

Form Enhances Function

As land development races across our nation, the need for stormwater control increases exponentially. Acres and acres of land with the capacity to absorb water and transmit it to the aquifer are being replaced by impervious surfaces including roofs, driveways, parking lots and roads.

The concept of stormwater detention—keeping water from storms onsite until it can be discharged to natural drainage courses in a controlled manner and free from sediment—has grown to include many other important functions. Many land planners, landscape architects, civil engineers and hydrologists have taken a creative approach to design these required structures. Water reservoirs on today's sites are no longer the dangerous eyesores they have been; modern design incorporates aesthetic structures that steer away from the basins that served as safety hazards and liability traps.

Traditionally, the stormwater basins in many locations have been segregated from the rest of the development by a chain link fence or other boundary. Today's dual- and multi-purpose water receptacles vary dramatically on sites across the nation. And integrating the design of stormwater features into the overall scheme of a development plan is a far more intelligent and progressive approach.

Patrick Stiehr, president of Watermark Engineering Inc. in Fair Oaks, California, is a leader of innovative stormwater solutions. On a subdivision development in Sacramento begun in 1995, Stiehr helped execute smart stormwater solutions with a sophisticated approach to drainage linked to the local reclamation district. The approximately 6,000-acre site, North Natomas, was a former FEMA 100-year flood plain and was largely undeveloped until the early 1990s mainly because of drainage issues and the high cost to protect the area. A portion of North Natomas is an historic lake bed.

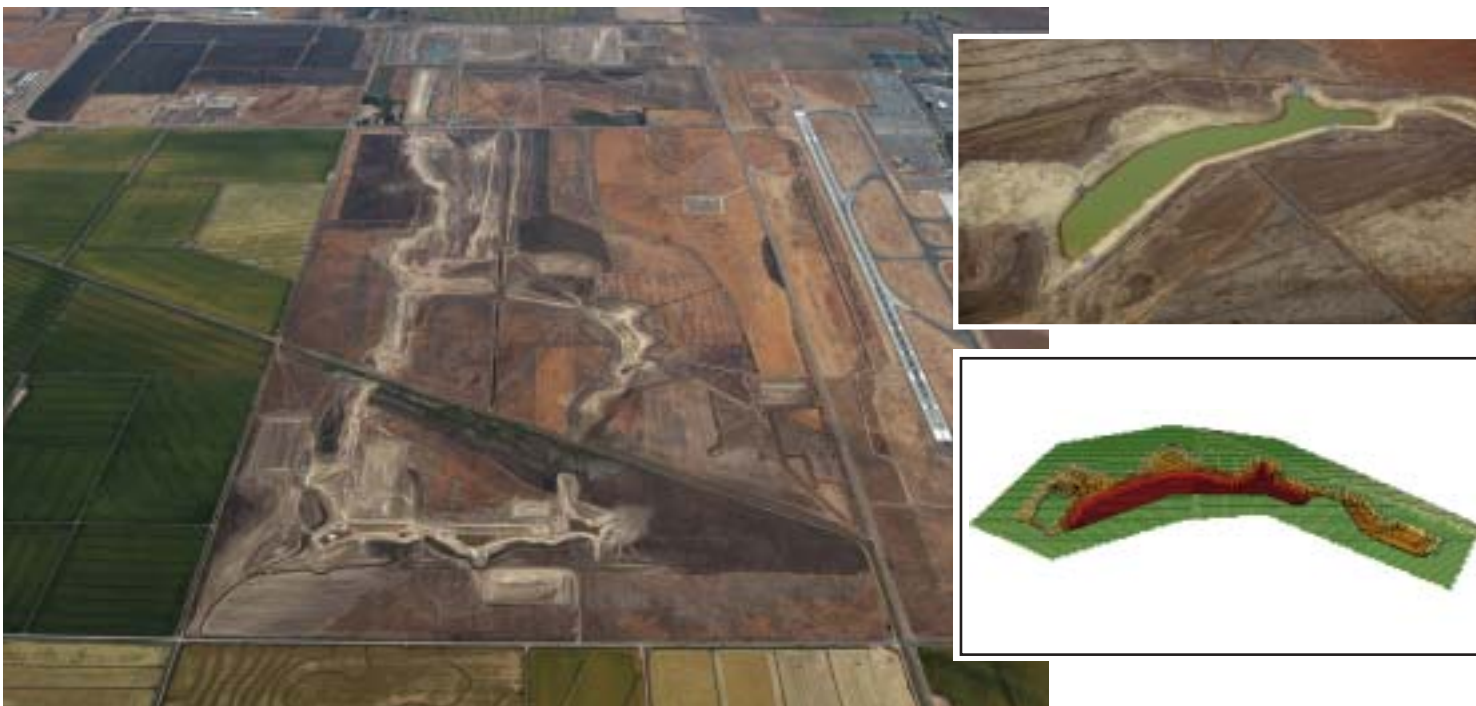
The area, which is part of a larger, virtually flat farming area, is at the downstream end of a 55,000-acre basin with pumped drainage provided by the local reclamation district. Levees along the drainage canals had to be raised and upgraded, and pumping capacity has been increased and reliability improved at three of the largest pump stations.

North Natomas has been divided into eight sub areas, each ranging in size from 330 to 700 acres except for one area at almost 1,900 acres. Each sub area is to have a complete drainage system with a discharge to the district's drainage canal system. The preliminary Drainage Master Plan for the project called for about 10 acres of the land to be set aside for a typical

Today's stormwater control plans give way to visually appealing, multi-purpose designs.



This complex basin at West Point Gardens in Elgin, Illinois, was graded and shaped with Topcon's 3D-GPS+ machine control systems. It is designed as a "wet pond" that will enhance the residential neighborhood and control stormwater.



Metro Air Park in Sacramento, California, is a model of innovative design. Contoured basins and meandering waterways were created to provide aesthetic elements for a golf course and function as stormwater controls. The 1,800-acre project was graded with 3D GPS machine control systems. The west lake (right top) exactly matched the 3D CAD model (right bottom) when completed.

detention basin, and for each basin to have a pump station to lift stormwater into the district drainage canals.

But instead of the traditional hard-lined channels, large pump stations and rectangular detention basins with security fencing and steep side slopes, the North Natomas Development Design Standards include multi-use detention basins with landscaping, no fences and side slopes of 4:1 or flatter. Channels with landscaped effects will meander and contain zero or minimal hard-lining, and side slopes of 3:1 or flatter. The pump stations have architectural features to blend with nearby structures.

The city of Sacramento also settled on the concept of wet basins or permanent pools at the bottom of the detention areas. The pools were designed to be 4 to 8 feet deep so that tule (a marsh plant) growth would be limited to the shallow edges and the deeper water would support at least small fish.

The detention basins have continued to grow in size as a result of ramped pumping and the water quality pool. Typical basins have become two to three times larger in surface area, but have had significant benefits. The permanent pools provide aesthetically pleasing lakes that are generally part of parks or green areas.

The North Natomas developers, engineers and contractors were not readily accepting of the design standards that required varied slopes and contouring because of the increased costs for detailed design, staking and fine grading. "However," Stiehr says, "today's design software and GPS systems for contractors have eliminated the extra efforts associated with 'non-standard non-linear' grading." Stiehr adds that efficient execution of effective design leads to higher priced premium lots and faster sales in more attractive subdivisions.

Pretty Greens

A few miles to the west, Stiehr also helped to forge a creative plan for Metro Air Park in California. The 1,886-acre project adjacent to Sacramento International Airport will ultimately be developed as a high-tech office park, providing warehouse, office, retail and hotel space as well as a golf course.

The largest part of the site was farmland used for growing rice. Extensive regrading was required to get the site to drain properly in anticipation of the road, building pad and parking lot construction. To deal with the volume of runoff that would be produced by the proposed improvements, a comprehensive stormwater management strategy was needed. Stiehr developed an innovative plan that created a series of interconnected lakes woven into the layout of the golf course.

Tees, greens and fairways are elevated above design storm levels. A series of long grassy swales, with just enough slope to allow water to drain, meander through the course. These swales are normally dry, but provide overland conveyance when it rains. Lake edges are contoured for a natural appearance. The lakes also serve as reservoirs for irrigation water. Stiehr's creative approach resulted in functional stormwater controls that enhanced the visual quality of the site. But Stiehr is just one engineer experiencing success with innovative stormwater design. Numerous sites across the country are applying intelligent stormwater design and technology with great results.

Dual-purpose Water

West Point Gardens, a high-end residential subdivision project in Elgin, Illinois, presented several challenges in the design and construction of stormwater controls. West Point Builders and Developers Inc. of Tinley Park, Illinois, hired

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Cowhey Gudmundson Leder Ltd. (CGL) of Itasca to prepare site development plans for the 172-acre tract. CGL is a civil engineering design firm with experienced land surveyors and natural resource professionals that specializes in subdivisions and commercial sites.

To maintain and enhance the natural qualities of this semi-rural site, CGL designed the stormwater basins for visual quality as well as engineering functionality. The ponds are contoured to provide a more natural appearance. Emergent and wetland plantings will be installed along the edges. A recirculating, aerating fountain will be installed in the central pond to provide a visual focal point for the development.

In the preliminary planning stage, general borings indicated that subsoils in the pond bottom areas would hold water. Other borings disclosed that pockets of sand and gravel might be encountered at or near the bottom of the basins. Allowances were made in the site development budget to cover the cost of dealing with these porous materials in the event that they were discovered during excavation.

High-tech Grading and Shaping

Neri Contractors & Excavators Inc., based in Lake in the Hills, Illinois, negotiated a site work contract with the developers of West Point Gardens in the spring of 2005. Bill Neri started his business in 1977, digging basements and preparing sites for small commercial projects. Twenty-nine years later, Neri has grown in size and reputation and is now one of the largest heavy earthmoving specialists in the northern part of the state.

The scope of work at West Point Gardens included 200,000 cubic yards of topsoil strip and stockpile, and 550,000 cubic yards of cut/fill excavation. At the actual time of construction, excavation for the triangle-shaped pond revealed sand and gravel that encompassed most of the pond bottom. It was obvious that these porous strata would not allow water to be retained in the basin. After consulting with the design engineer, the decision was made to line the pond with suitable material.

Bill Neri describes the pond construction and conditions his company encountered: “Stormwater ponds are not just big square boxes anymore—now they require technical grading. The ponds on this project are cut into glacial till comprised of sand and gravel with side slopes that range from 3:1 and 4:1 with multiple safety ledges. The soil conditions require overexcavation of the ponds to accommodate a cohesive soil liner to keep water from seeping in or out of the envelope.”

Grading the meandering curves, multiple ledges and varying side slopes of these ponds with conventional methods would have required multiple stakings and a full-time grade checker. Instead, Neri relied on Topcon (www.topcongps.com) 3D-GPS+ machine control systems to expedite earthwork operations, increase productivity and drastically reduce grade staking. A big factor in Neri’s choice to use the Topcon solution was the company’s “+” technology, which offers users satellite usage from both the U.S. Global Positioning System and the Russian GLONASS system.

Jerry Bickner, owner of Positioning Solutions in Rolling Meadows, introduced Neri to Topcon’s 3D-GPS+ machine control technology. Now Neri has 13 Topcon systems on various pieces of equipment to cover all possible sites and conditions. For fine grading roads and building pads, Neri uses Topcon’s fully automatic system on a Cat (www.cat.com) 14H motor grader. Five Cat dozers ranging from a D5 to D9 also are equipped with full automatic systems. For high volume work, Neri runs indicate systems on six Cat scrapers. An indispensable Cat 825 compactor also runs an indicate system.

Taking a complex design from concept to final form requires contributions from both the engineer and the contractor. CGL used creative planning to turn functional requirements into visually attractive elements that increased the value of the project. Neri Contractors used their extensive experience and investment in state-of-the-art technology to make the engineer’s vision take form.

John Kuebrich, project manager for CGL, commented on the design challenges of the ponds: “All three of the ponds



on the West Point Gardens project were very tight. Because of the site restraints, we didn't have much room for error. The design volume tolerance for all these ponds was under one-tenth of an acre."

The finished product met the design objectives. "We made a topo of the ponds after Neri installed them," he explains. "We double-checked the volume and area against the design. Neri put these ponds in and they met the design criteria. What he built matched what we designed—and within the tolerance."

Commercial Containment

In Missouri, Crackerneck Creek, a 122-acre retail site in Independence, is undergoing sophisticated stormwater design. Contractor Damon Pursell Construction (Liberty, Missouri) manages nearly 80 percent of the project. In business since before World War II, the second-generation, privately held corporation specializes in constructing large grading projects, streets, highways and site utilities. At Crackerneck Creek, Damon Pursell is readying the site for the installation of a series of wick drains, pre-fabricated vertical drains that increase settlement rate and reduce the distance water must move to reach a free drainage path. More than 900,000 vertical feet of the "soda straw"-like drains are pushed in the ground to refusal of between 25 and 60 feet. Clean drainable rock, extracted from the 450,000 cubic yards of rock on the site, forms a 2-foot top layer and guides water to the nearby 16.15-acre multi-purpose lake containing a dam. The lake will serve as both a stormwater retention basin and as an aesthetic showcase for the retail establishment that includes outdoor gear supplier Bass Pro Shops.

In addition to the site's conditions that challenged the work teams, which include constructing access paths for the machines to get through the swampy site and fulfilling strict requirements for soil stabilization prior to any building, the project is one of the common "fast-track" jobs of today—Crackerneck Creek will be complete in about nine months. To get the job done, Damon Pursell's mass grading and storm drainage teams are utilizing Leica Geosystems' (www.leica-geosystems.com) Series 500 rovers and a Leica System 1200 for grade checking along with Carlson (www.carlsonsw.com) Explorer II data collectors. Leica's Dozer 2000 machine guidance system and Gradestar 3D GPS system are used on Cat D8R track-type tractors. The machines execute operations from reading TIN models designed in Carlson SurvCADD engineering and surveying software. Damon Pursell keeps model design in-house for "better control and better reliability," says Estimator and



The 122-acre fast-track Crackerneck Creek retail site in Independence, Missouri, is being completed with the use of wick drains and drainable rock, precise surveying models and machine control from Leica Geosystems. The finished site will showcase an aesthetic and functional lake feature and basin.

Project Manager Gary Sheumaker, LS. "We've had to go in and modify the model eight or nine times in about six months. It's pretty important for us to do it in-house."

Aside from a messy site and a time-critical schedule, the project has been steady-going. The tolerances for most of the project at $\pm 3/10$ (with the Bass Pro Shop area at $\pm 1/10$) have been achieved with the use of advanced GPS technology. Later this spring, Independence will see the fruits of the team's labor, including a sophisticated lake feature and basin.

From 2D to 3D

Today's stormwater control plans transform the dangerous and unsightly eyesores of yesterday into attractive designs that integrate the entire development. Fountains, lakes and ponds, and aesthetically pleasing, innovative landscaping are enhancing residential and commercial sites abroad. Pristine and attractive settings are recognized as being on par with thoughtful land planning and landscape architect designs. As a result, surveyors, engineers, water specialists and contractors are undergoing artistic changes in their jobs; it is a boon to the companies and workers who work on these projects to undertake today's sophisticated and purposeful designs.

These advancements require the application of sophisticated design models and equipment for implementation, and the market has responded to this growing need. GPS, highly developed design, estimating and engineering software, and machine automation are helping to solve these challenges. The marriage of innovative design and advanced equipment is renovating area landscapes everywhere. Who knows what's next? **SP**

Lieca N. Hohner is Site Prep's editor.