6 Development and Water Quality

Current suburban zoning practices and densities preclude stream protection because they mandate use of the automobile to travel from one destination to another. Automobiles require large amounts of impervious surfaces, such as roads and parking lots, that adversely impact water quality and riparian (streamside) ecological communities.

The best way to protect our watersheds is to severely downzone sensitive riparian zones and less-disturbed rural areas, and to increase building densities correspondingly in compact sites deemed suitable for ecologically designed, walkable towns and villages. Such development has less impervious surface and conserves built area, diminishing the footprint of development. In a well-designed village, undisturbed natural areas can recharge streams with stormwater and ameliorate the adverse water quality impacts of development.

Continued construction of low-density automobile-dependent workplaces, homes, and shopping centers will degrade Orange County's streams and water supplies. Simple and time-tested water management practices modeled on natural systems will ensure that Orange County continues to be an enjoyable place to live.

6.1 Initial disturbance

When land is cleared for development, clear-cutting and flattening typically occur. This initial disturbance has several impacts on local streams. Without vegetative cover, soil is easily swept away by wind and water. Heavy equipment further disturbs soil and loosens it into streams. Trees and underbrush that formerly slowed runoff are now gone, allowing runoff to speed toward streams, worsening erosion as it goes. Sediment eventually chokes the life out of streams; microorganisms and fish alike struggle to obtain sufficient oxygen. Leafy materials that formerly housed tiny benthic (bottom-dwelling) communities disappear in the wake of speeding runoff (D'Arconte, 1998).

Water in a healthy ecosystem gradually seeps into the soil, a process called infiltration. This seepage is released over time, allowing streams to maintain a more constant baseline flow and sustaining riparian habitats through dry spells (D'Arconte, 1998). Infiltration also recharges our drinking water aquifers. Without slow seepage, immediate flooding worsens, and droughts become disastrous for aquatic life and wildlife. Flashiness (the difference between the highest and lowest points of a stream) becomes worse, reducing the amount of water humans can safely withdraw from the stream at any given time. Healthy ecological riparian zones purify water; without them local governments pay a higher price for water purification.

6.2 Impervious surfaces

The problems that occur when land is initially cleared are multiplied when building and paving begin. Tom Scheuler (of the Center for Watershed Protection) identifies two types of impervious surfaces. One type is the rooftop component, which is generally considered to be less important than the second type of impervious surface, the transportation component (Scheuler, 1995(b); Benfield et al., 1999). Roads, driveways, sidewalks, parking lots, and other transportation-related features typically make up 60–70% of a watershed's total impervious surface (Benfield et al., 1999). Moreover, the concentration of pollutants in runoff from transportation surfaces is much higher due to contact with automobiles and their various fluids.

Scheuler finds that streams become incapable of supporting aquatic life when impervious surface exceeds 10–15% of a watershed's area. This percentage is easily reached with conventional one-acre lot subdivisions, when the roads and commercial parking lots required to service such auto-dependent areas are factored in. And although researchers acknowledge the importance of imperviousness to estimate the ecological health of a watershed, they still recommend developing densely (Scheuler, 1999(b); D'Arconte, 1998). This may seem counterintuitive until we recall that it is the transportation component of impervious surfaces that does the most damage to a watershed.

When a given number of houses is planned for a specific development, we must examine the total area on which they are to be built. Even if the rooftop component is kept constant (the same square footage is covered by buildings), the percentage of impervious surface overall decreases in clustered developments, simply because shorter driveways and fewer roads are needed to connect the homes. Similarly, when shopping and workplaces are located near residences, pavement for parking and roadways can be significantly reduced. If multistory, multifamily mixed-use units were built instead of discrete single-family units, the comparative water quality improvements would be even more dramatic, because total impervious rooftop area would then also decrease.

6.3 Density is not the enemy

Total amount of impervious surface is increased by large-lot zoning not only within a given subdivision, but also over a region (Benfield et al., 1999). Accordingly,

> Because large-lot zoning requires a larger road network to serve a given number of houses, and spreads those houses over a greater number of subwatersheds, it not only usually fails to keep the total impervious cover below the 10 to 15 percent threshold necessary for watershed protection, but it actually increases total imperviousness both within a development and especially throughout a region. Indeed, research shows that large-lot subdivisions increase imperviousness by 10 to 50 percent compared to cluster and traditional town developments with the same number of households, and that they deliver up to three times more sediment into waterways.

Scheuler notes that because the threshold for stream protection (10–15% impervious surface) is so easily exceeded with conventional zoning, it is better to concentrate planning resources on saving those streams that have not yet been significantly impacted (Benfield et al., 1999). This means that we must carefully prioritize our resources so we can preserve water supply watersheds and relatively pristine stream areas that are still ecologically functional. It takes a great deal of time and money to remediate stream damage; restoration takes decades. New developments must ameliorate water quality impacts by observing the ecological attributes and limitations of a site.

6.4 Site planning to protect stream quality

Protection of natural features onsite begins with an inventory of features, because "if the project begins with a thorough evaluation, valuable amenities can be preserved. Costs of installation of infrastructure can be kept to a minimum [and] costs to remedy adverse environmental effects can be avoided...." (Parrin, 1996). Such an inventory should analyze qualities of the existing soil, topography, vegetation, water features, wetlands, and wildlife.

Because building will inevitably create some additional runoff, it is crucial that sediment and runoff management be addressed early in the site planning process to avoid increased flooding and sediment loading downstream. Runoff from construction can change the pH and oxygen contents of streams. Strictly limiting, regulating, and monitoring construction, especially on steep slopes or in sensitive streamside areas, can limit problems from runoff.

Measures to protect streams from construction impacts include minimizing total land area disturbed by equipment, reducing the total overall area that is cleared and/or graded, limiting the time that the property remains denuded and bare, protecting tree roots, and minimizing construction-related pollutants. Restricting the area in which construction equipment and automobiles are permitted is an effective overall strategy to minimize disturbance and reduce pollution.

6.5 Low-impact design

Low-impact design (LID) is a method of designing developments so that the least environmental harm results from their construction. In a presentation made to the Town of Chapel Hill, Phillip Berke, professor of planning at UNC-Chapel Hill, noted (2001):

> Low-impact design, although called innovative, actually combines time-proven site design methods for minimizing stormwater runoff in a way that enhances water quality protection and the aesthetics of site design. The approach offers a wide range of techniques, which can…include:
>
> - smaller parking lots and parking stalls and shared parking agreements
> - flexible road designs such as narrower streets integrated with open drainage
> - porous paving surfaces
> - clustering development
> - flexible lot layouts
> - managing and treating stormwater through using conditioned planting soil bed and planting materials (called bioretention)
> - use of rain barrels and cisterns and other on-site stormwater storage
> - riparian buffers
> - minimal disturbance technique to conserve forested or natural areas in site

Berke's summary is applicable to Orange County's needs as well. All of the techniques mentioned above can be used to reduce the amount of impervious surface on a site, which is closely linked to the net environmental impact of a development.

Pollution by chemicals or sediment is only one aspect of stream health. Hydrology (flashiness, base flow, and temperature) and habitat structure (benthic cover, aquatic life, and sedimentation) are also factors crucial to riparian communities. LID takes these factors into account, so the development ideally does not disrupt the ecological functions of the landscape in which it is placed at all.

According to a study prepared for the U.S. EPA, "if LID techniques can be used for a particular site, the net result will be to more closely mimic the watershed's hydrologic functions or the water balance between runoff, infiltration, storage, groundwater recharge, and evapotranspiration" (Herson-Jones, 1995). We can be a healthy part of an ecosystem by integrating our needs with the the natural world that provides for them. As we learn more about how nature deals with water, we can incorporate that knowledge into our low-impact designs, lessening our net environmental impact. Villages provide the best opportunity to apply these design techniques because of their emphasis on public transit, community-oriented scale, and attention to natural site features and existing amenities.

6.6 Stormwater management

Conventional wisdom manages stormwater by removing it from the site as quickly as possible (Prince George's County, 2000). The consequences of this strategy for the receiving body of water (and downstream communities) are flooding and pollution. We must revise our thinking about stormwater to mirror nature's stormwater management systems. Natural drainage systems offer many benefits, which were maintained in one development scenario to include:

> ...protection of trees and elimination of off-site storm water discharge…. The…natural solution included defining primary and secondary drainage easements to handle storm water runoff; minimizing erosion by specifying that no ground cover, understory, or trees were to be removed in the drainage easement areas; creating natural swales by layering native plants and vegetation; and designing temporary water storage ponds, check dams, and swales so that water would slowly flow over permeable surfaces, allowing it to infiltrate into the ground and recharge aquifers (Wilson et al., 1998)

Innovatively designed stormwater best management practices (BMPs) ideally can mitigate almost all detrimental impacts of impervious surfaces resulting from development. Current BMPs recommend slowing stormwater down rather than removing it from the site as quickly as possible. This can be accomplished through conveyance measures that slow the water and may filter it as well. Filter strips and swales are broad grassy areas that spread stormwater over large areas and may also remove pollutants.

Storage of excess rainwater is another method of reducing increased surface water flow. Green communities may eliminate the rooftop runoff component altogether by mandating that only rooftop-collected rainwater be used for irrigation or other purposes that do not require potable water, reducing both runoff and white water consumption.

Ground detention is another method that may be used to slow a storm's rush of water into streams. Generally, an artificial wetland is a better option than a retention pond if stream preservation is the primary concern (Parrin, 1996). Artificial wetlands emulate the nutrient contents and temperatures of a natural system, whereas detention ponds tend to cool water and do not utilize excess phosphorous and nitrogen. Careful selection of plants in an artificial wetland may also help remediate pollution; several species consume pollutants and release less harmful byproducts (Dietz, 2000).

6.7 Riparian buffers

One of the most important and well known of stream protective measures is riparian buffer zones. Not only are streamside areas more fragile than other land types, they are also more important to the total overall wellbeing of the ecosystem by virtue of the number of ecological services they provide. In addition to the services already mentioned (groundwater recharge and purification), intact riparian zones offer habitats and help maintain ideal water temperature for aquatic plants and animals.

An effective riparian buffer program might include wetland and floodplain preservation or restoration, stream bank stabilization, runoff reduction, and pollutant reduction (Herson-Jones, 1995). Large amounts of impervious surfaces on a watershed level will decrease capacities of riparian buffers to improve water quality. Indeed, the current manner of development is so deleterious for watersheds precisely because it impedes a watershed's ability to repair itself over time.

Streamside buffers need to be delineated for all streams and tributaries in new development projects in Orange County. Specific buffer guidelines should meet or exceed state requirements, be designed according to the landscape's physical and biological features, and be enforced throughout and after planning and development phases (Herson-Jones, 1995). Using buffers as a primary BMP for stormwater management is not necessarily recommended here. However, they should be included as part of an overall management plan that recommends reduction and disconnection of impervious surfaces; innovative stormwater collection, detention, and reuse; and preservation of natural drainage systems and functioning riparian zones.

The Stormwater Manager's Resource Center is an excellent online source for technical and general information on riparian buffers. A model ordinance for stream buffers, including examples from other communities, can be found on their website (http://www.stormwatercenter.net) (Stormwater Manager's Resource Center, 2000).

6.8 Flood prevention

These beneficial measures equate to flood prevention. We in North Carolina are all too familiar with the damage a flood can do. It is important to bear in mind that floods, while natural events, are worsened by human land use

Density is not the enemy.

practices, those that increase impervious surfaces in particular. Although communities cannot prevent hurricanes, floods, and severe weather events, they can help waterways by preserving the processes that work ecologically to normalize a riparian ecosystem after a severe weather event: natural drainage patterns, filtration of pollutants, infiltration, gradual groundwater recharge, and evapotranspiration. Communities that disrupt natural stormwater drainage patterns may have to pay for them several times over — water persistently takes or creates a path of least resistance.

6.9 Recommendations

Orange County must heed the call of the Shaping Orange County's Future Task Force to channel development into environmentally appropriate areas. Continued transformation of rural areas into large-lot auto-dependent subdivisions is perilous for the streams and aquatic life of Orange County. Clustering development into discrete mixed-use nodes and setting aside large undisturbed areas affords true watershed protection. A comprehensive watershed protection policy could also include enforcing ample riparian buffer zones, forbidding development in ecologically sensitive areas, maintaining areas that allow runoff infiltration and groundwater purification, and treating our wastewater and stormwater in an ecologically sound manner. If these simple strategies are implemented, Orange County will realize significant ecological and monetary benefits.

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