Waller Creek: Adapting Creek Form to an Altered Hydrology Urban Riparian Systems Symposium

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Environment

Waller Creek Urban Hydrology

- Urban hydrology is commonly affected by excessive imperviousness, intense runoff, functionally compromised creeks and rivers
- Ecological restoration requires careful attention to hydrologic underpinnings: functional lift
- This is typically challenging in developed urban systems never enough land area to redo the hydrology
- Austin's Waller Creek is a very unusual exception to the above: comprehensive solution that definitely manages the flood water, but more importantly creates the physical space for a new urban hydrology and ecology





Functional Lift



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FUNCTION: Biodiversity and the life histories of aquatic and riparian life PARAMETERS: Primary and Secondary Production, Macroinvertebrate Communities, Fish Communities, Riparian Communities, Landscape Pathways

PHYSIOCHEMICAL »

FUNCTION: Temperature and oxygen regulation; processing of organic matter and nutrients PARAMETERS: Dissolved Oxygen, Temperature Regulation, pH, Conductivity, Nutrient Processing, Organic Processing, Turbidity



GEOMORPHOLOGY »

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FUNCTION: Transport of wood and sediment to create diverse bed forms and dynamic equilibrium PARAMETERS: Sediment Transport Capacity and Competency, Channel Evolution, Streambank Erosion Rates, Percent Riffle and Pool, Depth Variability, Substrate Distributions, Large Woody Debris Transport and Storage, Riparian Vegetation density and composition

2

HYDRAULIC »

FUNCTION: Transport of water in the channel, on the floodplain, and through sediments PARAMETERS: Velocity, Shear Stress, Stream Power, Bank Height Ratio, Entrenchment Ratio, Rating Curves (discharge vs. stage), Groundwater/Surface Water Exchange

HYDROLOGY »

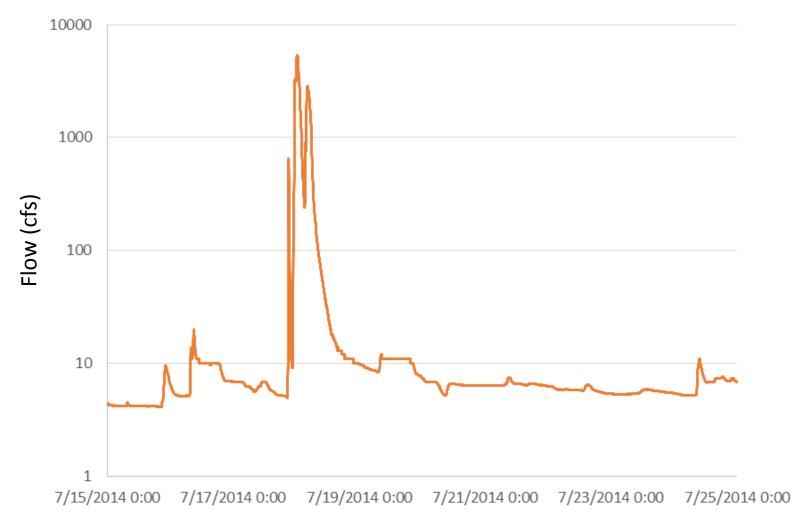
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FUNCTION: Transport of water from the watershed to the channel PARAMETERS: Precipitation/runoff relationship, Channel Forming Discharge, Flood Frequency, Flow Duration

USFWS: http://www.fws.gov/chesapeakebay/newsletter/Fall11/Pyramid/Pyramid.html



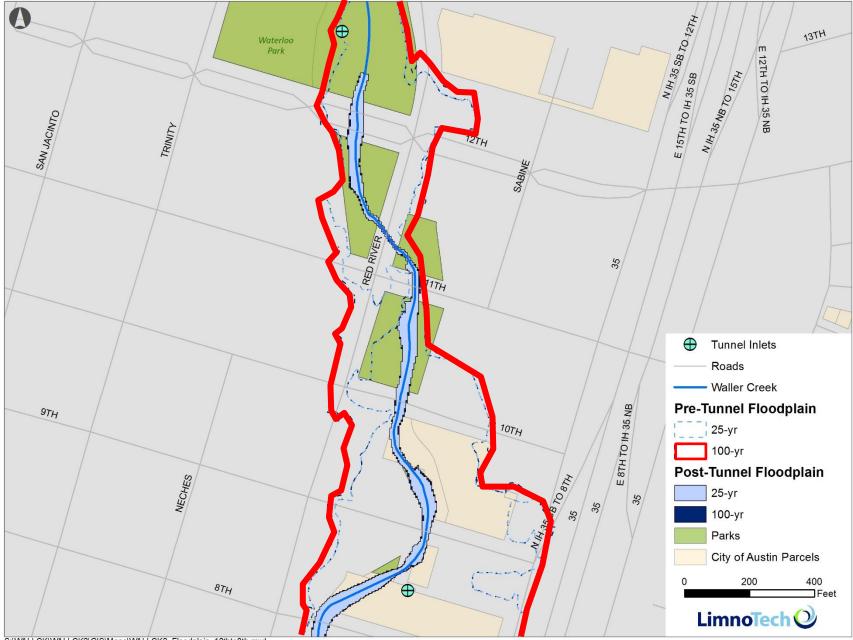
Urban Hydrology July, 2014 Waller Creek Flooding



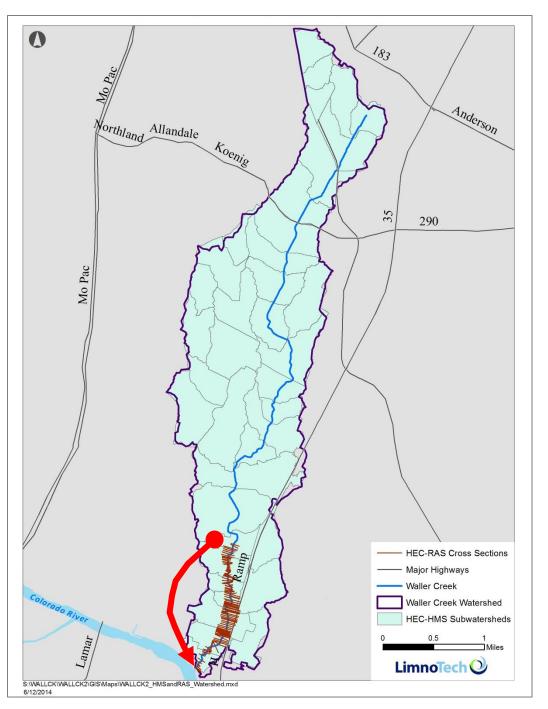




Waller Creek Floodplain - 12th St. to 8th St.



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Waller Creek Watershed

The tunnel diversion redirects approximately 82% of the watershed flows around the downstream reach of Waller Creek

Effects of modified hydrology

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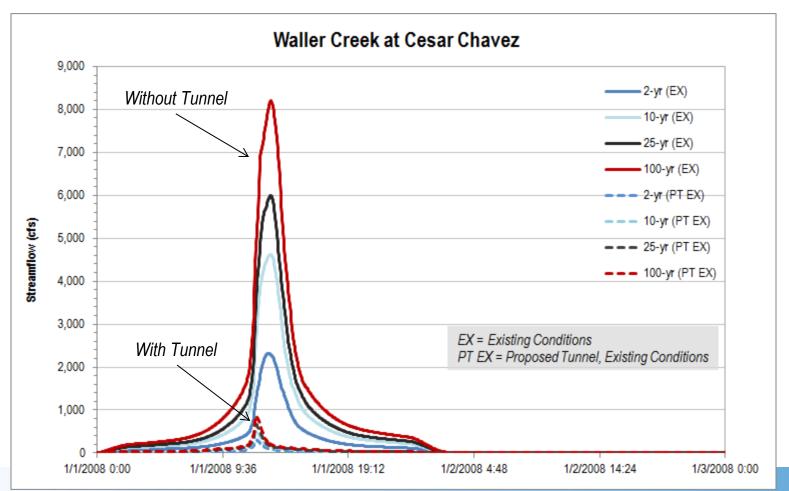
- Altered stream hydraulics
- Altered sediment transport
- Altered stream geomorphology
 - Sectionally
 - In Plan
- Altered water quality
- Altered biology

BIOLOGY » FUNCTION: Biodiversity and the life histories of aquatic and riparian life PARAMETERS: Primary and Secondary Production, PHYSIOCHEMICAL » 4 FUNCTION: Temperature and oxygen regulation; processing of organic matter and nutrients PARAMETERS: Dissolved Oxygen, Temperature Regulation, pH, Conductivity, Nutrient Processing, Organic Processing, Turbidity **GEOMORPHOLOGY** » З FUNCTION: Transport of wood and sediment to create diverse bed forms and dynamic equilibrium PARAMETERS: Sediment Transport Capacity and Competency, Channel Evolution, Streambank Erosion Rates, Percent Riffle and Pool, Depth Variability, Substrate Distributions, Large Woody Debris Transport and Storage, Riparian Vegetation HYDRAULIC » FUNCTION: Transport of water in the channel, on the floodplain, and through sediments PARAMETERS: Velocity: Shear Stress, Stream Power, Bank Height Ratio, Entrenchment Ratio, Rating Curves (discharge vs. stage). Groundwater/Surface Water Exchange HYDROLOGY » PARAMETERS: Precipitation/runoff relationship, Channel Forming Discharge, Flood Frequency, Flow Duration



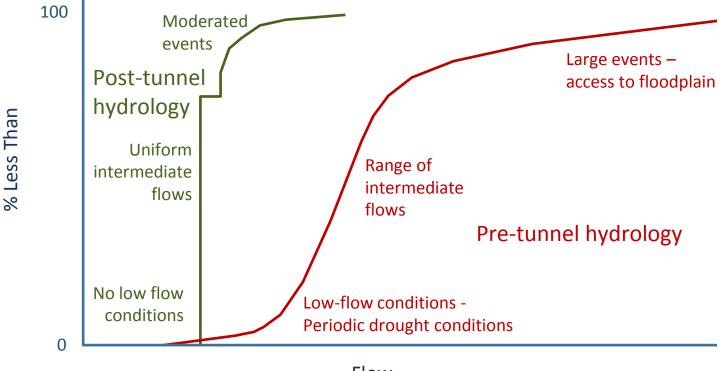
Effect on Event Flows: Hydrographs at Cesar Chavez Street

Hydrographs for a range of storms for pre- and post- tunnel, existing conditions





Effect on Flow Distribution: Conceptual Flow Distribution



Flow



Channel Evolution

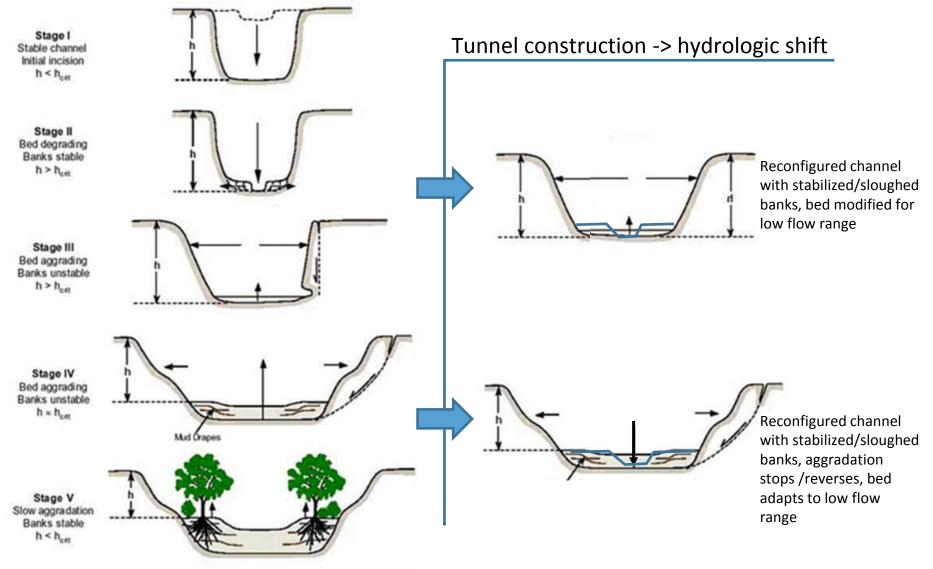


Image from http://www.austintexas.gov/faq/geomorphic-analysis





Sediment Supply \rightarrow Channel Form

- Supply \rightarrow Transport Mechanism \rightarrow Channel Form
- Transport Mechanism
 - Baseflow Continuously Dynamic Channel
 - Storm events Intermittently Dynamic Channel
 - None Static Channel
- 3 Options for Channel Form

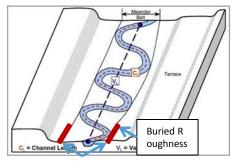


Creek Morphology: Options



Meander Belt – Continuous

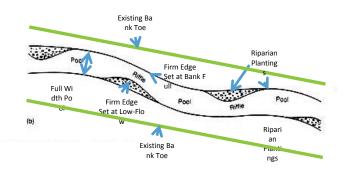
- Continuous feed
- Lower
 Construction Cost
- Higher O&M Cost
- High Risk of Failure



Armor Floodplain Boundary

Enlarged Pools – Intermittent

- Seasonal feeding
- Costs depend of degree of stability
- Lower Risk of Failure / adaptive



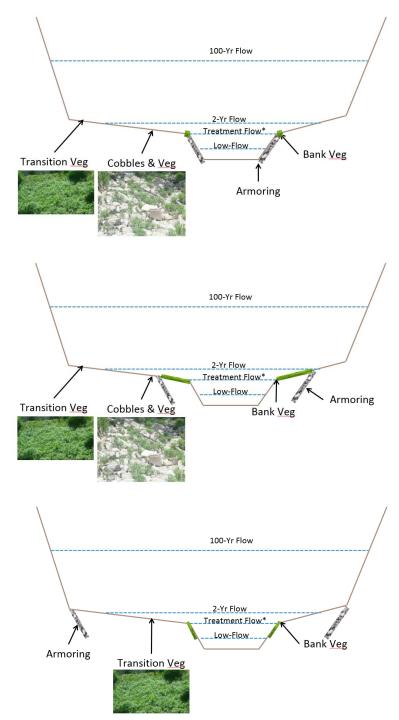
Stable – Static

- No Feeding
- Higher
 Construction Cost
- Lower O&M Cost
- Low Risk of Failure



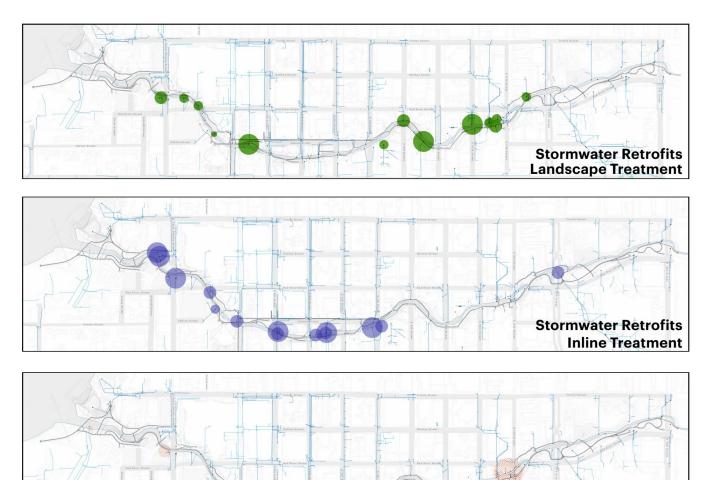
Implications for Channel Cross-Section

Different creek morphologies require different levels of armoring, in terms of location and intensity



Stormwater Quality Improvement Opportunities

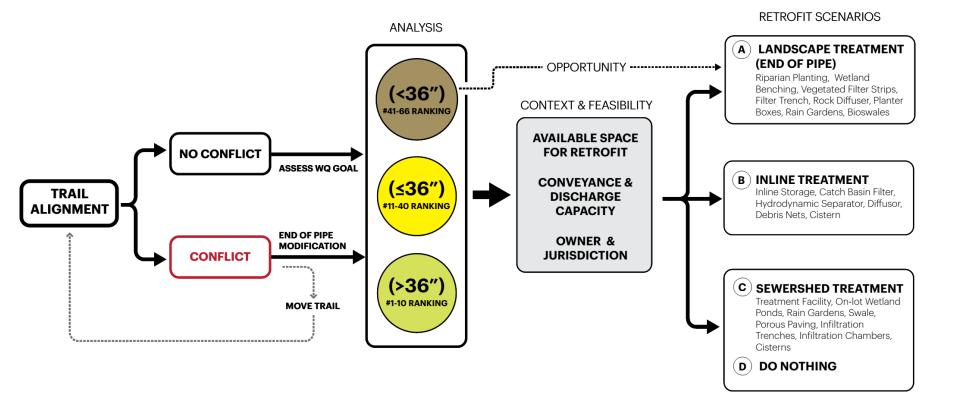


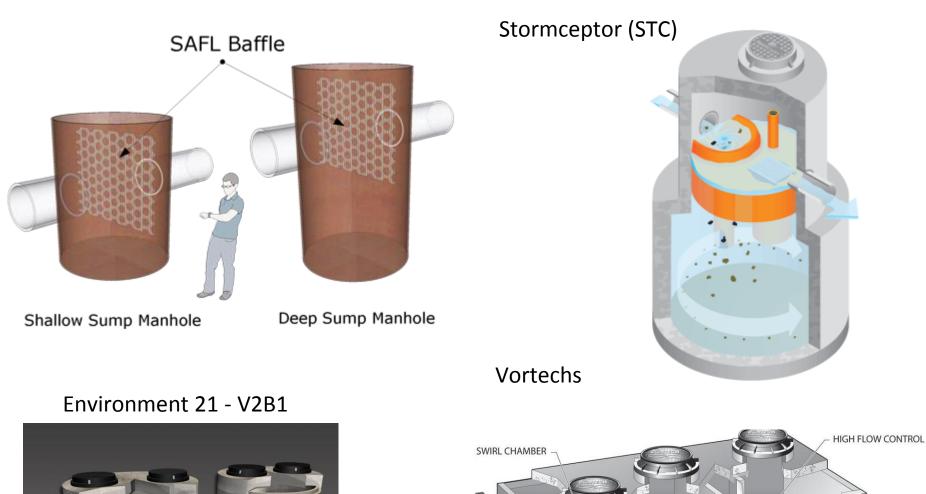


Stormwater Retrofits Sewershed Treatment

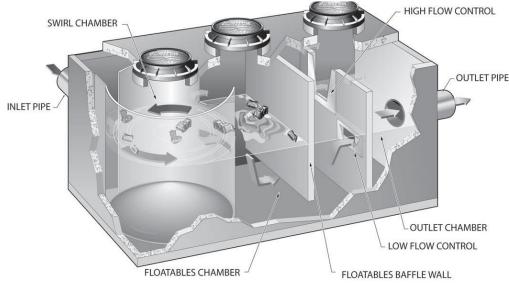
Stormwater Quality Improvement Opportunities













Conclusions

- Waller Creek framework plan presents an unusual opportunity to accomplish real restoration of hydrologic, geomorphic, and ecologic function in an urbanized creek
- Waller Creek functional restoration addresses: altered stream hydraulics, sediment transport, stream geomorphology, water quality, and biology
- Creates a new functional waterway that supports human use, complements development in the corridor, and provides a haven for a new biological community



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