Creating Value …

… Delivering Solutions

Stream Restoration Design and Implementation in Urban Environments

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Baker

Presentation Overview

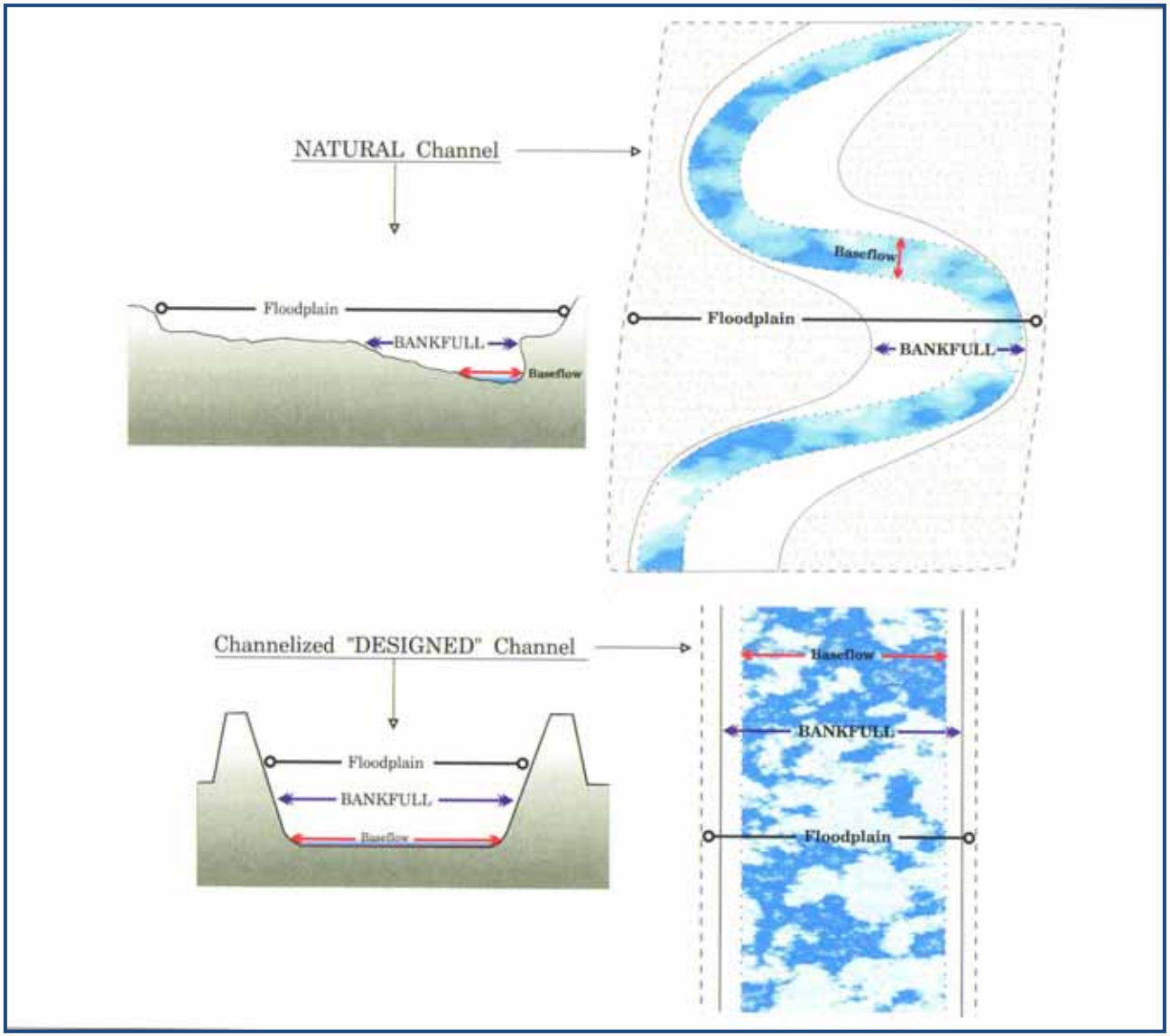
- **Natural channel design (NCD) versus traditional urban designs**
- **Urban challenges and opportunities**

Stream Restoration Overview

- **Stream restoration using natural channel design is increasing throughout the U.S.**
  - Mitigation Related Projects
  - Watershed Restoration Projects

Traditional vs. Natural Channel Design

Natural Versus Channelized Streams



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The Stable Stream Design Goal

A stable stream moves the sediment and water generated by its watershed while maintaining dimension, pattern and profile, without aggrading or degrading

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Bankfull Discharge

- Fills a stable channel up to the elevation of the active floodplain.
- Represents a breakpoint between processes of channel formation and floodplain development.
- Often leaves a visual indicator.

Bankfull Discharge

Identifying bankfull discharge in urban channels using visible indicators is often difficult.

- Channel disturbance
- Changes in hydrologic regime

Any visual indicators should be verified with further analysis.

The Evolution of Stream Restoration

- **Traditional Approach**
  - Spot fixes using hard armoring techniques
    - Concrete, gabion baskets, rip-rap

- **Evolving NCD Approach**
  - Holistic restoration to promote stream function and health
    - Green techniques for banks – live staking, brush mattress, coir fiber log, geo-lifts
    - In stream structures - cross vanes, j-hooks, double wing deflectors, root wads

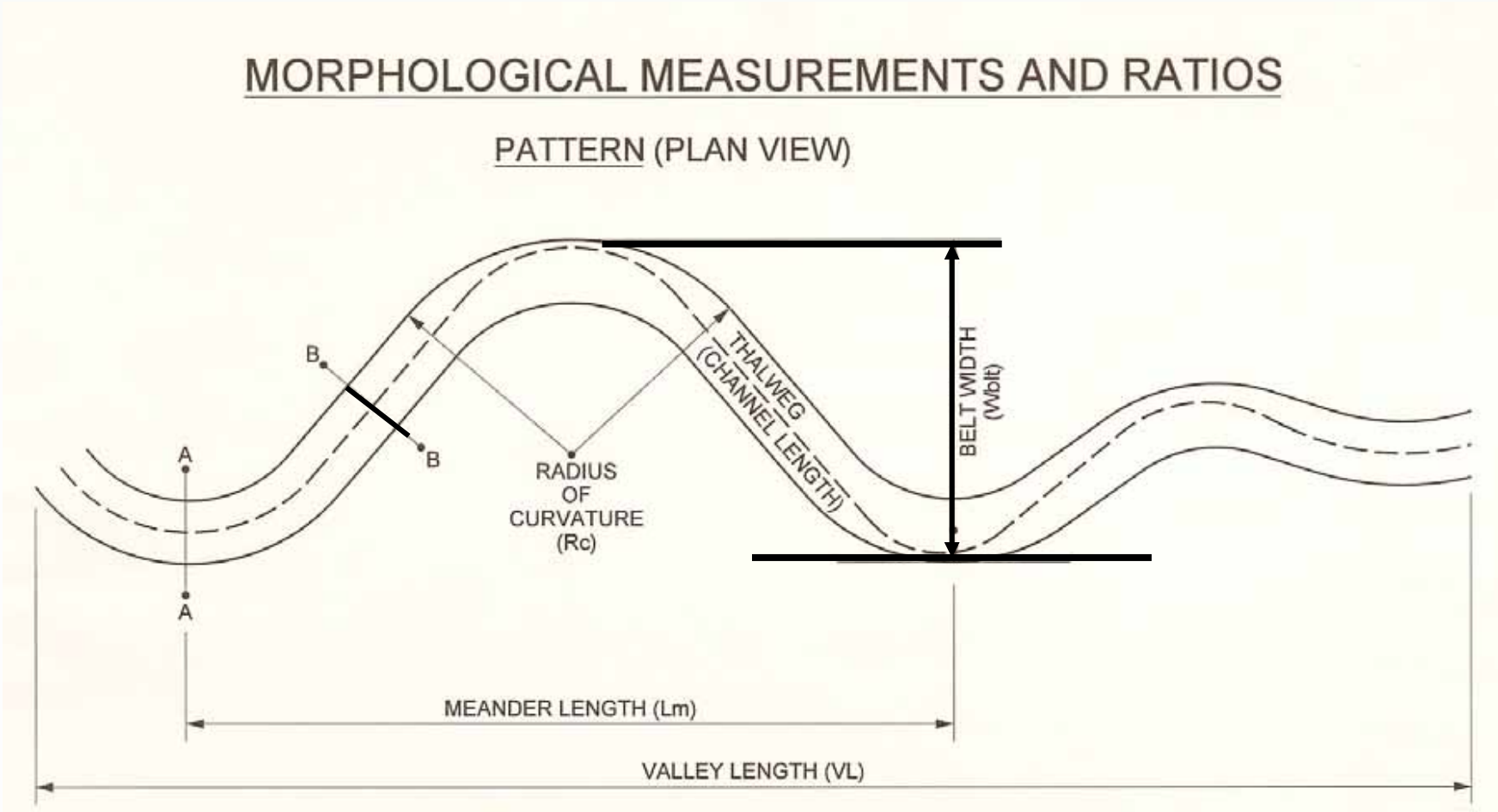
Urban Challenges

- Confinement
- Sediment supply and transport issues
- Flood control requirements
- Storm drainage networks
- General constraints
- Landowners / Public
- Utilities

Confinement

- **Confinement keeps more water in the channel and therefore increases stream power – the ability of the stream to do work.**
- **Encourages channel enlargement through incision and bank erosion.**

Quantifying Confinement



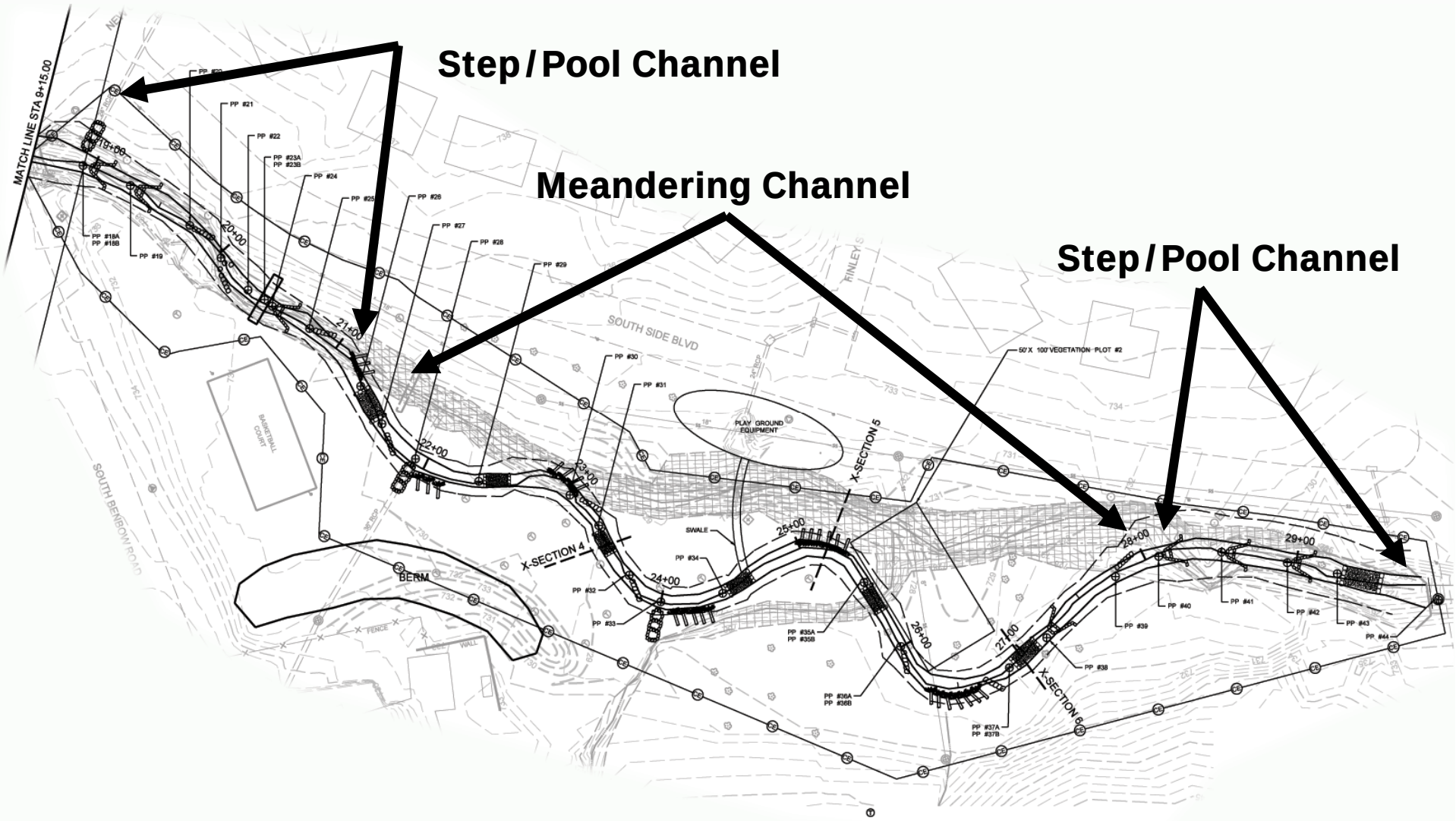
CHANNEL PATTERN MEASUREMENTS
MEANDER LENGTH (Lm)
RADIUS OF CURVATURE (Rc)
BELT WIDTH (Wblt)

CHANNEL PATTERN CALCULATIONS
RATIO: RADIUS OF CURVATURE / RIFFLE WIDTH (Rc / Wr)
RATIO: MEANDER LENGTH / RIFFLE WIDTH (Lm / Wr)
MEANDER WIDTH RATIO (MWR = Wblt / Wr)
SINUOSITY (K) = CHANNEL LENGTH / VALLEY LENGTH

Design Rule of Thumb

- **We have seen a number of projects experience problems because the designer tried to force a meandering channel in a confined valley.**
- **Must have a meander width ratio of 3.5 or greater to get a sinuosity greater than 1.2.**

Example of Meandering Design vs. In-line Design



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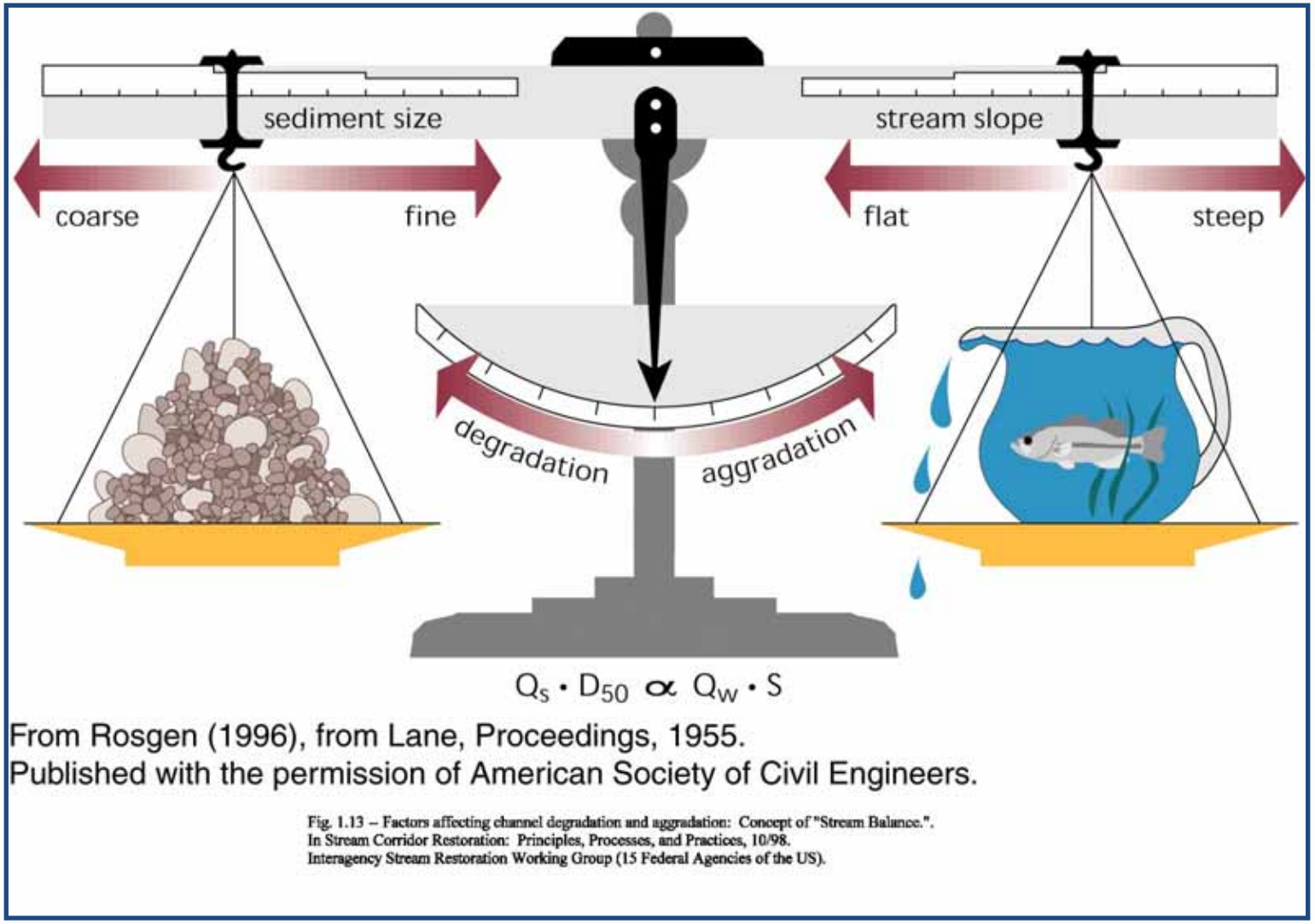
Sediment Supply and Transport Issues



From Rosgen (1996), from Lane, Proceedings, 1955.
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Fig. 1.13 – Factors affecting channel degradation and aggradation: Concept of "Stream Balance.". In Stream Corridor Restoration: Principles, Processes, and Practices, 10/98. Interagency Stream Restoration Working Group (15 Federal Agencies of the US).

Sediment Transport

- **Bed Load – material that rolls, skips, slides or hops along the bottom of the stream**

- **Suspended Load – material that is suspended; generally includes silt, clay, and fine sand**

From a stream restoration standpoint, we are most concerned with bedload when considering sediment transport issues.

Sediment Transport

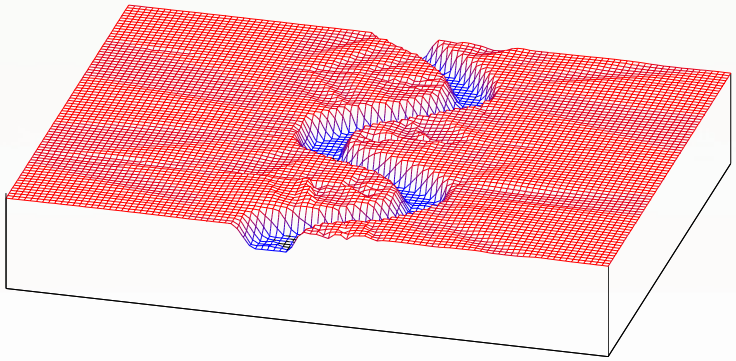
- **Competency**
  - The ability of the stream to move a given sediment grain size. Expressed as a force such as shear stress of tractive force.
- **Capacity**
  - The ability of the stream to move a quantity of sediment through a cross section. Expressed as a sediment transport rate and/or measurement of stream power.

Sediment Transport

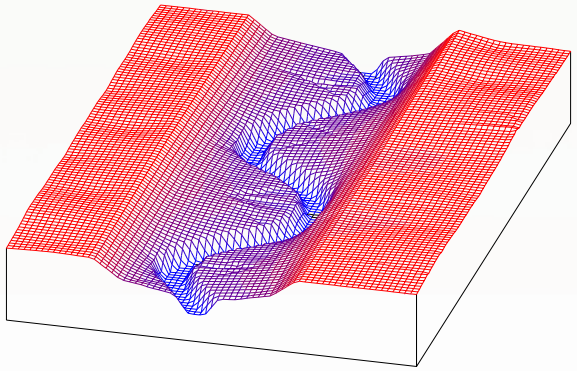
Special circumstances may require more robust methods such as sediment transport modeling.

Four Mile Run

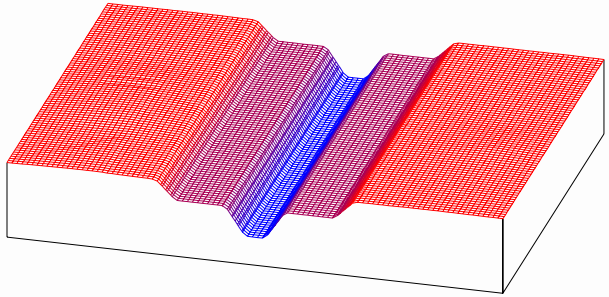
Flooding Considerations



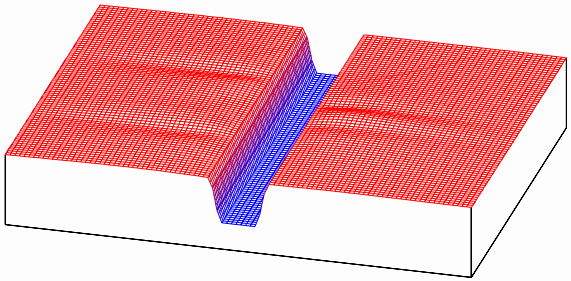
Priority 1: Restored Channel on Floodplain



Priority 2: Restored Stream within Excavated Floodplain



Priority 3: Bankfull Benches and Grade Control Structures



Priority 4: Stabilize the existing channel in place with structures and bank stabilization techniques.

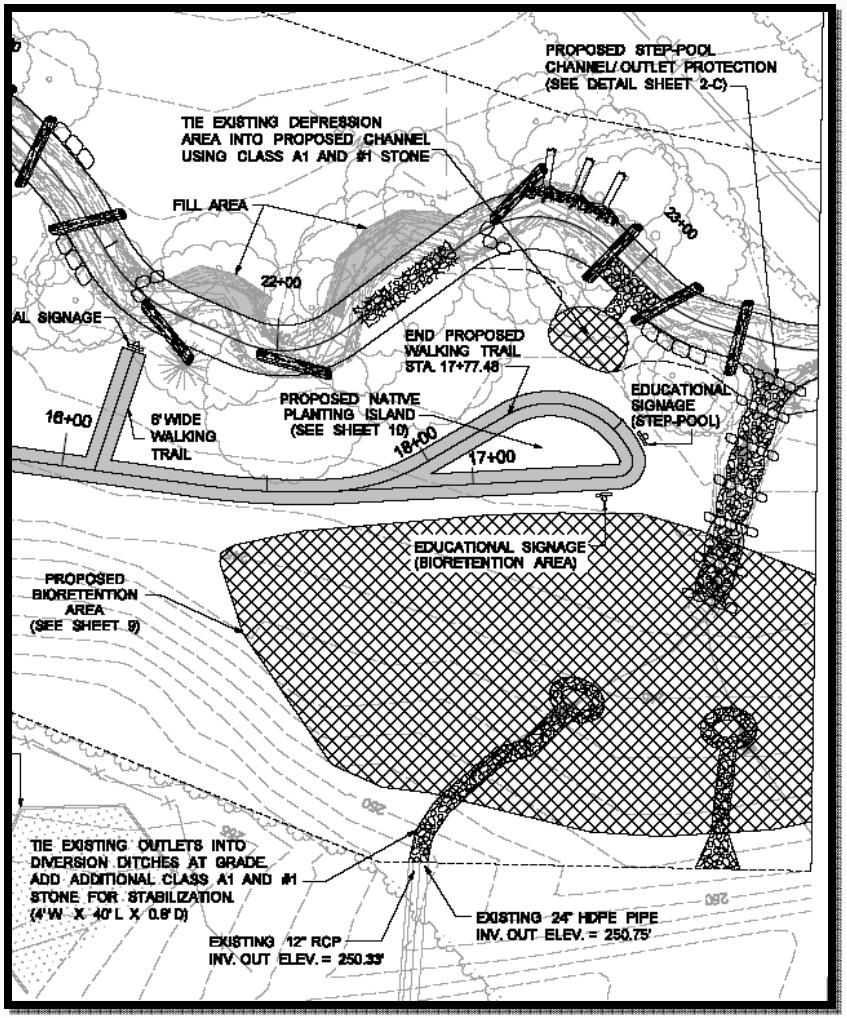
Because of flooding concerns, most urban restoration projects will require a Priority 2, 3, or 4 approach.

Priority 2 Example to Address Flooding

Stormwater Considerations

Many recent projects include both stream restoration, stormwater BMP's, and/or low impact development (LID).

- Stormwater outfall protection.
- Bioretention cells
- Wetland cells
- Filtration through buffers



Stormwater Considerations

Landowners / Public Considerations

The general public in urban environments is used to seeing manicured and maintained streams.

The public can be your biggest advocates or your biggest detractors. Involvement upfront is the key to getting buy-in from the public.

Landowners / Public Considerations

Natural channel design and bio-engineering approaches require the establishment of vegetation. You must be realistic with the public on expectations.

Landowners / Public Considerations

Landowners / Public Considerations

Steep eroding streambanks can cause a safety issue, especially in public areas such as parks. Improving public safety has been a goal of some past projects.

Before

After

Landowners / Public Considerations

In urban environments, we are seeing increased desire to incorporate recreational aspects with stream restoration projects.

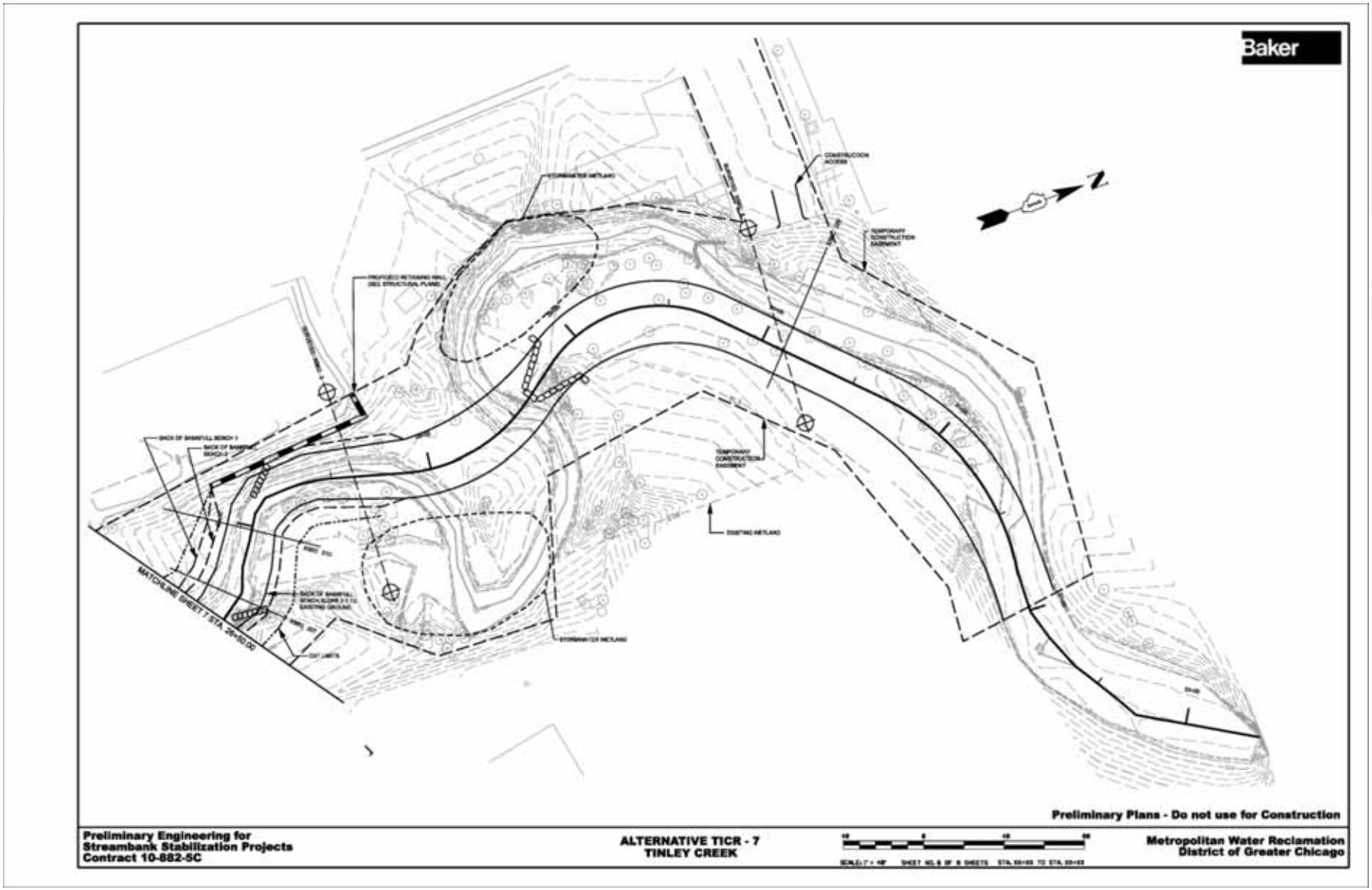
Example Project – Tinley Creek

MWRD is conducting feasibility studies to investigate stabilizing streams when structures and infrastructure are at imminent risk due to active erosion.

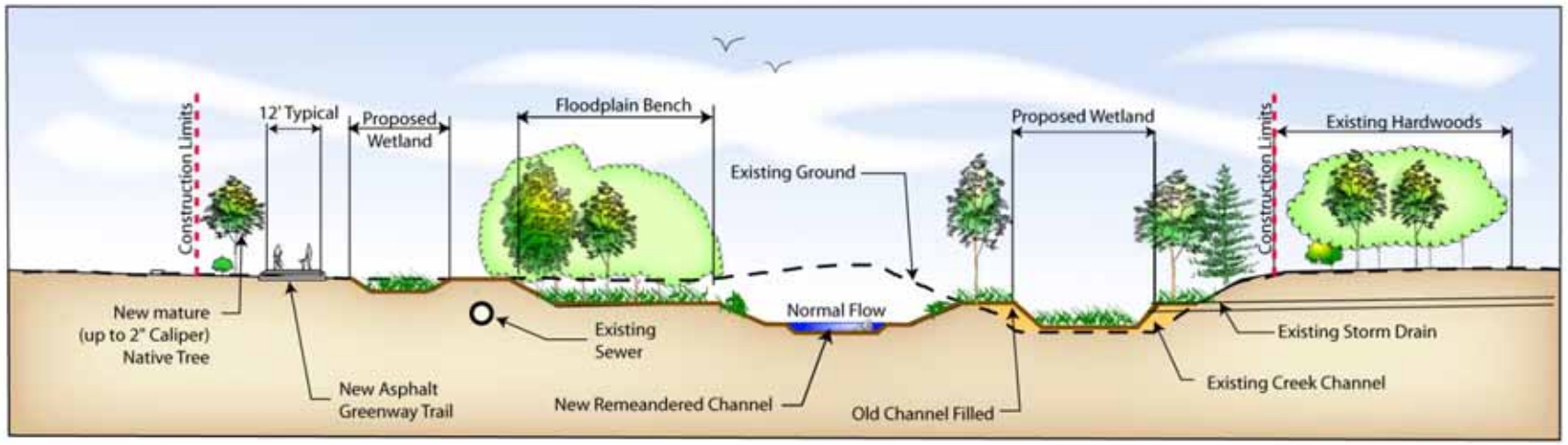
Example Project – Tinley Creek

Feasibility Study for Tinley Creek includes 3 miles of stream stabilization, including natural channel design and the replacement of some existing retaining walls.

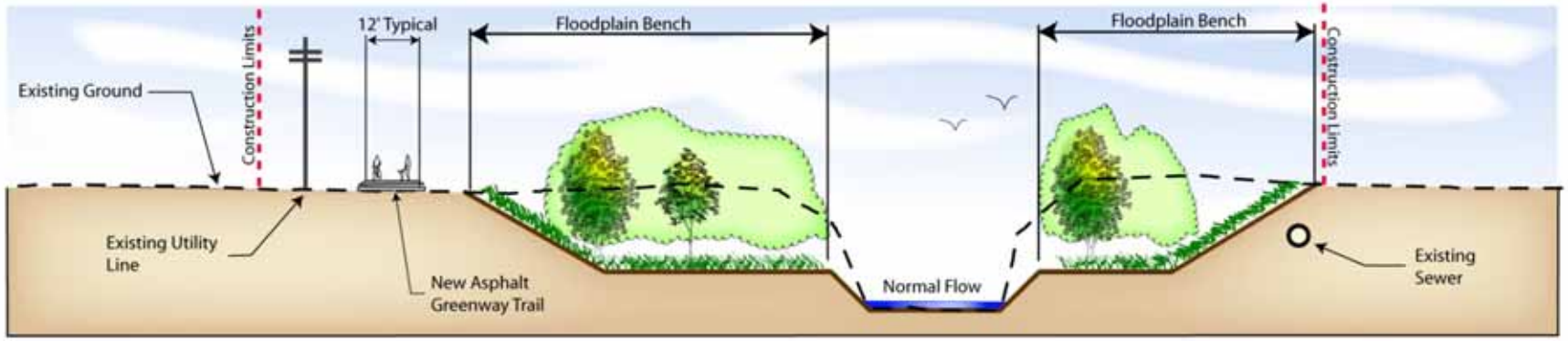
Example Project – Tinley Creek



Urban Stream Enhancement Concepts



TYPICAL STREAM RESTORATION CROSS SECTION



TYPICAL STREAM ENHANCEMENT CROSS SECTION

BAKER CREEK Watershed Plan

City of Kannapolis

Land Design

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Questions?