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Addressing Imperviousness In Plans, Site Design and Land Use Regulations

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Imperviousness As a Water Quality Barometer

Impervious surfaces are impenetrable materials that prevent water from percolating into the soil. Common impervious surfaces are asphalt, cement and roofing material, all associated with development. A ubiquitous modern landscape feature, impervious surfaces are accepted urbanization indicators. As two-thirds of all impervious cover is automobile related, imperviousness is a particularly good gauge of suburban sprawl with its extensive road and parking networks.

Impervious surfaces are also excellent barometers of development's impact on water quantity and quality. Hydrologists have long recognized that impervious surfaces affect water quantity by diverting subsurface flow to surface runoff, often resulting in increased flooding and stream bank erosion. In addition to imperviousness' adverse impacts on water quantity, numerous studies document its water quality impacts with evidence of stream impairment when watershed imperviousness approaches 10 Percent. Much of this damage is from polluted runoff.

Imperviousness As a Planning Tool

Land use planners interested in water resource protection will find imperviousness a practical tool for analyzing development's impact on water. As a planning tool, impervious coverage has several advantages. First, the relationship of impervious cover to water quantity and quality is well documented and can be used with confidence, even if the specific pollutants, sources, pathways and effects are unknown. Second, impervious cover is measurable. Whether estimated from "windshield" surveys, measured from site plans or digitized from aerial photos or satellite imagery, imperviousness can be documented with real numbers. Finally, impervious surfaces such as roads, rooftops, driveways, parking lots and sidewalks are easily recognized landscape features. They are not complex, invisible components of the polluted runoff stew, such as toxins and nitrates. The public sees impervious surfaces daily, and is more apt to grasp its use as a planning tool. (See Technical Paper 3, *"Methods for Measuring and Estimating Impervious Surface Coverage"* and Technical Paper 4, *"Do it Yourself! Impervious Surface Buildout Analysis".)*

Getting Down to Business

The NEMO Project offers the following suggestions on incorporating impervious coverage in land use plans and regulations. Each suggestion can be taken independently, but they are most effective if followed sequentially. As new information comes on line, additional runoff control options will emerge. And please, don't take ours as the last word. You might have your own creative ways of addressing this important issue.

1. Review and Revise Your Local Plan of Conservation and Development

As a blueprint for land use regulation, the municipal master plan should clearly state community goals and guidelines for conservation and development. It should specify areas to be developed and recommend permitted uses in each development area. The plan should also identify significant natural resources (based upon a natural resources inventory), such as water, and recommend areas worthy of conservation. As one of your community's most important documents, the plan should address the potential impact of development on water resources. Below, is a discussion of selected plan chapters that might address this issue, highlighting imperviousness' impact on water.

Introduction

Early in the plan, include a goal statement on the potential impact of various land uses on water resources. Consider as an example, "The community wishes to protect its water resources. As impervious surfaces can collect and convey polluted runoff to our waters, we seek to reduce their amount and impact." Once addressed in the introduction, there are several other plan

chapters where imperviousness might be discussed in greater detail, including:

Historical and Existing Land Use Trends - Include a discussion of past and use trends, highlighting the amount and type of impervious surfaces associated with each use. Conduct a survey of present land use and impervious coverage. Use actual impervious measurements or estimates based on the amount of imperviousness associated with various land uses. Present an overview of the impervious budget, highlighting the amount of imperviousness associated with transportation as compared to buildings. The plan might also include an analysis of where impervious surfaces are located within watersheds. For instance, impervious surfaces in headwater areas, near water bodies and over groundwater recharge areas can be particularly damaging to water quality. Rather than lumping all impervious surfaces together, the inventory might differentiate them as to their potential impact on water quality. For example, roads, parking lots and commercial/industrial rooftops often drain directly to stormwater sewers.

Runoff from these areas is not naturally filtered by soil and vegetation and moves rapidly in great volumes. In contrast, runoff from residential rooftops usually drains to lawns that promote infiltration, reduce runoff rates and filter pollutants. The general goal for impervious surfaces is to limit them when and wherever possible.

Topography - Use natural contours and watersheds for drainage system planning. As topographic lines and watersheds do not follow political boundaries, local officials need to address drainage in a regional context. A plan goal might be to utilize natural drainage systems where feasible and to recognize that certain development practices, such as site clearance and grading, change the landscape disrupting natural drainage patterns. Discuss the hydrologic cycle and the importance of infiltration in maintaining subsurface recharge and other natural functions. Establish goals of minimum site disturbance and maximum retention of existing topography while discouraging clear cutting of vegetation and extensive grade alterations. Emphasize the economic and environmental benefits of natural drainage over manufactured systems.

Watersheds - Local officials need to recognize ecosystems and land use's impact on them. A watershed is an ecosystem in which all surface water drains to a common outlet. The community plan should inventory and analyze land use and natural resources in local and regional watersheds. Local officials should know where water naturally drains and how development will affect those patterns. Applicants before local boards should delineate proposed uses within the watershed and report on the impact of their proposal on surface and subsurface water. Communities are recognizing the value of developing comprehensive watershed management plans to better understand land use impacts on drainage. Watershed management plans are highly recommended as important components of any community master plan. A recommended outline for a watershed master plan is included as Appendix A. The general goal for managing stormwater within a watershed is to manage it on-site using practices that closely mimic natural infiltration including, vegetative filters, grassed swales and bioretention areas and porous pavement.

Soils - Soils data can help delineate areas suitable for development and conservation. Soil surveys also identify areas with soils capable of supporting water management practices including; pond and reservoir areas, embankments, drainage, diversions and grassed waterways. Local officials can designate areas where natural drainage systems can be maintained or required by reviewing a site's soil properties including; slope, permeability, erodibility, wetness, depth to bedrock, hardpan and ability to support permanent vegetation. When development is directed to areas with soils suitable for urban uses, adverse impacts on fragile natural resources can be minimized. Soils can also be used to establish density limits. For example, some communities have adopted "net buildable areas" or soil based zoning, where permitted density is based the amount land suitable for development rather than total acres owned. This chapter should also address the importance of inland and tidal wetland soils as nature's sponges and filters. A key plan goal should be the protection and establishment of stream side or riparian buffer areas to offset the adverse impacts of development. While wetlands and riparian buffers can absorb floodwater and filter certain pollutants, policies should protect them from overloading and direct receipt of polluted runoff.

Open Space - Some plans analyze the various functions of open space including; recreation, resource protection and management, habitat conservation and open space's contribution to community character as well as it's economic benefits. Few however, discuss open space as a water resource protector. The soils and vegetation associated with open space are vital to stormwater management plans that emphasize infiltration. Hence, your plan should describe how open space could mitigate development's adverse impacts on water. For example, open areas can serve as filters buffers, swales, wet and dry ponds, as well as detention and retention areas. Open space obtained during development, such as subdivision and cluster dedications can be particularly protective of water resources. Urban open areas, such as vest pocket parks, plazas, playgrounds and vacant lots can be designed to filter polluted runoff from adjacent impervious areas.

Water Resources - This chapter addresses surface and subsurface water. Where available, water quality monitoring data as well as existing and proposed water quality standards should be used to help establish goals for the watershed. Discuss land use impacts on these standards, particularly known or inferred pollutant generators. Discuss the various pollutants found in stormwater runoff and relate them to existing and proposed land uses. Locate and classify watercourses and water bodies within their watershed and identify their drainage function. Present management strategies for each stream, river and pond. When

presenting water quality goals, include impervious surface reduction and infiltration as major objectives.

Community Design - Address the impacts of site design on the paving of your town by suggesting ways to reduce the imperviousness of streets, parking lots, sidewalks, driveways, structures and compacted earth. Encourage designs that direct runoff to open areas as opposed to more costly, and often less effective, structural "best management practices." The compatibility of clustering, neo-traditional development and traffic calming designs with naturalistic storm water management might be addressed. The contribution to "community character" of naturalistic stormwater management facilities such as swales, infiltration basins and wet ponds should be included. A discussion on how green areas are more pedestrian friendly than gray impervious surfaces designed for cars should also be included. Stress how porous materials such as crushed stone, porous pavers and porous asphalt mixtures might be substituted for more traditional impervious materials.

Community Character - This chapter should present strategies to reduce the social, economic and environmental impacts of sprawl and its associated features such as impervious surfaces. Address the compatibility of naturalistic landscaping and impervious coverage reduction with neo-traditional design and rural landscape protection. For example, roads serving low-density residential development need not be as wide as those serving more intense uses. Communities with a village center, might place porous parking spaces behind commercial structures to avoid the harsh visual impact of macadam seas flowing door to door. National studies indicate many communities require more parking than actually utilized. Conduct a local parking utilization survey and based on results, suggest revisions to existing parking regulations. Encourage landscaped parking lots with green areas used for infiltration. Review the many studies documenting the costs of sprawl with particular emphasis on property tax implications for communities relying on single-family homes as the major tax source. Discuss the importance of green areas in providing a sense of place and possible multiple uses of these areas including stormwater management.

Community Facilities - Municipal facilities with impervious surfaces including; buildings, parking lots, paved recreation and outdoor storage areas, should be analyzed for their potential contributions to polluted runoff. List ways to reduce the impervious surfaces associated with civic centers, schools, libraries, police and fire stations, garages, waste disposal areas, parks and other municipal sites. Consider replacing impervious surfaces with porous alternatives. Local government should serve as a model in water pollution prevention. Therefore, local policies must guarantee that public roads and parking areas are swept, storm drains vacuumed, storm sewers maintained, swales and other drainage systems cleaned and road runoff diverted from direct stream discharge. Care should be shown when washing municipal vehicles and planning sites for waste disposal and outdoor storage of materials such as sand and salt.

Public Utilities - Public utilities such as sewer and water lines are often constructed to correct water quality problems. However, public utility service areas can generally accommodate denser development than those served by on-site systems. Denser development may generate new water problems, such as polluted runoff from impervious surfaces. As a consequence, public utility impacts on water quality need to be addressed before committing to these expensive "public improvements." Even communities with sophisticated storm sewers can experience problems, such as broken pipes leaking polluted runoff into barren earth. In this situation, polluted water is quickly piped out of sight and often out of mind, yet the long-term effects are devastating. Storm sewers can also alter watershed hydraulics as runoff is directed to pipes preventing infiltration and base flow recharge. Any stormwater management facility requires maintenance yet, many are not properly maintained. For instance, storm drains should be vacuumed twice a year. Research shows few communities properly maintain storm drains. As a result they become literal petri dishes of accumulated pollutants waiting for the next rainfall to discharge their contaminated wastes upon the landscape.

Transportation - Rather than relying on a "one design fits all situations" approach to road construction, communities should develop road standards based on the function each road will serve. For instance, a cul-de-sac road serving a few residential lots need not be built to the same specifications as collector and arterial roads handling heavier traffic. Local standards regarding pavement type, sub-base specifications, road length and width, sidewalks, curbs, swales and street trees should be reviewed. Local roads can be constructed of porous materials, be fairly narrow, designed to follow natural contours and drain to swales rather than curbs. These design features not only produce functional roads, they also promote infiltration of runoff. Policies regarding sidewalks should also be reviewed. Sidewalks should only be required where needed. For instance, sidewalks may be needed only on one side of the road or, if not connected to municipal facilities, perhaps not at all. Review the impact of zoning requirements for front yard setbacks as they relate to driveway construction. Excessive front yard setbacks will generate long impervious driveways and research shows residential driveways to be "hot spots" of polluted runoff. Similarly large lot zoning will generate greater road lengths. A typical one-acre lot will require approximately 200' of road frontage. As alternatives to total reliance on automobiles, the plan should address mass transit as well as pedestrian and bike trails.

Parking utilization surveys should be conducted to determine whether present zoning requirements for parking are excessive. Many parking standards are based on peak utilization periods, such as the week before Christmas, and as a result many spaces are not utilized for most of the year. The benefits of landscaped and porous parking lots as natural filters and pleasant visual alternatives to seas of macadam and concrete should be promoted. Also review and comment on the water quality impact of local maintenance practices on roads and parking areas. Before

adopting the latest planning trends, analyze their potential impact on water. For instance in touring Disney's no-traditional town Celebration, it became evident that even though road lengths and widths were decreased, the use of alleys increased overall imperviousness. Of course, the alleys and the roads could have designed with more porous materials such as porous asphalt or paver stones.

Future Land Use and Build Out Scenarios - When projecting future land use, consider the imperviousness of various development types. Studies show commercial and industrial development can generate 70 Percent to 95 Percent impervious coverage, while residential areas vary from 15 Percent imperviousness in one-acre zones, to 65 Percent in one-eight acre zones. Build-out analyses, based on present zoning, should include impervious coverage projections. Growth management goals should encourage redevelopment of built areas served with public utilities as a practical alternative to costly sprawl. An Impervious Surface Reduction Study could suggest a full menu of techniques to reduce polluted runoff from existing and projected land use.

There are other chapters in your community's Master Plan that might address development's impact on water. The important point is, throughout your Plan, the community goal of reducing development's impact on water resources should be clearly stated.

2. Mirror Plan Goals in your Land Use Regulations

Your community's land use regulations should reference and repeat goals and recommendations regarding polluted runoff and impervious surfaces addressed in the Master Plan. While your Plan can broadly address these issues, the regulations should set specific standards each applicant must meet before the commission grants approval. Most communities rely on zoning, subdivision and wetland regulations to control land use. What follows are suggestions as to how those regulations might address development's impact on water with emphasis on imperviousness and runoff.

Review and Revise Zoning Regulations

Selected sections of zoning regulations that might address the impact of development on water quality include:

Definitions - When courts review zoning cases, they often reference the Definitions' Section to see how local officials define specific terms. Where local definitions are absent, the court will use it's own. Zoning regulations should include a comprehensive list of definitions for terms used in the zoning text, including those related to stormwater management. Definitions should be included for terms such as; impervious and porous surfaces, non-point and point source pollution, swales, lot coverage, best management practices, storm water runoff, infiltration, etc…

Permitted Uses - Zoning can permit uses by right, by special permit or prohibit them. Zoning can relegate certain uses to certain districts or prohibit uses judged to adversely impact public health or safety. For example, activities that might contaminate water because they involve the use, storage or disposal of hazardous materials might either be prohibited or permitted in certain locations provided the applicant can comply with certain performance standards mandated by the commission to protect natural resources. Most state environmental protection agencies compile lists of those businesses that might pose risks to water. Don't be afraid to prohibit uses state officials list as posing particular hazards to water quality. Carefully review permitted uses and be assured they pose no threat to water resources. Review site plan requirements for special permits paying particular attention to storm water runoff and impervious reduction standards.

Lot Size - Water resources may be protected, in part, by controlling the placement and density of structures and septic systems. Many local officials feel the best way to protect the environment and preserve rural character is to require large lots with expansive setbacks. However, these requirements generate extensive roads, driveways and sidewalks that, in turn, provide an efficient delivery system for polluted runoff. Zoning should encourage development in those areas that are capable of supporting growth and discourage development in areas with site characteristics posing limitations for development. An area's suitability for on-site utilities is a key factor for lot size determination particularly in those communities wishing to avoid public sewers or water. Requiring an applicant to perform an analysis of "net buildable area" will address these concepts.

Lot Coverage - Some regulations define lot coverage as the percentage of the lot covered by structures. A more comprehensive approach defines coverage as, the percentage of the lot covered by impervious surfaces including buildings, roads, sidewalks, parking areas, compacted earth or pipe. To calculate a site's impervious surface ratio, divide the area of impervious surfaces by the site's gross area. For example, in a 20-acre subdivision with 5 acres of impervious cover, the impervious surface ratio is .25 or 25 Percent. In residential areas, about 63 Percent of the impervious surface is related to paved areas while 37 Percent is attributed to roofs. Hence, if one wishes to reduce imperviousness in residential areas, the focus should be on roads, driveways, sidewalks and parking. In contrast, parking and roofs are the dominant impervious surfaces in commercial and industrial areas.

Some communities have established impervious coverage limitations. However, care must be taken in the development of limits. Impervious surface limits are best used where:

- there's a firm relationship between the regulated area and an identified priority natural resource;
- the regulated area is well-defined (special overlay zone; watershed);
- flexibility is built in to allow the developer to reach town goals through design considerations that reduce effective impervious surfaces (those that are collecting, conveying, and concentrating

polluted runoff). For example, Brunswick, Maine limits impervious coverage to 5 Percent in a watershed draining to fragile shellfish beds. The adverse effects of imperviousness can be minimized by stopping the pollutant generator, reducing the size of impervious coverage, or replacing impervious coverage with more porous surfaces and draining runoff from impervious to open areas.

Density - Zoning controls the density of development by regulating the number and type of structures permitted on various size lots, i.e., one dwelling unit per acre. Some regulations contain cluster or conservation development provisions that permit buildings to be "clustered" more densely than allowed by conventional zoning. In exchange, the undeveloped portion of the site is preserved as permanent open space. Open space may protect water by conserving sensitive aquatic habitat, preserving riparian buffers, as well as serving as detention and retention areas, ponds, swales and other drainage systems. Clustering not only provides direct open space and water protection, but if properly designed it can greatly reduce impervious surfaces such as sidewalks, driveways and road lengths. A review of several cluster designs shows imperviousness can be reduced anywhere from 15 Percent to 50 Percent compared to conventional designs.

Special Permits and Site Plan Review - Under zoning, uses are allowed either "by right" or as special permits. Special permits are uses the commission might allow, if the applicant complies with performance standards set forth in the regulations. Generally, the standards address the potential impact of the proposed use on the neighborhood and environment. Standards regarding the management and filtration of stormwater runoff should be included. The standards should guarantee that the proposed use would not generate runoff that will adversely impact receiving land or water. Special permits generally require that a site plan be submitted to help the commission determine if the proposed activity conforms to the regulations. The regulations must state what uses are subject to site plan review and list the standards each application must address. The commission acts in an administrative capacity when reviewing site plans, meaning applications complying with the regulations, must be approved. Regulations should require that site plans show the location of the proposed site within the local watershed, that post development runoff not exceed pre-development levels and proposed stormwater management practices are delineated and described (see stormwater management section below).

Proposed stormwater management techniques should reflect and respect watershed characteristics and comply with any approved watershed management plans. NEMO suggests that the management practice of choice be infiltration. There are only a few areas where infiltration should be avoided including: areas with steep unstable slopes; soil as impermeable as the pavement or buildings that will be placed upon it; areas close to water supply wells over known aquifers; areas close to septic systems; areas close to sensitive structural foundations; and contaminated sites that would leach with added flow.

Erosion and Sediment Controls - Erosion is soil removed from its place of origin by wind, rain or running water. Sediment is eroded soil transported to water. Erosion and sediment control regulations generally include the following principles; respect for and utilization of natural drainage systems, avoidance of development on steep slopes, keeping post development runoff equal to or less than pre development rates and minimized site disturbance and vegetation clearance. Zoning has traditionally addressed soil erosion more than other nonpoint pollutants. A potential problem with such emphasis is that local officials sometimes feel they have addressed the entire issue of polluted runoff by adopting erosion and sediment control regulations. Erosion, of course, is only one of many ingredients in the polluted stormwater bouillabaisse and based on water quality monitoring data, officials should make provisions to address the other pollutants of concern with the same rigor they have approached erosion control.

Stormwater Management - Zoning regulations should require that all development proposals contain stormwater management provisions that address the impact of development on both water quality and water quantity. Of particular concern, is the impact of the proposed use on the local watershed, not just the proposed site or adjacent parcels. Common stormwater management principles found in regulations include:

- no direct channeling to watercourses or wetlands;
- use of natural drainage systems;
- minimum site clearance and grading;
- maintenance of natural streams and riparian zones;
- development not creating downstream flooding or off-site erosion;
- no greater site runoff than existed prior to development;
- on-site retention and filtration of the first inch of runoff from impervious surfaces to on-site vegetative areas. NEMO suggests that the management practice of choice be infiltration. There are only a few areas where infiltration should be avoided including: areas with steep unstable slopes; soil as impermeable as the pavement or buildings that will be placed upon it; areas close to water supply wells over known aquifers; areas close to septic systems; areas close to sensitive structural foundations; and contaminated sites that would leach with added flow. Once again, these regulations can be most effective when developed and administered in conjunction with comprehensive watershed management plans.

Earth Removal - Zoning can regulate the removal of sand, gravel, rock, peat, top soil and other earth products, by restricting when, where, and how these products can be mined, if at all. As mining operations bare earth, they can generate erosion that might eventually find its way to water in the form of sediment. Site disturbance should be minimal and top soil stockpiled so it can be replaced on work areas. Gentle final grades and reseeding should be required once the operations are finished.

Aquifer Protection Zones - Zoning may reasonably provide for the protection of existing and potential surface and subsurface drinking water supplies by establishing standards to insure

proposed development will not have an adverse impact on these valuable resources. Many communities and states have mapped major known or inferred aquifers and the regulation might wish to reference those studies as "areas of particular concern." While NEMO promotes infiltration of stormwater, caution is needed when proposing infiltration on or near known aquifers, particularly in areas with excessively well-drained soils.

Floodplain Zoning - One of the statutory purposes of zoning is to secure safety from flooding. A floodplain is a flat or nearly flat land on the floor of a stream valley or tidal area that is covered by water during floods. That part of the floodplain subject to a 1 percent chance of flooding in any given year is designated as an "area of special flood hazard" by the Federal Insurance Administration, who delineates these areas on official maps for each community. The commission should protect the floodplain by regulating uses within it as well as those on higher elevations that drain to it. One of the great dangers of increased impervious surfaces is that stormwater moves rapidly over its surface and unless it is intercepted, can gain in volume and velocity often resulting in increased downstream flooding. Local officials must realize the contribution of upland development to the floodplain and develop land use regulations that mandate zero or minimal off-site runoff. In addition to the above sections found in most zoning regulations, there are other innovative ways zoning might address land use impacts on water quality, including:

Overlay Protection Zones - An overlay protection district or floating zone is the same as a conventional zone except it is not designated on the zoning map. It "floats" over the community until an application is approved and then is affixed to a particular parcel. The zoning text describes the conditions required for approval. The area protected by the overlay zone could be a water resource area. Generally uses will be permitted with restrictions beyond those in the underlying zone. However, bonuses such as increased density are often offered to encourage use of this protective tool. The underlying zone determines the permitted land use, while the overlay establishes the special restrictions and bonuses in place to meet the desired end, i.e., water resource protection. Impervious surface limits might be considered as a condition of approval. However, care must be taken in the development of limits. Impervious surface limits are best used where there's a firm relationship between the regulated area and an identified priority natural resource as outlined previously in the section of this paper on Lot Coverage.

Water Sheet Zoning - A new zoning technique of extending zoning districts onto water courses or water bodies. Under traditional zoning, areas of land are designated for various uses. Under Water Sheet Zoning certain areas of water are reserved for water dependent uses that will not have an adverse impact on the water quality.

Riparian Buffer Zones - A buffer zone is an area of open land separating two distinct land uses that acts to mitigate the adverse effects of one on the other. When used in water resource protection, buffers are usually strips of grass or other vegetation separating a waterway from adjacent land uses. Buffers are also referred to as filter strips, vegetated strips and grassed buffers. Buffer widths vary based on the sensitivity of the resource being protected and the land uses of concern. For example, to protect fragile areas such as trout hatcheries, buffers of 300' or more may be appropriate. When buffers are used as protective filter strips, required widths vary based on; the pollutant of concern, soil type, slope and vegetative cover. Buffers protect water by filtering pollutants, regulating water temperature and runoff, recharging groundwater, storing floodwater and protecting riparian habitat.

Slope Restrictions - As slope increases, runoff velocity, flooding, erosion and sediment transport increase. Some programs concerned with the impact of steep areas on water quality, such as Maryland's Chesapeake Bay Critical Areas Program, prohibit clearing on slopes greater than 25 Percent.

Transfer of Development Rights (TDR) - TDR is based on the concept that land has a bundle of different rights and a landowner can sell one of them, the right to develop, for use in another area. To implement a TDR program, a plan must be prepared to show sensitive areas to be protected, from which development rights may be sold, as well as developable areas which can receive those rights and be developed at a higher density than allowed in conventional zones. Several states including Connecticut, authorize zoning commissions to provide for the creation and permanent transfer of development rights.

Review and Revise Subdivision Regulations

Subdivision regulations provide standards for design of streets and public improvements associated with tracts of land to be divided into parcels for the purpose of development. The objectives of subdivision regulations are to promote orderly growth and protect natural resources by insuring land proposed for subdivision development is capable of supporting intended uses.

In Connecticut, a stated objective of subdivision review is to insure proposed development adequately provides for drainage and flood control. Selected sections of a subdivision regulation that might address drainage, flood control, stormwater management and impervious surfaces include:

Policy or Purpose - This section should clearly state that it is the policy of the municipality to assure that the land proposed for subdivision is of such character that it can be safely used toaccommodate the intended use without danger to the communal health, safety and welfare and that proper provision be made for drainage, flood control, stormwater management, protection of water resources and any required municipal improvements.

Definitions - It is important for subdivision regulations to include definitions for key words used in the text. Definitions for; best management practices, buffers, curbs, catch basins, channels, culverts, detention basin, ditches, drainage, drainage facility, drainage system, driveway, drop pipe, easement, erosion, grade,

ground cover, gutter, impervious surface, infiltration, open space, parking space, pervious surface, point and non-point pollutants, porous surfaces, retention basin, runoff peak rate of discharge, runoff volume, sedimentation, septic system, sidewalk, stormwater management plan, stormwater runoff, sub grade, swales, watershed, wet ponds, etc…

Site Location Map - show the location of the proposed subdivision within its local watershed and delineate streams, rivers, water bodies and wetlands within that watershed. Also show all areas in the watershed subject to a 100-year flood. Major known and inferred aquifers should also be delineated.

Stormwater Management Plan (As part of the Subdivision Site Plan) - As drainage and stormwater management are among the most critical public improvements within a subdivision, the applicant must show the planning commission that the proposed subdivision will have no adverse impact on existing drainage facilities and will protect or enhance the community's water resources. A critical area to be addressed is the ability of the proposed development to accommodate existing upstream drainage and prevent increases in downstream flooding. A sound stormwater management plan addresses not only quantity of water to be generated by the new development but also how that development will be protective of water quality. To adequately determine the impact a proposed subdivision might have on water quantity and water quality; the subdivision regulations should require the submission of a detailed Stormwater Management Plan. It is suggested that any stormwater management plan be based on the following principles:

- Encourage on-site infiltration of water rather than diversion by impervious roads, parking areas and drainage structures. Diverted storm water alters the natural hydrologic cycle producing increased runoff and flooding.
- Development should retain the natural landscape by minimizing grading and disturbance of existing vegetation. Storm water management systems should utilize natural drainage patterns.
- Compensate for development impacts by protecting and enhancing riparian buffers.
- Minimize impervious surfaces and encourage permeable paving.
- Permit flexible road designs to create narrow, gently curving, porous roads draining to grassed swales rather than wide, straight impervious roads draining to curbs and storm drains.
- Permit shared and porous paved driveways and sidewalks.
- Stormwater should be carried as sheet drainage, diffused over large surfaces such as the face of gentle slopes, as opposed to concentrated drainage directed to curbs, storm sewers or ditches.
- Where pipes are used, encourage perforated over closed pipes to allow leaching or filtration.
- Drainage from roads, parking and roofs should be carried on the surface in shallow, gently sloping swales. Swales regulate velocity, minimize erosion and maximize percolation.
- Curbs, catch basins, storm drains and imperviously lined ditches should be avoided in favor of open swales. In areas where curbs are necessary, their length should be shortened to minimize stormwater volume and velocity.
- Look at total watershed drainage patterns not just those at the project site. Closing or restricting natural drainage ways should not be allowed as uphill drainage problems could result.
- The applicant must assess watershed and site characteristics before suggesting detention and retention ponds. Before approving any structural drainage system the commission must be assured it is appropriate for the entire drainage basin, as well as the proposed site. For example, in many watersheds, regional rather than site specific detention ponds may have less adverse impact on receiving waters.
- Construction activities should be coordinated and conducted in staged or limited time frames, taking advantage of low flow seasons. The contractor may be required to do any major clearing during winter months when the ground is frozen to minimize erosion and sedimentation and to avoid wildlife nesting and breeding seasons.
- When the proposed subdivision is crossed by a watercourse or drainage way there should be a stormwater easement or drainage right-of-way provided of such width and construction as determined by the commission.
- Where public storm sewers are accessible, connections shall be made in accordance with applicable construction standards and specifications.

Review and Revise Road Standards - Generally one objective of subdivision regulations is to insure that the proposed subdivision is served by roads that meet local standards designed to safely provide for present and future traffic needs. In most instances, this means the developer must construct new roads that comply with locally adopted road construction specifications. In some communities these specifications are found in the subdivision regulations while in other they are found in local ordinances and cross-referenced in the subdivision regulations.

While traditionally the main objective of road design has been to move vehicular traffic as swiftly and safely as possible, there is growing concern that roads are being "over designed" and many communities rely on a "one design fits all occasions" approach to road building. There is also a heightened awareness of the impact of roads on sprawl, pedestrian safety and environmental protection. As one of the major sources of impervious coverage, how roads are designed and where they are placed can greatly influence the quality of a community's water resources. Roads should be designed based on the function they will serve. A local road serving access to a few homes need not be built to the same standards as a collector or arterial roads serving higher density mixed land uses and greater traffic volumes. One of the key design elements local officials should review is the recommended widths of local roads. Road width should be based on the following four variables; traffic volume, design speed, lot width and parking needs.

Traffic Volumes - When dealing with existing and projected traffic volumes a simple rule prevails, the fewer the vehicles, the narrower the road may be. Many communities call for all roads to be built with a minimum width of 32' or 34' of pavement, or

two, adjacent 16' or 17' travel lanes. Research shows that for most local roads all that is needed is 20' or 24' road widths composed of two 10' or 12' travel lanes. In some of the recent Neo-Traditional Neighborhood Design Manuals, specifications for local roads, suggest 18' widths composed of two 9' travel lanes

Design Speed - As design speed declines, road widths narrow. Research shows that long, wide, straight roads produce higher traffic speeds and higher accident counts particularly fatal accidents. Local residential roads should be designed to provide safe access to home sites and not as mini raceways. Research shows that narrow streets are the safest. For example, a study by Swift Associates and the City of Longmont, Colorado looked at 20,000 automobile accidents over an eightyear period and found, "The most significant casual relationships to injury and accident were found to be street width and street curvature." According to the Swift Report, "... as the street widens, accidents per mile per year increases exponentially, and that the safest residential street width is 24 feet."

Lot Size - Another planning variable that effects road design is the size of the lots the road will serve. As a general rule, large lots with long widths and long front yards require less on-street parking. Large lots by their very nature generally have enough area to accommodate on-site parking. Hence roads serving large lots do not have to designed with on-street parking lanes and thus can be quite narrow.

Parking - If the function of the road is to provide overflow parking from adjacent sites, an extra lane or two of roadway parking is required. However, one should not assume that every road needs to accommodate off-site parking. In neo-traditional design, on-street parking is only provided where densities exceed 4 dwelling units per acre. When on-street parking is needed lanes of 8' or 9' are provided.

One of the most common difficulties of gaining approval for narrow roads is objections from emergency vehicle operators such as policemen, firemen and ambulance drivers who predict awful consequences if proper access and adequate parking is not provided. The answer to such concerns is that the actual road right-of-way should still be the standard 50' or 60'. What is reduced is the paved portion of the right-of-way. If curbs are replaced with well-designed swales, those swales will more than adequately accommodate any squadron of emergency vehicles, including hook-and-ladder fire trucks. The swale to be effective as a stormwater filter must be designed with a sub-base equal to or exceeding that found under the best roads. The sub-base of the road extends to the swale. The only difference between how the road and swales are designed and built is that the road is covered with pavement while the swale is covered with grass. Many local officials confuse a ditch dug by a backhoe with a well-designed bio-retention swale and hence assume swales will not support heavy parking loads. A well-designed swale can serve as an efficient filter of polluted stormwater runoff as well as a safe parking area for cars and emergency vehicles.

When the four variables of traffic volume, design speed, lot size and parking needs are considered it becomes evident that road design, particularly road width will vary based of the function the road will serve. Reducing road widths from 32' to 20' will produce a 6 Percent reduction in impervious area. When this reduction is applied on all local roads, it can result in a substantial reduction of the impervious coverage in your town.

Review and Revise Wetland Regulations - (APPLICABLE ONLY TO CONNECTICUT)

Under Section 22a-42(c) of the Connecticut General Statutes, each municipality is required to establish an Inland-Wetlands and Watercourses Agency. Once established the Wetlands Agency must develop regulations to protect wetlands that conform to model regulations adopted by the Commissioner of the State Department of Environmental Protection. The Statutes state that, among other things, inland-wetland regulations must include criteria and procedures for application review. Section 7.5 of the DEP. Model Regulations entitled "Application Requirements" states that all applications will include information in writing or on maps regarding; the proposed activity, proposed erosion and sedimentation controls, other management practices and mitigation measures which may be considered as a condition of issuing a permit including measures to (1) prevent or minimize pollution, (2) maintain or enhance environmental quality or (3) restore, enhance and create productive wetlands.

Section 2 of the Model Regulations deals with Definitions and subsection 2.1 defines "Management Practice" as a procedure, activity, structure or facility designed to prevent or minimize pollution or other environmental damage or to maintain or enhance environmental quality. The Model Regulations list selected examples of such practices including; erosion and sedimentation controls, land use restrictions, setbacks, waste disposal, equipment maintenance to prevent fuel spillage, methods of construction to prevent flooding or damaging wetlands, maintenance of continual stream flow and time restrictions on in stream construction.

Wetlands Agencies thus have the legal right to ask applicants to address the issue of land use impacts on water quality and, if they so desire, may require specific information regarding the impacts of impervious surfaces on wetlands and watercourses. To this end, if the commission wishes to get more specific regarding stormwater management practices, Section 7.5 might include the following:

- As the Wetlands Agency is particularly concerned with the adverse impacts of polluted storm water runoff on wetlands and watercourses, applicants shall submit a detailed Stormwater Management Plan that indicates how the following principles will be addressed:

- Minimal site disturbance and retention of existing vegetation, especially native species.
- Retention of the natural landscape by avoided grading and regrading.
- Utilization of natural drainage patterns.
- Impervious surfaces kept to a minimum.
- Stormwater to be managed on-site with no greater runoff post development than existed prior to development
- Infiltration should be the primary method of stormwater management, where feasible
- Protect and enhance existing riparian buffers to offset adverse development impacts
- Minimize direct discharge of runoff to wetlands
- Proposed development is capable of receiving upstream drainage and will not contribute to downstream flooding
- The Plan shall address water quality as well as water quantity
- Investigate the applicability of regional stormwater facilities.

Appendix A

Recommended Outline for a Watershed Master Plan

1. Watershed Boundaries and Characteristics
A. Topography
B. Land Use and/or Land Cover
C. Wetlands
D. Watercourses
E. Soils
F. Impervious Cover

2. Watercourse Inventory
A. Hierarchy of Streams
B. Aquatic Habitat Quality
C. Bed and Bank Characteristics-Scour and Deposition Areas
D. Pools and Riffles
E. Direction of Flow and Discharge Points

3. Hydrology
A. Rainfall
B. Runoff Coefficients
C. Storage Capacities
D. TR-20 Computer Runoff Model Data
E. Low Flow Evaluations
Management Structures

4. Hydraulic Structures Location, Size and Condition of:
A. Culverts
B. Bridges
C. Dams
D. Storm Drains
E. Detention/Retention Ponds and other Storm Water

5. Water Quality Surveys
A. Known Point and Nonpoint Sources of Pollution
B. Water Quality Monitoring Test Results
C. Macro invertebrate Surveys
D. Base Flow and Runoff Sampling

6. Projected Quality Models
A. Impervious Surface Build-Out Analysis
B. Nutrient Load Analysis
C. Identify Potential Problem Areas

7. Management Alternatives
A. Land Use Planning-Areas To Be Developed and Preserved.
B. Site Design Review Standards to Reduce Impervious Coverage.
C. Best Management Practices
   1. Naturalistic-porous paving, bio-retention swales, buffers, infiltration into open space.
   2. Structural-pipes, storm drains, sewers, filters, trenches, dry and wet ponds.

8. Management Implementation
A. Revisions to Town Natural Resource Inventory, Town Plan and Open Space Plan.
B. Revisions to Zoning, Subdivision and Inland-Wetland Regulations.
C. Revisions to Town Road Standards.
D. Public Education for local officials and selected landowners.
E. Suggested Changes in Local Policies Regarding Maintenance of Roads, Parking Areas and Community Facilities.
F. Capital Improvements Plan-Who will do what, when, why and how much it will cost.

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