Erosion Control Design Basics

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Erosion control landscaping has become a huge industry, and a lot of work has opened up for landscape contractors in the field. From the beginning of even small projects, contractors need to make sure that the design is executed properly. These can be complex designs requiring expertise in hydrology and engineering, as well as knowledge of current regulations and available materials.

Contractors are not usually called upon to design large erosion control projects. That job falls to landscape architects, civil engineers and erosion control specialists. However, a landscaper might be asked to design a small job, and he might want to bid on a project – large or small.

Stantec, based in Edmonton, Alberta, Canada employs over 8,000 people in over 100 North American locations. One of the company's specialties is the control of erosion, storm water and sediment.

"It's becoming more and more important," Kevin McCaffery says of erosion control work. Part of the reason is that as populations increase, there are more impervious surfaces in and around cities, which increases runoff and the complexity of controlling erosion and sediment. Another reason is that governments are realizing that increased runoff contributes to a lot of problems related to erosion, including pollution and loss of groundwater recharge. It can raise numerous health and environmental issues in the immediate area, as well as in downstream waterways. "You're dealing with a lot of force there; it doesn't obey property lines or financial situations."

Some erosion control designs are complex, as around this bridge where native rocks and commercial wattles are placed to slow runoff on both steep and shallow slopes.

McCaffery, a civil engineer and senior project manager for Stantec in North Springfield, Vermont, says that a landscape architect or civil engineer called in to analyze a site and draw up an erosion control plan – either on its own or as part of a larger development plan – will start by looking at the site in detail. Initial factors to take into account are slope, soil, existing drainage and any new structures that will go on the site. Impervious construction on the site, whether buildings or roadways, will increase runoff dramatically. Rainfall estimates are crucial, and those will come from government, university or Natural Resource Conservation District statistics for the region.

The ultimate goal, he notes, is to design a plan that will avert erosion, even in "worst-case" rain events known as "design storms." Some of the pitfalls for a landscape designer are unusual weather events, not leaving enough time to make a proper design and a failure to prepare for the unexpected during construction.

Galen Drake, McCaffery's Stantec counterpart in Phoenix, Arizona, points out that the approach to a job is different if it is a remedial project rather than new construction. A remedial project brings with it more immediate problems, some of which will be obvious from the start because of the evidence of previous erosion. New development may have actually caused the problems, which brings an added responsibility to the design.

The beauty of having a new site to work on is that erosion can be avoided entirely, but Drake also interjects aesthetics into the mix. He comes at a design a little differently because he is a landscape architect and a certified professional in erosion and sediment control. He points out that one of the reasons that landscape contractors have become so valuable to this industry is that they not only bring in an established ability to make a site look good, but they also have knowledge of plant materials, which are good erosion control devices in themselves.

On the downside, Drake notes that landscape contractors are sometimes not very knowledgeable about the complexity of erosion control, or how much damage can be done by ignoring the destructive potential of water. That's particularly true in the desert Southwest, because there often is no water present, even in riverbeds, to remind a landscaper that water will someday come down in a deluge.

Essential to a design, are the calculations and testing that lay the groundwork. Drake points out that soil tests, for example, will always be done if structures are going onto a site. For erosion control purposes, soil percolation tests are necessary to determine the rate of water penetration. Soil fertility tests should be taken to find out whether plants will need amendments in order to grow there.

Beautiful wetlands, such as this restoration by Stantec at Wellesley College, are often the result of complicated landscape designs by erosion and storm water control specialists who can create wetlands as retention areas.

Another strict requirement nowadays, McCaffery says, is to protect the needs of downstream waterways, some of which can be far off-site. A design must take into account the effects on waterways that will take the discharge, as well as water quality of the waterways and the runoff itself. Pollution or degradation of streams and lakes is not allowed (the cleaner the water, the more strict the requirements for runoff), and wetlands downstream may not usually be used as part of the water retention system. Wetlands can be created on the site, however, as part of the system. In general, historical water release levels may not be exceeded, and any discharge must be gradual.

Stream bank stabilization is an entire field that requires special attention to details, McCaffery says, because streams and rivers that have been degraded are carrying more water than they can handle. Because that water can rise and fall, and be swifter than normal during storm surges, bank restoration requires more substantial erosion resistance treatments. Old methods such as concrete canalization or gabions have given way to more natural treatments. Some streambeds may even require widening.

Drake says that desert streams are a special problem, because they may rise and fall so quickly in the flood season. He has done a lot of bank stabilization work in both dry and live streams using natural materials. The old soil cement solution for riverbanks is going by the wayside. An erosion designer must also be knowledgeable about retention basin design and capacity in the Southwest, because these huge, empty basins are common in cities that require all storm water to be retained on-site. They may often be designed into parks or golf courses and have specific overflow requirements.

Retaining walls are another option for slopes, McCaffery says, and there are many excellent designs out there. However, on normal slopes natural solutions are usually more desirable. Walls are usually used on steep slopes, where space is at a premium, though they come with their own drainage challenges.

Restoration of the Trout River in East Berkshire, Vermont, reveals how the use of natural materials, such as native rocks, can be part of an effective erosion control design.

Both McCaffery and Drake say that it is important to determine the needs of the client, and in particular whether the site will be out of the way or visible to the public. The design will have to take into account not only aesthetics, but also the additional runoff pressure that comes from the creation of impervious areas, such as driveways, sidewalks and parking lots. Even foot traffic can compact areas and reduce water penetration.

McCaffery says that one of the factors that makes a modern erosion control project so complex is the amount of regulatory pressure on designers and contractors. Federal legislation and Environmental Protection Agency guidelines have been taken into account by state and local governments in the creation of their own regulations and permit systems. The requirements have become more far-reaching since the EPA's National Pollutant Discharge Elimina-tion System (NPDES) permitting requirements began applying to projects as small as 1 acre in size in its Phase II implementation in 1999.

"It affected a huge number of people," Drake says, because it means that every project of any size must meet strict guidelines. He notes that a Stormwater Pollution Prevention Plan is required by state and federal governments as part of a design. It may never be requested, but if you don't have it your project can be in trouble. Developments may require a state land use permit, a storm water permit and land disturbance plans. These are in addition to the normal water, sewer and transportation permits.

"If you've got any disturbance in wetlands, you'll have to have a permit for that," McCaffery adds. Plans must take into account not only sediment and runoff issues, but also issues such as the pollution generated by having construction vehicles and fuel on-site. Often, municipalities even call for methods of preventing mud on vehicle tires from reaching city streets.

Roadway embankments are prime targets of erosion control, and after some time they begin to look natural again.

The situation now is that cities and counties are adapting the NPDES guidelines for use in their local regulations and permit requirements, and this is making the job of preparing erosion control plans much more demanding. In areas known for flooding, mudslides or other catastrophic events, regulations are often even more strict. In addition to oversight on new projects, local governments are playing catch-up for decades of poor erosion control work on sites developed in an era when there were no regulations.

One other subject that erosion control designers must be aware of – and it's a bright spot in the field – is the types of materials available for construction. There has been a boom in the design and manufacture of erosion control devices, materials and methods in recent years. Drake says that anybody involved in this type of work should know what is available.

Many erosion control projects call for specialized treatments, and these can be in the form of drainage materials, soil stabilization products or construction aids. "There's a specific product for just about any problem there is," McCaffery says. For example, there are many fiber blankets and nettings available, in both natural and synthetic fibers, that help stabilize soil and plant materials.

Plant materials are commonly used by erosion control designers.

Drake, who designs a lot of highway embankments, says that there is a wide range of products such as wattles, or long tubes of straw or excelsior wood fibers, used to trap sediment and slow water runoff on slopes, and then biodegrade over time. He’s also used various native willow wattles or heavier coir coconut fiber logs to stabilize stream banks. McCaffery has been looking at new “mechanical pretreatments,” such as catch basins with filters or other means of cleaning storm water before it enters a drainage system. One of the exciting developments is the availability of permeable products for use in driveways, parking lots and other normally impervious surfaces. The use of paving surfaces such as slotted concrete blocks that can be filled with gravel or turf means that much more water can be captured in the ground.

Of course, the soil itself can be amended or topdressed to prevent erosion; decomposed granite has become a well-established coating for moderate slopes to allow water percolation, and plant materials are a common tool for erosion control designers to use. Natural rock is also a desirable treatment and is used in many situations. Native seed mixes are commonly used to stabilize soil, combining grasses, annual forbs and shrubs for both short-term coverage and long-term stabilization. A thorough knowledge of plant materials is handy in this field, because even salty or rocky soils can be stabilized with specialized plantings.

Stantec designers use CAD computer programs to draw up plans, and usually employ teams of architects, engineers and graphics designers to do so. Drake says that some cities now require both paper and digital copies for their records. From the design of a project to the end product, erosion control design is a field not to be taken lightly.

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