THE BENEFITS OF HEADWATER STREAMS AND THEIR VEGETATED BUFFERS - HOW TO INCORPORATE STREAM BUFFERS INTO THE DEVELOPMENT PROCESS

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ABSTRACT

The scientific community has verified and quantified the function and value of headwater streams and their associated riparian buffers. Nevertheless, first and second order streams are being lost at an alarming rate due to small, incremental losses allowed through the Army Corps Nationwide Permits. Even cities with additional stream protective regulations, such as Austin, Texas, leave the upper reaches of the stream system largely unprotected. By combining regulatory incentives with mandatory headwater setbacks, it is hoped that these important components of the aquatic ecosystem can be preserved and reconnected with the watershed's hydrology during the development process to enhance water quality and help prevent flood and erosion problems. By examining a variety of studies that quantify the width of a buffer necessary to preserve the riparian zone's integrity, combined with studies that quantify the pollutant removal efficiency of grassy filter strips and stream courses, an empirical water quality value can be assigned to both the stream buffer and the streambed itself. If stormwater

BACKGROUND

Over thirty years ago, the U.S. Congress recognized the potential for the continued and accelerated degradation of the Nation's waters, so they enacted the original legislation that began protection of 'waters of the U.S'. - The Clean Water Act. The term 'waters of the U.S.' has a broad meaning, and encompasses deep water habitats as well as special aquatic sites including territorial seas, coral reefs, lakes, wetlands, and navigable waters. This discussion focuses on tributaries to navigable waters, including adjacent wetlands. In Austin, only the Colorado River and the lower reaches of Barton, Onion, and Walnut creeks are considered navigable waters.

The U.S. Army Corps of Engineers is the regulatory authority, enforcing rules pertaining to The Clean Water Act. The Army Corps considers any stream contributing to navigable waters, which forms a stream bed and stream bank, to be jurisdictional headwaters. However, from a local jurisdictional perspective and a more ecological viewpoint, we are referring to first and second order streams - that is streams with no tributaries or one tributary. This is a significant component of fresh water aquatic ecosystems. Leopold et al. (1964) estimates that first and second order streams account for 95% of stream channels.

Headwater Values and Functions

When the National Academy of Sciences reported to Congress on the state of the nation's waters, one of the more significant statements they made was that headwaters should be protected in the same manner that all other ‘waters’ are protected, including wetlands (Federal Register, 1996). The scientific community also recognizes the integral importance of vegetated buffers around our waters, and the Army Corps has recently allowed establishment of these buffers as compensatory mitigation for development impacts to waters of the U.S. Nevertheless, the bottom line is that the federal regulatory Nationwide Permits (NWPs) can allow as much as $1/10^{th}$ acre or 300 linear feet of stream to be filled before even notifying the Army Corps, and NWPs allows up to .5 acres to be filled before requiring an individual permit (Federal Register, 2002). This is much better protection than in the past, but we are still losing headwaters rapidly and incrementally.

Headwaters and their buffers support important ecological communities like wetlands, mature woodlands, and remnant native prairies. The US Federal Register (1996) states that vegetated buffers next to streams provide many of the same functions that wetlands provide. As a wetland delineator, my experience is - if headwater areas are not wetlands, they almost always meet the vegetation criteria as wetlands, often can meet the hydrology criteria, but may only lack the soil criteria, due to lack of long term anaerobic saturated conditions.

Headwaters and their buffers also function as prime natural retention areas.
These adjacent riparian plant communities, soils, and alluvial deposits act as sponges, creating a groundwater-surfacewater interaction zone where rainfall is stored and slowly discharged into the stream as baseflow. So, the stream’s importance extends beyond its bed and bank to include a riparian zone. Riparian zones are a relatively small proportion of the landscape where land and water interface, intricately connecting the terrestrial and aquatic ecosystems -physically, chemically, and biologically (Vannote et al. 1980). It’s been demonstrated that even benthic macroinvertebrate larvae live in the alluvial deposits of these groudwater-surfacewater interaction zones (hyporheic zones) (Stanford, 1988). Our entire stream system is like the human circulatory system, and the headwaters are like the capillaries, where most of the interactions occur between the blood and the body.

One of the most important functions of headwaters is their ability to filter pollution from stormwater runoff. This reduces concentrations of nutrients, sediment, and toxic pollutants from surface runoff. Not only are toxic pollutants removed in the root zones and sediment trapped in the leaves, but the biological and physical action of riffles and pools also polishes the water quality as it runs on the surface. There’s something to be said for the old saying - “water purifies itself after running a mile”. 15 of the leading ecologists in the country recently reported in the Journal Science that headwaters do a better job removing nutrients than do higher order streams (Peterson, 2001). This is because there is more biological contact between the streambed and the water in headwater areas. City of Austin staff has documented restoration of nutrient enriched waters along Barton Creek. All Environmental Resource Management’s research shows that undeveloped tributaries have significantly better water quality than all types of developed tributaries. Furthermore, preliminary City research findings have shown, through a paired watershed study, that the buffered residential stream maintains better water quality than the unbuffered residential stream (COA, 1997). This has been well documented through numerous other scientific studies (Meyer & Wallace 2000). A review of this literature by Castelle et al. (1994) concluded that stream buffers should be a minimum of 50 to 100 feet wide to preserve the stream values. Much of this scientific research is documenting and quantifying the obvious, because this kind of knowledge is intuitive to most of us. No reasonable person would doubt that streams and their riparian zones play a restorative role in water quality.

Preservation of these headwater zones not only serves the City of Austin Watershed Protection Department’s mission of water quality protection and program objective of preventing water pollution, but it also benefits our other two missions, erosion and flood control. Flood frequency increases or becomes ‘flashier’ as small headwater streams are lost. Bankfull conditions are 10-20 times more frequent when headwaters are decreased or eliminated. As flood frequency increases, so does stream bank erosion (Meyer & Wallace, 2000). When headwater are preserved, flood waters are stored and slowly released in the alluvial aquifers of the riparian zones, and the root systems of vegetated buffers stabilize soils, preventing erosion.

An additional benefit of protecting small streams and their buffers is preserving wildlife habitat within an urbanized environment. Headwater buffers provide shade that moderates water temperature changes, detritus for the primary food chain, woody debris for aquatic habitat, and they act as a sediment trap which prevents embeddedness of macroinvertebrate habitat. These benefits become particularly important for protection of endangered species and species of concern, but all wildlife are benefited by providing habitat corridors for movement and dispersal.

Last but not least, headwaters benefit people. When headwaters are protected with stream buffers, parks and trails can be created along these greenbelts. The Austin Metropolitan Trails Council site studies conducted across the country that have shown that trails and greenbelts add to the value of the properties around them (http://www.tpl.org/tier2_cl.cfm?folder_id=725). In particular Charles A Flink, founder of Greenways Incorporated, has presented case studies at seminars around the country, including Austin, showing a positive cost – benefit correlation between preservation of stream buffers and value of the resulting waterfront property (personal attendance, www.Greenways.com). Recently, lot prices were compared here in Austin at new subdivision, Avery Ranch. Lots bordering green spaces fetched substantially more money (Sylvia Pope, COA staff, personal communication 2003). So, besides benefiting all of the City's principal watershed protection missions, headwater protection also serves our goal to improve the quality life by facilitating public use of floodplains and drainage areas.

Consequence of Headwater Loss

So, what happens when a headwater stream is filled in? Research of CRWR (The University of Texas Center for Research into Water Resources), www.ce.utexas.edu/centers/crwr/html, shows that with increased impervious cover baseflow in a stream dries up (Barrett et al., 1998). It's a logical assumption to say that this relationship is even more valid when the impervious cover is placed in the critical riparian area that forms the surfacewater/groundwater interaction zone between the land and the stream.

Currently we are not utilizing this riparian zone to treat stormwater. We are putting the runoff in enclosed storm sewers and piping it strait to our higher order streams where the increased velocity causes erosion and water quality degradation. Even when we treat the stormwater in constructed sand filtration structures, the effluent bypasses the riparian infiltration zone and is channeled directly to the stream course. "The ability of a particular buffer to actually realize its many benefits depends on how well the buffer is planned or designed."(Schueler, 1995)

Austin's Current Stream Protection Regulations

Austin is divided into several watershed regulation classifications. The urban watersheds feed Town Lake for the most part. The Barton Springs Zone feeds the Southern Edwards Aquifer and Barton Springs. The Water Supply Rural and Suburban watersheds feed Lake Austin and Lake Travis. The Suburban watersheds feed the Colorado River below Longhorn Dam (The Code of The City Of Austin).

As far as stream buffer protection is concerned, the most important environmental regulation the City has in its Land Development Code is the critical water quality zone (CWQZ) requirement, because this regulation mandates a buffer along qualifying streams. All of the values previously discussed are preserved and all of the Watershed Protection and Development Review Department's (WPDR) goals are addressed to some degree by this one regulation. The establishment of CWQZs alone makes Austin, Texas a world leader in urban environmental protection and conservation. That is why practically no one in the profession of water quality, erosion control, or flood control will argue that a CWQZ on any headwater stream does not serve their mission.

Right now the City has the best headwater protection or CWQZs in the Urban, BSZ, and Water Supply Rural watersheds. These watersheds receive a critical zone with drainages of 64 acres or more. A Water Supply Suburban watershed receives a critical zone on drainages of 128 acres or more. The Suburban watershed doesn't get a critical zone until it has a drainage of 320 acres. First and second order streams frequently have drainages of 320 acres, and the Suburban watersheds are in the City's preferred development zone.

Streams falling under the CWQZ acreage limits are unclassified and may be considered uplands by a development interest. Development Review staff has seen all manner of construction proposed over these unclassified stream courses. In most cases, development will be placed right up to the bank's edge, but parking garages, streets, and almost all other forms of development have been proposed right over the unclassified headwater streams. This not only eliminates the value of the stream buffer but replaces it with potentially polluting and eroding impervious cover or landscapes where fertilizers and pesticides are applied in close proximity to the stream.

That's why, right now, with these CWQZ cutoffs, it's so important to regard any size wetland as a critical environmental feature (CEF). If wetlands fringe unclassified streams or ponds, these areas are considered CEFs. WPDR's policy is to recommend a modified continuous setback along the entire unclassified stream that supports the wetland rather than drawing the standard CEF setback of 150' around only the wetland areas. The development community prefers this type setback because it is less intrusive, and they understand the protective superiority of this type setback. In effect, WPDR regulatory policy is saying that if a stream supports wetlands it rates something similar to a CWQZ in protection.

Nevertheless, many of these unclassified streams do not meet all wetland criteria, and can then be treated as uplands. The National Academy of Sciences has stated that all headwaters exhibit many of the same functions and values as wetlands; therefore, we are leaving the most sensitive, environmentally important parts of the landscape unprotected in many cases.

The only other thing that might protect some of an unclassified stream reach is the presence of another CEF or a mapped floodplain. Seldom are floodplains mapped in the upper reaches of a watershed and the best floodplain maps stop at 64 acres. Our Code does provide for floodplain modification criteria to preserve natural character and significant riparian vegetation. Therefore, City environmental staff can have some control over dredge and fill activities in streambeds with 64 acres of drainage or more. Nevertheless, even though the streambed is considered floodplain up to the 64 acres, a riparian buffer may not be considered part of the floodplain, and there is no mandate for preservation of a uniform stream buffer. Streams with less than 64 acres are always considered uplands. The presence of another CEF such as a spring, bluff, or rimrock will only protect, at the most, a 150' long reach of the stream.

The intent of our Land Development Code (LDC) is to protect natural drainage patterns and the overland flow to them (LDC, Section 25-8-185, Overland Flow Section). It states that natural drainage patterns, native vegetation, and overland sheet flow through buffers are to be preserved to the greatest extent practicable. Construction of enclosed storm sewers is discouraged in this section of the code. Unfortunately, this section is written as more of a guidance than a rule and is open to interpretation because of such words as "where possible" and "to the greatest extent practicable". This section also often conflicts with our rules to require water quality treatment, and the approved method of choice is a centralized sedimentation-filtration structure. Instead, we need to provide alternatives that reconnect stormwater runoff to buffer zones around our natural stream courses.

The Walnut Creek watershed in Austin is suburban, so a major waterway has to have 1280 acres of drainage to get 200-400 feet of protected buffer or CWQZ. Intermediate waterways start at 640 acres and get 100-200 feet of buffer. A minor waterway must have 320 acres of watershed before it rates a 50-100 foot buffer. So, under our current code, the City provides protection along about 288,000 feet of stream, mostly the mainstem and some of its major branches (Ellen Wadsworth 2002, Arcview 3.2A, WPDR staff calculation). This is good, but if Walnut Creek had the same level of regulatory protection as the Barton Springs Zone or even the Urban watersheds, 533,381 feet of stream course would be protected as minor waterways, because 64 acres would be the cutoff point for a minor waterway. The current Code leaves 245,381 feet of stream and riparian zone vulnerable to development impacts, leading to stream degradation. This impacts in entire receiving stream system. As headwater streams are lost, drainage density decreases, average nutrient uptake length in the Walnut Creek basin increases, resulting in a reduction of the ability of the stream network to provide it's valuable function of pollution attenuation (Meyer and Wallace, 2000).

If all stream courses in the Walnut Creek watershed with five acres of drainage became minor waterways instead of being considered uplands, 1,628,372 feet of stream would be protected with a buffer. Under this scenario of examination, over 2/3rds of our stream network is left at risk and unused as a stormwater filter. The five acre level of stream course examination represents the natural drainage patterns as defined by a USGS-created 30 meter digital elevation model (Ellen Wadsworth, 2003, personal communication). This is the level of drainage patterns the spirit of our Code recommends preserving during the development process. Taking conservation a step further, developers could sheet-flow stormwater runoff through these natural filters and preserve the hydrology and function of the entire aquatic ecosystem. These small stream courses and drainage swales are the capillaries, where most of the biological and physical action occurs in our hypothetical stream circulatory system.

Historical Proposals For Increased Stream Buffer Protection

When the City drafted an Urban Watersheds Ordinance, we allowed for better headwater protection than ever before, giving drainages of 64 acres or better a CWQZ. This 64 acre area is rather arbitrary, but encompasses a nice round number of 0.1 square miles. Although most of the urban watersheds were already built out to the edge of every stream before any ordinance was written, this regulation still affords an opportunity to reclaim a riparian zone when new development is proposed in a previously developed area.

The Save Our Springs (SOS) ordinance also used the 64 acre cutoff for CWQZs when it was enacted for the Barton Springs Zone. This is good, but still leaves many tributaries or capillaries feeding the watershed's main artery unprotected.

Environmental Resource Management's 1997 comprehensive report - <u>The Barton Creek Study</u> made a policy recommendation to protect all first order streams with 100' native buffers. This recommendation was based on numerous national studies by scientific experts including Tom Schueler, who published a list of 20 benefits for urban stream buffers in the nationally recognized <u>Watershed Protection Techniques</u> bulletin (Schueller, 1995). City staff also recommended the purchase of stream recovery zones and streamside conservation easements similar to CWQZs outside the City's regulatory sphere. This last recommendation was realized when the City passed Proposition 2, providing 65 million dollars to buy stream recovery zones in Austin watersheds outside the City's regulatory sphere.

After the Barton Springs salamander was listed as an endangered species, US Fish and Wildlife recommended stream buffers for drainages as small as 5 acres within all Southern Edwards Aquifer watersheds (U.S. FWS, 2000). This recommendation was to protect water quality before reaching the Edwards Aquifer and ultimately Barton Springs. We also have a species of concern which actually lives in these upper headwaters. This is the Jollyville salamander, and much of its habitat is in the Water Supply Suburban category, with a 128 acre CWQZ. The salamander prefers the headwaters for habitat and is often found along stream courses with as little as five acres of drainage (personal and other City staff reconnaissance for Jollyville salamander monitoring sites).

During the Smart Growth planning process, WPDR staff presented an option to the Smart Growth subcommittee that all watershed categories be treated the same with regard to CWQZs and that we adopt the most protective criteria of a 64 acre minimum drainage. However, this measure was not supported by all stakeholders on the Smart Growth subcommittee, and was not adopted. Talking to development consultants, one of the main objections to increasing the CWQZs is that the developers can't count a CWQZ in their impervious cover calculations.

WPDR Master Plan

Most recently, WPDR has constructed a Master Plan for addressing these three missions: water quality, flood control, and erosion control. In an inventory report of recommended management practices for the Master Plan, consultants, Glen Rose Engineering and Loomis Austin recommended studying a regulatory change that protects all headwater streams, forming a bed and bank, with a minimum 50' setback. A draft proposal of this recommendation is now being studied as an incentive-based regulatory Code change. WPDR is also recommending other regulatory changes that include problem prevention and incentives in its final proposed Master Plan report. Some of these recommendations could incorporate stream buffers as part of their strategy.

Under the Master Plan's problem prevention, WPDR recommends establishment of erosion control-based stream setbacks; however additional water quality-based setbacks, that is, CWQZs, are not suggested because of objections from the development stakeholders. The most erosive watersheds are in the east part of Austin, where we have the poorest headwater protection and where Austin prefers development (suburban watersheds such as Walnut Creek). Austin may want to look at other regulatory authorities around the country to see how an entire stream system can be preserved. Baltimore County may have the best stream protection regulations in the country. They are protecting their 2,100 miles of streams with forest buffer regulations beginning with any evidence of channelized flow. Buffer widths of 75' to 150' are determined by a variety of field conditions, particularly susceptibility to erosion (www.baltimorecountyonline.info).

WPDR's Master Plan also recommends a development mitigation policy, whereby development rights over sensitive lands can be transferred to less sensitive lands. Credit for preserving buffers around streams would, in effect, cluster development away from these sensitive environmental parts of the landscape. The City could allow these headwater protection zones on unclassified streams to count in the impervious cover calculations. This would be a benefit to developers in comparison to the CWQZ regulations, which do not allow CWQZs to count in the net site area when calculating allowable impervious cover.

WPDR's proposed Master Plan recommends that water quality credit be given to developers who incorporate Low Impact Development (LID) designs into their projects. This type subdivision might include many small rainwater collectors, rainwater irrigation of landscapes, and grassy swales to slow and filter excess stormwater drainage throughout the development. Streamside buffers could be part of the equation by serving as a secondary BMP in the form of a vegetated filter strip.

In addition, the Master Plan recommends research into alternative water quality controls based on average annual pollutant load reductions. One of the best alternatives for a centralized treatment system may be the bioretention facility. It combines flood detention and water quality into a naturally vegetated, low maintenance system which infiltrates and sheet flows storm water into a buffer zone rather than shooting it straight to the creek through a storm sewer. A gravel substrate allows for infiltration through soil and root zones before filtering through gravel and out into the buffer zone of the creek. The structure also allows for sheet flow through a level spreader design for storm events which overtop the structure. The creek buffer zone then becomes a grassy filter strip. This 'best management practice' adds a wet prairie greenspace to the riparian corridor and further screens the stream's greenbelt from the developed area rather than placing unattractive concrete sedimentation/filtration ponds within the corridor (Department of Environmental Resources, Prince George's County, Maryland 1997).

All of these incentives could be applied to buffering unclassified streams. These areas could be used as sensitive land transfers or water quality treatment credits, especially when combined with LID designs or innovative water quality controls such as detention basins that infiltrate stormwater into the ground or irrigate stormwater above ground. WPDR also desires detention for smaller, channel forming storms. This type detention may also play well into combining detention, water quality, and headwater buffer filter strips.

Quantifying The Water Quality Benefits Of Stream Buffers

Numerous studies have documented the water quality value of riparian buffers, and the general consensus recommends a minimum 50' to 100' vegetated buffer around streams to maintain their physical, chemical, and biological integrity. GIS analyses around the country have indicated strong correlations between larger buffer widths and decreased nutrient concentrations. For example, a multiple-regression analysis of the Salt Fork watershed in Illinois indicates that nonbuffered urban streams are likely to have higher nonpoint source loadings than streams buffered by as little as 100 feet (Tippett, et al., 1993).

Higher order streams are currently protected with buffers by the City's Land Development Code. These undeveloped buffers, termed Critical Water Quality Zones (CWQZs), are mandated if the waterway meets or exceeds a defined minimum drainage area. Depending on the watershed's location (drinking water supply, suburban, or Barton Springs zone), a minimum buffer of 50 to 200 feet is required for streams with drainage areas of 64 to 320 acres or greater. This leaves many of the first, second, and sometimes third order streams without mandated buffers, and they are termed unclassified streams because their drainage area does not meet an arbitrary minimum size. If a quantitative value could be placed on these unclassified streams and their buffers, the City could provide a developer with regulatory incentives, such as water quality credit, for preserving a headwater greenbelt, similar to a CWQZ. The City currently requires constructed water quality BMPs for developments with impervious cover over 20%. Greenbelts along unclassified streams might be considered a BMP, since these areas on the landscape provide multiple benefits relating to the Watershed Protection and Development Review Department's principal missions: water quality preservation, flood control, and erosion control.

One of the tasks for developing a headwater protection proposal is to determine what kind and how much water quality credit be given to developers who protect unclassified streams with a vegetated buffer. There are very few monitoring studies examining the water quality benefits of vegetated buffer strips in urban areas. However, two recent studies can be used to quantify removal efficiencies of vegetated buffers and the stream course itself. Walsh et al. (1997), Use of Vegetative Controls for Treatment of Highway Runoff, examines the effectiveness of vegetated buffer strips for removing constituents in highway runoff in the Austin area. Peterson et al. (2001), Control of Nitrogen Export from Watersheds by Headwater Streams, examines the nitrogen removal capacity of headwater streams from biomes throughout North America. A summary of some of the variables and findings from these two reports follows:

Use of Vegetative Controls for Treatment of Highway Runoff

The treatment length of the two study sites averages about 8 m. The vegetative cover is a mixture of bunch grass, buffalo, and sod grass. The highway is 3 lanes wide (about 12 m) draining towards the filter strip. Therefore the ratio of impervious cover treated to filter strip is about 1.5 to 1. TSS is removed at an average of 86%. Nitrate is removed at an average of 37%. Other constituents are removed at relatively high rates as well. "The pollutant removal capabilities of filter strips treating highway runoff are comparable to those of structural controls, such as sand filters." (Walsh et al. 1997)

Control of Nitrogen Export from Watersheds by Headwater Streams

This study examined the nitrogen removal efficiencies of headwater streams from all over the United States. They found that the smaller the stream (lower the order), the higher the efficiency for removal of nitrogen. This is because the water is in greater contact with various biofilm surfaces in smaller streams. On average, dissolved nitrogen (both NH_4 and NO_3) is removed at a rate of 64% per kilometer of stream. This means that the streambed itself acts as a water quality BMP, and provides about the same nitrogen removal as a wetpond or sedimentation/filtration pond every 0.6 miles of streambed. (Peterson et al. 2001)

Summary

There is some quantification now for the water quality value of leaving headwater streams and their buffers undeveloped. Buffers may be worth up to 1.5 times their area in treating impervious cover (especially if all the impervious cover's stormwater runoff flows over the filter strip). Furthermore, the streambed itself can provide the same benefit as a structural control every kilometer (0.6 miles). These are controlled experiments that may not apply to every real-world situation. A lot depends on the density and type of vegetative cover, soil type and depth, slope, percent impervious cover, and type of development. Nevertheless, these two studies give us some idea as to the empirical water quality benefits from stream buffers and streambeds.

Discussion

The real estate council has recently proposed that if a headwater is buffered 50-75 foot from its centerline, the developer should not have to do water quality controls in that headwater's subwatershed until the impervious cover reaches 30%. Currently water quality controls are required at 20%. This incentive seems to be justified considering the known water quality benefits of stream buffers. Furthermore, Tom Schueler, with the Center for Watershed Protection, allows for the treatment of 10% of surface water generated in an urban watershed by stream buffers, even when rainfall is rapidly converted into concentrated flow and short circuits the stream buffer (Schueler, 1995). This estimate fits nicely with the proposal to allow an additional 10% of impervious cover before some kind of structural BMP is needed, if a stream buffer is established.

The Austin Real Estate Council also wishes to be able to transfer development rights 2:1 (twice the impervious cover that would have been allowed in the headwater zone can now go in the upland areas). Also, the headwater zone could be used to satisfy their parkland dedication requirements (about 5 acres per 1,000 people, LDC 25-4-212). These incentives would cluster development away from unclassified streams, which would not get protection otherwise. The value of the preservation of these headwater riparian areas is great, so the incentives must also be great to achieve voluntary compliance. If we want buy-in from development stakeholders, the real estate council's incentives must be seriously considered.

However, to merit these additional incentives, WPDR should consider some additional requirements which would insure sheet flow runoff and infiltration from bioretention ponds into the buffers. Another alternative could allow extended detention (< 72 hours) in the headwaters and their buffers to insure runoff is treated by the headwater buffer and stream course. This would insure that the stream buffer comes into contact with the stormwater runoff and that stormwater infiltrates into the buffer.

Potential Elements of a Headwater Protection Regulation

What would it take to get all stakeholders on board with a regulatory change that included headwater protection zones? First, the science tells us we need a 50 -100 foot buffer along headwater streams to retain the aquatic system's function and value.

Second, the development community would prefer we not call these new riparian buffer zones CWQZs, so that these areas can count in the development's net site area for impervious cover calculations. The zones might also be used for transfers of development rights to other areas of development off site.

If headwaters are protected with mandated buffers, the wetland CEF rules becomes unnecessary, because these are the areas that staff is currently concentrating on when investigating for wetlands. Eliminating the wetland CEF rule reduces potential conflict between the City and development community. It would streamline the development process and add certainty to the planning process when designing development.

These headwater protection zones might also qualify for parkland dedication credit. These are certainly areas that where nature trails and woodlands could be enjoyed within an urban environment.

Finally, developers could be given water quality credit if these lands can be used to treat stormwater runoff.

In conclusion the Watershed Protection and Development Review Department recognizes the benefits of providing headwater protection for all streams from first order on down. The science backs up the numerous environmental advantages of buffers. Wetlands and other vegetated stream setbacks are usually the most important, sensitive environmental parts of the landscape. All of WPDR's missions are addressed by headwater protection. The current WPDR Master Plan calls for increased setbacks in some unprotected areas for erosion control. Unclassified stream buffers could be included as incentives for water quality credit. Finally, a headwater protection initiative is an incentive based concept which is more development friendly than the CWQZs. Further study of the efficiencies for pollutant removal in headwater buffers coupled with economic and quality of life benefits will hopefully convince all stakeholders that every headwater stream should be protected with a buffer.

BIBLIOGRAPHY

Barrett, Michael E., et al. 1998. Water quality and quantity inputs for the urban creeks. Future needs assessment. Center for Research in Water Resources, Bureau of Engineering Research. The University of Texas at Austin.

Castelle, A.J., A.W. Johnson, and C.Conolly. 1994. Wetland and stream buffer size requirements. Journal Environmental Quality 23:878-882.

City of Austin. 1997. The Barton Creek Report. Canyons study section. Environmental Resource Management Division. Water Quality Report Series.

Department of Environmental Resources, Prince George's County, Maryland 1997. Low-Impact development design manual.

Federal Register. 1996. Volume 61. No. 241. December 13, 1996. Notices. P. 65891

Federal Register. 2002. Volume 67. No. 10. January 15, 2002. Notices. P. 2076

Leopold, L.B., Wolman, M.G. & Miller, J.P. (1964) Fluvial Processes in Geomorphology. W.H. Freeman, San Francisco.

Meyer, J.L., Wallace, J.B. April 10-13, 2000. Ecology: achievement and challenge. IN: The 41st symposium of the British ecological society. Orlando, Florida, USA.

Peterson, Bruce J., et al. 2001. Control of nitrogen export from watersheds by headwater streams. Science 292:86-90.

Schueler, Tom. 1995. The architecture of urban stream buffers. Watershed protection techniques. Vol. 1, No. 4. Pp. 155-163.

Stanford, J.A., J.V. Ward. 1988. The hyporheic habitat of river ecosystems Nature, Vol. 335, No. 6185, pp. 64066

Tippett, John, et al. 1993. Linking land use to water quality. Research Triangle Institute. Illinois Natural History survey. Technology. September 1993.

U.S. Fish and Wildlife Service. 2000. Recommendations for protection of water Quality of the Edwards Aquifer.

Vannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R. & Cushing, C.E. (1980) The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37.

Walsh, Patrick M., et al. 1997. Use of vegetative controls for treatment of highway runoff. Center For Research In Water Resources. Bureau of Engineering Research. The University of Texas at Austin. J.J. Pickle Research Campus. Austin, Texas.