LandStudies' Approach to Stream Corridor and Floodplain Restoration

Understanding Historical Impacts

Many floodplains – the broad and/or flat surfaces adjacent to rivers and streams – do not actually function as floodplains were intended to in stable, natural channel environments. Rather, these current surfaces are higher terraces created by past impacts such as the construction of mill dams/ponds (see Figure 1) and more recent alluvial deposits or "legacy sediments" that filled in the valleys as a result of poor land-use practices from the early 1700s to the 1950s, known as the post-settlement era. These post-settlement impacts filled floodplains with a layer of loamy material ranging from three to 20 feet thick (see Figure 2). The floodplains that existed prior to settlement appear to have had only a thin layer of loam, less than two feet thick, near the surface (see Figure 3). Therefore, today's terraces are not providing the same functions that are inherent to stable, natural channels. Additionally, channel re-location, straightening, and encroachments into the floodplains are ubiquitous throughout the Northeast. Modern streams with overly high stream banks and excessive in-channel flow forces readily cut through legacy sediment fills, resulting in highly erosive conditions. This process of channel degradation through the post-settlement alluvium is highly detrimental to downstream environments.

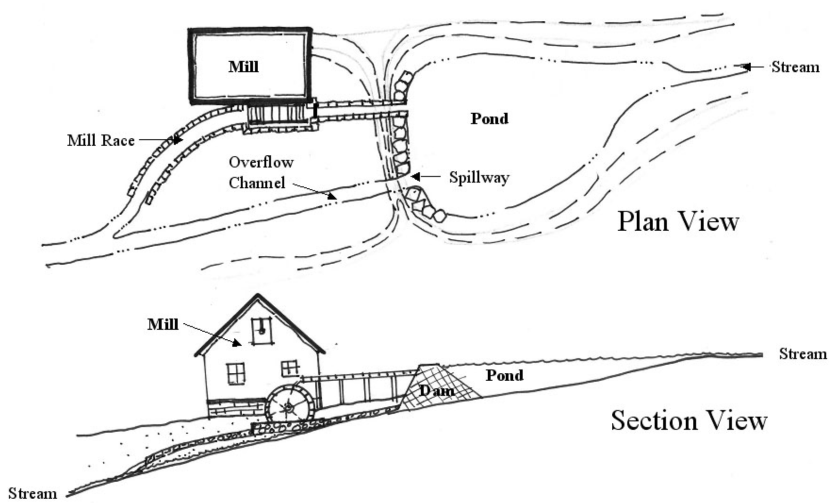

Figure 1.
Mill and Dam Construction.
Plan and section views make it easy to see how water slowed and ponded behind dams and allowed sediments to build up behind the dams.

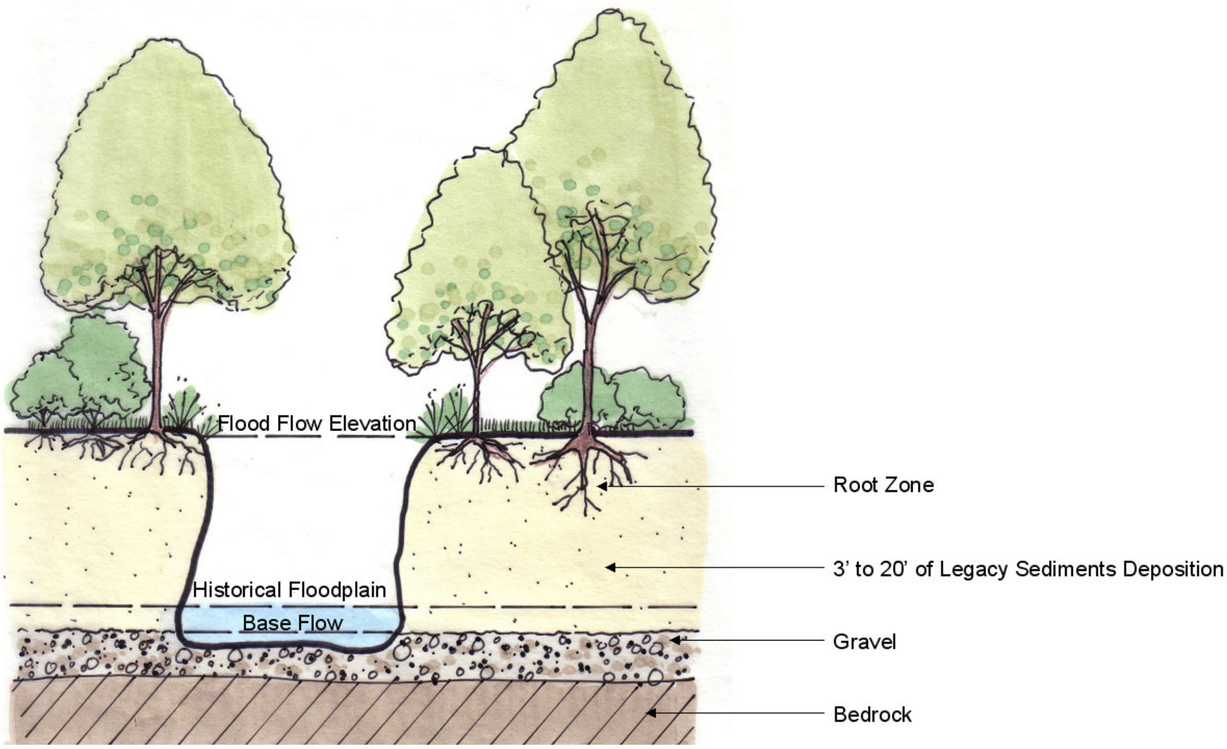

Figure 2. Existing Conditions.
Stream channels are eroding or have eroded down through sediments that collected behind mill dams, leaving their alluvial floodplains high above the current base flow water elevation, and disconnecting riparian root systems from groundwater flows. The processes of frequent floodplain inundation, relieving in-channel stresses; groundwater infiltration through porous floodplain material; and nitrogen removal from groundwater through root systems and bacterial processes are lost under these conditions that are prevalent today throughout the Northeastern United States.

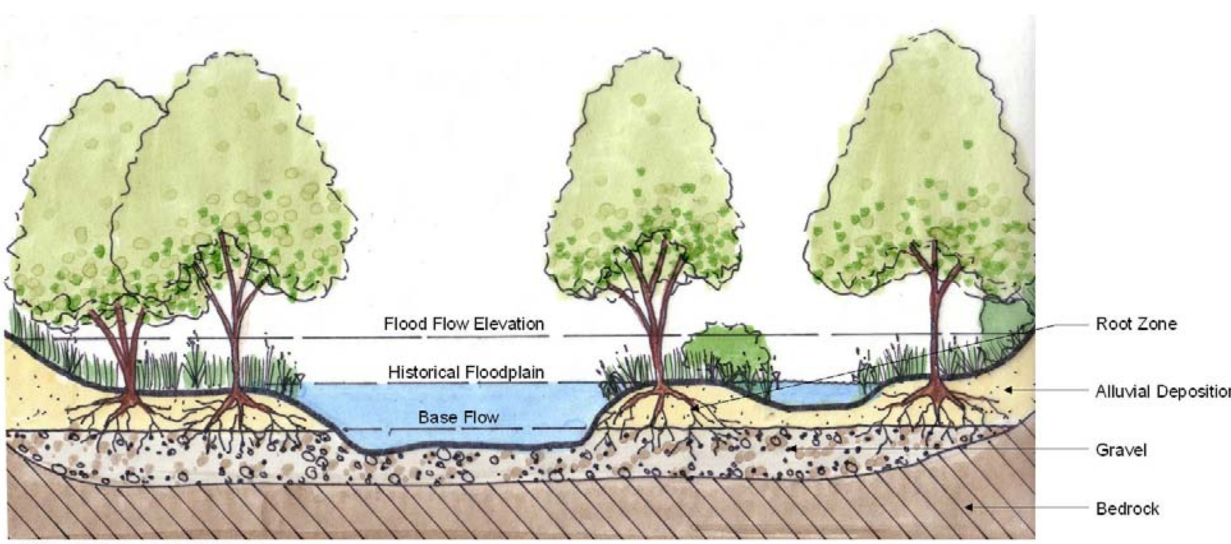

Figure 3. Pre-Settlement and Restored Conditions.
Stable, pre-settlement stream and floodplain systems were characterized by: a low, porous floodplain in close contact with surface water in the stream channel, allowing for frequent inundation of the floodplain during high flows; riparian vegetation with roots zones in contact with ground water that enabled groundwater denitrification through root uptake and bacterial processes; and a channel bed composed of cobble and gravel, which helped protect the underlying bedrock from erosive flow forces.

During much of the post-settlement era, residences and industry discharged pollutants, such as raw sewage and chemical byproducts from milling operations, directly into our waterways. Most of the larger cities in the Northeast did not construct sanitary sewer collection and treatment systems until the early to mid-1900s. Therefore, the alluvial deposits that filled in our valleys during this period are likely to be loaded with high levels of nutrients (e.g. phosphorus and nitrogen) and industrial chemicals that may be referred to as "legacy" pollutants. Phosphorous attaches to sediment; substantial amounts are likely to be stored in the vast quantities of post-settlement fill now being scoured and eroded from our stream channels. Nitrogen in the form of nitrates and ammonium also exists within the floodplains. Minimal denitrification occurs in these elevated floodplains because streamside root systems (which take up nitrogen) are, except during the highest flows, too high above the water surface elevations.

LandStudies' Approach to Restoration

Because of the extent of historical impacts to our waterways in the Northeast, LandStudies employs a restoration approach focusing on the re-connection of the active channel to an attached floodplain area. The flat, well-developed floodplains that existed along our waterways in our region prior to the post-settlement era allowed high flows easy access to the floodplain (flooding), typically numerous times per year. The large valley fills created during our nation's settlement era have increased the flow forces within the channel to levels much higher than the bed and bank materials can withstand, thereby promoting widespread channel degradation, frequent debris jams, and poor floodway conveyance.

In some cases, LandStudies has found it to be feasible to restore streams to the historical or pre-settlement condition and in other cases not, depending on specific site constraints. Whichever the case, the LandStudies restoration design focuses on restoring new floodplains at the proper elevations relative to site-specific variables, including the size and quantity of the bed/sediment load, downstream base-level controls, and stream bank materials, among others. Restoring our waterways using this methodology has the potential to stem the tide of the current evolutionary path of stream corridor degradation in the Northeast. The multiple and interconnected benefits associated with LandStudies' natural approach to stream corridor and floodplain restoration are discussed below.

The Benefits

<u>Flood Conveyance and Reduction</u>

Wetland pockets and functional floodplains will help alleviate nuisance flooding both in the immediate restoration area and downstream as well. During high flows, water that used to add to the downstream flow is now dispersed and slowed through restored floodplains, where it filters slowly down through the soil. A connected floodplain also reduces the shear stresses or erosive forces in the channel and floodplain areas, thereby significantly reducing tree-falls and subsequent debris jams. In addition, the connected floodplain area serves to trap incoming debris and sediments on the floodplain itself. This helps to reduce the frequency of debris jams at constriction points, bridges, and culverts.

Wetland Creation

Wetland pockets created along the length of the restoration in the restored floodplain areas have multiple benefits, including improved water quality, flood control, groundwater recharge, and wildlife habitat. Water from frequent out-of-bank flows settles in the wetlands, where water-borne sediments can drop out, nutrients can be used by the wetland plants, and nuisance flooding can be abated. Water in the wetlands gradually filters through the ground, recharging groundwater systems. Well-vegetated wetlands are prime habitat for a wide variety of aquatic and terrestrial wildlife.

Groundwater Recharge

As water from high stream flows comes out of the newly restored channel and onto the attached floodplain, the water collects in the created wetland areas, where it is vegetatively filtered and allowed to move slowly down through the soil to recharge the groundwater supply. Removal of the post-settlement/milldam alluvial deposits, which includes the impervious clay layers formed within the material, provides for higher infiltration rates through the remaining loam and gravel/cobble material in the floodplain areas and active channel after the restoration is complete.

Sediment and Nutrient Reduction Benefits

Lowering overly high stream banks that are subjected to high stresses and erosive forces to re-create an attached floodplain immediately removes a source of sediment and nutrient (phosphorus and nitrogen) loadings from the project site. Our studies have demonstrated that sediment and nutrient loadings from eroding stream channels are extremely significant. The removal of this post-settlement fill in our floodplains can have an immediate impact on improving water quality.

In the long-term, the frequent connection of flow to the historical floodplain provides enhanced water quality benefits by: removing sediments and debris from the active channel through frequent deposition into the floodplain; limiting in-channel flow forces to non-erosive levels during flooding events because flows spread out into well-developed valley flats; providing efficient nutrient uptake through root zones that extend into or very near base flow elevations; improving nitrate reduction in restored floodplains and wetlands through bacterial denitrification; allowing regular exchange of organic materials between the channel and the floodplain; creating wetlands; and improving groundwater recharge.

Stormwater Management

Stream corridor and floodplain restoration can be viewed as an ecologically harmonious, alternative method to address municipal stormwater management issues. A complete stream corridor and floodplain restoration project can help meet stormwater management goals for water quality and quantity. Water quality enhancements can be obtained immediately by eliminating sediments and nutrients held in the highly erodible, artificially high stream banks. Over the long term, the frequent flooding into the floodplain and the use of wetland areas throughout the floodplain help trap and filter incoming floodwaters, thus eliminating not only excess water but also water-borne sediments and pollutants from downstream receiving waters. Water quantity benefits can be had by reducing in-stream flow forces to appropriate levels based on site-specific variables, including the size and quantity of the bed/sediment load, downstream base-level controls, and stream bank materials, among others. This approach serves to correct the root cause of the problem, which is stream channel degradation, rather than chipping away at the symptom with numerous stormwater ponds that hold or infiltrate small portions of the watershed in an attempt to protect the receiving stream channels.

Riparian Buffers

Native plants, both herbaceous and woody, provide many benefits to the stream itself and to the water that moves into the floodplain. Trees and shrubs help shade the stream, keeping it cooler and healthier for aquatic wildlife. Leaf litter from these woody plants also provides a source of food for macroinvertebrate life in the stream. Herbaceous plants in the wetland pockets help reduce nutrients through nitrogen and phosphorus uptake.

Wildlife Habitat Improvement

A cleaner stream, wetland pockets, and a variety of native plants create and improve habitat for both in-stream and terrestrial wildlife, starting with the macroinvertebrate life in the stream and continuing up the food web to fish, birds, and mammals. The newly restored site will provide food, cover, and nesting sites for a variety of species. The quality of fish habitat improves significantly with the reductions in both sediment erosion and subsequent deposition in the channel farther downstream.

Invasive Species Removal

The excavation involved with creating a more natural stream channel and floodplain results in the immediate elimination of any invasive species present on the site. The post-construction installation of native herbaceous and woody plants along the riparian corridor discourages the re-establishment of invasive, non-native plant species.

Topsoil Generation

One of the immediate economic benefits that come from excavating an abnormally high floodplain is the generation of high-quality, nutrient-rich topsoil. The tons of topsoil salvaged from a stream corridor/floodplain restoration site can be readily recycled back into farming practices, which basically restores the soil to its origins. Developers also provide a ready outlet for high-quality topsoil.

Aesthetic Enhancement

A restored landscape will produce lush green vegetation, bright flowers, and seeds and fruits that will attract a variety of butterflies, birds, and other wildlife species.

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