- StreamStats
- PBLR Checklist and H&H Go-by Sheets
- Hydraulics Design Manual Procurement Wave 2 2026

Preliminary Bridge Layout Review — Hydrology & Hydraulics Checklist						
PROJECT 20241114		PBLR ID: _____ CS-2 Proposed NB number: _____ Highway crossing: _____ Reviewer: _____ Date: _____		 <p>Texas Department of Transportation Every project is a safety project.</p>		
Checklist Item No.	Item Description	Non-PBLR			Standard Review Comments <small>(To select comment from the drop-down, click on the comment & then click on the comment icon.)</small>	Additional Guidance for the Reviewer
		Required	Recommended	Optional		
1	Drainage report provided				<p>If a drainage report is required but not provided for H&H (i.e., 3 Sub 1), a drainage report is required for any bridge replacement or rehabilitation project, or any existing or construction project requiring a PBLR (special flood hazard area (SFHA). This project would have a critical, and a drainage report is therefore required – but was not provided with the PBLR. Please confirm that a drainage report will be developed for this project before the design is completed.</p>	<p>The H&H (i.e., 3 Sub 1) drainage reports are only H&H (i.e., 3 Sub 1) special flood hazard areas (SFHA) – they are not critical or District described for all other circumstances. Verify with coordination for level of complexity.</p> <p>If a drainage report is available, it should be submitted with the PBLR. Reviews, PBLRs are conducted as early as 30% into project development, and the use of design standards for the District to prepare a drainage report in the early stage of project development.</p> <p>When a drainage report is required but not provided with the PBLR, the H&H reviewer will continue to facilitate the request contribution from the District that a drainage report will be developed before the design is completed, to ensure that TxDOT guidelines being followed.</p>
Drainage Area Map						
Graphics						
1	Drainage area map provided	+				
2.1	Unshaded and sub-acute delineated and labeled	+				Please show the delineated sub-acute boundaries on the drainage area map.
2.2	Unshaded and sub-acute areas (20 or 10% of area)	+				
2.3	Contours shown with major elevation labeled and flow direction arrows shown	+				
2.4	Drains and major tributaries shown & identified	+				
2.5	Major highways labeled	+				
2.6	Project location shown	+				
2.7	Shed rock shown	+				
2.8	Mark gages shown	+				
2.9	Legend identifying legend number	+				
Data Tables						

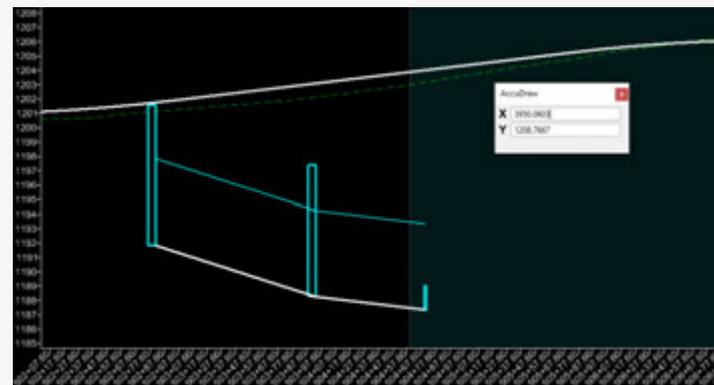
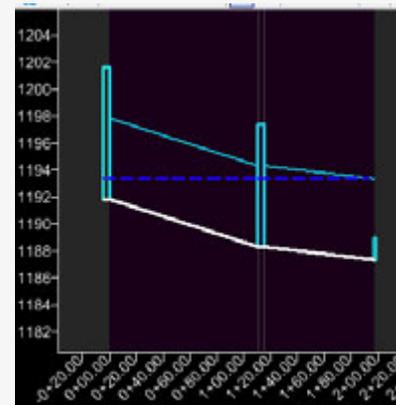
ORD DU Update

- Recent release of update to ORD workspace brings TxDOT closer to Digital Delivery
- Civil Cells for Headwalls
 - Workflow Manual
- Pre-cast Base minimum height adjusted for cell
- Plastic Pipe
- Review of Bentley OpenFlow capabilities
 - Civilstorm – (Unsteady flow)
 - PondPak – (detention Ponds)
 - SewerGems – (Pump Stations)



ORD DU 10.12 Known Issues

- HGL does not project to Alignment
- Drainage Areas not updating with changes or when adding inlets
- DU Culvert Calculator gives different results than HY-8. Do not use DU for culvert analysis.
- PAZD head depth changes when using trapezoidal section when keeping flowrate constant.





Hydrology & Hydraulic Training Program Updates

Training Program Update

Mission

To deliver cutting-edge hydrology and hydraulics training that increases the expertise of TxDOT staff, equipping them with the skills and knowledge needed to excel in their roles.

Our Vision

To be a best-in-class hydrology and hydraulics training program, enhancing the expertise of TxDOT staff, driving innovation and critical thinking, and delivering comprehensive hydrology and hydraulics solutions that increase community resilience and encourage agile recovery in the face of environmental challenges.

Highlights

- Course Updates
- Resource Updates



Course Updates: H & H Training Course Flow Paths

- Overall Flow Path
- Drainage Review and Senior Level Flow Path
- H & H Software Modeling Flow Path
- Roadway Drainage Flow Path

**TxDOT
CrossRoad
ACCESS ONLY**



Flow Charts

Hydrology & Hydraulic Training Course Flow Path for Roadway Drainage



COURSE	SUBJECT	PRE-REQUISITE COURSE	THEORY COURSE	SUBTITLE	COURSE		
DES 601 Basic Fundamentals of Hydrology & Hydraulics for TxDOT Drainage Design	ROADWAY DRAINAGE	NHI 135092 ¹ Highway Hydrology: Basic Concepts and Methods (WBT)	DES 613 NHI 135065 Intro to Highway Hydraulics	STORM SEWER	DES 607 NHI 135027 Urban Drainage Design (Option 1 Day Stormwater Pump Station)	DES 750 Openroads Designer for Plan Development	DES 752 Openroads Designer for Drainage Utilities
		NHI 135091 ¹ Basic Hydraulic Principles Review (WBT)		CULVERTS	NHI 135094 ¹ Culvert and Hydraulic Analysis and Design Program (HY-8) (WBT)	DES 608 NHI 135056 Culvert Design	
		NHI 135087 ¹ Scour at Highway Bridge: Concept & Definitions (WBT)		BRIDGES	DES 821 NHI 135090 Hydraulic Design of Safe Bridges		
		NHI 135086 ¹ Stream Stability Factors and Concepts NHI 135091 ¹ Basic Hydraulic Principles Review (WBT)		STREAM STABILITY	DES 805 NHI 135046 Stream Stability at Scour at Highway Bridges	DES 807 NHI 135048 Countermeasure Design for Bridge Scour and Stream Instability	

Course Updates

NHI Updates

New Virtual Course Options

- DES 607 Urban Drainage Design FHWA-NHI-135027
 - Course updated to 4th edition HEC-22 Manuel (2024)
- DES 608 Culvert Design FHWA-NHI-135056
- DES 800 Two-Dimensional Hydraulic Modeling of Rivers at Highway Encroachments FHWA-NHI-135095
- DES 805 Stream Stability and Scour at Highway Bridges FHWA-NHI-135046
- DES 807 Countermeasure Design for Bridge Scour and Stream Instability FHWA-NHI-135048



Course Updates

On Demand Training

- DES 601 Basic Hydrology & Hydraulics
- DES 611 Intro to HEC-HMS
- DES 612 Intro to HEC-RAS
- DES 617 Fundamental Concepts of GIS & ArcGIS for H & H
- DES 618 Advanced Concepts of GIS & ArcGIS for H & H
- DES 621 Advanced HEC-HMS
- DES 622 1D Unsteady using HEC-RAS
- DES 624 1D_2D HEC-RAS
- DES 798 TxDOT Scour Analysis

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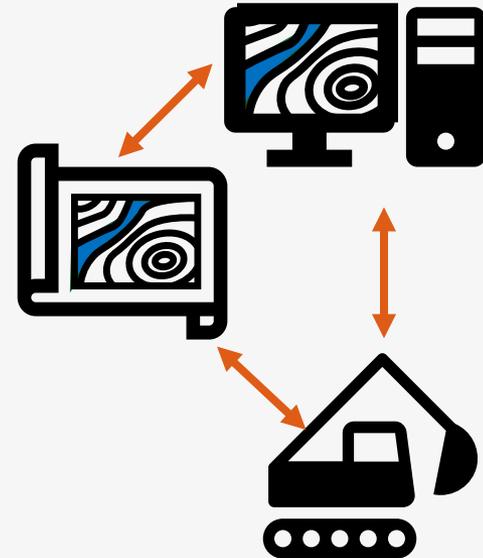


On Demand Training

Course Updates

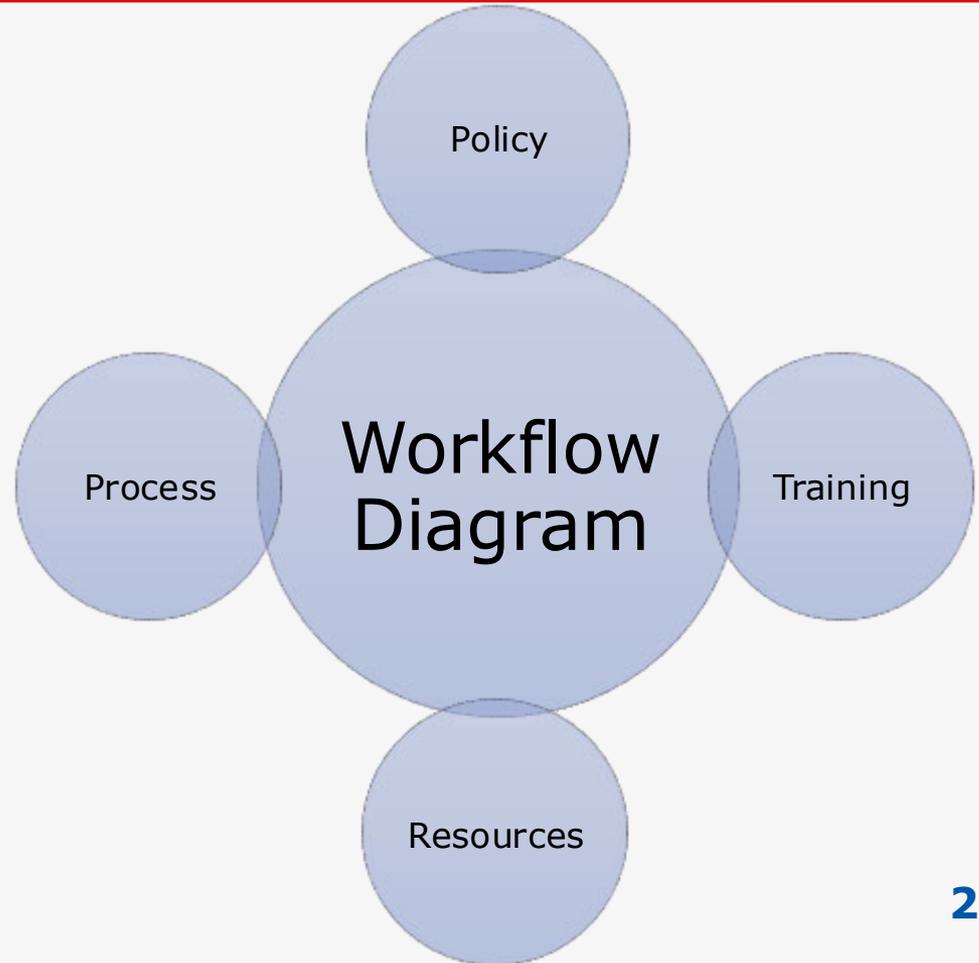
NEW Drainage Review Training

- Drainage Review Training
 - Module 1: Cross Drainage Review Training
 - Module 2: HEC-RAS Review Training
 - Module 3: HEC-HMS Review Training
 - Module 4: EPA SWMM Review Training
- Virtual & live courses
- 1 - 2 day training session
- Start Date: FY 2026



Resource Updates

Workflow Diagram



Rational Method Workflow (TxDOT HDM Ch4, Section 12)

Hydrology Flowchart 001B

Sub Task Detail - additional detail/clarifications for primary steps

Training Resources and Tools

Process Overview

Primary Steps – General description/overview for each step.



- Ensure the watershed characteristics align with the assumptions of the **Rational Method**, see TxDOT HDM Chapter 4, Section 12 (pg. 4-48).
- Identify point(s) to compute discharge (i.e. bridge, culvert, channel junctions).
- Obtain most current contour map with aerial (preferred).

- Distribute flow arrows at spread out locations in the contour map (flow direction is always perpendicular to contours).
- Trace any possible streams.
- Identify high points and berms.
- Trace drainage area.
- Verify uncertain areas.
- Verify selected hydrologic analysis method is appropriate based on watershed characteristics using the **Hydrologic Method Selection Flowchart, Hydrology Flowchart 001**.

- Determine Time of Concentration from the most remote point in the watershed to the outlet using the Kerby-Kirpich method or the National Resources Conservation Service (NRCS) method (TxDOT HDM Ch 4, Section 11).
 - One good practice is to run both methods concurrently and compare results.
 - Consider antecedent moisture conditions, channel characteristics, and flow paths.
 - Minimum time of concentration is 10 minutes (see TxDOT HDM pg. 4-51)

- No significant surface storage, such as ponds or lakes with a controlled outlet.
- Drainage area smaller than 200 acres.
- Analysis primarily for urban storm drain systems, small roadside & median ditches, or driveway culverts where no significant surface storage is present.

- Uncertain areas refer to drainage area boundary sections not easily defined using available contour data and/or areas where an existing structure may be directing additional area runoff to point of interest.
- Multiple drainage areas may be needed for varying soil types or land uses, varying types of land cover, or other factors that would influence runoff coefficients and infiltration rate.

Kerby-Kirpich Method

- Applicable to watersheds ranging from 0.25 square miles to 150 square miles, main channel lengths between 1 and 50 miles, and main channel slopes between 0.002 and 0.02 (ft/ft).
- Obtain the input variables for the **Kerby Method TxDOT HDM Equation 4-14** to calculate overland flow travel time.
- Obtain the input variables for the **Kirpich Method TxDOT HDM Equation 4-15** to calculate channel flow travel time.
- Combine overland flow travel time and channel flow travel time to obtain total time of concentration.

National Resources Conservation Service (NRCS) method

- Applicable for small watersheds, in which the majority of flow is overland.
- Obtain the input variables for the **Sheet Flow TxDOT HDM Equation 4-17** to calculate sheet flow travel time
- Obtain the input variables for the **Shallow Concentrated Flow TxDOT HDM Equation 4-18** to calculate shallow concentrated flow travel time.
- Obtain the input variables for the **Channel Flow TxDOT HDM Equation 4-19** to calculate channel flow travel time.
- Combine sheet flow travel time, shallow concentrated flow travel time, and channel flow travel time to obtain total time of concentration.

[Rational Method Video Tutorial](#)

[Delineate a Watershed in ArcGIS PRO](#)

[Time of Concentration Guidance Document](#)

[Time of Concentration Spreadsheet](#)

Questions

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TxDOT Resources for Scour Analyses and PBLRs

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H&H Community of Practice
TxDOT Roadway Design and Bridge Conference

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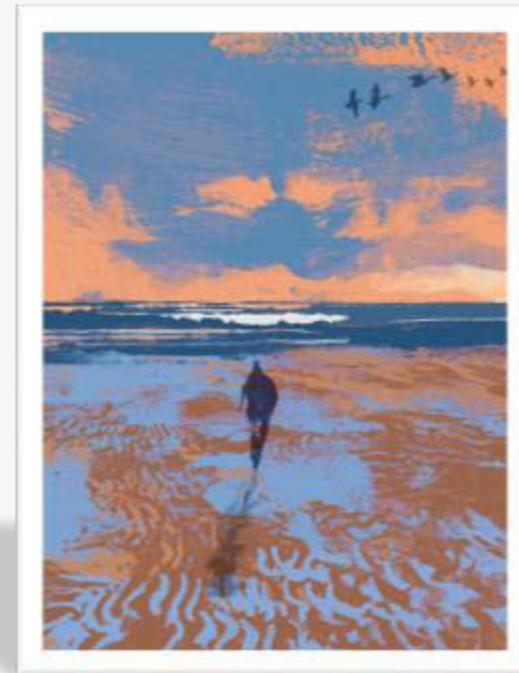
7 | Scour Analysis Guide

16 | Scour Analysis Tools

20 | DES 798

21 | Preliminary Bridge Layout Reviews

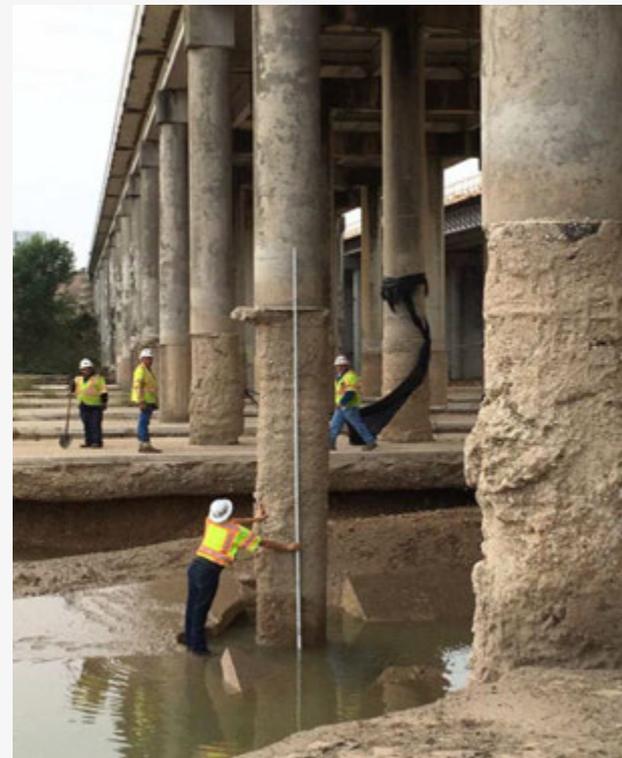
23 | New H&H Checklist



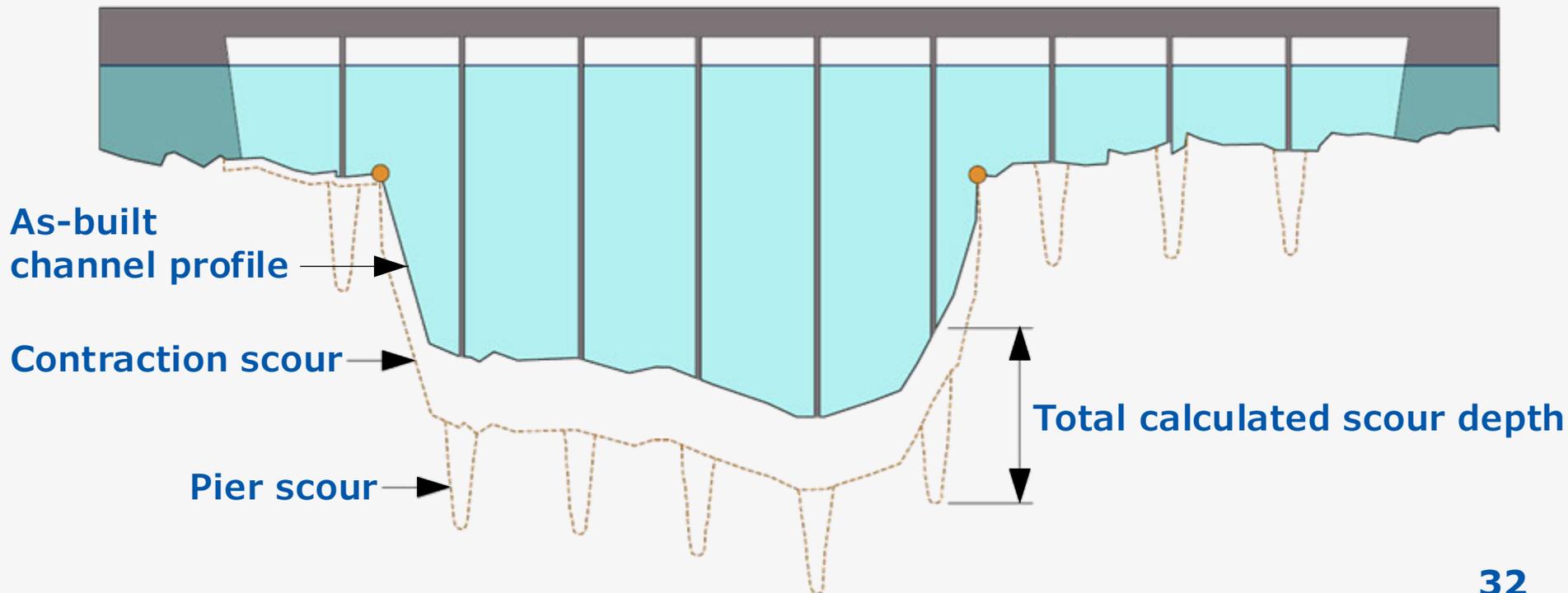
texashighways.com

What is bridge scour?

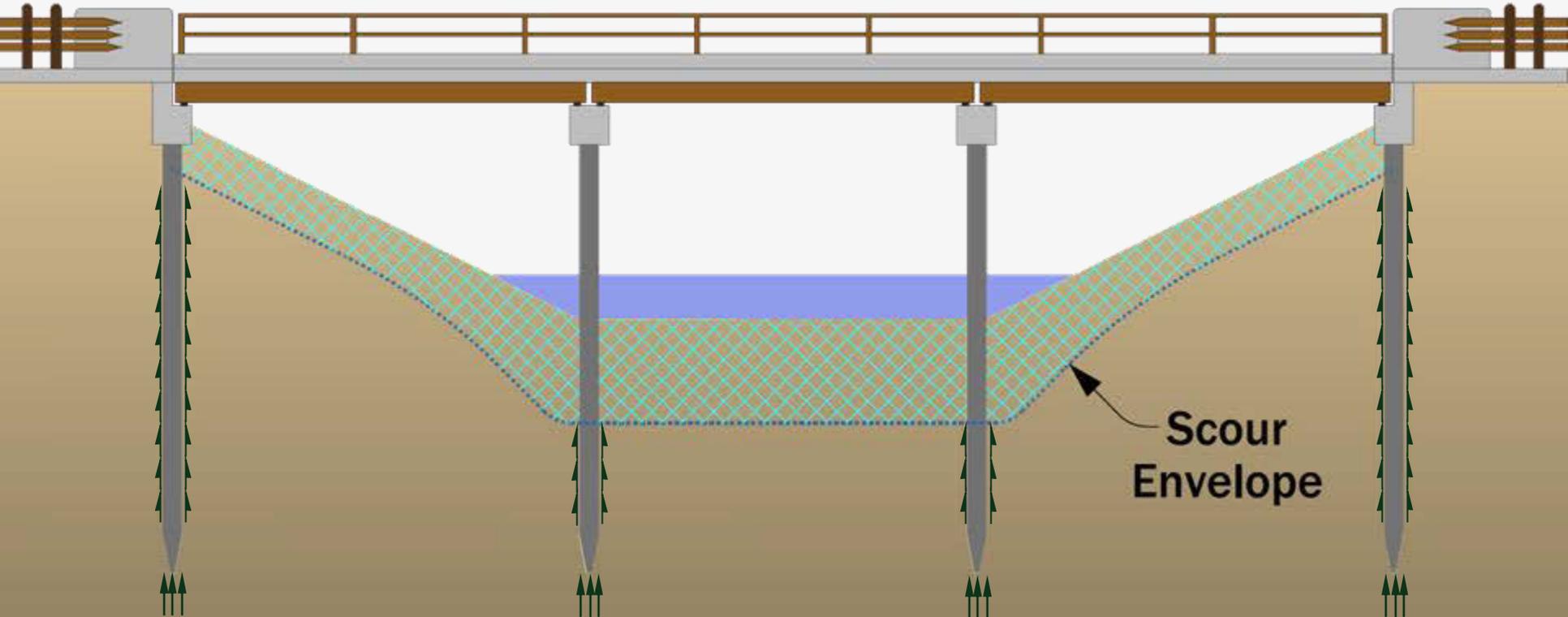
- **The most common cause of bridge failures**
- Erosion of streambed or bank material due to flowing water; often considered as being localized:
 - Contraction scour
 - removal of materials **across all or most of the channel width** caused by a reduction in flow area
 - Pier scour
 - removal of material **localized around piers** caused by obstruction to flow



What is a scour analysis? A data-driven prediction

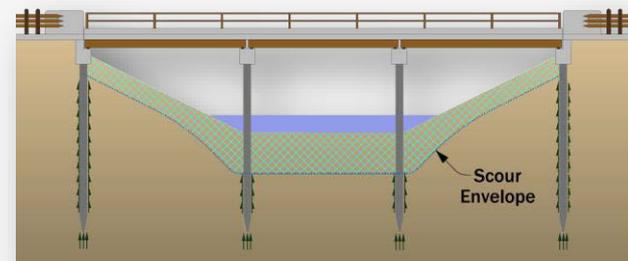
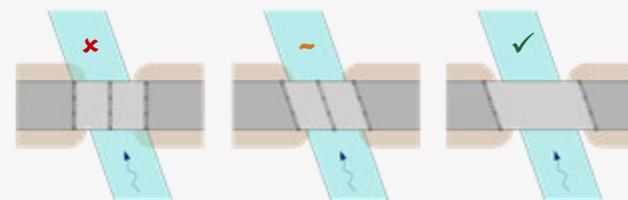
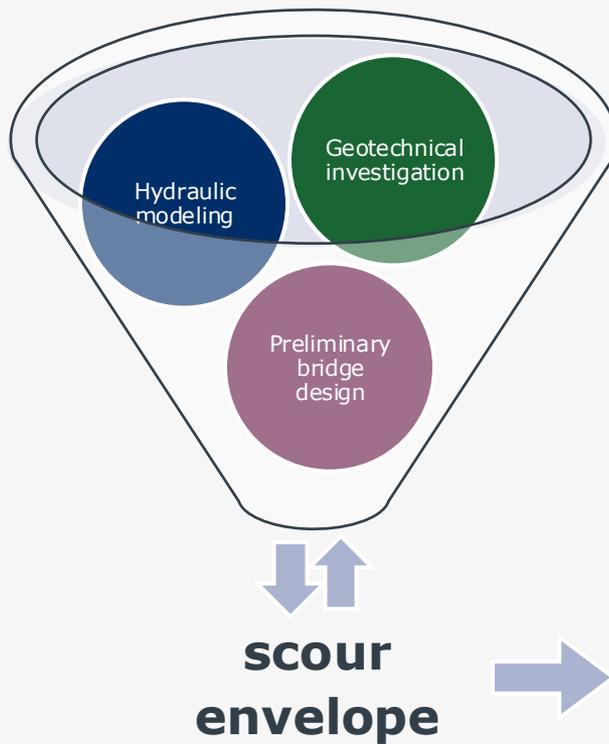


Why is bridge scour the leading cause of bridge failures?



What is a scour analysis? A multidisciplinary collaboration

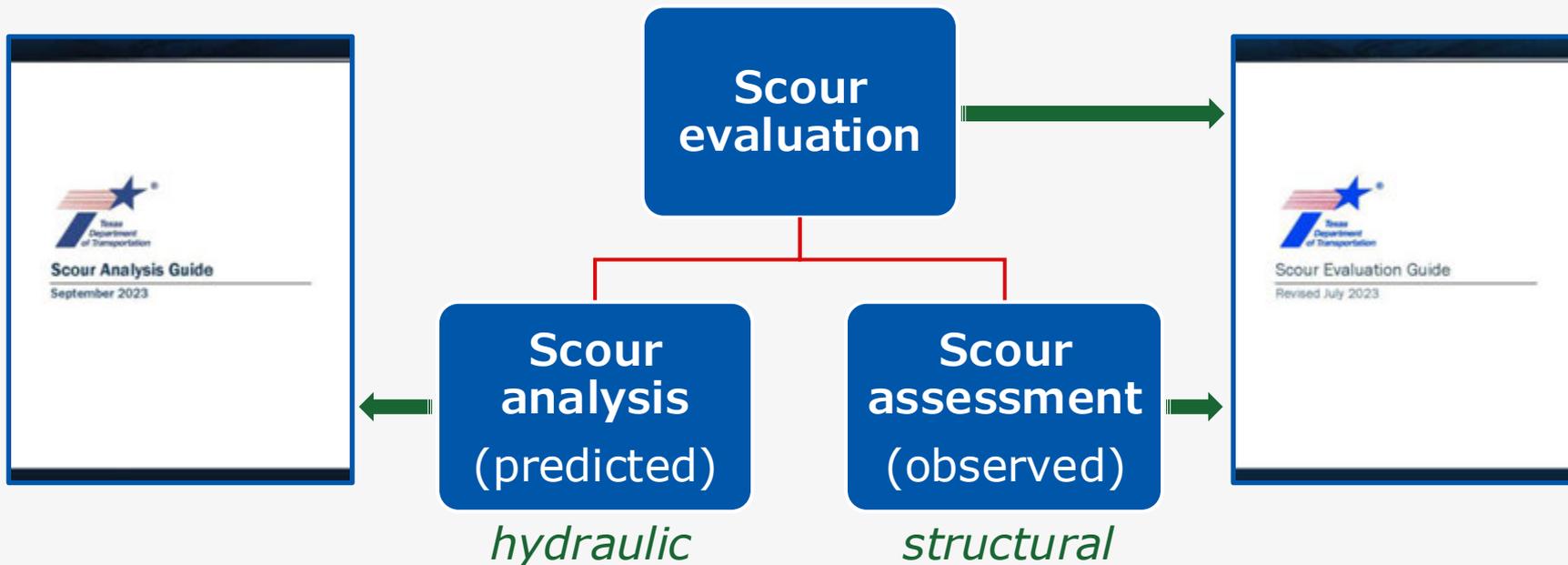
- Hydraulic data
 - Flow (Q)
 - Velocity (V)
 - Hydraulic depth (y)
- Geotechnical
 - Stratigraphy
 - USCS classification & D_{50}
- Structural details
 - Span layout
 - Substructure geometry
 - Angle of attack



**new bridges designed
to resist damage
resulting from scour**

The vocabulary of bridge scour resources at TxDOT

- A scour evaluation considers both predicted and observed scour conditions
 - The least stable of the two conditions governs the overall condition rating



TxDOT Scour Analysis Guide

- Hydrologic design criteria for scour analyses

Table 2-1 – Scour Design and Scour Design Check Flood Return Periods

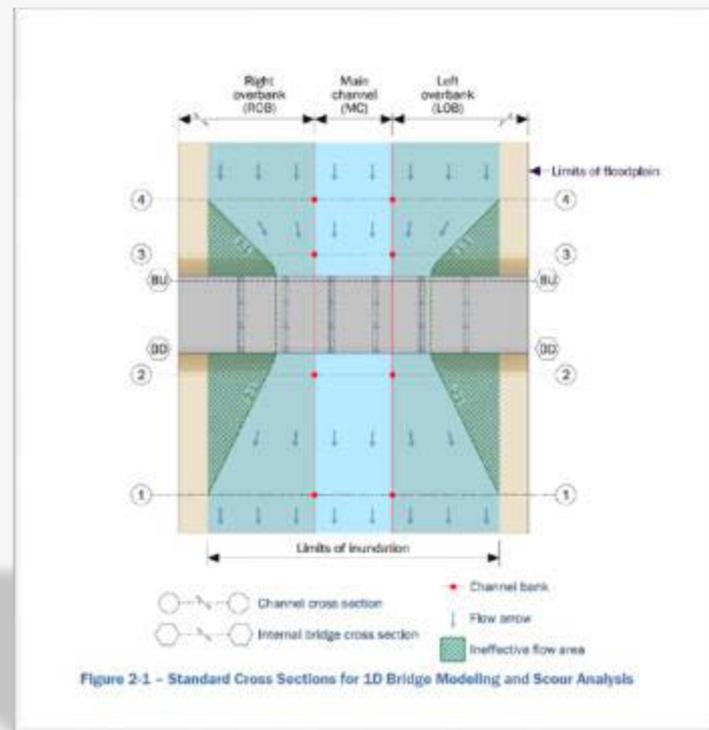
Hydraulic Design Flood ¹	Scour Design Flood	Scour Design Check Flood
< 10-year	2, 5, 10, and 25-year	50-year
10-year	25-year	50-year
25-year	50-year	100-year
50-year	100-year	200-year
100-year	200-year	500-year

¹ Refer to most recent version of TxDOT Hydraulic Design Manual.

<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

TxDOT Scour Analysis Guide

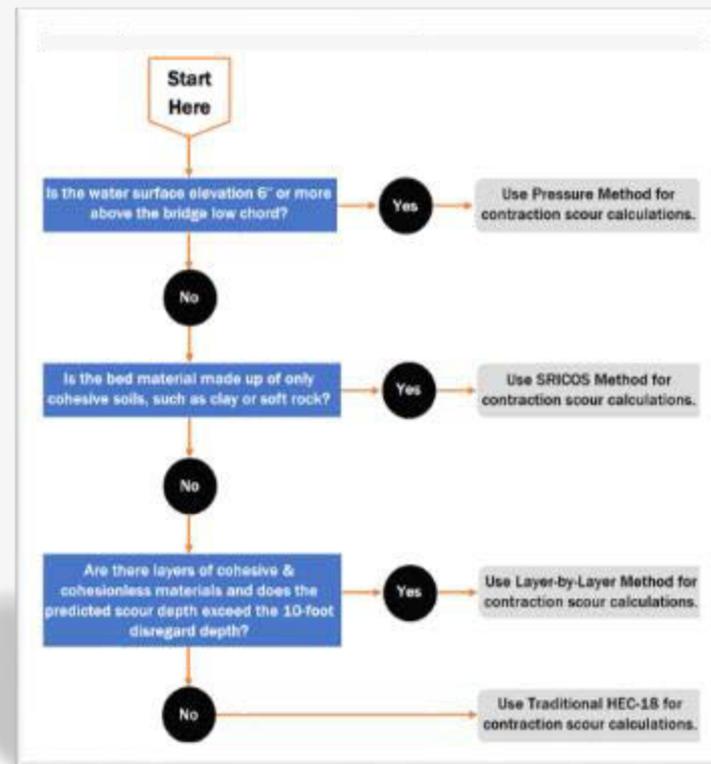
- Hydrologic design criteria for scour analyses
- Hydraulic modeling guidance



<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

TxDOT Scour Analysis Guide

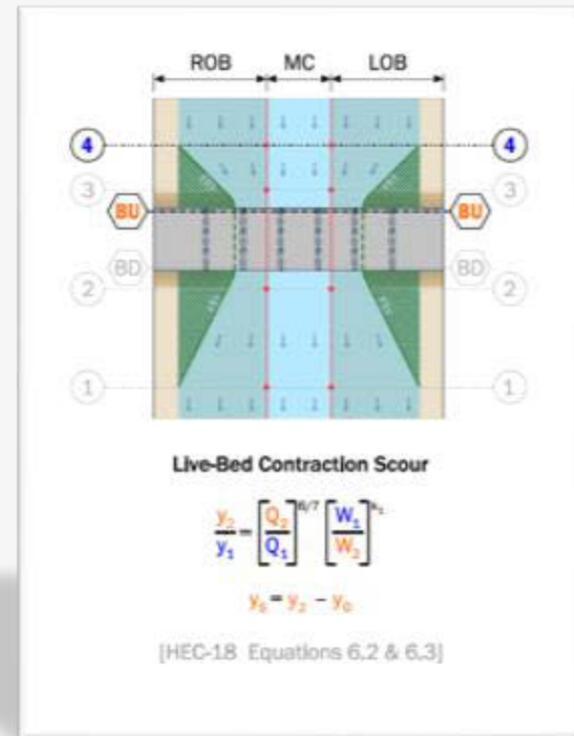
- Hydrologic design criteria for scour analyses
- Hydraulic modeling guidance
- Scour analysis method selection



<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

TxDOT Scour Analysis Guide

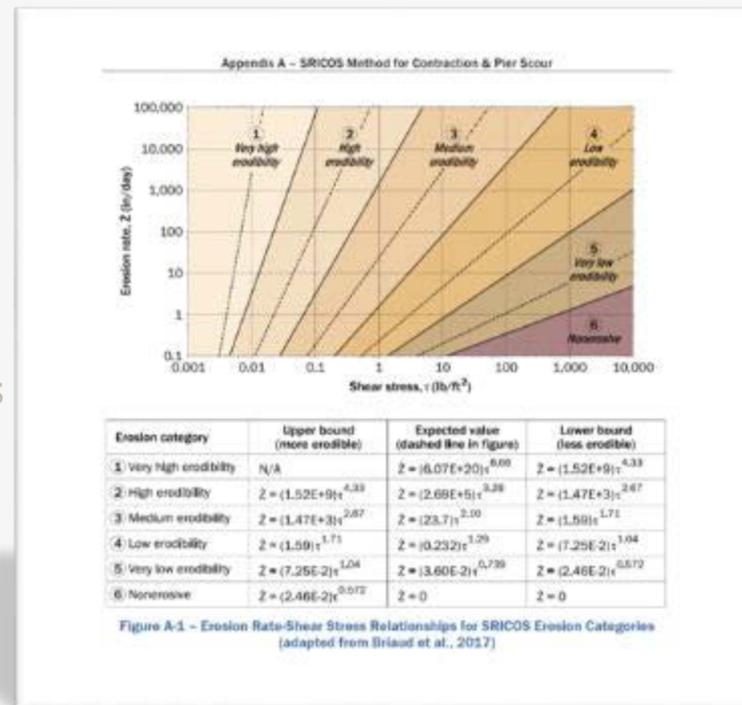
- Hydrologic design criteria for scour analyses
- Hydraulic modeling guidance
- Scour analysis method selection
- Detailed guidance for scour analysis equations



<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

TxDOT Scour Analysis Guide

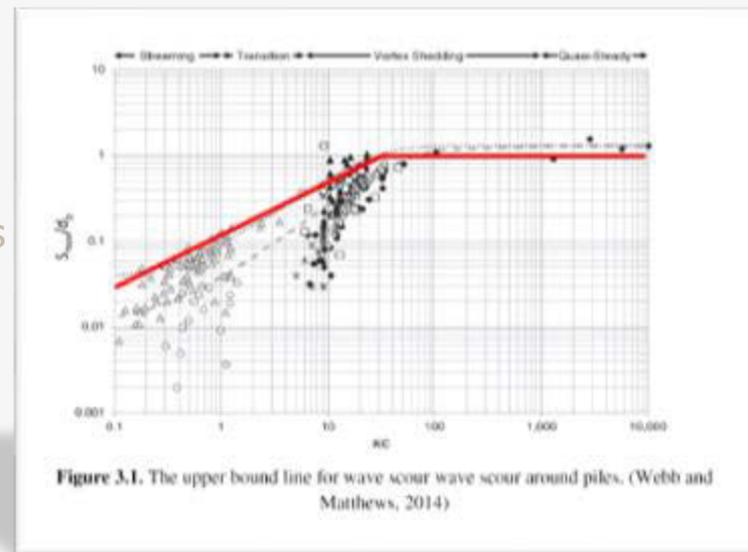
- Hydrologic design criteria for scour analyses
- Hydraulic modeling guidance
- Scour analysis method selection
- Detailed guidance for scour analysis equations
- Special topics
 - SRICOS



<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

TxDOT Scour Analysis Guide

- Hydrologic design criteria for scour analyses
- Hydraulic modeling guidance
- Scour analysis method selection
- Detailed guidance for scour analysis equations
- Special topics
 - SRICOS
 - Lacustrine scour



<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

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 - Parallel bridges

Case 1: Shared embankment

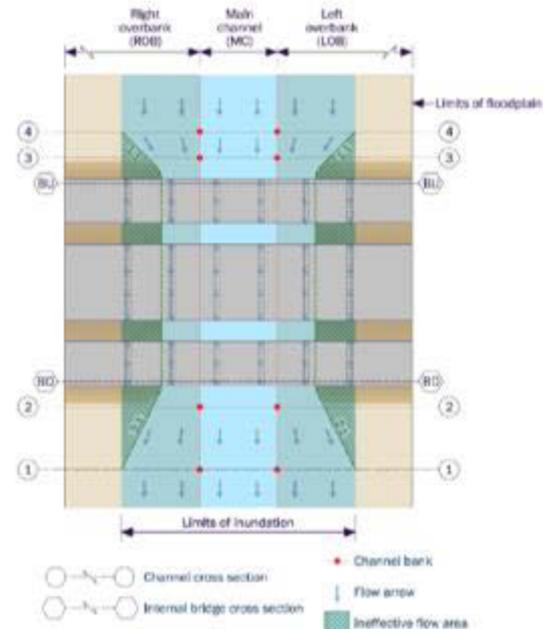


Figure B-49 - Parallel Bridges on Shared Embankment: Idealized Cross Section Layout

<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

TxDOT Scour Analysis Guide

- Hydrologic design criteria for scour analyses
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 - Parallel bridges

Case 2: Separate embankments

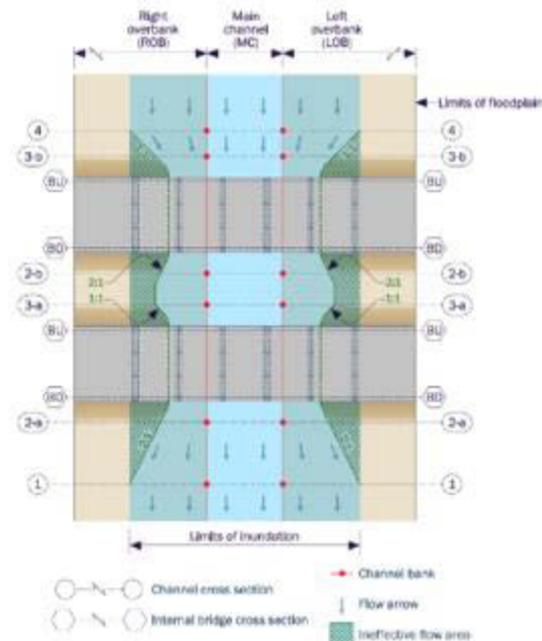
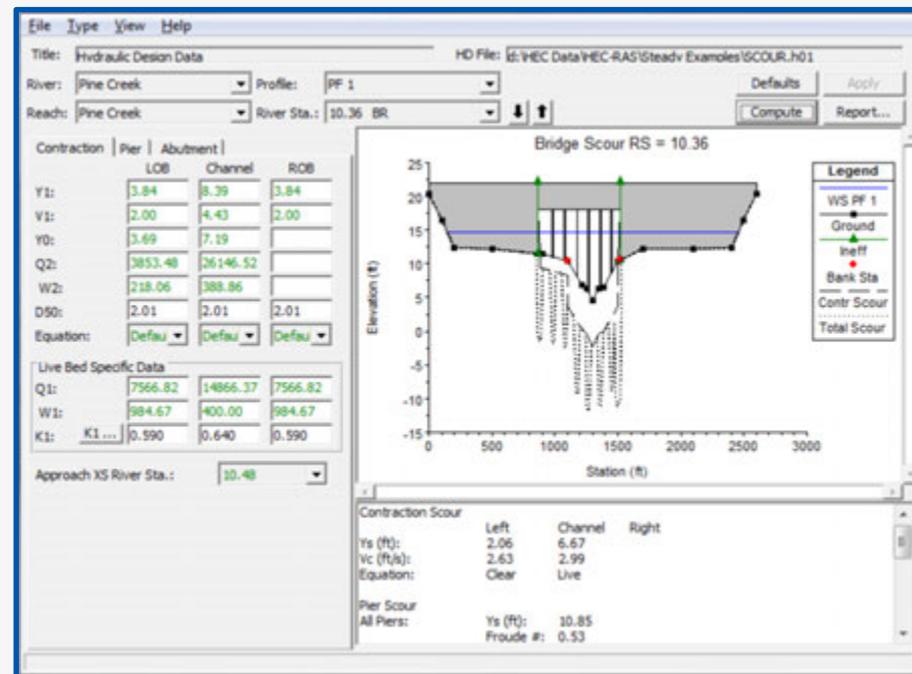


Figure B-54 - Parallel Bridges on Separate Embankments: Idealized Cross Section Layout

<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

Scour Analysis Software

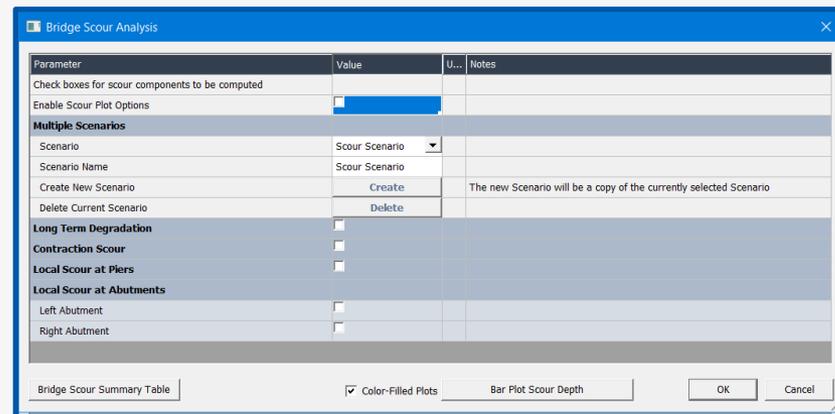
- HEC-RAS scour calculations
(not recommended)
 - Automated routine doesn't always choose the right cross section for input parameters
 - Calculations not updated to latest HEC-18 procedures



<https://www.hec.usace.army.mil/software/hec-ras/>

Scour Analysis Software

- HEC-RAS scour calculations (not recommended)
 - Automated routine doesn't always work
 - Inconsistencies with HEC-18 5th Ed.
- FHWA Hydraulic Toolbox (acceptable)
 - Lacks detailed guidance for users



<https://www.fhwa.dot.gov/engineering/hydraulics/software/toolbox404.cfm>

Scour Analysis Software

- HEC-RAS scour calculations (not recommended)
 - Automated routine doesn't always work
 - Inconsistencies with HEC-18 5th Ed.
- FHWA Hydraulic Toolbox (acceptable)
 - Lacks detailed guidance for users
- TxDOT Scour Analysis Spreadsheet (recommended)
 - Consistent with HEC-18 and TxDOT guidance
 - Available to everyone on TxDOT.gov

Hydraulic Design Flood	Scour Design Flood
25-year	50-year

If analyzing incipient overtopping or a lower flow event, please check this box and use the two dropdown boxes below to describe the flood under consideration:

Corresponding Hydraulic Model Cross Sections

Identify the hydraulic model cross sections that correspond to the standard bridge-modeling cross sections shown in Figure 1.

Cross Section ID	Corresponding HEC-RAS Cross Section Number	Model Name
Cross Section 4		
Cross Section 3		
Cross Section B0		
Cross Section 2		
Cross Section 1		

Plan Used

Critical Velocity

$$V_c = K_{sc} V_{*c}^{1.49} D_{50}^{1/16}$$

V_c = critical velocity above which bed material of size D and smaller will be transported (ft/s)
 V_1 = mean velocity in **Cross Section 4** (ft/s)
 y_1 = average depth of flow in **Cross Section 4**. Refer to Figure 1 for cross section location. (ft)
 D_{50} = median grain size of bed material (ft) ≥ 0.00060 ft. Refer to Figure 2 for selection guidance.
 $K_{sc} = 11.17$ English units

Conveyance zone	y_1	D_{50}	K_{sc}	V_c	V_1	Regime ¹
Left Overbank			11.17	0.0		
Main Channel			11.17	0.0		
Right Overbank			11.17	0.0		

Clear-water contraction scour = $V_c > V_1$
 Live-bed contraction scour = $V_c < V_1$

¹The overbanks and main channel may have different regimes. Complete the Live-Bed or Clear Water sections below, as appropriate, depending on the regime for each conveyance zone.

TxDOT Scour Analysis Spreadsheet

- Developed by TxDOT to promote accuracy and consistency
- Includes key figures and tables from Scour Analysis Guide for quick reference
- Requires input from hydraulic modeling results
- Easy-to-print documentation

Pier Scour

$$\frac{y_s}{y_1} = 2.0K_1K_2K_3 \left(\frac{a}{V_1} \right)^{0.43} F_1^{0.42} \quad y_s \leq \begin{cases} 2.6a & F_1 \leq 0.8 \\ 3.0a & F_1 > 0.8 \end{cases}$$

y_s = scour depth (ft)
 y_1 = local depth of flow in **Cross Section 3** (ft)
 K_1 = correction factor for pier nose shape, reference Table 3 & Figure 5
 K_2 = correction factor for angle of attack of flow, reference Table 4
 K_3 = correction factor for bed condition, reference Table 5
 a = pier width (ft)
 L = length of pier (ft)
 ψ = angle of attack of flow (°)
 F_1 = Froude Number in **Cross Section 3** (equal to $V_1/(g y_1)^{0.5}$)
 V_1 = local velocity in **Cross Section 3** (ft/s)
 g = 32.2 ft./s²
 ψ = pier nose shape (round or square)

Conveyance zone	a	L	ψ	θ	K_1	K_2	K_3
Left Overbank					1.00	0.00	1.10
Main Channel					1.00	0.00	1.10
Right Overbank					1.00	0.00	1.10

Conveyance zone	y_1	V_1	F_1	Channel Material	$y_{s,max}$	y_s
Left Overbank					0.0	
Main Channel					0.0	
Right Overbank					0.0	

This table applies a 50% reduction factor to y_s for clay or clayey channel materials.

... Scour Design Flood HEC-18 | Scour Check Flood HEC-18 | Pressurized Flow Design Flood | Pressurized Flow Check Flood | SPICOL

<https://www.txdot.gov/content/dam/docs/design/txdot-scour-analysis-spreadsheet-2024-05-31.xlsx>

TxDOT Scour Analysis Training

- DES 798 – TxDOT Bridge Scour Analysis
 - Instructor-led, virtual training
 - Covers the Scour Analysis Guide
 - Guided examples using TxDOT Scour Analysis Spreadsheet
- Free, 12-hour course
 - Open to TxDOT and outside learners; no sessions currently scheduled
 - On-demand content available in SharePoint

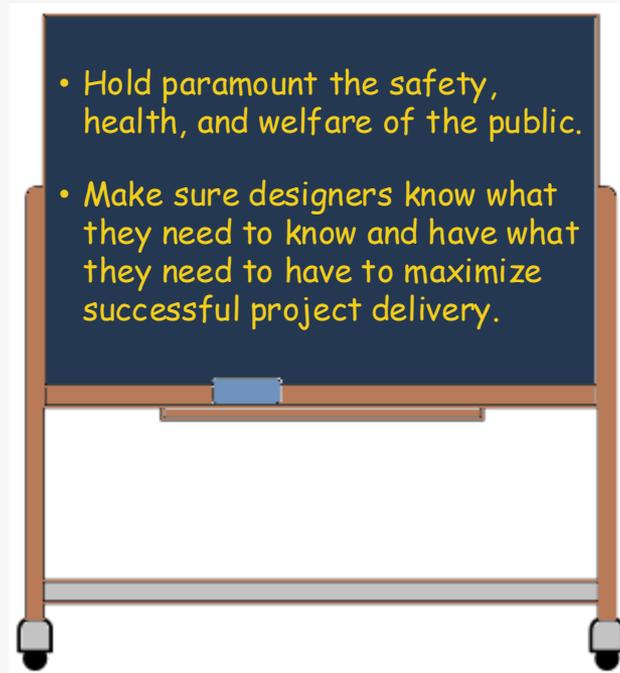
What is a PBLR?

- **Preliminary Bridge Layout Review**
 - Multi-disciplinary review administered by Bridge Division
 - Purpose is to ensure TxDOT and FHWA policies are being followed BEFORE commencing major structural design work
 - Typically, 30% - 60% PS&E completion



Challenges we wanted to address

- Address inconsistency among H&H reviewers
- Support rapid pace of project development
- Establish consistent practice for impact analyses
- And in general, we wanted to clarify the intention and guidance for each checklist item



New H&H Checklist for PBLRs



- **Instructions**

- Detailed instructions for new reviewers and first-time users of the checklist

- PBLR checklist

- Standard review comments

General Instructions		
Standard Review Comments	Standard review comments are provided for each checklist item to promote consistent feedback between reviewers for common issues. Please review the collection of standard comments (summarized in the standard review comments tab) before using this checklist for the first time.	After selecting a standard response from the drop-down a Column H of the PBLR checklist tab , the reviewer may copy the standard text from the formula bar in Excel into the Bluebeam session – and then edit the text in Bluebeam a needed for specificity.
Drainage Report	<p>HDM Ch. 3 Sect. 5: A drainage report is required for any bridge replacement or rehabilitation project, or any roadway reconstruction project impacting a FEMA special flood hazard area (SFHA).</p> <p>HDM Ch. 3 Sect. 5 applies to span bridges and bridge-class culverts.</p> <p>Drainage reports are only REQUIRED for projects in a FEMA SFHA; they are created at district discretion for all other circumstances, ideally with consideration for level of complexity.</p>	<p>A PBLR may be conducted before the associated drainage report has been completed.</p> <ul style="list-style-type: none"> • The district must provide enough information for the DE HYD reviewer to verify methods and data. If additional information is needed to complete a review, the DES-HYD reviewer will request that information specifically. • The H&H reviewer will not hold up PBLR approval solely because a drainage report has not yet been completed - we will accept District confirmation that report will be developed later in the design process.
H&H Models	<p>PBLRs do not include a detailed review of hydrology and hydraulics (H&H) models within the native digital format.</p> <p>Districts may request detailed H&H model reviews, on a case-by-case basis, by contacting the Hydrology & Hydraulics Section i Design Division.</p> <p><small>To comply with Texas Water Code, Chap. 11.066, the designer must verify that removal conditions will not create a</small></p>	

New H&H Checklist for PBLRs



- Instructions
- PBLR checklist
- **Standard review comments**
 - This tab summarizes all the standard comment responses that are pre-populated for each checklist item

Item No.	Standard Review Comments		
Drainage Report			
1	Drainage report provided	If a drainage report is required but not provided, per PDH Ch. 3 Sect. 8, a drainage report is required for any bridge replacement or rehabilitation project, or any roadway reconstruction project occupying a FEMA special flood hazard area (SFHA). This project meets those criteria, and a drainage report is therefore required - but was not provided with the PBLR. Please confirm that a drainage report will be developed for this project before the design is completed.	If a drainage report is not required, but should be considered. View this comment. A drainage report is not required because the project is outside of a FEMA special flood hazard area (SFHA). However, given the complexity of this project, please consider providing a drainage report to adequately document drainage considerations, materials, and systems.
Drainage Area Map			
2	Drainage area map provided	Please provide a drainage area map with summary of hydrologic data.	
2.1	Watershed and sub-basins delineated and labeled	Please show the delineated sub-basin boundaries on the drainage area map.	The sub-basin (S) and area values do not match the data provided in the drainage report. Please verify the data and update.
2.2	Watershed and sub-basin areas (AC or SPM) shown	Please label and show the area of the watershed and sub-basins on the drainage area map.	In case of discrepancy of data, the watershed acreage does not match the data provided in the drainage report. Please verify the data and update.
2.3	Contours shown with major elevations labeled and/or flow direction arrows shown	Please display contours with major elevation values OR Please provide	If contours are provided without elevation values, please display the

Thank you! Any questions?

Scour Analysis Guide

<https://ftp.txdot.gov/pub/txdot-info/des/guides/scour-guide.pdf>

Scour Analysis Spreadsheet

<https://www.txdot.gov/content/dam/docs/design/txdot-scour-analysis-spreadsheet-2024-05-31.xlsx>

H&H Checklist for PBLRs

<https://www.txdot.gov/content/dam/docs/design/h-h/2024-11-14-hyd-pblr-chklst.xlsx>

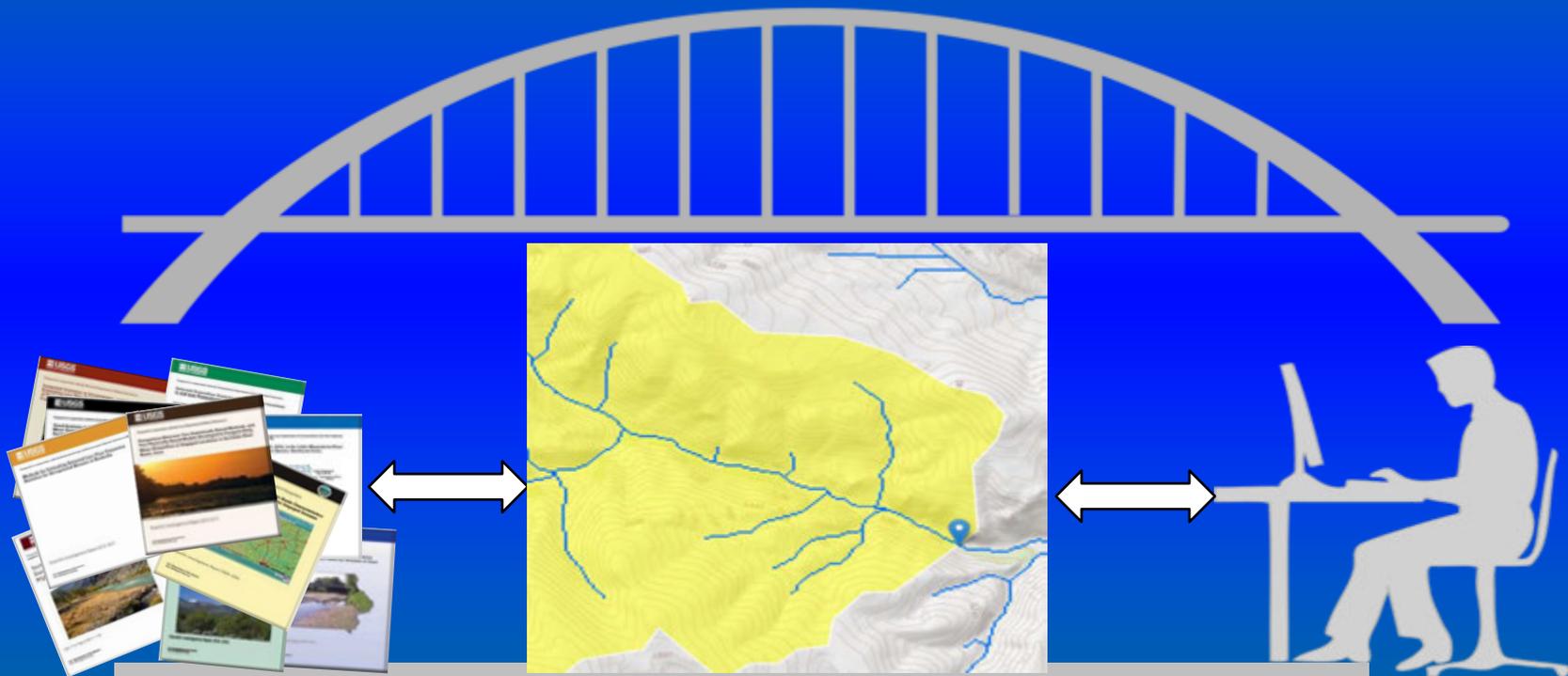
Texas StreamStats

Delivering web-based geospatial and hydrologic
information to the public

By Kristine Blickenstaff and Kara Garvin, USGS
April 15, 2025

In Cooperation with the Texas Department of
Transportation

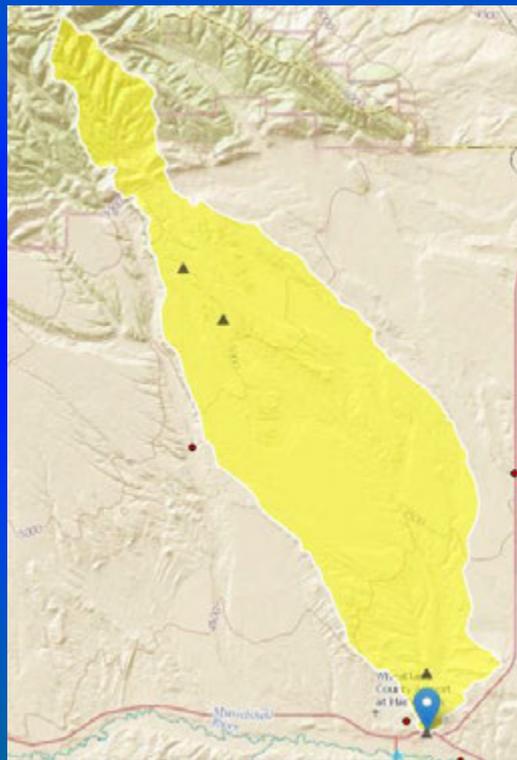
What is StreamStats?



Making complex science easily available and useful

What is StreamStats?

- Web-based map application for retrieving basin and streamflow characteristics
 - Delineates basins
 - Computes basin characteristics
 - Retrieves streamflow statistics
 - Solves regression equations for estimating streamflow statistics
- Plus other functionality and applications in an Ecosystem of Services



The Ecosystem of Services

- Delineation
- Basin Edit Tools
- At-site statistics
- Ungaged estimates
- Regulation
- Rainfall runoff computations
- Hydraulic geometry
- State-specific layers (i.e. bridges)
- Coordinated flows (Indiana)
- Network navigation
- Similar gages
- Flow duration curve transfer
- StreamEST
- Storm drains
- Water Use and water availability
- International StreamStats (Rainy River Basin)
- PROSPER (Pacific Northwest)
- National Application
- Time of Travel (developing nationwide on NHDPlusV2.1)
- Fire hydrology tools and data
- Continuously solved regression equations
- NHDPlusHR Refresh
- Lidar-developed StreamStats
- Conditional hydrologic networks
- Hydraulic channel parameters
- Machine learning models (proposed)
- Sediment transport (proposed)

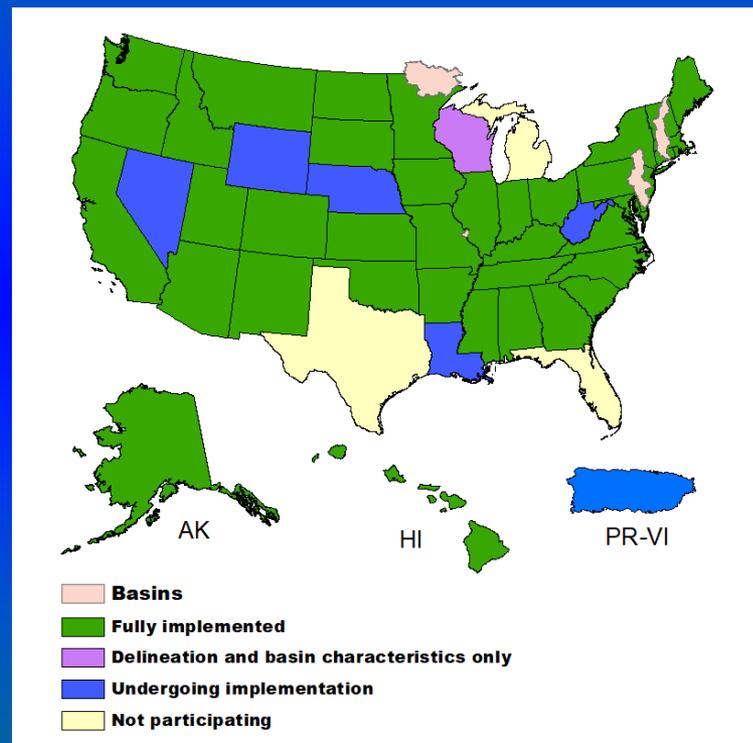
Who developed StreamStats?

- StreamStats application developed by USGS StreamStats development team
- Data, analyses, and equations prepared locally (USGS Water Science Centers) in cooperation with federal, state, and local cooperators
- The StreamStats Team charge is to support the WSCs to implement data, methods, and functionality

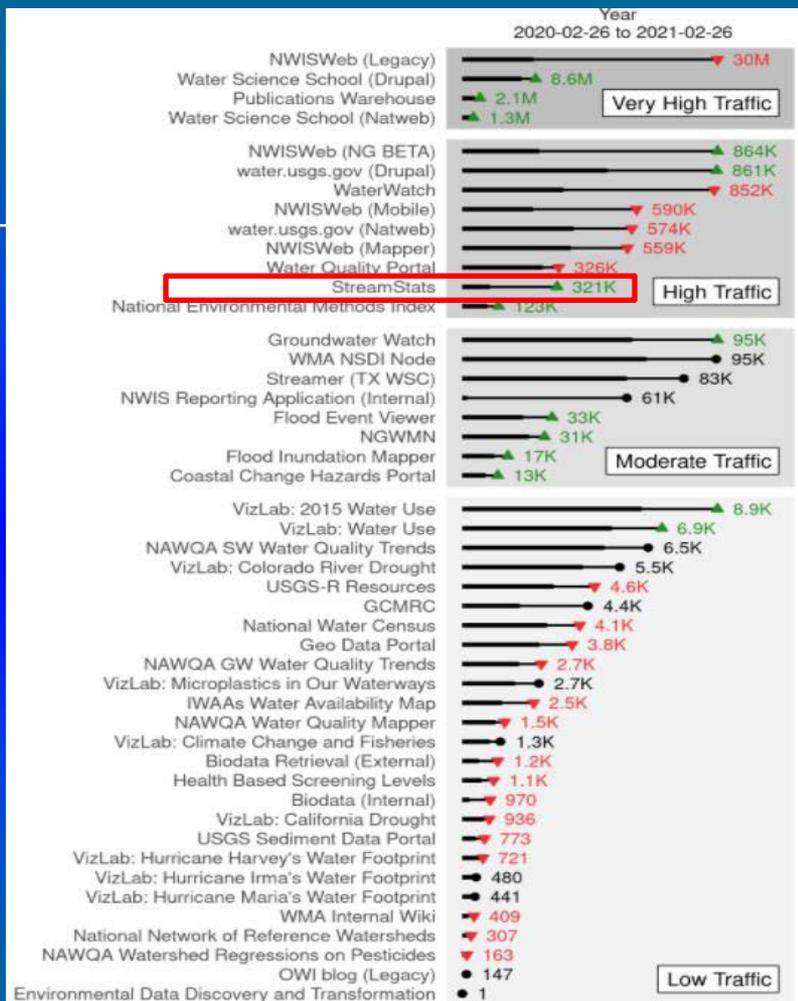
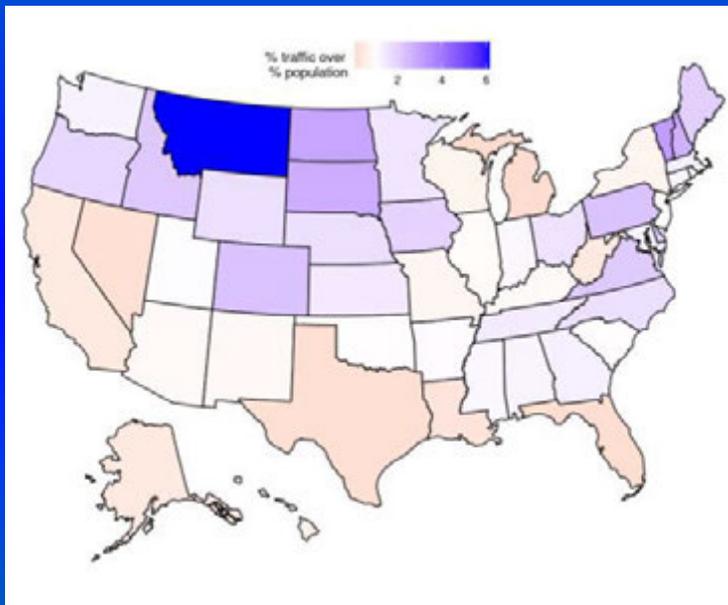


Who developed StreamStats?

- Data, applications, and availability of equations vary by state (or region)
- Innovations are everywhere
- Nearly all implemented states have flood frequency equations



Who's using StreamStats?



South Carolina

"Over the next ten years, SCDOT anticipates a savings of \$20,300,000 (20.3 million dollars) in engineering costs. Further, the research led SCDOT to modify the Requirement for Hydraulic Design Studies and designated StreamStats as the recommended method for delineating watersheds and obtaining discharges":-

abstract submitted to the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee's (RAC) Value of Research Task Force (written communication with Jimmy Clark 5/21/2020).

StreamStats was selected as a 2019 Sweet Sixteen High Value Research Project by AASHTO

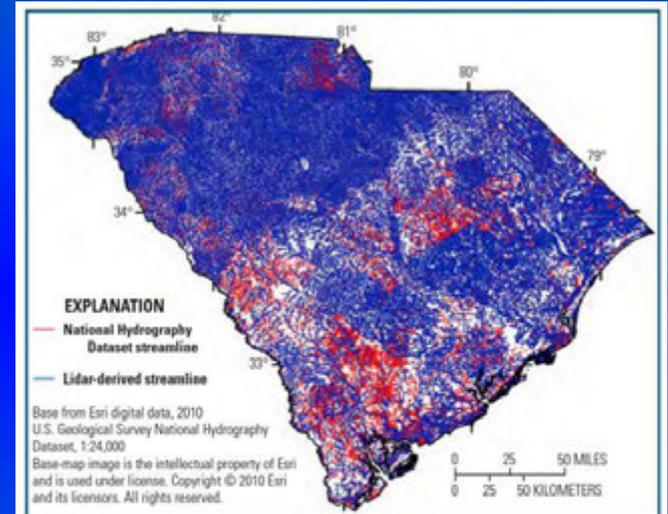


Figure 2. Light detection and ranging (lidar)-derived streamline coverage and National Hydrography Dataset coverage in South Carolina. Red lines show areas where the NHD is denser than the lidar coverage. Flow accumulation streamlines (fig. 1B) filled in these areas by adding to the lidar streamlines and continuing up stream channels.

Montana

- 2018 Presentation to ASFPM “Advantages of Collaboration with USGS”
- Needs more thorough analyses
 - regulated,
 - unregulated,
 - record extension methods
 - USGS preferred analyses based on local expertise and research of flood history
- Built on strong relationships and trust
- Flood frequency equations based on channel widths
- >700 gages of which nearly 300 are CSGs, many of which cannot be represented by NHDPlusV2

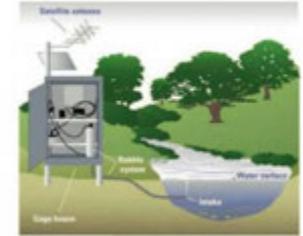
WORKING WITH USGS

• Strong Relationship with USGS MT Staff

- Previous collaboration
- Trust

• USGS

- Experts in Hydrologic Analyses
- Reports are the definitive resource for peak flow hydrology
- Accepted by FEMA



ASFPM | June 2018



• Advantages of Collaborating w/USGS:

- New streamlined process for publishing Flood Frequency Updates
- Future Projects = lower cost and higher cost share
- Schedules/Deadlines Prioritized
- Credibility

• Challenges & Solutions

- Strong Relationships make a difference



Colorado

- Colorado DOT requested a proposal to upgrade Colorado to lidar data and use surveyed culvert locations to inform the processing
- Added datasets developed in Colorado to implement TR-55 and rational method

Customizing StreamStats for Colorado

The following **Five** research projects related to StreamStats put CDOT in a ***Nationwide leading status***

- 2014 - Crest-Stage Gage Network Research Project. Installation of 10 Stream Gages for Plains (Eastern Colorado) Hydrological Region (1)
- 2015
 - Paleo-Flood Studies Research Project for Plains Hydrologic Region (2)
 - Partial Basin Delineation Research Project for the entire state (3)
- 2016 - Additional Basin Characteristics added to StreamStats for the entire state (4)
- 2017 - Addition of Rational and Natural Conservation Service (formerly Soil Conservation Service) Hydrological Methods for the entire state (5)



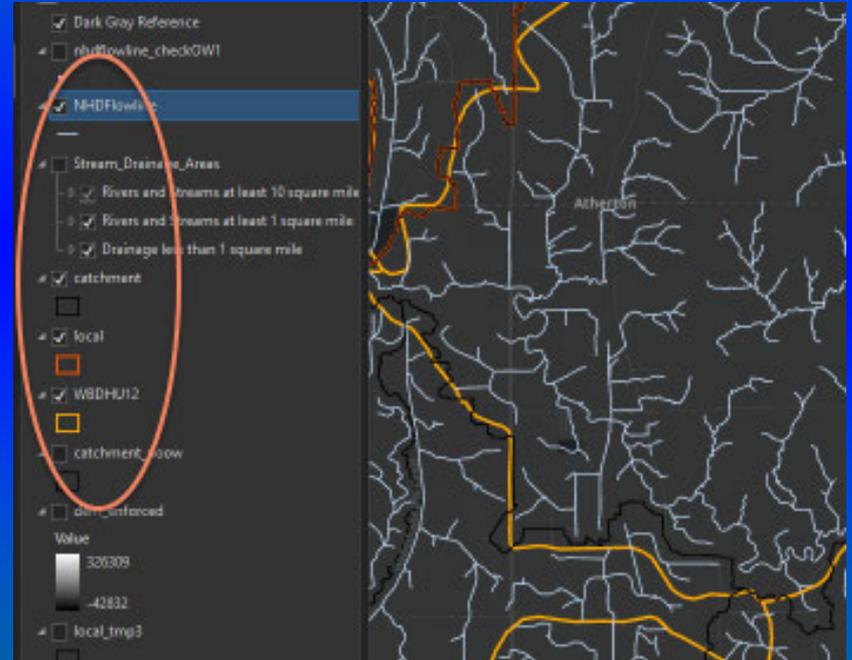
2/28/2021

Dr. Mommandi of the Colorado Department of Transportation presentation at the 2016 AWRA Conference in Sacramento

Indiana

“...Streamstats is mission critical for us, we could not function without it at this point...” -David Knipe, Indiana Department of Natural Resources

- Coordinated discharge statistics based on multi-agency MOU
- Applications directly using StreamStats services
- NHD streams resolution greater resolution than NHDPlus could process
- New 3-meter lidar derived StreamStats application in process



Minnesota

- ❑ Sediment transport data
- ❑ Calibrated machine learning models as services (proposed)
- ❑ Combine machine learning models, QPPQ methods, and sediment transport to get daily sediment transport estimates anywhere



Prepared in cooperation with the U.S. Army Corps of Engineers, Minnesota Pollution Control Agency, and Lower Minnesota River Watershed District

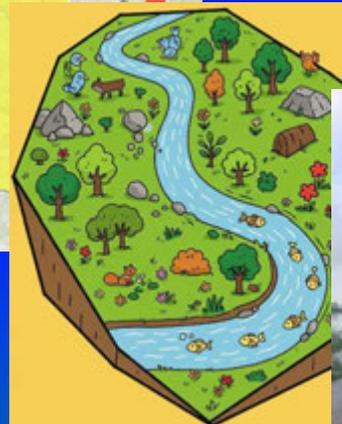
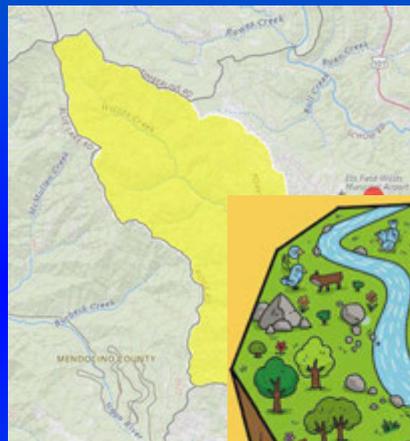
Suspended-Sediment Concentrations, Bedload, Particle Sizes, Surrogate Measurements, and Annual Sediment Loads for Selected Sites in the Lower Minnesota River Basin, Water Years 2011 through 2016



Scientific Investigations Report 2016-5174

StreamStats for Texas - Data at Your Fingertips

- Streamflow statistics, watershed basin boundaries, and basin characteristics such as land use aren't readily available to users at gaged and ungaged sites along a stream.



USGS StreamStats Application

The screenshot displays the USGS StreamStats application interface. At the top left is the USGS logo with the tagline "science for a changing world" and the text "StreamStats". To the right of the logo are navigation links: "Batch Processor", "Report", "About", and "Help".

The main interface is divided into several sections:

- Navigation Panel (Left):** Includes a "SELECT A STATE / REGION" dropdown, a "Step 1" instruction box, a search bar labeled "Search for a place", a "Help" icon, and a vertical menu with options: "IDENTIFY A STUDY AREA", "SELECT SCENARIOS", "BUILD A REPORT", and "POWERED BY WIM". At the bottom of this panel are links for "USGS Home", "Contact USGS", "Search", "USGS Accessibility", "FOIA", and "Privacy".
- Map Area (Center):** Shows a map of the United States with a highlighted study area in the Pacific Northwest. A "Zoom Level: 4" box displays "Map Scale: 1:36,978,596" and "Lat: 26.2737, Lon: -95.4492". A scale bar at the bottom left shows "500 km" and "300 mi".
- Tools and Layers (Right):** Features an "Exploration Tools" section with a "+" and "-" icon, and a "Layers" panel with "Base Maps" and "National Layers" (checked) options.

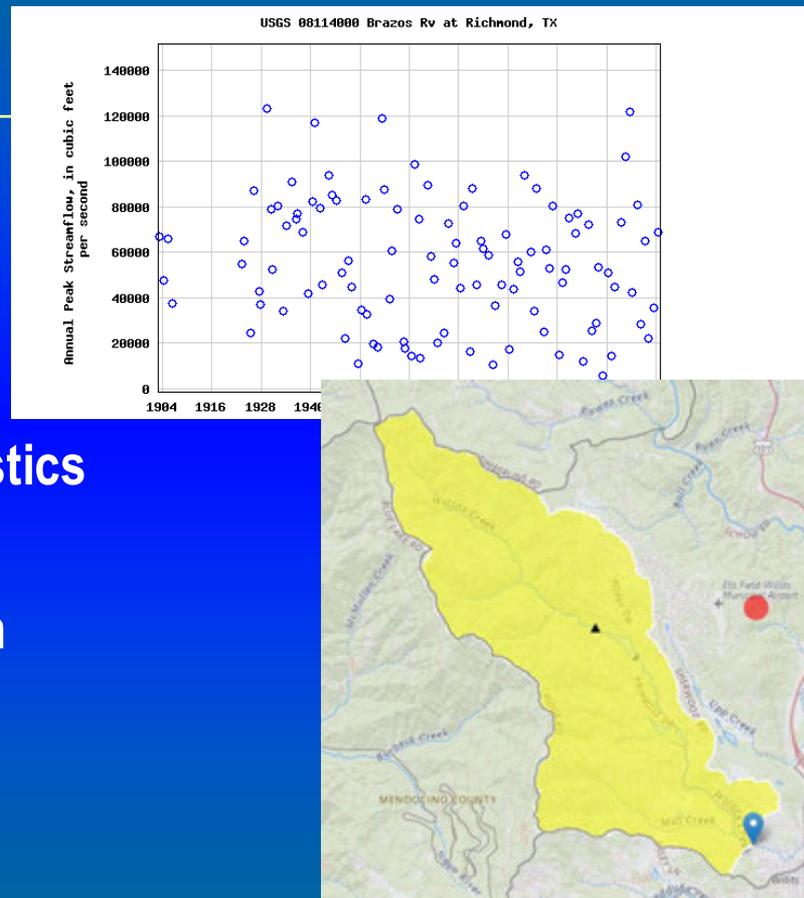
USGS StreamStats Application

- StreamStats is a map-based web application that provides an assortment of analytical tools that are useful for water-resources planning and management, and engineering purposes
- StreamStats provides estimates of streamflow statistics for user selected ungaged sites on streams as well as for USGS streamgages

StreamStats Outputs

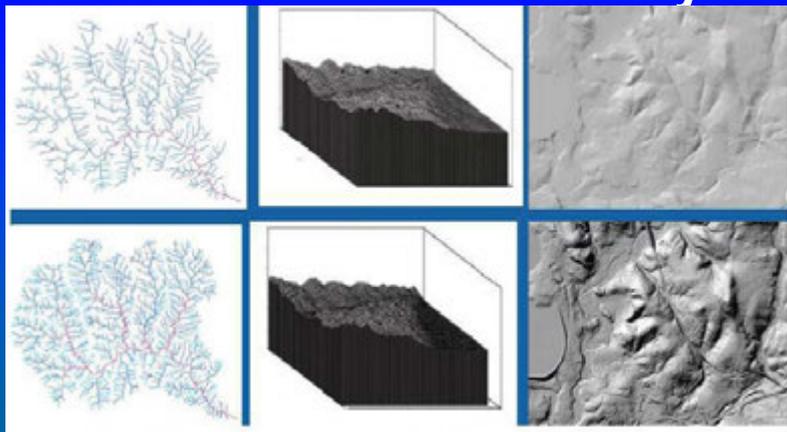
The Texas StreamStats application will provide automated tools to:

- 1) Delineate basins
- 2) Derive basin characteristics
- 3) Generate peak-flow flood frequency statistics
- 4) Create reports with tables and maps
- 5) Download geographic information system (GIS) basin boundary and spreadsheet files
- 6) Link to published USGS reports and data.



Digital Elevation Model

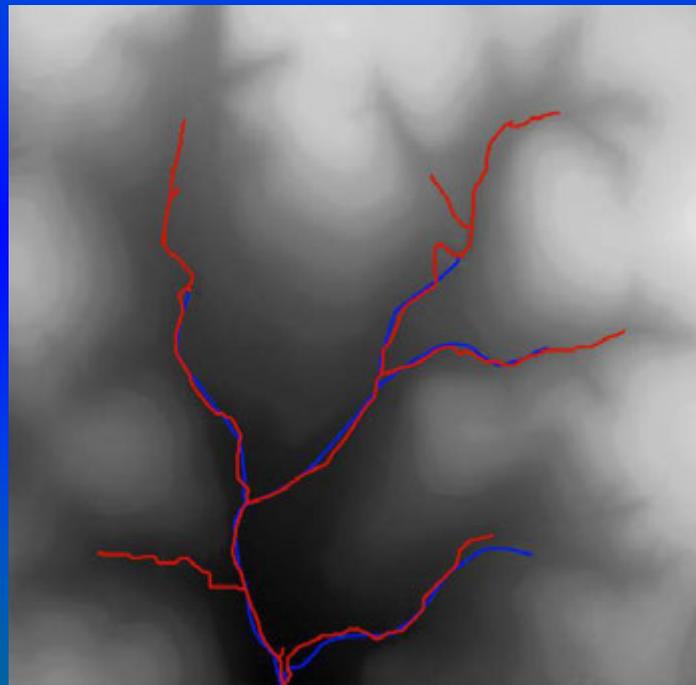
- Statewide 3-meter Lidar DEM dataset from Fathom
- Stream lines will be developed from the DEM data using geospatial tools
- Creating a new 3-meter statewide stream layer



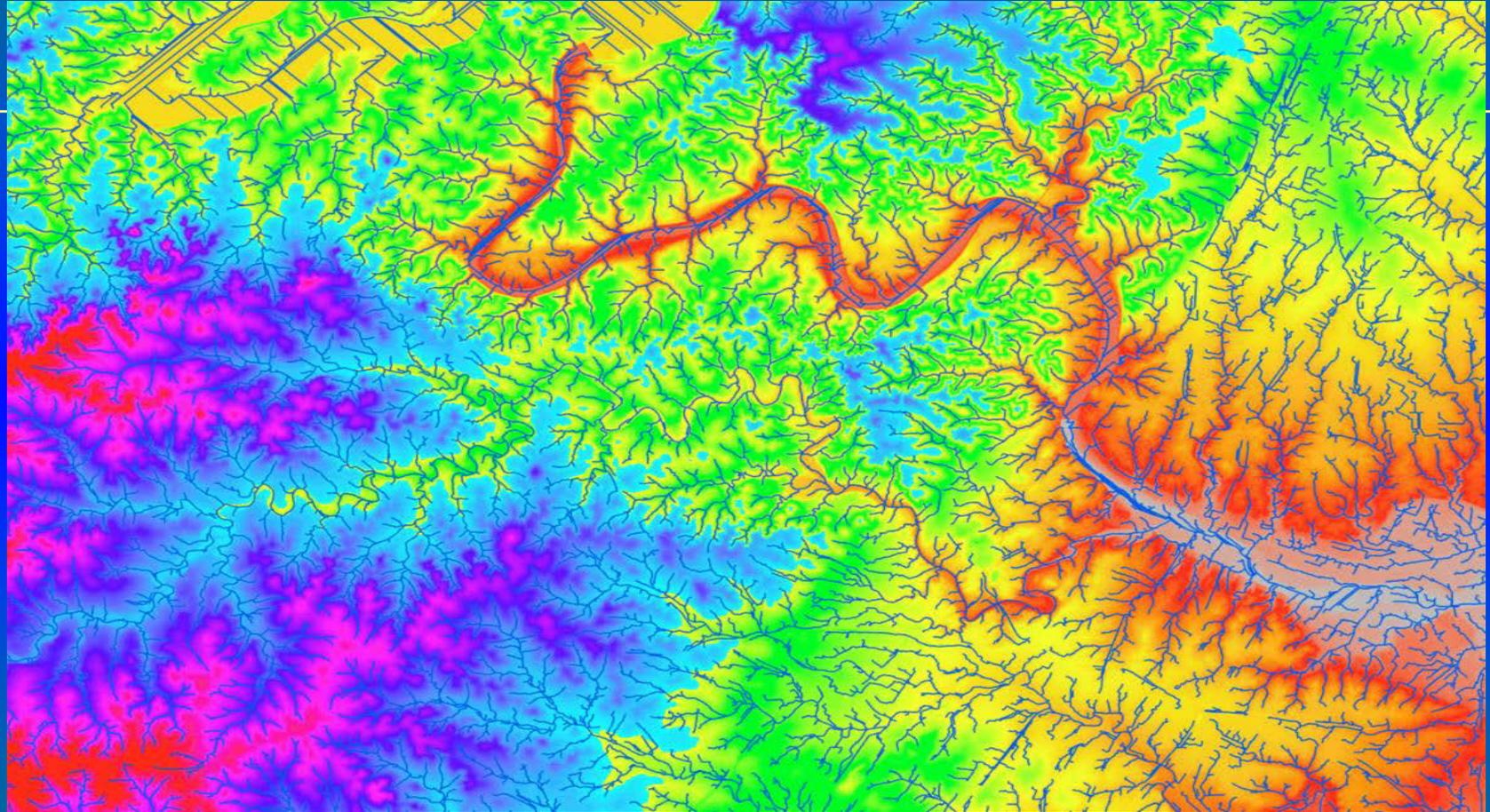
Lidar Derived Streamlines

A 3-meter stream-line dataset will be created for Texas as a product of this project

- Cutting-edge methodology
- Created using lidar dem data
- Includes precise detail- only Texas and Florida using this updated method
- Streamlines will extend further upstream



Lidar Derived Streamlines

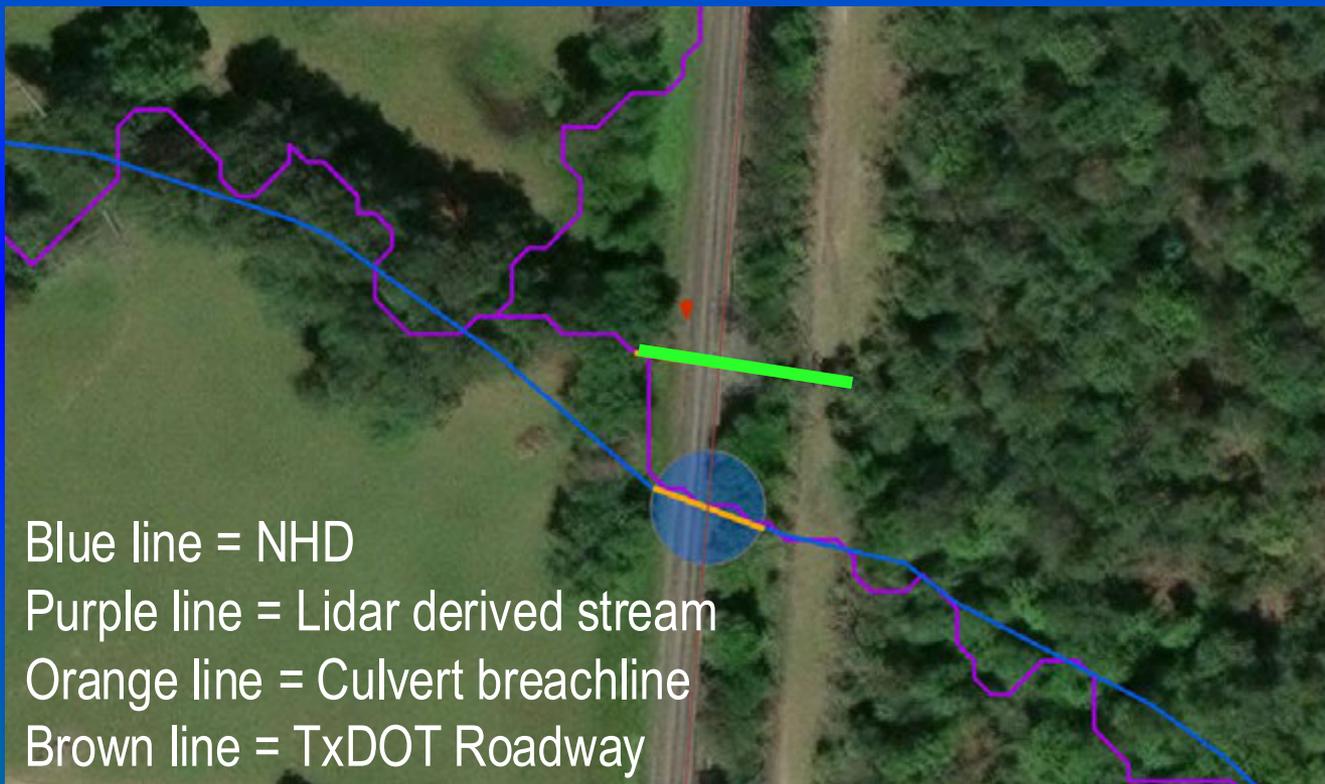


Culvert Breaching

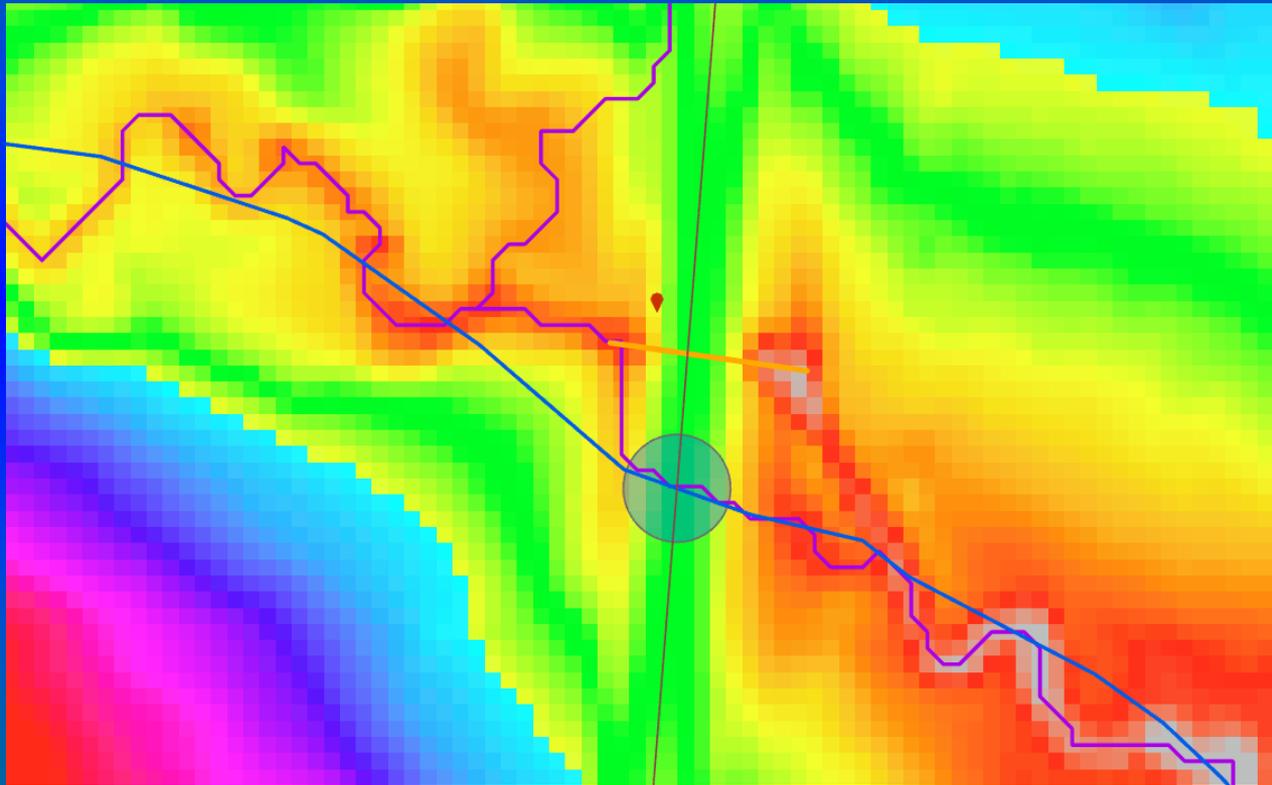
- TxDOT Bridge-class culvert inventory dataset
- TxDOT Roadways
- National Hydrologic Database (NHD)



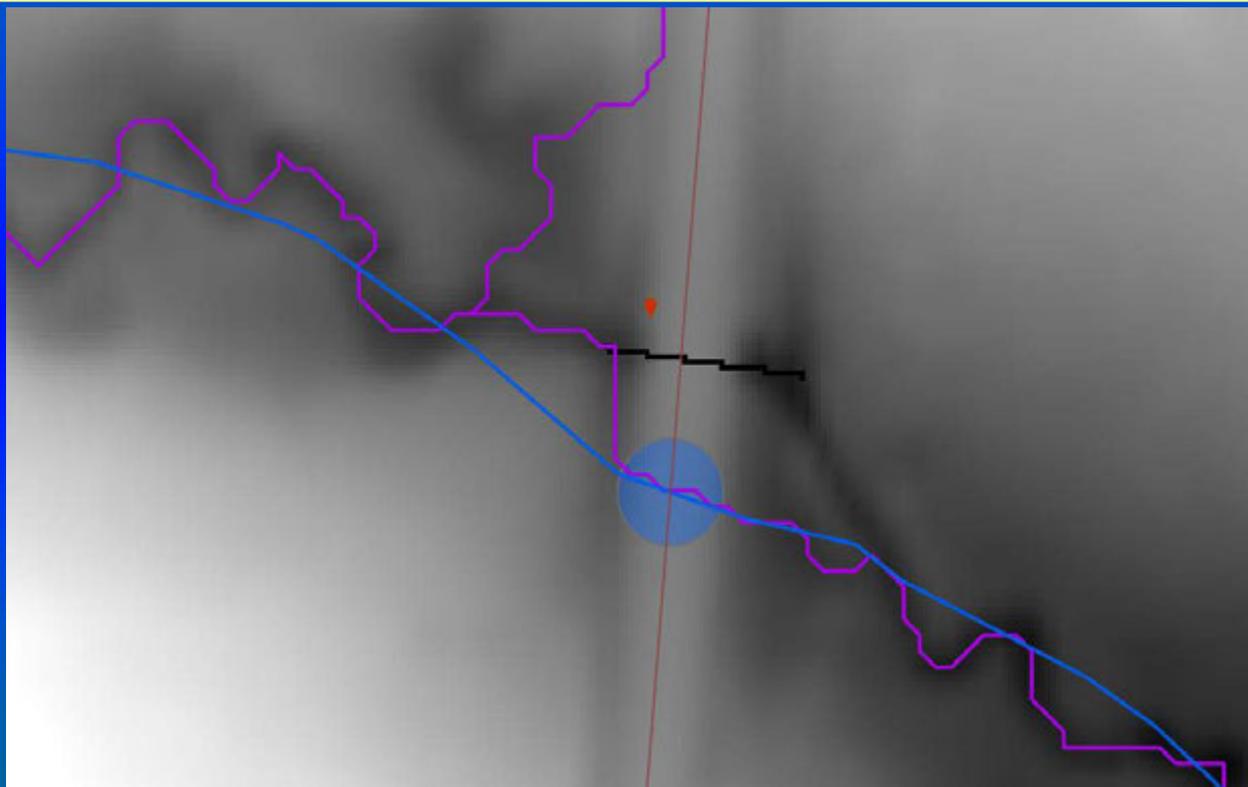
Culvert Breaching



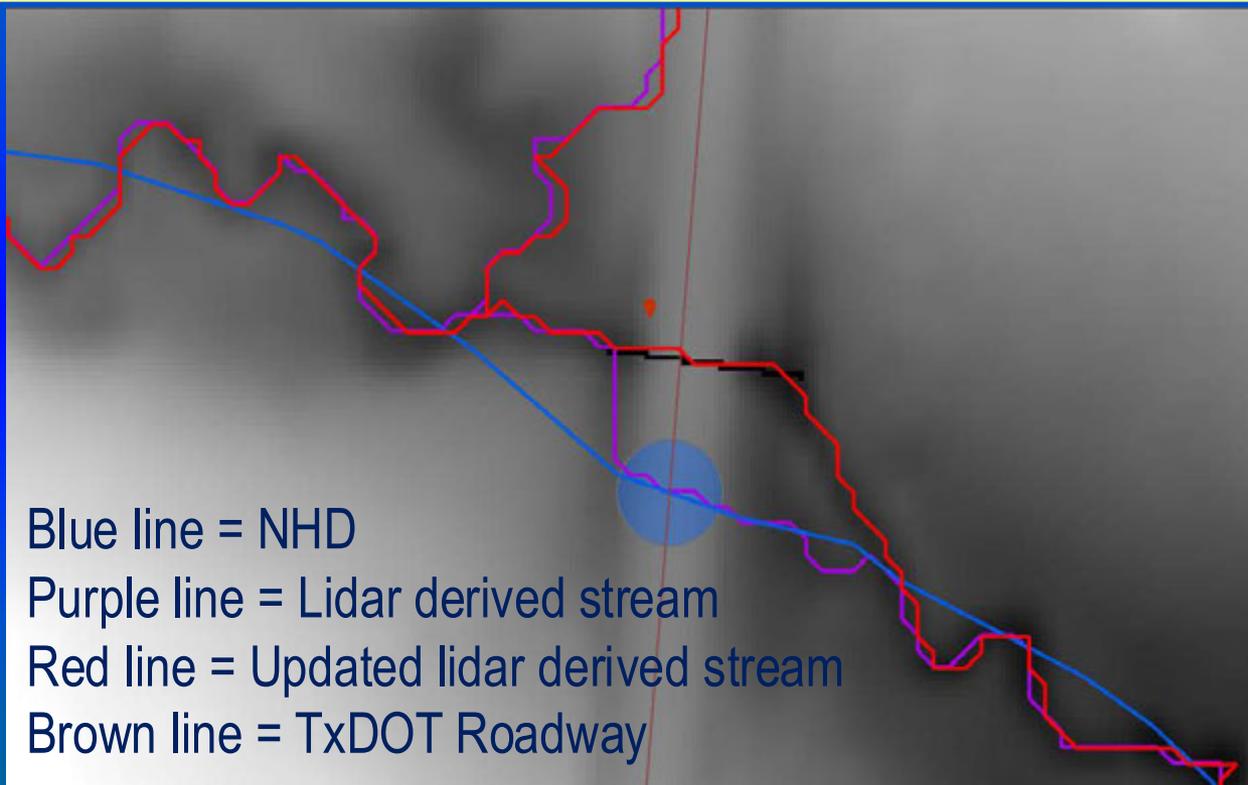
Culvert Breaching with 3-meter DEM



Culvert Breaching- DEM breached



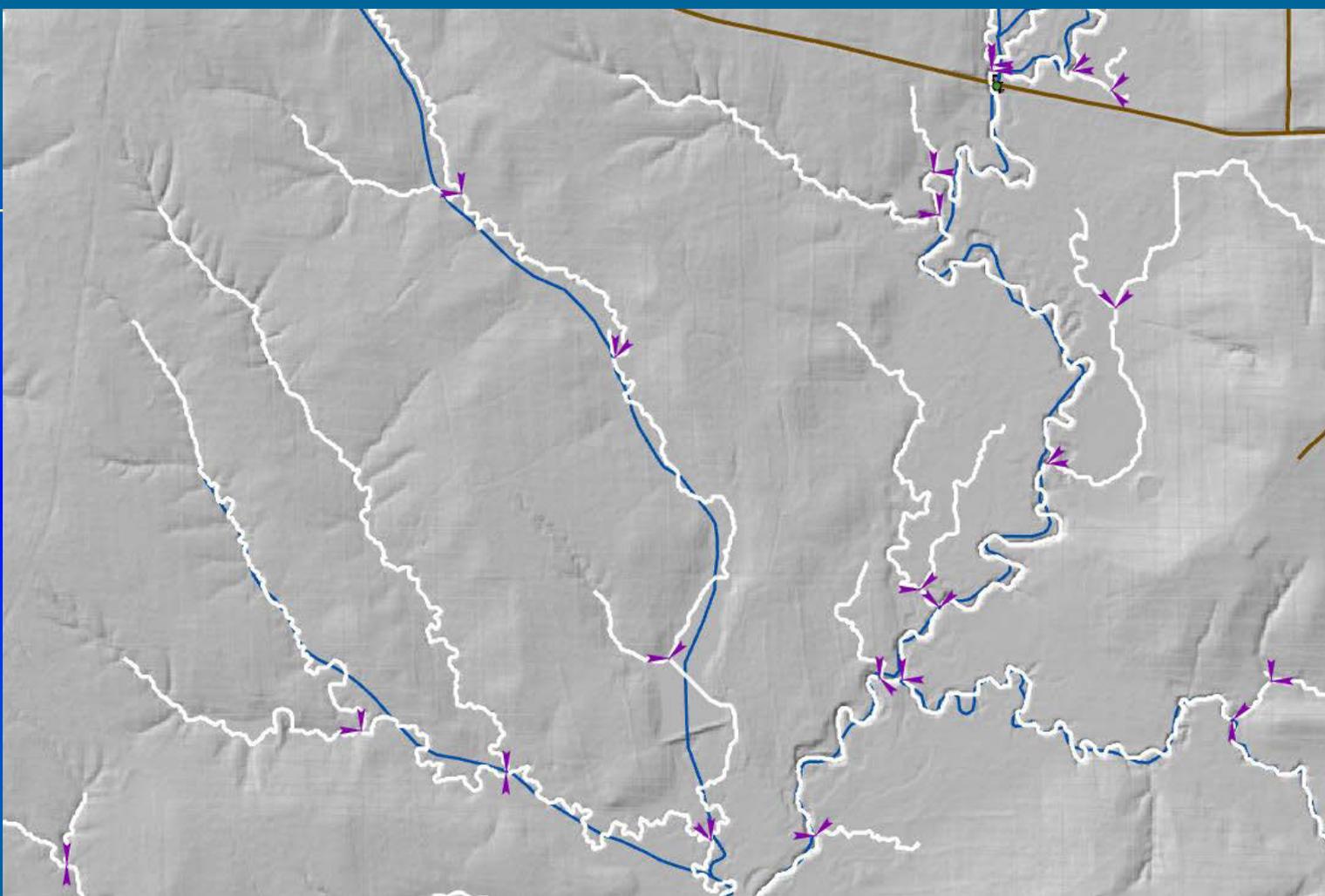
Culvert Breaching



New Streamlines By The Numbers

- HUC4- 1210 Central Texas Coast
- TxDOT culverts = 2,877 (21,433 total in statewide dataset)
- Breachlines created = 15,692
- NHD Streamline length = 36,691 miles
- New created str50k streamline length = 117,659 miles
- 3+ times more streamlines





Playas



USGS StreamStats Application

The screenshot displays the USGS StreamStats application interface. At the top left is the USGS logo with the tagline "science for a changing world". The main header includes "StreamStats" and navigation links for "Batch Processor", "Report", "About", and "Help".

The left sidebar contains a "SELECT A STATE / REGION" dropdown menu. Below it is a "Step 1" instruction box: "Step 1: Use the map or the search tool to identify an area of interest. At zoom level 8 or greater State/Region selection will be enabled." A search bar with the placeholder "Search for a place" and a "Help" icon are also present. Further down are menu items for "IDENTIFY A STUDY AREA", "SELECT SCENARIOS", and "BUILD A REPORT". At the bottom of the sidebar, it says "POWERED BY WIM" and provides links for "USGS Home", "Contact USGS", "Search", "USGS Accessibility", "FOIA", and "Privacy".

The central map shows the United States with a green shaded area over the Pacific Northwest. An "Exploration Tools" panel is visible above the map with zoom in (+) and zoom out (-) buttons. A "Layers" panel on the right shows "Base Maps" and "National Layers" (checked). A status box at the bottom left of the map displays: "Zoom Level: 4", "Map Scale: 1:36,978,596", and "Lat: 26.2737, Lon: -95.4492". Scale bars for 500 km and 300 mi are shown at the bottom left. The map includes labels for major cities, geographical features like the "GREAT PLAINS" and "APPALACHIAN MOUNTAINS", and neighboring countries like "MEXICO".

<https://streamstats.usgs.gov>

Streamlines

The screenshot displays the USGS StreamStats web application interface. At the top left is the USGS logo with the tagline "science for a changing world" and the text "StreamStats". To the right of the logo are navigation links: "Batch Processor", "Report", "About", and "Help".

The main interface is divided into several sections:

- Left Sidebar:**
 - "SELECT A STATE / REGION" dropdown menu set to "California".
 - "IDENTIFY A STUDY AREA" button.
 - "Step 2: Click the 'Delineate' button to activate the delineation tool" instruction.
 - "Delineate" button.
 - "SELECT SCENARIOS" dropdown menu.
 - "BUILD A REPORT" dropdown menu.
 - "POWERED BY WIM" text.
 - Footer links: "USGS Home", "Contact USGS", "Search", "USGS Accessibility", "FOIA", "Privacy Policy", and "Notices".
- Map Area:**
 - "Exploration Tools" button.
 - A map showing a residential area with streamlines overlaid in blue. Street names include Clover Dr, Rose Ter, Buckeye Dr, Tulip Dr, Ponderosa Rd, Buckeye Rd, Willow, Azules St, Acacia Ct, Lilac Ln, Lilac Dr, Birch St, Birch Dr, Birch Ct, Birch Ter, Birch Cir, and Sherwood Rd.
 - Map controls: a zoom in (+) and zoom out (-) button, a scale bar (300 m / 1000 ft), and a coordinate box showing "Zoom Level: 15", "Map Scale: 1:18,055", and "Lat: 39.4328, Lon: -123.3951".
 - Map attribution: "Leaflet | Esri".
- Right Panel:**
 - "Layers" dropdown menu with a close (X) button.
 - Layer options: "Base Maps", "Application Layers", "National Layers" (checked), and "CA Map Layers".

Basin Delineation

USGS StreamStats
science for a changing world

Batch Processor Report About Help

Peak-Flow Statistics
Bankfull Statistics
Maximum Probable Flood Statistics
Basin Characteristics

Select All Basin Characteristics

Select	Parameter	Description
<input type="checkbox"/>	BASINPERIM	Perimeter of the drainage basin defined in SIR 2004-5262
<input type="checkbox"/>	BSLDEM30M	Mean basin slope computed from 30 m DEM
<input type="checkbox"/>	CENTROXA83	X coordinate of the centroid, in NAD_1983_Albers

Exploration Tools

Layers

- Base Maps
- Application Layers
- National Layers
- CA Map Layers

Zoom Level: 13
Map Scale: 1:72,223
Lat: 39.4306, Lon: -123.3878

1 km
3000 ft

Leaflet | Esri

Report

StreamStats Report

Region ID:	CA
Workspace ID:	CA20240220183414088000
Clicked Point (Latitude, Longitude):	39.42363, -123.37749
Time:	2024-02-20 10:33:59 -0800



⊕ Collapse All

Computed Basin Characteristics

> Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	7	square miles
ELEV	Mean Basin Elevation	2018	feet
ELEVMAX	Maximum basin elevation	2811	feet
FOREST	Percentage of area covered by forest	64.5	percent
LAKEAREA	Percentage of Lakes and Ponds	0.17	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	13.6	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.4	percent
MINBELEV	Minimum basin elevation	1472	feet
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88	1472	feet
PRECIP	Mean Annual Precipitation	57.8	inches

Texas Basin Characteristics

Name	Description
Drainage Area	Area that drains to a point on a stream
Stream Slope Blue Line Method	Change in elevation of the longest blue-line stream (not extended to the boundary) divided by stream length
Mean Annual Precipitation	Mean Annual Precipitation
Stream Density	Stream Density -- total length of streams divided by drainage area
Mean Basin Elevation	Mean Basin Elevation
Mean Basin Slope ft per mi	Mean basin slope determined by summing lengths of all contours in basin multiplying by contour interval and dividing product by drainage area
Percent agriculture	Percent agriculture computed as total of grass, pasture, and crops, from current NLCD classes 71, 81 and 82
Percent Forest from NLCD	Percentage of forested area from current NLCD classes 41-43
Percent Storage from NLCD	Percentage of area of storage from current NLCD classes 11-12, 90, 95
Percent Developed from NLCD	Percentage of developed (urban) land from current NLCD classes 21-24
Percent_Impervious_NLCD	Average percentage of impervious area determined from current NLCD impervious dataset
Average Soil Permeability	Average Soil Permeability
Main Channel Sinuosity	Main Channel Sinuosity
Texas Ecological Regions (10)	Percentage of area within the 10 Texas Ecological Regions
Mean Monthly Precipitation (12)	Mean monthly precipitation for each of the twelve months

Estimated Peak Flows

Peak-Flow Statistics Parameters [2012 5113 Region 1 North Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	7	square miles	0.04	3200
PRECIP	Mean Annual Precipitation	57.8	inches	20	125

Peak-Flow Statistics Flow Report [2012 5113 Region 1 North Coast]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	570	ft ³ /s	234	1390	58.6
20-percent AEP flood	1040	ft ³ /s	498	2170	47.4
10-percent AEP flood	1380	ft ³ /s	686	2780	44.2
4-percent AEP flood	1820	ft ³ /s	934	3550	42.7
2-percent AEP flood	2150	ft ³ /s	1100	4200	42.7
1-percent AEP flood	2500	ft ³ /s	1250	5000	44.3
0.5-percent AEP flood	2820	ft ³ /s	1410	5650	44.4
0.2-percent AEP flood	3250	ft ³ /s	1580	6670	46

Peak-Flow Statistics Citations

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles, 2012, *Methods for determining magnitude and frequency of floods in California, based on data through water year 2006*: U.S. Geological Survey Scientific Investigations Report

TX- Regional Regression Equations

- Using existing USGS developed estimating equations
- Asquith, W.H., and Roussel, M.C., 2009, [\[http://pubs.usgs.gov/sir/2009/5087\]](http://pubs.usgs.gov/sir/2009/5087)
- Asquith, W.H., Herrmann, G.R., and Cleveland, T.G., 2013, [\[https://doi.org/10.1061/\(ASCE\)HE.1943-5584.0000635\]](https://doi.org/10.1061/(ASCE)HE.1943-5584.0000635)

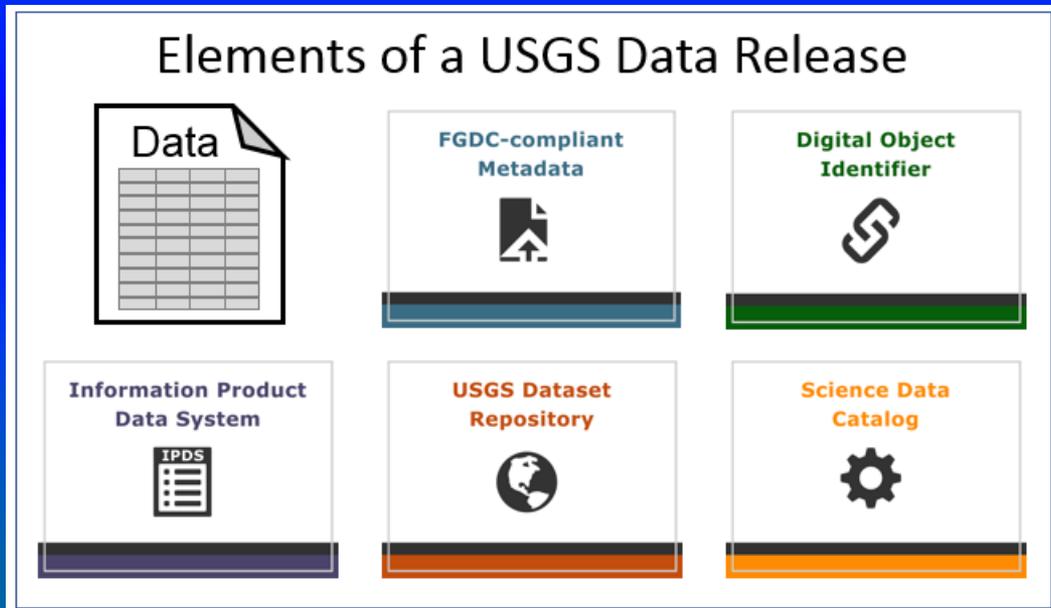
Benefits of StreamStats

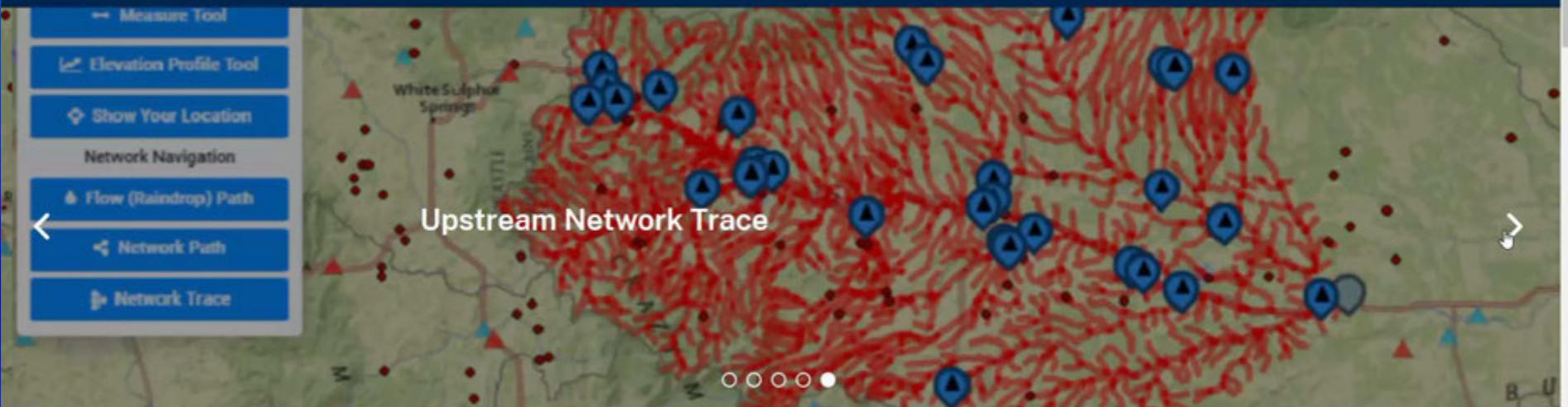
- Use of higher-resolution datasets
 - Refined consistent estimates of streamflow
 - More detail to smaller basins
- Output of **consistent** basin characteristic values for and streamflow statistics
- Peak-streamflow frequency estimates are needed by planners, managers, and design engineers for flood-plain management; for objective assessment of flood risk; for cost-effective design of roads and bridges; and also for the design of culverts, dams, levees, and other flood-control structures.



USGS ScienceBase Data Release

- Digital elevation, flow direction, flow accumulation, and new streamline GIS data as well as basin characteristic datasets





Upstream Network Trace

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StreamStats

StreamStats provides access to spatial analytical tools that are useful for water-resources planning and management, and for engineering and design purposes. The map-based user interface can be used to delineate drainage areas, get basin characteristics and estimates of flow statistics, and more. Available information varies from state to state.

Was this page helpful?

For more information on StreamStats:



<https://www.usgs.gov/streamstats>

Thank you!

