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

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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

1. HYDROLOGY
   FUNCTION: Transport of water from the watershed to the channel
   PARAMETERS: Precipitation, Runoff relationship, Channel Forming Discharge, Flood Frequency, Flow Duration

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

3. GEOMORPHOLOGY
   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

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

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

USFWS: http://www.fws.gov/chesapeakebay/newsletter/Fall11/Pyramid/Pyramid.html
Urban Hydrology
July, 2014 Waller Creek Flooding

The graph shows the flow (cfs) over time from July 15 to July 25, 2014. There was a significant increase in flow on July 19, 2014, peaking at a high value before declining rapidly. The flow then stabilizes at a lower level for the remainder of the period.
Waller Creek Watershed

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

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

Pre-tunnel hydrology

- Large events – access to floodplain
- Low-flow conditions - Periodic drought conditions
- Range of intermediate flows
- Uniform intermediate flows
- No low flow conditions

Post-tunnel hydrology

- Moderated events

% Less Than

Flow
Channel Evolution

- **Stage I**: Stable channel, initial incision. $h < h_{\text{eff}}$
- **Stage II**: Bed degrading, banks stable. $h > h_{\text{eff}}$
- **Stage III**: Bed aggrading, banks unstable. $h > h_{\text{eff}}$
- **Stage IV**: Bed aggrading, banks unstable. $h = h_{\text{eff}}$
- **Stage V**: Slow aggradation, banks stable. $h < h_{\text{eff}}$

Tunnel construction -> hydrologic shift

Reconfigured channel with stabilized/sloughed banks, bed modified for low flow range.

Reconfigured channel with stabilized/sloughed banks, aggradation stops/reverses, bed adapts to low flow range.

Image from http://www.austintexas.gov/faq/geomorphic-analysis
Sediment Supply → Channel Form

- Supply → Transport Mechanism → 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

**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 Quality Improvement Opportunities
Habitat creation 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