

March 2016 Vol. 2 Issue 12

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ON THE COVER

The China Pavillion Milan Expo 2015, featuring a complex glulam roof structure, received the Beauty of Wood – Innovation award in WoodWorks' 2016 Wood Design Awards — story on page 56.

Photo: Sergio Grazia



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PUBLISHER

MARK C. ZWEIG
Founder & CEO
508-380-0469
mzweig@zweiggroup.com

SALES

BOB DORAN
Director of Sales
770-587-9421
bdoran@zweiggroup.com

EDITORIAL

BOB DRAKE
Editor-in-Chief
210-973-5070
bdrake@zweiggroup.com

CHAD CLINEHENS, P.E.

Senior Editor
501-551-2659
cclinehens@zweiggroup.com

H. KIT MIYAMOTO, PH.D., S.E.

Contributing Editor
miyamotointernational.com

ANDREA BENNETT

Research & Publications
Manager
479-435-6520
abennett@zweiggroup.com

CONTINUING EDUCATION & EVENTS

RYAN RENARD
508-651-1559
rrenard@zweiggroup.com

MARKETING

SHANNON BURNETT
Advertising &
Sales Marketing Manager
800-466-6275
sburnett@zweiggroup.com

PRODUCTION

DONOVAN BRIGHAM
Art Director
479-435-6978
dbrigham@zweiggroup.com

CUSTOMER SERVICE

For subscriptions or change of address, please visit our website WWW.ZWIEGGROUP.COM/SUBSCRIBE or call 800-466-6275, or fax 800-842-1560.



1200 North College Avenue, Fayetteville, AR. 72703
800-466-6275 | Fax: 800-842-1560

P.O. BOX 1528, Fayetteville, AR 72702-1528

MARK C. ZWEIG, CHAIRMAN & CEO, ZWIEG GROUP LLC



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RECRUITING FOCUS

WOW — TIME FLIES! It's already March and spring is in the air. Bob Drake and his crew have put together another outstanding issue of **Civil + Structural Engineer** magazine for us all to read and enjoy!

Take a good look at your hiring process to see whether it accomplishes your ultimate goal of attracting good people.

Nothing we do would be possible without good — make that great — people. Great people don't need to be told what to do every day. They make it happen on their own with little direction. And you don't have to watch over them to check every single task that falls within their wheelhouse.

Oil patch slowdown or not, great engineers are not easy to find. It doesn't matter if you work in the public or private sector — the talent shortage is real. There just aren't enough people out there who really get it — who are competent engineers and creative problem solvers, who have the work ethic we all need because the job never stops, and who have the communication skills required to succeed in a responsible position in either the public or private sectors.

Part of the problem most of us seem to have is that the people we have doing our recruiting and hiring have the wrong idea about what their job is supposed to be. They think they are supposed to be working to keep the bad people out. I say they should be more oriented toward getting the best people in. There's a big difference between the two. If you think your role is the former, you'll be grilling job candidates on why they want to make a job change and setting up hiring processes with many hurdles and hoops to jump through. If your orientation is the latter, you will be much more likely to look at the job opportunity and interviewing process through the lens of someone you know the company would want to hire. That means you will be selling versus screening.

I encourage all of you to take a good look at your hiring process with fresh eyes and see how it's set up. Work to retool it so it accomplishes your ultimate goals of attracting good people and being able to actually hire them when you want them.

And meanwhile — enjoy our latest issue of **Civil + Structural Engineer**. We have our usual focus on the people, projects, materials, and technology that make this such a fun and rewarding endeavor for us all!

A handwritten signature in black ink that reads "Mark C. Zweig".

MARK C. ZWEIG
mzweig@zweiggroup.com



Economical mid-rise solution for two-layer drywall conditions



Mid-rise buildings can be more economical when using wood. Recently, the Type III construction classification of non-combustible walls has been expanded to include wood-frame construction with fire retardant-treated lumber and two layers of $\frac{5}{8}$ " gypsum board. As a result, Simpson Strong-Tie® now offers the new DHU and DHUTF drywall hangers, which are specially designed and tested to transfer floor joist loads to a wood stud wall through two layers of drywall. These hangers install after the drywall is in place so there's no need to cut around joists – making installation easier.

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PROFESSIONAL (BUSINESS) DEVELOPMENT

ANYONE WHO READS my column knows the importance I place on ambition, business acumen, and long-term thinking. When considering how to broaden your knowledge as an engineer, I strongly recommend starting with topics related to marketing and business development.

As I have said before, those who can sell work have job security for life in the consulting industry. I realized in my early days that the secret to selling engineering services was not having a certain look, knowing a certain script, or being an extrovert. Rather, it is simply understanding how to listen and then how to develop a strong proposal or presentation.

As a young engineer I got plugged into an organization that really gave me the tools I needed to grow my knowledge base and also allowed me to get those important professional development hours for my license. If you are looking for such a resource, I recommend looking outside the traditional sources of engineering professional development at organizations such as the Society for Marketing Professional Services (SMPS; www.smps.org). I have been attending meetings and conferences in this organization for more than 12 years and find them to be tremendous value for the education you get.

Additionally, organizations like this allow you to build your network with other folks who work in the engineering field but have other roles like marketing and sales. I think an engineer who is well-rounded and seeks knowledge to better them as an engineer and a business person at the same time brings great value to any organization they are in!

CHAD CLINEHENS, P.E., is Zweig Group's executive vice president. Contact him at cclinehens@zweiggroup.com.

Look beyond the traditional technical sources of continuing education for engineers.



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ENGINEERING FOR SCHOOL SAFETY

WORKING AROUND THE WORLD, I have witnessed the destructive power of earthquakes. Seeing the anguish of parents searching through the rubble of a collapsed school, I am reminded of my own kids. I first saw this on a large scale in 2008 in China, where more than 7,000 classrooms were destroyed. When a catastrophic magnitude-7.0 earthquake hit Haiti in 2010, many children died because of unsafe schools. Equipped with the knowledge that many dangerous schools had no funding for critically needed seismic strengthening, we created a nonprofit organization, Miyamoto Global Disaster Relief, to focus on providing safety for dangerous schools.

Schools should be the safest places, but even in the United States, many earthquake-unsafe schools exist.

A school called Lycée Nationale de Cité Soleil in Port-au-Prince was brought to our attention. Almost three years after the earthquake, classes still met in shabby plywood shelters topped with noisy sheet metal that leaked in the rain and were blazing hot in the summer. A 1,500-student, two-story concrete structure damaged by the 2010 earthquake sat there untouched. Everyone gave up on it — no money and no expertise. Miyamoto Relief offered to help, even when no one believed that such a structurally unsound building could be made safe. We provided engineering expertise pro bono, recruited dozens of Haitian businesses and international donors to contribute resources and funds, and engaged local engineers and contractors to do the work, training them to build safely. The October 2014 opening celebration was amazing. Not only was the school seismically upgraded per international standards, it also was equipped with a new computer room, solar panels, and landscaping.

Miyamoto Relief is carrying on similar work in Nepal, where a magnitude-7.8 earthquake leveled 20 percent of the country in 2015. More than 30,000 high-density classrooms collapsed and tens of thousands more have been tagged as unsafe to enter. The earthquake was on Saturday afternoon. Had the quakes hit when school was in session, we probably would have lost more than half a million students.

Thanks to the support Miyamoto Relief received immediately after the Nepal earthquake, we've assessed and begun engineering the repair and retrofit of a number of schools, including a damaged 18-classroom school in the Nuwakot region. Four children from the school died.

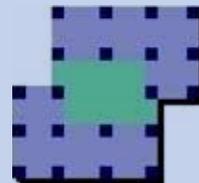
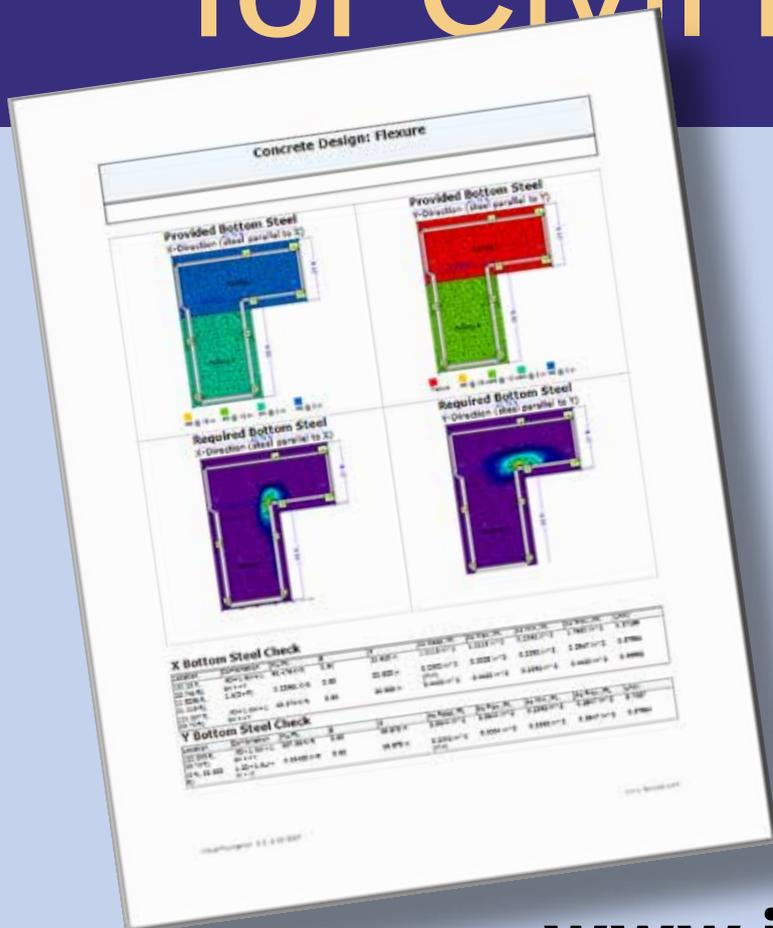
Schools should be the safest places, but even in the United States, many earthquake-unsafe schools exist. As engineers, we can make a difference. Let's start with our own towns. You should be able to identify the old buildings that potentially jeopardize our children's safety.

H. KIT MIYAMOTO, PH.D., S.E., is the CEO and a structural engineer for Miyamoto International (<http://miyamotointernational.com>), Global Risk Miyamoto, and a nonprofit organization, Miyamoto Global Disaster Relief. He specializes in high-performance earthquake engineering, and disaster mitigation, response, and reconstruction.



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TALKIN' BOUT MY VALUATION

By Andrea Bennett

WHAT'S YOUR FIRM really worth? Many architecture, engineering, planning (A/E/P), and environmental consulting firm leaders don't have a solid grasp on their firm's value. But, if you're a firm owner, you can't risk not knowing this information because the firm's value factors into several situations, including:

- establishing a price for transactions under shareholder or buy/sell agreements;
- establishing a price for a merger, acquisition, or sale;
- developing a plan for ownership transition and/or management buy-outs;
- establishing share prices for employee stock ownership plans;
- determining the fair-market value for gift and estate tax issues;
- preparing for an initial public offering;
- supporting litigation efforts, such as partnership dissolutions, disputes, and marital divorce; and
- other corporate purposes, such as division spin-offs or divestitures.

Enter Zweig Group's 2016 Valuation Survey of A/E/P & Environmental Consulting Firms. Though not a substitute for a formal valuation or a consultation with a business appraiser, the Valuation Survey is a must-have resource for any firm owner interested in determining the worth of his or her company.

The Valuation Survey is divided into three parts: Business Valuation Considerations, 2016 Survey Results, and Case Studies. In addition to the overall survey data — broken down by firm type, size, region, growth rate, and more — Zweig Group provides actual valuation information for each of the 141 firms (43 percent of which are multidiscipline engineering firms) that have participated in the survey since 2013. Zweig Group also provides the formulas that survey respondents' firms use — if they opt against employing an external appraiser — in addition to its own Z-values, which measure total invested capital (TIC) and equity values.

Among the statistics that readers will find most interesting are comparisons of the TIC per employee. Because A/E/P and environmental consulting firms sell staffers' time, it is generally accepted that people are firms' most valuable assets. Just as some firms generate more revenue per employee than others, some are more valuable than others in proportion to their staff sizes.

The median TIC value per employee for firms overall has steadily increased since 2006 to an all-time high of \$65,498 in 2016 (see Figure 1). The Valuation Survey breaks out this statistic — and all of the statistics it presents — by firm type; staff size; years in business; headquarters' region; growth rate; reasons for valuation; who conducted the



Figure 1: Median total invested capital (TIC) per employee, 2006-2016

valuation, when, and by what means; net service revenue, profit, EBITDA, backlog projections; and minority versus controlling interests.

For example, the 2016 Valuation Survey shows the highest average TIC values per employee for:

- single-discipline engineering firms;
- firms with fewer than 25 employees;
- firms founded in the last 16 years;
- firms based in the South Central U.S.;
- firms with moderate growth rates;
- firms that performed the valuation for the purposes of a sale/merger;
- firms that employed a consultant or accountant to perform the valuation, which was conducted via an appraisal in 2014;
- firms that project flat net service revenues; profits; and expenses before interest, taxes, depreciation, and amortization for the next fiscal year;
- firms that project a growing backlog in the next fiscal year; and
- firms with a controlling interest.

Does your firm fit any — or all — of these categories? If so, chances are its TIC per employee is pretty high. But, you can't know for sure until you conduct a valuation, or at least apply the formulas in the Valuation Survey to obtain a general idea.

The 2016 Valuation Survey of A/E/P & Environmental Consulting Firms is available for purchase at <https://zweiggroup.com/p-2243-valuation-survey-2016>.

ANDREA BENNETT is research & publications manager for Zweig Group. She can be contacted at research@zweiggroup.com.

EVERY MONTH, CIVIL + STRUCTURAL ENGINEER PROVIDES ADDITIONAL COLUMNS AND ARTICLES ONLINE TO SUPPLEMENT THE CONTENT IN THIS PRINT ISSUE. CHECK OUT THE FOLLOWING ARTICLES POSTED ONLINE WITH THE MARCH ISSUE:

Project Profitability: Business education for project managers

By Howard Birnberg, Association for Project Managers

The modern business school and masters of business administration (MBA) programs have a long history. Nearly every U.S. and international college and university of any size now offers an MBA program. However, some commentators have noted that the degree has become a commodity, the education watered down, and the return on investment (ROI) highly questionable.

For design and construction industry project managers, business education is a valuable and necessary addition to your technical undergraduate degree. Architects and engineers, in particular, suffer from a near total absence of any business training and often pay the price in an inability to run their businesses effectively, manage projects, control budgets, develop business plans, understand financial reports, and be successful in a wide array of other vital skills. While an MBA may not be affordable (time and/or money), or necessary, project managers should seek to obtain the knowledge many business courses offer.

Read the entire article at <http://tinyurl.com/projectprofit-mar16>.



Diversions: Things that make you go, 'Hmm'

By Andy Sciarabba, P.E.

I was having dinner with a couple colleagues recently and the topic of vetting new hires came up. We shared insights on what has worked and what hasn't. We finally arrived at the conclusion that no matter how good someone looks on paper, no matter how many times you interview them, and no matter how many people say they are the greatest thing since sliced bread, you never really know what you are getting — until they have worked with you for a while.

This is where the conversation *really* got interesting. The “remember that guy/girl who...” stories started to emerge and quickly turned into a contest of the best of the worst.

Read the entire article at <http://tinyurl.com/diversions-mar16>.

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AWARDS, PROMOTIONS, AND NEW HIRES

Anthony Risko joined Freese and Nichols, Inc.'s coastal services group and will serve as a senior engineer in the Austin, Texas, office. **Kalli Clark-Egan, P.E.**, joined the firm's Houston office as a senior engineer with the Southeast Water Resources Group. Her move follows a distinguished career of designing and managing large-scale infrastructure projects with the U.S. Army Corps of Engineers, Tulsa District. **Sandip Faldu, P.E.**, joined Freese and Nichols' Dallas office as a senior engineer with the Transportation Planning Group. He has considerable expertise in transportation planning, traffic engineering, and project management.

H2M architects + engineers promoted **Charles Martello, P.E., LSRP**, to director of its regional office in Parsippany, N.Y. **Brian Murrell** joined H2M architects + engineers as senior disciple engineer in the Civil Engineering Department. His responsibilities range from performing initial due diligence and feasibility assessments to preparing detailed site engineering construction documents.

The American Concrete Institute (ACI) promoted **Christopher J. Darnell** to managing director, Customer & Product Strategy. He will focus on improving member and customer experience by aligning ACI products and services with user expectations, market demand, and communication channels.

Emily H. Cyle joined the Salisbury, Md., office of Davis, Bowen & Friedel, Inc., where she will be providing architectural design services.

Brian Funkhouser, P.E., president and CEO of York, Pa.-based Buchart Horn, received the Alumni Fellow Award by the Penn State Alumni Association in recognition of his professional accomplishments. It is the highest award given by the Penn State Alumni Association.

Horner & Shifrin's board of directors elected **Steven Donahue, P.E.**, as the company's seventh president since its founding in 1933. Donahue succeeds **Duane L. Siegfried, P.E., S.E.**, who served as president from 2010 to Dec. 31, 2015.

Peggy Van Eepoel, P.E., an associate principal in Thornton Toma-

setti's Weidlinger Protective Design practice, will be recognized for her leadership on the National Science Foundation Headquarters project in Alexandria, Va. The project was selected to receive a Beverly Willis Architecture Foundation Built by Women District of Columbia Award. Thornton Tomasetti promoted three of its executives: **Andrew Goldbaum** to chief operating officer; **Rimma Zaleznik, CPA, PMP**, to chief financial officer; and **Tod Rittenhouse, P.E.**, to East Region leader. **James V. Brunetti, P.E.**, joined the firm's New York Wall Street office as a vice president in the Forensics practice.

Gary Klein, executive vice president and senior principal at Wiss, Janney, Elstner Associates, Inc. (WJE), was elected to the National Academy of Engineering. Klein, a 37-year veteran of WJE, was selected for his "investigations of national and international infrastructure and conveying knowledge from these investigations to the profession."

Gafcon promoted **Sean Olcott** to technical director — Virtual Design and Construction. In his new role, Olcott will implement Gafcon's strategy for applying Building Information Modeling (BIM) and other emerging technologies to improve how project owners design, construct, and manage built assets.

Veda Montalbano, P.E., CPM, joined Jones|Carter's Transportation Practice as senior project manager. She has more than 25 years of transportation planning and design experience and will be managing complex, high-profile projects for the firm.

RETTEW announced four promotions to senior leadership positions within the firm: **John Doughty** to vice president of the land development and survey groups, overseeing more than 80 staff members in nine of RETTEW's 10 offices; **Tim Falkenstein** to vice president, leading the client liaison staff of seven as well as the safety consulting group of 12; **Scott MacNair** to vice president of corporate services, maintaining his title as CFO and overseeing the corporate administration, facilities, financial services, human resources, and information technology groups; and **Matt Malozi** to regional vice president for one of the firm's three geographical regions, overseeing two of RETTEW's offices, as well as business development in Delaware, New Jersey, New York, and eastern Pennsylvania.

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Devarati (Dev) Rastogi, P.E., leads LAN's Transportation Business Group. In 2013, the Texas Society of Professional Engineers Dallas Chapter named her as the Engineer of the Year.

DEV RASTOGI: THE BUSINESS BUILDER

A TRACK RECORD OF SUCCESSFUL PROJECTS COMBINES WITH A PASSION FOR SERVING CLIENTS AND COMMUNITIES.

By Maureen Foody

AS THE DAUGHTER of a physician and homemaker/Montessori school teacher who emigrated to the United States in the late-1960s and moved around from New York to Iowa to their longest-lasting home in Little Rock, Ark., Devarati (Dev) Rastogi, P.E., vice president and managing director of the Transportation Business Group at Lockwood, Andrews & Newnam, Inc. (LAN), experienced the sights of many different cities as she grew up. Both her mother, Kusum, and her father, Shivnandan, encouraged all three of their children to pursue their interests. Rastogi had a clear penchant for mathematics and anything that was problem-solving related.

"I'll always remember Ms. Bond, who, after I was put in a lower-level math class due to moving around, saw something in me and encouraged me to keep studying math at higher levels, which definitely mattered in my development," Rastogi said.

Benefiting from a supportive family and teachers, Rastogi eventually



Dev Rastogi with her husband David Fremerman and daughters Priya Fremerman (bottom right) and Eisha Fremerman (bottom left).

enrolled at Washington University in St. Louis in 1979, majoring in civil engineering. She took a broad range of courses and using this expansive knowledge began her career as a project engineer working for Hydro Air in St. Louis.

After a few successful years, Rastogi moved south to work for Espey, Huston Associates in Dallas as a project engineer, where she spent the next eight years on many types of projects including transit, water and wastewater, land development, and more.

"The variety of project experience opened up so many areas for me," Rastogi said, "and also reminded me that there's a need to be well rounded. It's important to resist being one dimensional early in any career but especially for engineering. I also began to be intrigued by the idea of being part of a female engineer-driven firm, so I moved to what was Wendy Lopez & Associates in 1993."

Starting with just 10 people, the firm expanded to more than 200 employees as projects grew larger in both the public and private sectors. Rastogi helped grow and eventually merge the firm; it was acquired by URS Corporation in 2008.

"I was able to simultaneously grow as an engineer and a leader with the company as I developed relationships with new clients and furthered relationships with long-term clients," Rastogi said. "It was the people side of the business that stood out most in that role for me."



Dev Rastogi with other LAN Business Group directors at the firm's monthly senior management meeting.

Some of her high-profile projects included the AT&T Performing Arts Center, the Perot Museum of Nature and Science, and the George W. Bush Presidential Library and Museum in Dallas. She was also involved with quite a few projects spread out over the south-central region of the U.S.

In 2015, Rastogi joined LAN and was quickly promoted to be one of the first female business group leaders at LAN. "The culture of a company is important," she said. "Each company has its own culture and you need to align yourself with a company that rings true to your professional and personal values. That's what makes a difference. The caliber of work at LAN is what drew me, and I want to accelerate our growth."

Inspired by her team's talent, Rastogi speaks highly of the projects LAN has taken on, including the SH-71 Express Project, which will help reduce congestion along the primary route to Austin-Bergstrom International Airport. LAN also has assisted with 70 miles of the 90-mile Dallas Area Rapid Transit (DART) light rail system, including most recently serving as the general engineering consultant for the DART Orange Line 14-mile route. Both of these are helping improve the daily lives of anyone who uses transportation in Texas, which is part of the reason Rastogi loves her work as an engineer.

"We as engineers create the communities we live in," she said. "It's part of our job as civil engineers to help improve those communities. One of the biggest challenges is upgrading our aging infrastructure

while continuing to encourage new development that aids communities to grow into something truly remarkable."

One of the more rewarding aspects of engineering is being able to see your efforts and projects become physical in real time. "It's always a great feeling whenever I get to ride DART and directly witness our hard work. There's a special pride that exists in getting to help that many people," Rastogi said.

Another exciting aspect of engineering today is the availability of new technology and innovation. Working with the Texas Department of Transportation, LAN is using state-of-the-art 3D modeling design for MoPac Expressway improvements at Slaughter Lane and La Crosse Avenue in Austin. The MoPac/Slaughter interchange will be constructed as a Diverging Diamond Interchange — the first in the Austin city area — to handle the large volume of left-turning traffic.

"As we further develop 3D modeling and other tools, we're able to use technology to improve and speed up the whole analysis and design process," Rastogi said.

LAN has already been involved in many critical roadway projects and is continuing this path by currently serving as the design engineer for the University Boulevard North/Stadium Drive connection for the city of Sugarland, Texas. This project is one of the essential components of the city's master thoroughfare plan to help facilitate long-term growth and improve mobility for every citizen.

Rastogi believes that problem solving is the true root of engineering, and this takes both a technical expertise and a creative mind. “We are always solving problems with constraints, and you have to view the problem through multiple solutions,” she said. “Sometimes engineers are labeled as uncreative, but I don’t think that’s accurate because most engineering jobs demand out-of-the-box solutions.”

The competition for young talent is fierce for most burgeoning fields and engineering is no exception. “My advice to those starting out is to invest in themselves,” Rastogi said. “Learn as much as you can and observe others because everyone does it their own way. I often volunteered to help out on projects just to learn new approaches; you have to seek out opportunities for yourself — don’t wait for someone to ask for your help.

“It’s important that we see more women going into engineering. I try to be as active as possible in various professional organizations to encourage young women to explore our field because they can do anything they choose. I want them to know engineering is a really great choice to pursue for a career path.”

Rastogi has been honored by her peers many times, including being named the Texas Society of Professional Engineers Dallas Chapter 2013 Engineer of the Year. She is quite humble to mention her involvement in numerous professional and community organizations, including serving as a board member at the Perot Museum of Nature and Science and the Trinity Commons Foundation, as well as dedicating time on the Grant Committee for Susan G. Komen.

After chuckling at the idea of free time, Rastogi said she mostly likes spending any spare time with her husband, David, two daughters, Priya and Eisha, and the rest of her family and friends. Rastogi greatly enjoys traveling when she’s able to wind down on the beach with a good book. “Even in my down time I still love to learn.” she said.

She has enjoyed her tenure helping to be a business builder for a number of companies before her current track at LAN, which she is also excited to see grow. “A career is an evolution; you have to take on whatever challenges and opportunities you can,” Rastogi said. “One of the most important considerations is to think about the customer — what do they want or need — but also to remember it’s not just technical. Provide a solution that is specific to every client because they are the ones that matter.”

Communication is a cornerstone to Rastogi’s approach to her own success as she began as a project engineer but quickly rose to helping manage large-scale projects. Actively engaging employees to pursue their interests and providing opportunities to work in a variety of projects is also critical in helping a company grow, Rastogi said.

“I’m inspired by the talent of people on my team,” she said, “so as an interactive leader I get to know them and their strengths, which helps me combine people’s talents to work together in a collaborative environment.”

MAUREEN FOODY is a freelance writer and editor who lives and works in Chicago. She can be reached at maureen.t.f@gmail.com.



Dev Rastogi with Susan Fraser, LAN’s Central Texas Transportation manager, at the State Highway 71 Express project site. SH 71 serves as the primary access route leading to Austin-Bergstrom International Airport. Completion of this 3.9-mile limited-access toll road will significantly reduce congestion along the corridor.



Dev Rastogi discussing MoPac Expressway improvement plans with Andrea M. el Arculli, LAN’s project engineer.



The MoPac Expressway improvements include TxDOT’s first Diverging Diamond Interchange in the City of Austin. The project features a state-of-the-art 3D modeling design.

GETTING THERE ON TIME IS ALWAYS IMPORTANT

DRIVABILITY MATTERS



"When I'm meeting my girlfriend for dinner, roadway construction means missing our reservation. It's frustrating, but only an inconvenience. When I'm on the job, a delay can be the difference between life and death. With asphalt, construction typically happens at times when fewer cars are on the road, and the delays are counted in minutes. That matters."

-Lee Look | Fireman | Boyfriend



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ENGINEERING IS MORE THAN MATH

MENTOR CREATIVE, CURIOUS PROBLEM-SOLVERS
TO ENCOURAGE FUTURE ENGINEERS.

By Michelle Kam-Biron, P.E., S.E., S.E.C.B., and Lori Koch, P.E.

THERE IS NOTHING specific that makes men or women particularly suited to be an engineer; you need to be good at and enjoy solving problems and be willing not only to listen to the ideas of those around you but also brave enough to contribute your own ideas. For the engineering we do, it helps to have a desire to develop structural solutions to help improve construction across America.

While more women are earning engineering degrees now than ever before, we still make up a small percentage of the profession. A number of reasons are often floated for the lack of women engineers, such as a misperception about what it takes to be successful in the career or not having female engineering role models. Our goal is to encourage more girls to consider engineering as a career.

About us

We are two female engineers working for the American Wood Council (AWC), the trade association that represents the North American wood products industry in the codes and standards arena for building design and construction. Michelle is a structural engineer with an established, 20-year career, and Lori passed the P.E. exam just over a year ago. Michelle oversees AWC's education program that reaches audiences around the world and, as the first female president of the Structural Engineers Association of Southern California, she is creating a networking group to support growth opportunities for women in structural engineering. As a project engineer, Lori makes a difference every day by helping designers understand wood structural design standards and codes, helping them design safer, more structurally sound buildings using a sustainable building material.

Networking among our peers is important, but encouraging young girls to think about engineering as a profession is imperative. Practicing engineers need to inform girls that engineering is so much more than just liking or being good at math. For example, following are some other areas important to the profession:

Creativity — This isn't an attribute that's typically on a short-list when describing engineering, but engineers are problem solvers and the best solutions come from ingenuity. It's rare for there to be just one solution to a problem, and there may be more than one way to get to that solution. Sometimes you have to be creative — thinking outside of the box! It may be as simple as using an existing tool in a new way or creating something from scratch to solve a complex problem.

For example, in our focus area — construction — some engineers may view the building code as a set of limitations; however, we view it as an opportunity. Creative engineers see the building code as a guide, and by applying creative thinking, come up with innovative solutions based



on sound structural engineering that are explainable and acceptable to building officials.

Communication — Engineers use a wide skill set to solve unique problems based on almost every subject studied in school. Math and science are, of course, a big part of engineering, but the communication skills learned in English and other writing-oriented courses is invaluable to be a successful engineer. Also important is the ability to communicate verbally with others. While many engineers are very “technically savvy,” the ability to communicate well and listen to others is equally important in the collaborative process, along with being able to share one's findings, analyses, and conclusions in written form.

Teamwork — Some of the most challenging yet rewarding experiences in an engineering career come from working on a team. Diversity of experience and backgrounds on an engineering team allows problems to be approached from different angles, which can help lead to innovative solutions. In short: Don't be afraid of being different or standing out with a unique viewpoint.

Persistence — Engineering isn't always easy and even engineers get discouraged at one time or another. More times than we can count, we've all wanted to throw our arms in the air and go do something easier. You will come up against obstacles — both internal and external. You may come across people who don't think you belong on a construction site or on a project team, simply because they're not used to seeing women in that context. The important part isn't that you succeed on the first try, it's that you learn from your past experiences and keep trying when you don't succeed. Your attitude when facing adversity can be your greatest strength, or greatest hurdle.

Confidence — Being a successful engineer will force you to not be a wallflower. You'll need to engage with others and not be afraid to ask questions! Even engineers who have more than 40 years of experience still ask questions and learn new things every day. The industry is constantly changing, and the only way to keep up on things is to be inquisitive. Be willing to jump in and help and you'll likely find a mentor for life who will continue assisting as you navigate your career. Volunteering and getting involved with a professional organization will not only enlarge your network and allow you to meet likeminded peers and

mentors, but help you gain confidence in a professional environment outside of work. See yourself as the amazing engineer that you are.

Those who are ultimately successful in their engineering career are passionate about what they're doing. Curious problem-solvers are likely to find great satisfaction in the field.

So, to our fellow practicing engineers, do not let young girls you encounter be intimidated from entering the engineering profession — assist them, mentor them, and guide them. Both men and women can step

up and be mentors — they have been for us in our careers. Consider doing a classroom visit or allowing students to job shadow in your company to expose more girls to engineering.

MICHELLE KAM-BIRON, PE., S.E., S.E.C.B., is a California-licensed structural engineer and director of education for the American Wood Council (AWC). She is also the first female president of the Structural Engineers Association of Southern California. **LORI KOCH, PE.**, a licensed engineer in Virginia, is a project engineer at AWC. She has a bachelor's degree in civil engineering from Penn State University, a master's degree from Clemson University in civil engineering, and a second master's degree in forestry from Virginia Tech.



Vertical aerial photography is used for photogrammetry and mapping applications.

AERIAL PHOTOGRAPHY TIPS EVERY ENGINEER SHOULD KNOW

UNDERSTAND PROJECT GOALS AND REQUIRED LEVEL OF DETAIL BEFORE CONTRACTING FOR SERVICES.

By Sherry Eklund and Brett Eklund

WHETHER IT IS for a power plant, overpass, airstrip, or any engineering undertaking involving large-scale construction, aerial photography offers a unique, comprehensive perspective that is difficult to obtain by any other means. For an effective airborne imaging project, the services of a qualified flight team and camera operator and solid sense of your project goals are required. Following are a few of the key points that need to be considered when engaging an aerial photographer.

First, recognize the types of aerial photography available. Oblique images, captured at an angle from the subject (rather than top-down) can

help with site selection and evaluation, or can even provide geological information and visual documentation of site conditions that may impact how a civil engineering project is approached. Vertical aerial photography, on the other hand, done when the camera is pointing straight down (perpendicular to the ground), is more commonly used for mapping applications.

Vertical photography is also traditionally used for photogrammetry, a powerful tool in aerial mapping. Basically, it is the science of making measurements from overlapping photos, and is particularly useful for civil engineers for project site assessment and planning. One important consideration for civil engineers is establishing what kind of information is required and the level of detail needed to achieve this goal.

A skilled aerial photogrammetrist can make measurements that distinguish changes of only a few inches, depending on the resolution of the photography. However, if accuracy requirements are less restrictive, a high degree of detail is probably not needed, and a lower resolution may be suitable and more cost-effective.



Oblique images can help with site selection and evaluation and visual documentation of projects.

Another technique used in vertical mapping is Light Detection and Ranging (LiDAR). This aerial system uses lasers to acquire 3D models of ground features during the flight. While LiDAR does not provide natural color visualization like aerial photography, it sometimes allows surface visualization that would otherwise be obscured when using a visual photographic approach. LiDAR can also be incredibly detailed, to the degree that tree leaves or power lines are clearly visible in the resulting 3D model.

While that kind of detail may sound exciting, in many situations the old adage “less is more” applies. Engineers have found out the hard way on some projects that it isn’t cost effective to invest in heavily detailed data when a lower-resolution shoot would have served their goals just as well. It’s just a matter of understanding and defining your goals before the aerial acquisition begins.

Once you establish your goals and know what level of detail you need, it’s time to choose a team to work with. It pays to call around and get pricing estimates from several sources. For a variety of reasons, quotes between companies can differ by as much as 500 percent, which can mean tens or even hundreds of thousands of dollars. One reason for cost differences is getting the airplane to the site. Some companies

may have aircraft already deployed in close proximity to your worksite while others may have to mobilize hundreds of miles, adding to the cost.

Surprisingly, it can also pay to get quotes from firms based in cities outside of the project area. Companies dock their airplanes all over the country depending on where they last had a project. You never know if they might already be on a project in your area. Of course, when evaluating a potential new vendor, it’s always good practice to look into past work and customer references.

The big takeaways: understand and define your goals, be wary of contracting for more detail than you need, and make sure to get a few quotes for every project. As with every part of a civil engineering undertaking, choosing the well-seasoned professionals to assist your team is the first step in ensuring a successful project.

SHERRY EKLUND, an aerial photographer, and **BRETT EKLUND**, a pilot, cofounded Desert View Aerial Photography (<http://dvaerialphoto.com>). They have been involved in construction for more than 30 years, providing aerial photo construction documentation since 2006.

PRELOADING APPROACH TO COLUMN REMOVAL

BUILDING RENOVATION REQUIRES TRANSFERRING UPPER-STORY LOADS AND REMOVING A FIRST-FLOOR COLUMN.

By Pratik Shah, P.E.



Figure 1: Column #60 (center) was removed between the first and the second floor.



Figure 2: The transfer girder was designed as back-to-back built-up channels. The individual channel members were delivered into the building through a window on Level 2.



Figure 3: The transfer girder channel members were connected using stiffener plates and cross bracing at the top and bottom.

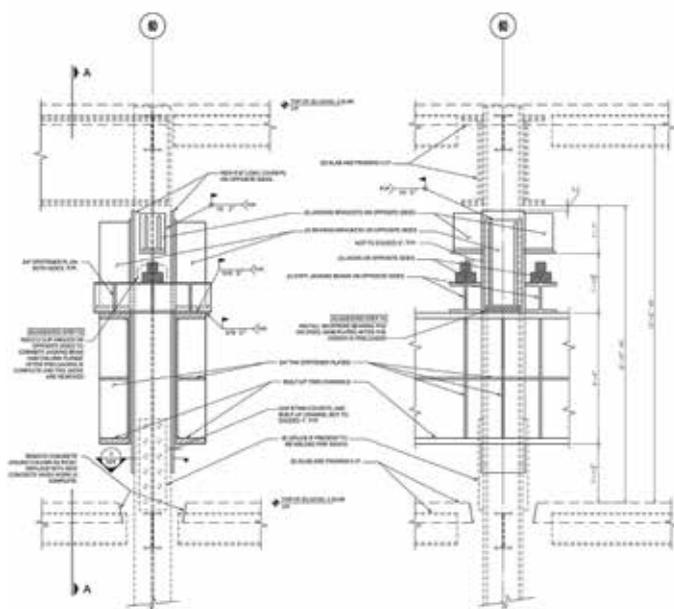


Figure 4: Details of the transfer girder and preloading approach to column removal.

475 FIFTH AVENUE is an existing building near Bryant Park at the intersection of 41st Street and Fifth Avenue in New York City. The 24-story, 1920s-era building had a major renovation that required structural engineering to support the building's architectural and mechanical changes. The structural scope for the project included strengthening the flooring system of the second floor for retail loading, framing a new mechanical penthouse, framing new floor and wall openings to accommodate MEP ductwork and louvers, framing a new canopy, framing a new stair crossover, and closing abandoned shafts and openings. One challenging aspect of the project was to remove an existing column between Level 1 and Level 2 that was in the middle of the lobby (Column #60 in Figure 1). Its removal is the primary focus of this article.

The building's structural system is a steel moment frame. The gravity system consists of cinder concrete topping slab over a wire mesh-reinforced concrete slab supported by steel beams spanning between girders. The girders are moment connected to the columns in both directions to resist lateral loads. All existing shear and moment connections are rivet connected, as is typical for these buildings. The original structural drawings for the building were unavailable so all information necessary for design had to be obtained in the field.

Since no structural drawings existed, DeSimone Consulting Engineers carried out exhaustive exploratory work, including structural probes, walkthroughs, and field measurements. Structural steel coupon tests revealed the steel to be weldable with a yield strength close to that of ASTM A36 steel. Concrete density tests determined the weight of the existing floor system was 110 pounds per cubic foot.

Transfer system analysis and design

Figure 1 shows the portion of the frame where the column is to be removed between the first and the second floor (labeled Column #60). The bay spacing between columns was approximately 18 feet. A transfer girder was designed to span 36 feet to support the weight of the 23 floors above Column #60 and transfer it over to the adjacent supporting columns (numbered #52 and #68).

Based on the exploratory work, service gravity loading carried by each of the columns was estimated. To maintain the tall floor-to-floor height at the ground floor lobby, the transfer girder was designed to be supported at Level 2. For ease of delivery and rigging, the transfer girder was designed as back-to-back built-up channels. The individual channel members were delivered into the building through a window

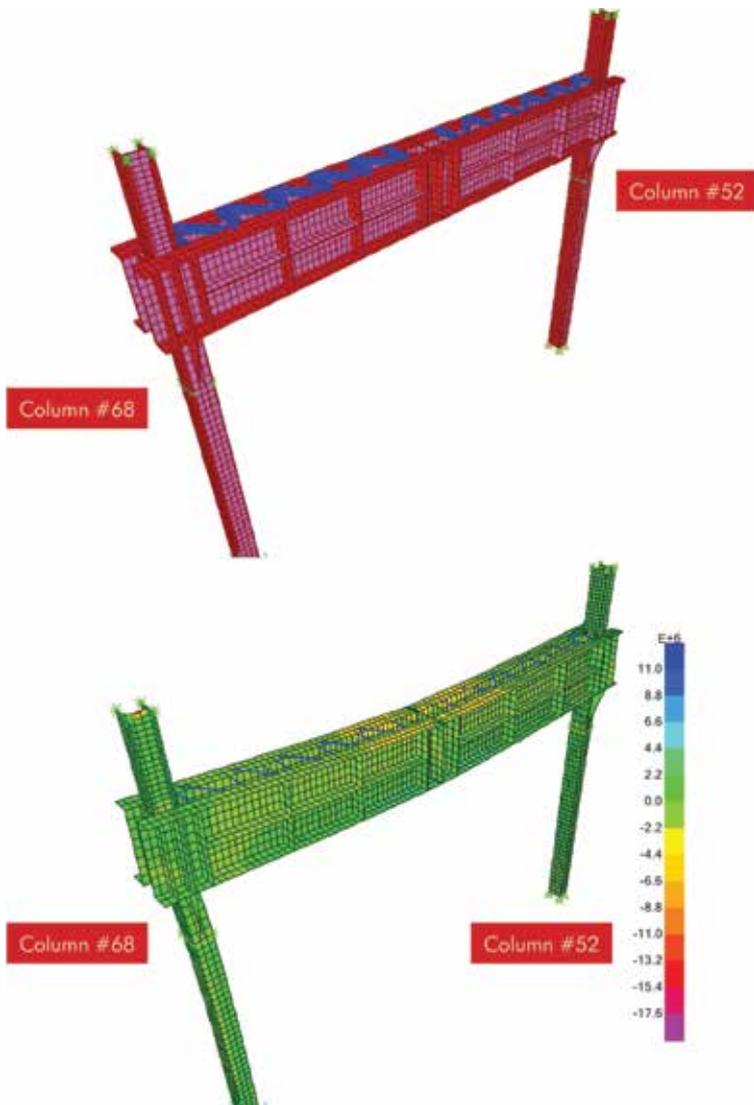


Figure 5: Finite element analyses were performed to check stresses and susceptibility to buckling of the transfer girder and supporting columns.

on Level 2 (Figure 2). They were connected using stiffener plates and cross bracing at the top and bottom (Figures 3 and 4).

The supporting columns were cover plated to increase their capacity to support the additional load. Bearing and supporting brackets were designed to be welded directly to the columns to transfer the load to the girder. Existing footings (concrete piers) for Columns #52 and #68 were found to have enough reserve capacity to support the additional load increase; however, lean concrete was poured around the top of the piers to increase confinement of the existing concrete at the point of load transfer. Finite element analyses, including Eigen value buckling analysis, were performed to check stresses and susceptibility to buckling of transfer girder and supporting columns (Figure 5).

Preloading approach to column removal

In a conventional column removal, a transfer girder is installed and connected to the supporting columns. Then the column to be removed

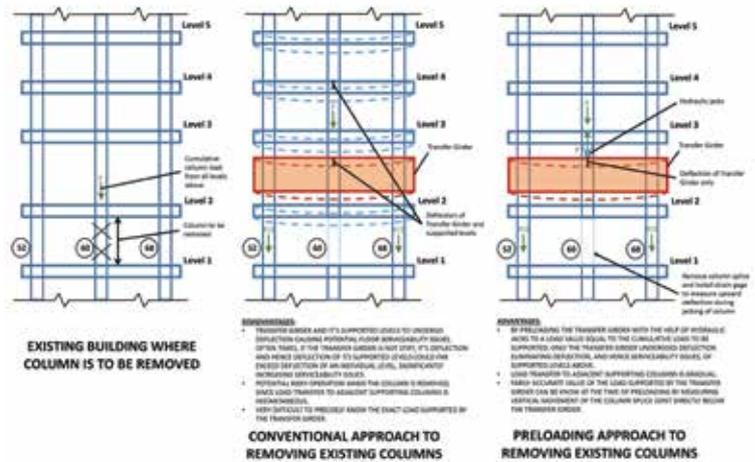


Figure 6: Conventional and preloading approaches to removing existing columns.



Figure 7: Two pairs of brackets were welded onto Column #60 — a pair of bearing brackets to transfer the load from the column onto the transfer girder and a pair of brackets used for jacking.

is attached to the transfer girder and cut below the girder. As illustrated in Figure 6, the transfer girder is loaded instantaneously from an undeformed state. This causes the girder and its supported levels to undergo deflection instantaneously, leading to potential serviceability issues such as cracks in the concrete floor, finishes, partitions, etc.

To counteract potential problems with the conventional approach, DeSimone employed an innovative preloading method to transfer the column load. The transfer girder was preloaded using hydraulic jacks to a load value equal to the service dead load supported by the column to-be-removed (Column #60). This imposes an initial dead load deflection on the girder.

Details of this approach are shown in Figure 4. First, two pairs of brackets are welded onto Column #60 — a pair of bearing brackets that will transfer the load from the column onto the transfer girder and a pair of brackets used for jacking (Figure 7). A small gap was left

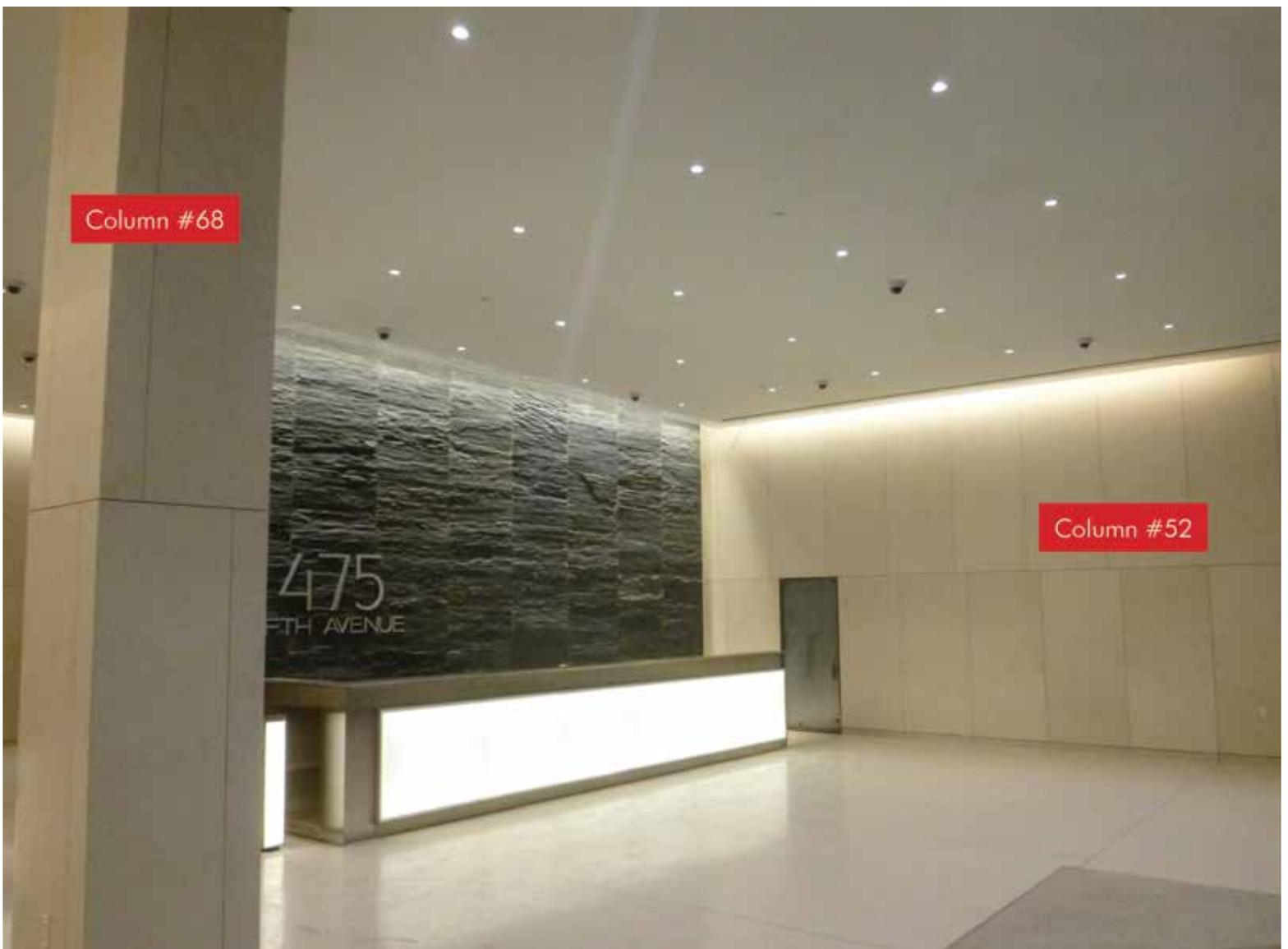


Figure 8: The finished lobby space without the existing Column #60.

directly below the bearing brackets to ensure that all the load during the preloading operation goes to the jacking brackets and bearing brackets are not engaged.

The existing column splice for Column #60 between Levels 1 and 2 was removed and strain gages were installed at the splice to monitor the vertical movement of the column during the jacking operation. The transfer girder was gradually preloaded to the service dead load value or until vertical movement at the splice was detected by the strain gages.

The hydraulic jacks were then locked and shim plates were introduced to close the gap between the bearing brackets and the transfer girder. Once the shim plates were in place, the hydraulic jacks were removed, thereby disengaging the jacking brackets and transferring the load to bearing brackets. This finally allowed for Column #60 to be cut between Level 1 and 2.

This preloading approach to column removal has several advantages over the conventional approach. The primary advantage is that only the transfer girder undergoes deflection and the supported floors are unaffected, causing no serviceability issues on the supported levels.

DeSimone successfully removed the column from the ground floor of an existing 24-story building using this innovative preloading approach, which minimized serviceability problems that are common in such projects. The finished lobby space without the existing Column #60 is shown in Figure 8.

PRATIK SHAH, P.E., is a project manager in DeSimone Consulting Engineers' (www.de-simone.com) New York City office. He has more than nine years of experience in various aspects of structural engineering, with a focus on high-rise buildings, structural analysis and design, value engineering, and peer reviews.



Figure 1: Ponding water on an artificial turf field. Photo: Town of East Greenwich, R.I.

DRAINAGE OF ARTIFICIAL TURF FIELDS

UNDERSTAND THE DETAILS TO DESIGN

A WELL-DRAINED FIELD.

By Bryan P. Strohman, P.E., and Aaron R. Lewis, P.E.

ARTIFICIAL TURF FIELD construction has increased significantly during the last three decades. A new field is a significant investment for an owner; however, drainage problems resulting in ponding water on the surface of the field can be a source of aggravation (Figure 1). Understanding the drainage details is essential to providing a well-drained field.

Most artificial turf fields consist of a multi-layered system consisting of resilient artificial grass blades attached to a coated backing layer, infilled with a mixture of sand/rubber (Figure 2). The backing configuration varies between manufacturers, but is generally an impermeable coated woven or non-woven geotextile fabric, except for perforated holes or strips left uncoated. The field system is placed on a thin (± 2 -inch-thick) layer of finish stone over base stone (4 inches or thicker).

Drainage typically relies on infiltration through the field surface materials and stone layers and is ultimately collected by perforated circular drains embedded in buried stone-filled trenches in a herringbone pattern (Figure 3). In some cases, flat drains at the bottom of the base stone are used instead of the trenches. The field drains are connected to a collector drain located around the perimeter of the field that discharges

into the site storm drainage system. In addition, slot or trench drainage is sometimes used to collect surface water at the perimeter of the field.

Permeability, infiltration, and permittivity

On typical developed sites, stormwater runoff is handled via storm drain inlets exposed to the ground surface (i.e., catch basins or trench/slot drains). However, artificial turf fields without drain inlets rely on infiltration and seepage. As such, an understanding of permeability, permittivity, and infiltration is essential. Permeability is the fundamental material property describing water flow, and infiltration and permittivity are simplified forms of permeability. These concepts are outlined below. To simplify, we will consider saturated conditions (i.e., no air in the soils, stone, or synthetic turf materials).

Permeability (k_{sat} ; inches/hour) enables calculation of the volumetric flow rate (Q ; cubic inches/hour) based on ponded area and gradient (change in total head of water (ΔH) over the flow length (L)). The total head increases with an increased depth of ponded water (Figure 4).

$$Q = k_{sat} \frac{\Delta H}{L} A$$

A lower permeability value or longer flow length will decrease the flow rate and a larger depth of ponded water or drainage area (A) will increase the flow rate.

Infiltration rate (I ; inches/hour) is a simplified form of permeability and describes the velocity of flow through the surface of the field:

$$I = \frac{Q}{A} = k_{sat} \frac{\Delta H}{L}$$

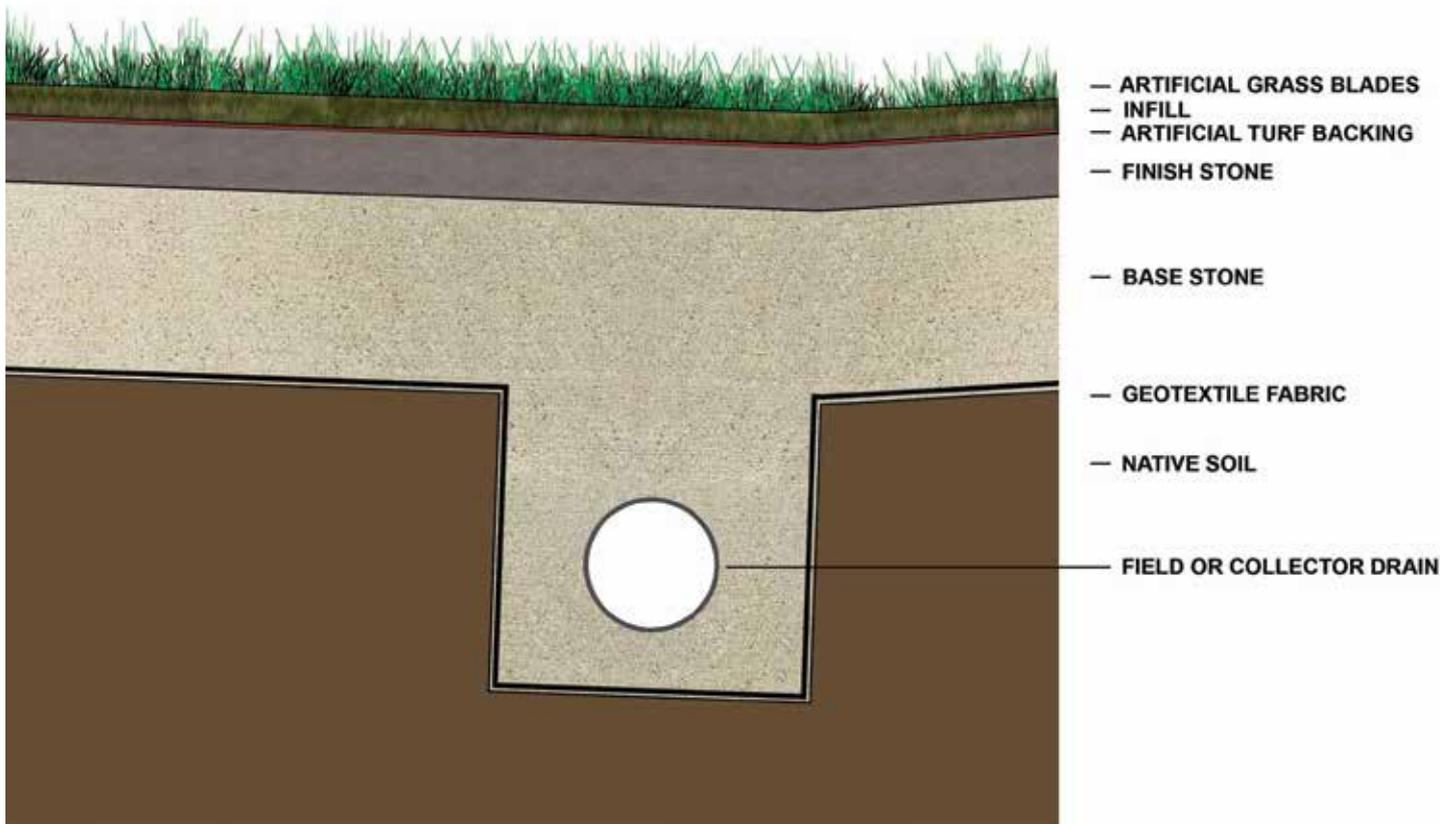


Figure 2: Typical artificial turf field cross section

Permittivity (Ψ , sec^{-1}) is generally used for geotextile fabrics that have a known thickness and simplifies the formula to exclude its thickness or flow length:

$$Q = \Psi \Delta H A$$

Infiltration rate of field surface materials

Several test methods are available to test infiltration or permeability rates for the field surfacing. Manufacturers typically provide the results of infiltration tests for qualifying their product; however, understanding the test methods used is important for interpreting the test data. Industry standards, such as Suggested Guidelines for the Essential Elements of Synthetic Turf Systems published by the Synthetic Turf Council, indicate that the field surface should have an infiltration rate of at least 10 inches/hour; however, no specific test procedure is noted.

Manufacturers generally provide test results in conformance with ASTM F1551, which references DIN 18-035, Part 6. This test consists of a large-diameter vertical pipe with a flange and gasket on the bottom and can be a laboratory or an in-situ field test. Water is introduced into the top of the pipe and the drop in water level in the pipe versus time is measured to determine the infiltration rate. Unfortunately, these test results on infilled-type field systems are not a good indicator of the vertical infiltration rate through the system since it is challenging to preclude water from flowing laterally under the flange and gasket during the test. This test method appears to be more appropriate for non-infilled turf systems of the past.

DIN 12616 is another test method (laboratory or in-situ field test) but uses a double ring infiltrometer, which helps to preclude lateral flow.

This test method is more appropriate than ASTM F1551 for infilled-type field systems. However, test data is rarely provided by manufacturers and it is difficult to implement due to challenges installing and sealing the outer ring through the infill.

Recently, ASTM F2898 was introduced, which provides an in-situ test method for evaluating the infiltration rate. The test includes flooding a portion of the field and documenting the lateral spread and the time to drain the pond of water. The method includes corrections for the amount of lateral spread and precludes using the results if the lateral spread is too high (i.e., large horizontal preferential flow), which is common with the infilled turf field surface systems. Due to the size of the flooded portion of the field, it is best suited for in-situ field testing.

Another option is to perform a laboratory permeability test on an extracted specimen of backing and infill using a test similar to ASTM D2434. This test is commonly used for testing soils and provides reliable results for vertical permeability; however, this test data is rarely provided by manufacturers. In addition, this test is a laboratory test and cannot be used for in-situ field testing without extracting specimens.

Permeability of finish stone and base stone materials

The permeability of the stone materials is also important, since water must flow through the stone materials to get to the underdrains. Suggested Guidelines for the Essential Elements of Synthetic Turf Systems requires a minimum permeability of 14 inches/hour for the stone materials. Testing is generally based on ASTM F1551 (field) or ASTM D2434 (laboratory).

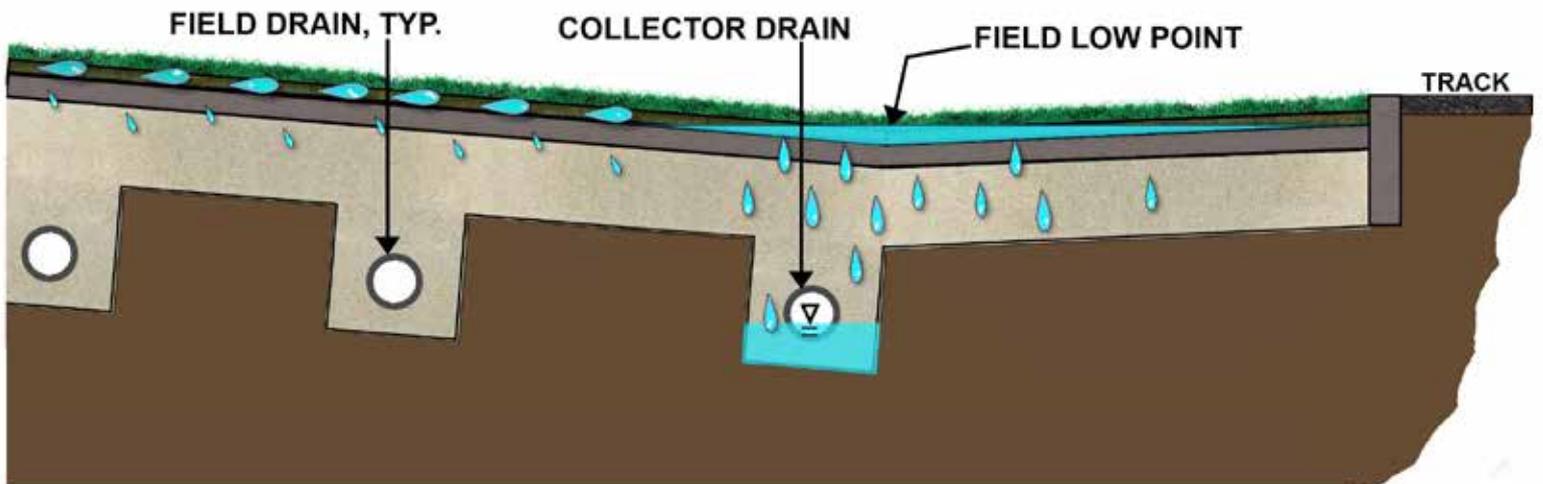


Figure 3: Artificial turf drainage elements

Specifications also generally require materials meet a specific particle size gradation, in part to provide reasonable permeability values. The particle size gradation is generally assumed to be as-manufactured or as-stockpiled rather than as-placed. When gradation tests are done after placement, the fines content (particles smaller than 0.074 mm) will increase due to handling and compaction of the material, and breakdown of larger particles due to point-to-point contact, abrasion, and fracturing. The fines content increase — commonly a 1 percent to 5 percent increase — is dependent on the toughness and abrasion characteristics of the rock and the handling and compaction methods.

Geotextile fabrics

New geotextile fabrics are fairly permeable and permittivity testing is performed based on ASTM D4491. However, geotextiles are prone to clogging and their location needs to be selected carefully. They can be used as a separator between dissimilar soils (such as below the base stone and around the edges of the crushed stone trenches), but they should not be placed perpendicular to the direction of flow where fine particles can collect on them and reduce their permeability.

A common situation where this occurs is above the field and collector drain trenches, where the geotextile fabric below the base stone is sometimes extended over the top of the trench due to ease of construction (Figure 5). This requires the water to flow through the geotextile and is not recommended. Additionally, geotextile fabric socks placed around and directly in contact with the drains are not recommended for similar reasons.

Grading

The surface of the field generally slopes at about 0.5 percent toward the sidelines for aesthetic reasons. Due to the slope of the field surface backing layer, a preferential flow path occurs toward the sidelines and water does not infiltrate over the entire field (Figure 3). Consequently, most, if not all of the water will flow to the field's low point at the field's perimeter. This results in an increased flow of water to the sidelines

and the time to drain the field will be longer than if uniform infiltration occurs over the entire field.

Water from adjacent areas outside the field must also be precluded from flowing onto the field because it increases the volume of water that must infiltrate. More importantly, the water can carry fine soil particles that can accumulate in the infill and on the backing and reduce its infiltration capacity.

One exception is track surfaces, which are often allowed to flow onto the field since they do not contribute to fine soil particles; however, the tributary flow from the track must be considered. If the track is large, designers should consider using trench/slot drainage. A defined low point should be established away from the track edge to preclude water ponding on the track, which can contribute to premature track deterioration.

Field underdrains

Field underdrains are typically located in a herringbone pattern and sized based on their tributary area. Due to the significant preferential horizontal flow path at the field surface, the field underdrains are commonly ineffective until the field is ponded. Consequently, the collector drains around the perimeter of the field take most of the flow.

Considering the hydraulic grade lines in the site storm drainage system is also important to ensure the field underdrains and collector drains are not inundated by backwater effects of downstream detention systems during the design event. In addition, provisions for cleanouts should be considered to inspect and maintain the collector drains.

Unsaturated and transient conditions

The conditions and testing procedures described above assume the materials are fully saturated; however, at the beginning of a rainfall event, the field is not fully saturated. The unsaturated permeability of the materials is often orders of magnitude lower than the saturated

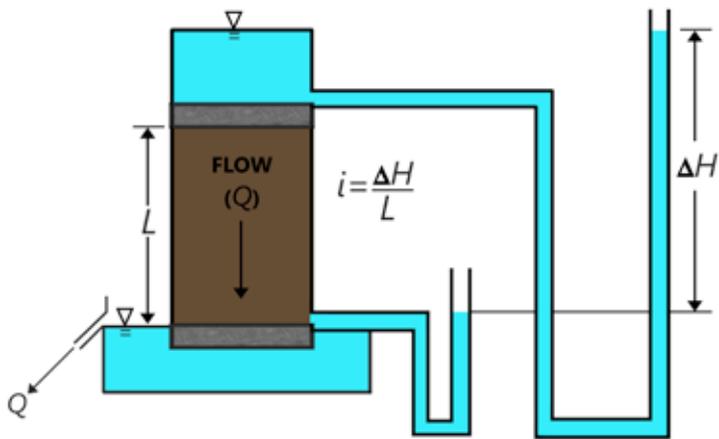


Figure 4: Laboratory soil permeability test

permeability. Computational models are available to understand the unsaturated and transient conditions.

Another nuance of unsaturated flow is the air permeability and resulting air pressures within the base stone materials whereas air-permeability and water-permeability are inversely related. As materials become saturated (the air permeability reduces and the water permeability increases), the pores fill with water and there are less-interconnected channels for the air to flow through and air pressure can accumulate within these pores.

One of the material properties that defines air permeability is the air-bubbling value, which is the air pressure required for the air to break through the surface. If the air-bubbling value of the backing is too high, air-locking of the system can occur, allowing substantial air pressure buildup below the field surface, air bubbles raising the field surfacing off the finish stone, and ponding water on the field surface. Several fields have experienced air bubble formation and ponding issues. Air venting was ultimately used to relieve air pressure and promote drainage.

Runoff hydrograph

The USDA TR-55 methodology is well known for development of runoff hydrographs (rate of runoff) for designing drainage systems. The runoff curve number within the TR-55 methodology develops the infiltration and runoff portions of the rainfall depth.

In typical site drainage situations, the infiltrated volume is discarded since it generally does not enter the drainage system; however, with an artificial turf field, the water infiltrated is the runoff volume. Although beyond the focus of this discussion, special consideration is required to develop the runoff hydrograph for fields incorporating the infiltration volume and rate.

BRYAN P. STROHMAN, P.E., is senior project manager, Simpson Gumpertz & Heger Inc., (www.sgh.com) in Waltham, Mass. He can be contacted at bpstrohman@sgh.com. **AARON R. LEWIS, P.E.**, is principal, Simpson Gumpertz & Heger Inc., in Waltham. He can be contacted at alewis@sgh.com.

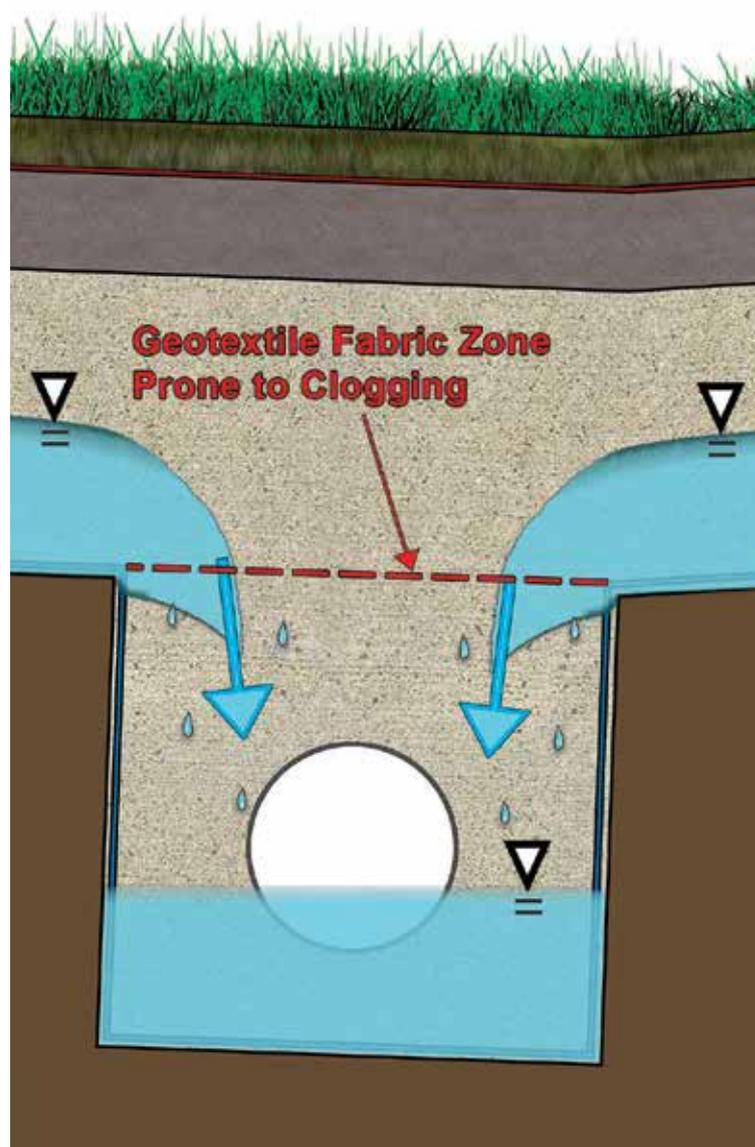


Figure 5: Commonly misplaced geotextile fabric

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QUARRYING STONE SUSTAINABLY

COLDSPRING RECEIVES NEW ANSI/NSC 373
GOLD AND PLATINUM CERTIFICATION.

COLDSPRING, A QUARRIER and fabricator of natural stone in North America, received ANSI/NSC 373 Sustainable Production of Natural Dimension Stone certification. It is one of only two companies in the United States to achieve the recognition thus far. Accredited by the American National Standards Institute (ANSI), the voluntary standard establishes criteria to determine the degree to which natural dimension stone is extracted and manufactured sustainably.

Following facility inspections by NSF International's Sustainability division, which develops standards and conducts audits to protect the environment, Coldspring's corporate headquarters and primary manufacturing operations in Cold Spring, Minn., received Gold certification. The company's Charcoal Quarry (St. Cloud, Minn.), Mesabi Quarry (Babbitt, Minn.), and Rockville Quarry (Rockville, Minn.) received Platinum certification.

"We are extremely proud of our team and the efforts toward obtaining ANSI/NSC 373 certification," said John Matke, Coldspring president and chief operating officer. "Coldspring has had a longtime commitment to sustainability and continues to show this commitment by achieving third-party verification through the stone industry's newly adopted standard."

The ANSI/NSC 373 standard examines numerous areas of stone production such as water use and recycling; custody and transportation of the stone; site and plant management; land reclamation and adaptive use; corporate governance; energy use and conservation; management of excess process materials and waste; safer chemical and materials management; worker health and safety; and optional innovation credits. Certification is based on point totals in each category to achieve Bronze, Silver, Gold, or Platinum level certification.

"ANSI/NSC 373 is a rigorous, science-based standard that helps the building community identify more sustainable materials. As a further sign of its value, the standard was recently referenced as a compliance path in the 2015 International Green Construction Code (IgCC)," said Jenny Oorbeck, NSF International's sustainability general manager. "Through certification, Coldspring has made a significant public declaration about its commitment to sustainability while also providing more sustainable material options for architects and designers."

ANSI/NSC 373 also includes a companion Chain of Custody (COC) program, which is important to the certification because it ensures traceability of certified stone from the quarry to processing and throughout the supply chain and ultimately to its journey's end.

"More than ever before, sustainability is on the forefront of top minds in the building industry — from architects to owners to product manufacturers," said Kathy Spanier, Coldspring director of marketing. "Coldspring's ANSI/NSC 373 certification will help ensure architects and owners that the stone for their buildings is produced in an economical, environmental, and socially responsible manner. It will help project teams and consumers clearly recognize which natural stones support these important project goals."



For more information about ANSI/NSC 373, visit <http://naturalstonecouncil.org/education-training/nsc-initiatives/dimensional-stone-standard>.

Information provided by Coldspring (www.coldspringusa.com).

POWER UP!

DOMINION VIRGINIA POWER PLANS \$9.5 BILLION IN INFRASTRUCTURE AND UPGRADE EXPENDITURES.

DOMINION VIRGINIA POWER plans to invest nearly \$2 billion per year through 2020 to add new, clean generation, including solar energy, and to expand, secure, and upgrade the electric grid in Virginia and northeastern North Carolina. The planned \$9.5 billion spend builds on a substantial record of new capital investment by the company in recent years for new electric infrastructure designed to meet growth, enhance reliability, and promote cleaner air and water. The company made \$1.8 billion in similar investments in 2015.

The investments are in addition to the proposed Atlantic Coast Pipeline, a \$5 billion natural gas pipeline that is being built by a sister company to serve Dominion Virginia Power and other electric and natural gas utilities.

Robert M. Blue, president, Dominion Virginia Power, said that since 2008, the company has invested more than \$8 billion in new electricity infrastructure, including environmental control equipment designed to reduce fossil power station air emissions.

“Over the same period, our reliability has improved 25 percent,” he said. “Our reliability in 2015 was 99.98 percent — which translates into approximately 2 hours of outage time per customer over the whole year.” Dominion and other utilities typically do not include outages from major storms in reliability measures, the company said.

Virginia Power’s electric rates remain significantly lower than national, regional, and state averages even while making major expenditures for new infrastructure. In recent years, residential rates have increased by an average of less than 1 percent annually. This was achieved in part by the company increasing its efficiency and holding down operating costs.



Of the \$9.5 billion planned capital expenditures through 2020, \$2.4 billion is slated for the company’s distribution system, \$3.6 billion for transmission lines and substations, and \$3.5 billion for new generation and environmental improvements. Included in those amounts are \$700 million for new solar generation and additional funds for undergrounding vulnerable distribution lines, if approved by the Virginia State Corporation Commission.

Information provided by Dominion Virginia Power (<https://www.dom.com/residential/dominion-virginia-power>).

CLEAN ENERGY ATTRACTS RECORD GLOBAL INVESTMENT

DESPITE FOSSIL FUEL PRICE CRASH, WIND AND SOLAR ENERGY PROJECTS REMAIN COST COMPETITIVE.

CLEAN ENERGY INVESTMENT surged in China, Africa, the United States, Latin America, and India in 2015, driving the world total to its highest ever figure — \$328.9 billion — up 4 percent from 2014’s revised \$315.9 billion and beating the previous record, set in 2011, by 3 percent. The latest figures from Bloomberg New Energy Finance

show dollar investment globally growing in 2015 to nearly six times its 2004 total and a new record of one third of a trillion dollars (see Figure 1), despite the following four influences that might have been expected to restrain it:

- further declines in the cost of solar photovoltaics (PV), meaning that more capacity could be installed for the same price;
- strength of the U.S. currency, reducing the dollar value of non-dollar investment;
- continued weakness of the European economy, formerly the powerhouse of renewable energy investment; and
- perhaps most significantly, the plunge in fossil fuel commodity prices.

Over the 18 months to the end of 2015, the price of Brent crude

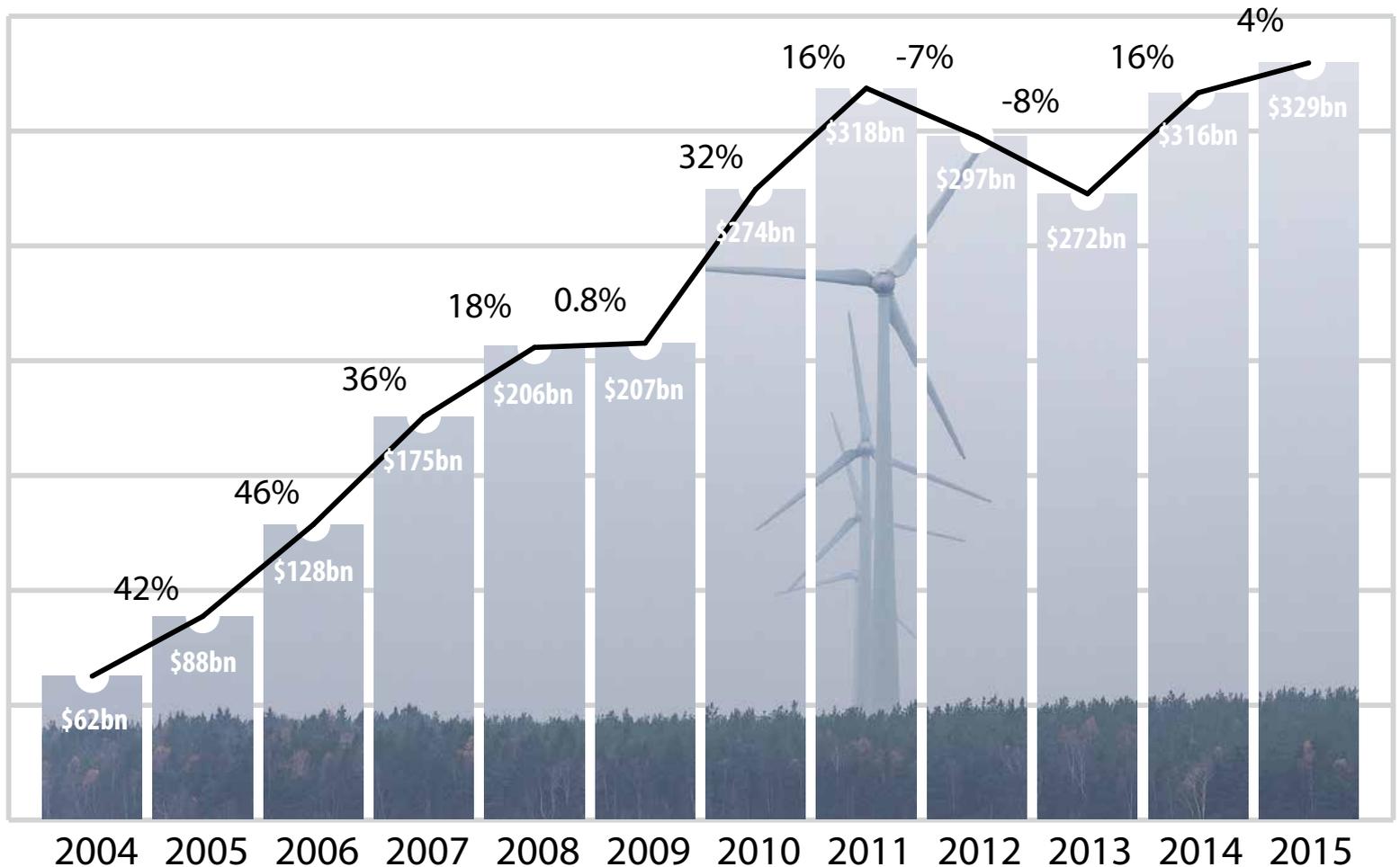


Figure 1: Global clean energy annual investment, 2004-2015 (\$US billion).
Source: Bloomberg New Energy Finance

plunged 67 percent from \$112.36 to \$37.28 per barrel and international steam coal delivered to the northwest Europe hub dropped 35 percent from \$73.70 to \$47.60 per metric ton. Natural gas in the U.S. fell 48 percent on the Henry Hub index from \$4.42 to \$2.31 per million British Thermal Units.

Michael Liebreich, chairman of the advisory board at Bloomberg New Energy Finance, said, “These figures are a stunning riposte to all those who expected clean energy investment to stall on falling oil and gas prices. They highlight the improving cost-competitiveness of solar and wind power, driven in part by the move by many countries to reverse-auction new capacity rather than providing advantageous tariffs, a shift that has put producers under continuing price pressure.

“Wind and solar power are now being adopted in many developing countries as a natural and substantial part of the generation mix: they can be produced more cheaply than often high wholesale power prices; they reduce a country’s exposure to expected future fossil fuel prices; and above all they can be built very quickly to meet unfulfilled demand for electricity. And it is very hard to see these trends going backwards, in the light of December’s Paris Climate Agreement.”

Looking at the figures in detail, the biggest piece of the \$328.9 billion

invested in clean energy in 2015 was asset finance of utility-scale projects such as wind farms, solar parks, biomass and waste-to-energy plants, and small hydro-electric schemes. This totaled \$199 billion in 2015, up 6 percent on the previous year.

The biggest projects financed last year included a string of large offshore wind arrays in the North Sea and off the coast of China. These included the UK’s 580-MW Race Bank and 336-MW Galloper, with estimated costs of \$2.9 billion and \$2.3 billion, respectively; Germany’s 402-MW Veja Mate, at \$2.1 billion; and China’s Longyuan Haiyan Jiangjiasha and Datang & Jiangsu Binhai, each of 300 MW and \$850 million.

The biggest financing in onshore wind was of the 1.6-GW Nafin Mexico portfolio, for an estimated \$2.2 billion. For solar PV, it was the Silver State South project, at 294 MW and about \$744 million; and for solar thermal or CSP, it was the NOORo portfolio in Morocco, at 350 MW and around \$1.8 billion. The largest biomass project funded was the 330-MW Klabin Ortiguera plant in Brazil, at about \$921 million; and the largest geothermal one was Guris Efeler in Turkey, at 170 MW and an estimated \$717 million.

After asset finance, the next largest piece of clean energy investment

was spending on rooftop and other small-scale solar projects. This totaled \$67.4 billion in 2015, up 12 percent on the previous year, with Japan by far the biggest market, followed by the U.S. and China.

Preliminary indications are that, thanks to this utility-scale and small-scale activity, both wind and solar PV saw around 30 percent more capacity installed worldwide in 2015 than in 2014. The wind total for last year is likely to end up at around 64 GW, with that for solar just behind at about 57 GW. This combined total of 121 GW will have made up around half of the net capacity added in all generation technologies (fossil fuel, nuclear, and renewable) globally in 2015.

Public market investment in clean energy companies was \$14.4 billion last year, down 27 percent from 2014 but in line with the 10-year average. Top deals included a \$750 million secondary share issue by electric car maker Tesla Motors, and a \$688 million initial public offering by TerraForm Global, a U.S.-based “yieldco” owning renewable energy projects in emerging markets.

Venture capital (VC) and private equity (PE) investors pumped \$5.6 billion into specialist clean energy firms in 2015, up 17 percent on the 2014 total but still far below the \$12.2 billion peak of 2008. The biggest VC/PE deal of last year was \$500 million for Chinese electric vehicle company NextEV.

There was \$20 billion of asset finance in clean energy technologies such as smart grid and utility-scale battery storage, representing an

11 percent rise on 2014, the latest in an unbroken series of annual increases over the last nine years. The final category of clean energy investment, government and corporate research and development spending, totaled \$28.3 billion in 2015, up just 1 percent. This figure provides a benchmark for any surge in spending in the wake of announcements at COP21 in Paris by consortia of governments and private investors led by Bill Gates and Mark Zuckerberg.

National trends

China was again by far the greatest investor in clean energy in 2015, increasing its dominance with a 17 percent increase to \$110.5 billion, as its government spurred on wind and solar development to meet electricity demand, limit reliance on polluting coal-fired power stations, and create international champions.



Clean energy and other trends are chronicled in BNEF and the Business Council for Sustainable Energy’s (BCSE) fourth annual Sustainable Energy in America Factbook, a 150-slide almanac of key facts and figures on the evolution of the U.S. energy sector. The 2016 edition of the Factbook can be downloaded from the BCSE website at www.bcse.org/sustainableenergyfactbook.html.

Information provided by Bloomberg New Energy Finance (<http://about.bnef.com>).

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FOR NON-FINANCIAL MANAGERS

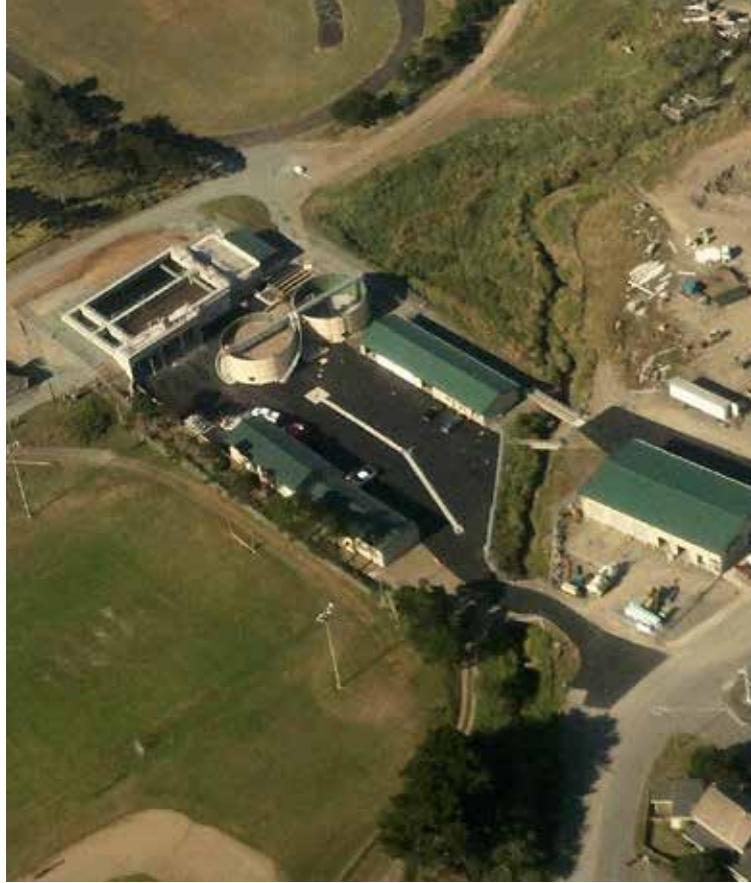
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Gold Beach, Ore., has three drainfield distribution systems, each supplied by a single pump and each discharging into seven drainfields. The lead pump alternates each cycle so that the drainfields are dosed evenly. When flows are below 1.3 mgd, the operator may program the system to allow any one set of drainfields to rest for a day.



The reconstructed wastewater treatment plant for the community of Gold Beach will provide permit compliance that corrected over-capacity issues.

ONSITE OPTIONS ENHANCE GROUNDWATER RECHARGE

DECENTRALIZED WASTEWATER TREATMENT CAN MEET LARGE COMMERCIAL AND COMMUNITY TREATMENT DEMANDS.

By Dennis F. Hallahan, P.E.

TWOGENERAL METHODS are considered for wastewater treatment planning and design — centralized and decentralized models. Centralized wastewater treatment involves collection of wastewater from a large area to one centralized location where it is most commonly treated and discharged to local surface waters. Decentralized wastewater treatment provides treatment and discharge either directly on site or within close proximity. Advancements in technology allow either method to provide equivalent levels of treatment and protection of public health.

However, centralized and decentralized wastewater treatment systems vary greatly, as do the impact they have on environmental health and potable water supplies. Centralized systems obtain potable water from one location, that water is utilized by the public, then collected as wastewater and transported to the treatment plant following which it is discharged to surface waters. This process short-circuits or bypasses the local water cycle and can cause aquifer depletion.

The decentralized model can collect, treat, and then discharge to the subsurface all within a local area. This has the benefit of replacing the original water resource back to the local aquifer. When adequately designed and installed, decentralized wastewater systems have the capacity to process large quantities of wastewater into the underlying soils, making it one of the most passive, sustainable forms of aquifer recharge.

Rather than partially to fully treating wastewater effluent then discharging it to a surface pond or injection well before recharging the aquifer, decentralized systems can provide both wastewater treatment and groundwater recharge in one step. Via this sustainable practice, the replenished aquifer can then supply wells, recharge wetlands for wildlife, maintain base flow, and in the case of coastal cities and towns, counteract saltwater intrusion.

Restoring aquifers and reducing costs

Decentralized systems are being designed and implemented for large-scale municipal and commercial wastewater projects across the United States and Canada. While decentralized systems have and will continue to serve rural areas outside city limits, the notion that the decentralized system is only there to serve small, single-family homes has been transformed with large decentralized systems handling flow rates in excess of 1 million gallons per day (mgd).

Given that the technologies and the operations and maintenance



Workers backfill an 80,223-square-foot infiltration bed disposal field with a flow rate of 350,000 gpd at the Hopkinton, Mass. wastewater treatment plant.



Benefits to the Village of Omeme, Ontario of a decentralized approach included that the town already owned the property, soils were well drained, and the lagoon-treated effluent was of a quality ready for disposal without additional treatment. Infiltration beds return water to the local aquifer, recharging groundwater supplies.

infrastructure are available, many engineering firms are offering their services in this new niche. Large businesses and communities no longer have to wait or pay exorbitant tap fees to tie-in to existing centralized services. Consultants will perform feasibility studies reviewing options for their clients, and the decentralized solution may yield the most beneficial cost position.

As technology continues to advance, an increasing number of sites have become viable candidates for decentralized systems. For example, designing a small-scale, advanced treatment train prior to dispersal of the effluent into the native soil can decrease both the absorption area and depth to limiting layers that are required for adequate treatment. This has allowed decentralized systems to be placed in areas previously inaccessible, in turn increasing the volume of groundwater recharge associated with decentralized systems.

Community decentralized systems are being designed and installed on an increasing basis where sewers have become prohibitively expensive, or where lot sizes or site conditions limit the use of individual onsite wastewater treatment systems. Large systems can also be developed for large-flow commercial and industrial sites, decreasing the hydraulic and nutrient stress placed on centralized wastewater treatment plants.

Centrally managed, decentralized wastewater treatment systems, such as publicly and privately owned community systems, are being

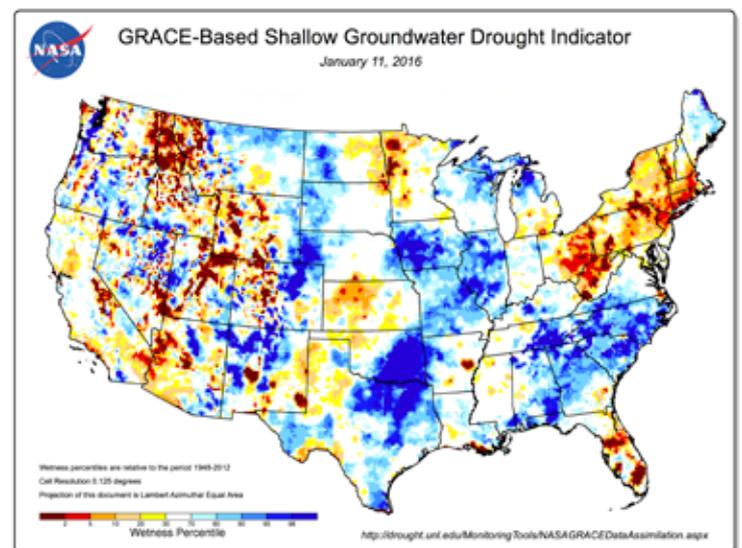


Figure 1: Groundwater deficits in the United States. The areas in dark red are in aquifer decline. A general correlation can be made between higher septic utilization rates and greater groundwater availability. While other factors greatly impact groundwater depletion (e.g., precipitation, urbanization, and agricultural practices), the figures can be interpreted to show that decentralized wastewater treatment has an impact on groundwater storage. Maps by Chris Poulsen, National Drought Mitigation Center at the University of Nebraska-Lincoln, based on data from Matt Rodell, NASA Goddard Space Flight Center, and the GRACE science team.

staffed with trained and educated personnel in the same manner as centralized systems.

Community wastewater treatment system

The community of Gold Beach, Ore., has approximately 2,250 residents. Wastewater is treated by a Sequencing Batch Reactor Plant, followed with ultraviolet disinfection, and then discharged to a series of subsurface drainfields. Under existing permit conditions, treated effluent discharge was to subsurface absorption fields located at an airport; however, the existing drainfields did not have the capacity for the peak wet weather flows and were experiencing effluent surfacing along with overflows discharged to a creek.

The Port of Gold Beach, which leases the property to the city, expressed concerns about construction of additional drainfields and requested that drainfield operations be confined to the limited, existing easement. Aaron Speakman of The Dyer Partnership Engineers designed a new system based on the maximum allowable area within the existing easement. It is strategically placed adjacent to an airport runway and is designated as a Runway Safety Area (RSA), defined as an area “prepared or suitable for reducing the risk of damage to airplanes in the event of an excursion from the runway.” As the RSA must be clear of obstacles and capable of supporting an occasional aircraft, the 2.2 mgd Infiltrator chamber drainfield design was modified to include stone, increasing the structural capacity of the drainfield in case of an airport emergency condition. The system is covered with a geotextile to prevent sand intrusion into the stone.

FACILITY LOCATION	DESIGN FLOW
Foxboro, Massachusetts	1.2 MGD
City of Gold Beach, Oregon	2.2 MGD
Town of Los Osos, California	1.6 MGD
Village of Omemee, Ontario	350,000 gpd
Bozeman, Montana	200,000 gpd
Port Burwell Ontario	280,000 gpd
Manistee, Michigan	180,000 gpd
Breckenridge, Colorado	500,000 gpd
Plymouth, Massachusetts	300,000 gpd
Yolo County, California	225,000 gpd

Table 1: Installed decentralized systems designed for large flow.

The innovative design with 21 drainfields rather than the original nine offers flexibility and redundancy to the city. Flushing ports and isolation valves also allowed the city to flush the lines during new plant construction, which was critical when the existing plant failed prior to startup of the new plant.

Subsurface outfall

The Town of Hopkinton, Mass., had a municipal sewer system but did not have a wastewater treatment plant. Wastewater was being sent



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to other towns but they were at their discharge limits. A study was conducted to investigate town-wide alternatives and to perform a cost analysis, which led to construction of a new 350,000-gallon-per-day treatment plant.

An innovative sewer-mining solution was designed that partially diverts flows from an existing sewer main to the new treatment plant. A new surface discharge was impossible; therefore, a subsurface outfall consisting of a large infiltration basin was proposed. Due to the proximity to natural wetlands, the space available for the system was constrained. A highly efficient 80,223-square-foot Infiltrator chamber infiltration system solved this problem. Another challenge solved by the infiltration system was that it could fit on the constrained and irregular site as well as recharge the local aquifer and adjoining wetlands.

Centralized and community decentralized treatment

Loudon County, Va. has adopted a combined approach to wastewater treatment, utilizing both centralized and community decentralized treatment facilities. Community decentralized treatment facilities are publicly owned and maintained by Loudon Water in the same manner as the county's centralized treatment plant. As the county continues to grow, developers integrate new community decentralized facilities then transfer ownership and operation to Loudon Water.

All homes connected to the community systems pay taxes and fees matching those paid by homes connected to the centralized system,

which allows for sustainable operation and maintenance. One of the subdivisions serviced by decentralized wastewater treatment is the Elysian Heights wastewater treatment system. This system was designed to serve a 324-home subdivision and five acres of commercial land.

Conclusion

Decentralized wastewater treatment can provide equal protection of public health while outshining centralized wastewater treatment in environmental protection. Where individual lots are not suitable for decentralized treatment onsite, community decentralized systems can provide sustainable and responsible wastewater treatment. With aquifers becoming depleted at rapid rates and water tables dropping, minimizing the impacts to the water cycle that are under our control is critical for sustainability.

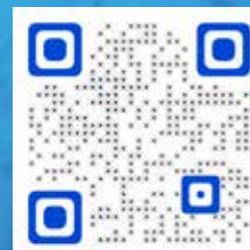
Decentralized systems provide a low-cost, environmentally friendly, passive form of both wastewater treatment and aquifer recharge, combatting the declining groundwater table and protecting public health.

DENNIS F. HALLAHAN, P.E., technical director at Infiltrator Water Technologies (www.infiltratorwater.com), has more than 25 years of experience with onsite wastewater treatment system design and construction. He is responsible for technology transfer between Infiltrator and the regulatory and design communities and consults on product research and testing for universities and private consultants. He can be contacted at dhallahan@infiltratorwater.com.



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DISRUPTIVE LAND DEVELOPMENT — PART 2

MERGING CIVIL ENGINEERING, PLANNING, AND ARCHITECTURE
FOR MORE SUSTAINABLE HOUSING.

By Rick Harrison

HOME DESIGN is critical to advance civil engineering. Increased density compacts space, which sacrifices livability, efficiency, curb appeal, views, and environment. Arguing that the environment is not harmed by increased density ignores the fact that while the lot and home sizes are reduced, other infrastructure elements such as streets, walks, and garages remain the same size. Thus, the ratio of housing footprint to paved areas is likely to increase, and “organic” (landscaped) space is sacrificed.

Figure 1 shows “coving” for urban redevelopment. Note the varied setbacks forcing individual lot shapes. In this plan, the homes are redesigned to fit within the lot. Homes along an inside of arc have garages that extend to the side, increasing the front width of the home, thus providing more curb appeal. Homes that arc to the outside are wider at their rear, offering better views from within the home to their larger rear yards.

Coving lot width begins at the narrowest regulation-allowed distance along the home and then widens without a density loss. With past coved design, every lot was unique. Each lot had a different angle from one side to the next.

During the recession, research allowed discovery of a solution: If the angle of one side lot line to the opposite is held to a minimum, then a home would be wider at the front or rear without requiring excessive floor plans. The 700-lot Trasona at Addison Village, Viera, Fla., is the first neighborhood using this more advanced design form.

What makes Trasona in VIERA revolutionary is that designers started from scratch. Every lot and every home harnesses Architectural Shaping — there are no rectangular-based floor plans! This higher level of design geometry requires a tight collaboration between architects, the planner, the engineer, and the surveyor, who must stake out an organic, free-flowing site layout with homes properly placed on each of the 700 lots.

The architect was provided a predetermined maximum, non-rectangular building envelope for each of the home series (lot widths). The floor plan was not designed in a void, instead coordinating with spac-



Figure 1: A redevelopment study using coving. Note how the homes undulate in and out forcing non-rectangular lots

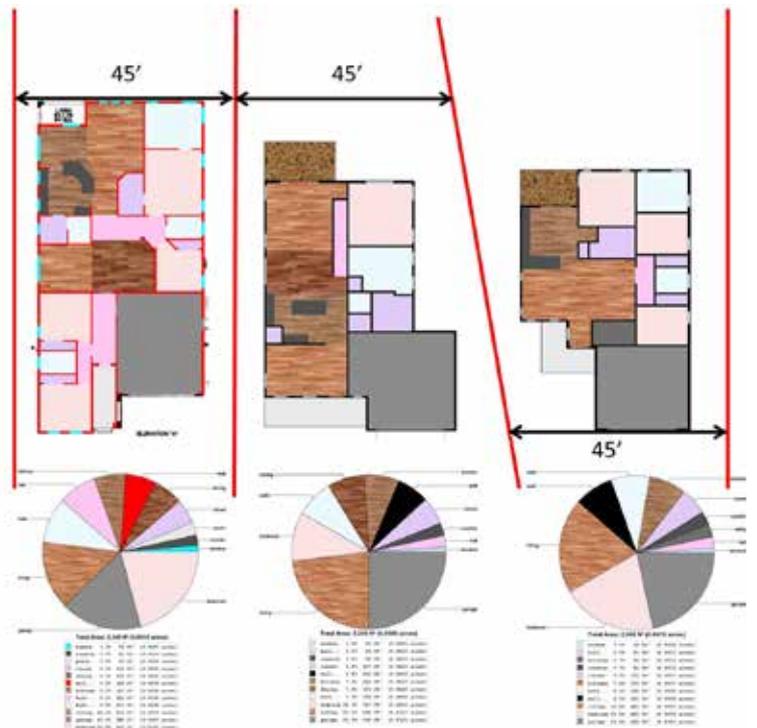


Figure 2: Floor plan and spatial comparison charts side by side: original floor plan (left); interior lot (center); and exterior lot (right).

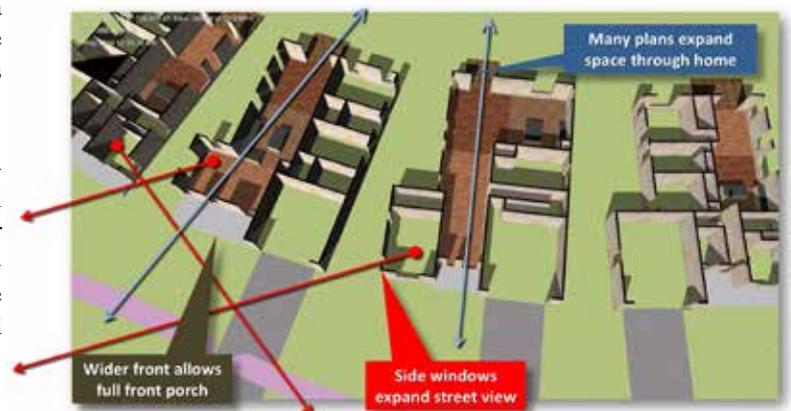


Figure 3: Depiction of interior room living spaces, non-living space, walls, and window locations with viewsheds



Figure 4: Windows make a major difference in the perception of space in a 33-foot-wide living space.

es in the proposed site plan to create the best views from within living spaces. This higher level of design mandates an intimate communication and collaboration between design professionals at the beginning stages of the design; no detail is an afterthought.

In other words, to advance the neighborhoods in which we dwell, which make up the cities we live in, we need to reinvent and disrupt the consulting industry as well as reteach professors who will produce the next generation of designers.

Reducing architectural waste coincides with reducing land development design waste — the geometrics are similar. LandMentor technology was used to compare the original floor plan to an interior and exterior shaped floor plan (see Figure 2). An original 35-foot-wide floor plan is on the left. The interior lot in the middle has no hallway space. Stairs consume 2.5 percent of the area compared with 8.1 percent hallway of the rectangular plan. Shifting the garage gains significant front views from within living spaces and provides width for the full front porch. The exterior-lot home on the right is 35 feet wide at its front and 41 feet wide at the rear. With no hallway (waste), it provides more quality views from within its living spaces compared with the rectangular plan.

For higher-density single-family homes, Architectural Shaping provides more room to increase efficiency and deliver quality views.

Architectural Blending coordinates interior and exterior spaces. Thus, space management becomes a primary function of site planning, civil engineering, and the all-important surveying stakeout process (see Figure 3).

Homes set at angles to each other provide views out corner windows to the surrounding space. The open great room space demonstrates the huge difference architectural blending can make on a 33-foot-wide living area (see Figure 4). Limiting the number of windows compresses the “feel” of space (left panel in Figure 4). The middle panel shows how space increases if windows extend to a corner. If windows wrap around a corner, the perception of space increases significantly. The room remains the exact same size.

Compare the above to a similar high-density grid neighborhood as seen in Figure 5. Few homes have side windows because there is nothing to see. Compare Figure 5 to the similar-density Transona (Figure 6). Homes in red are 35 feet wide. Higher-density housing



Figure 5: A gridded neighborhood in South Carolina using traditional neighborhood development (TND) and New Urbanism design methods



Figure 6: Angle relationships between homes of a curved design increase the length of views from within the homes.

has the same feel and perception of space along the streetscape as lower-density (yellow and brown). The angled relationship between homes provides coordinated view corridors, which expand space far beyond the minimum front yard setbacks while eliminating monotony. Wide (usable) meandering walks set in easements as they leave the right-of-way invite a stroll rather than a drive and enhance the sense of space through scale even more!

This “free” space did not reduce any required widths or setbacks as you would assume. The more efficient coved design reduced public infrastructure (street length) by 38 percent compared to the previous grid layout. Again, by reporting and recognizing waste, you can learn methods to eliminate it. Less wasted right-of-way allows more space for lots. This reduces environmental and economic impacts as well as maintenance burden to the municipality — forever. However, for consultants who charge a percentage of construction costs, this is bad news indeed. The new era of design mandates a different billing model, perhaps per lot or a flat fee.

The consumer purchases a home by how large it seems, thus, if it simply feels much larger it should sell faster, justifying increased density without sacrificing desirability. A home-buying public made aware of these new products will foster change with their purchase decisions, the same way other industries progress. This is as dramatic as comparing a dial phone of the 1960s to the I-Phone (see Figure 7).

More than any other profession involved with land development, civil engineers will have the greatest influence in making this change in the way the world grows. Will the next 276+ square miles of growth



Figure 7: Spatial technology translates to virtual reality allowing an accurate peek into the future.

continue to use methods rooted in your grandfather’s day, or are you willing to retool, re-educate, and collaborate with other design professionals?

Will your new skills and knowledge be given without reservation for the public good to give the utmost to enhance the living standards, safety, function, beauty, value, and environmental impact of the world’s growth? It really is up to you.

RICK HARRISON is founder of Rick Harrison Site Design Studio (www.rhdsplanning.com).



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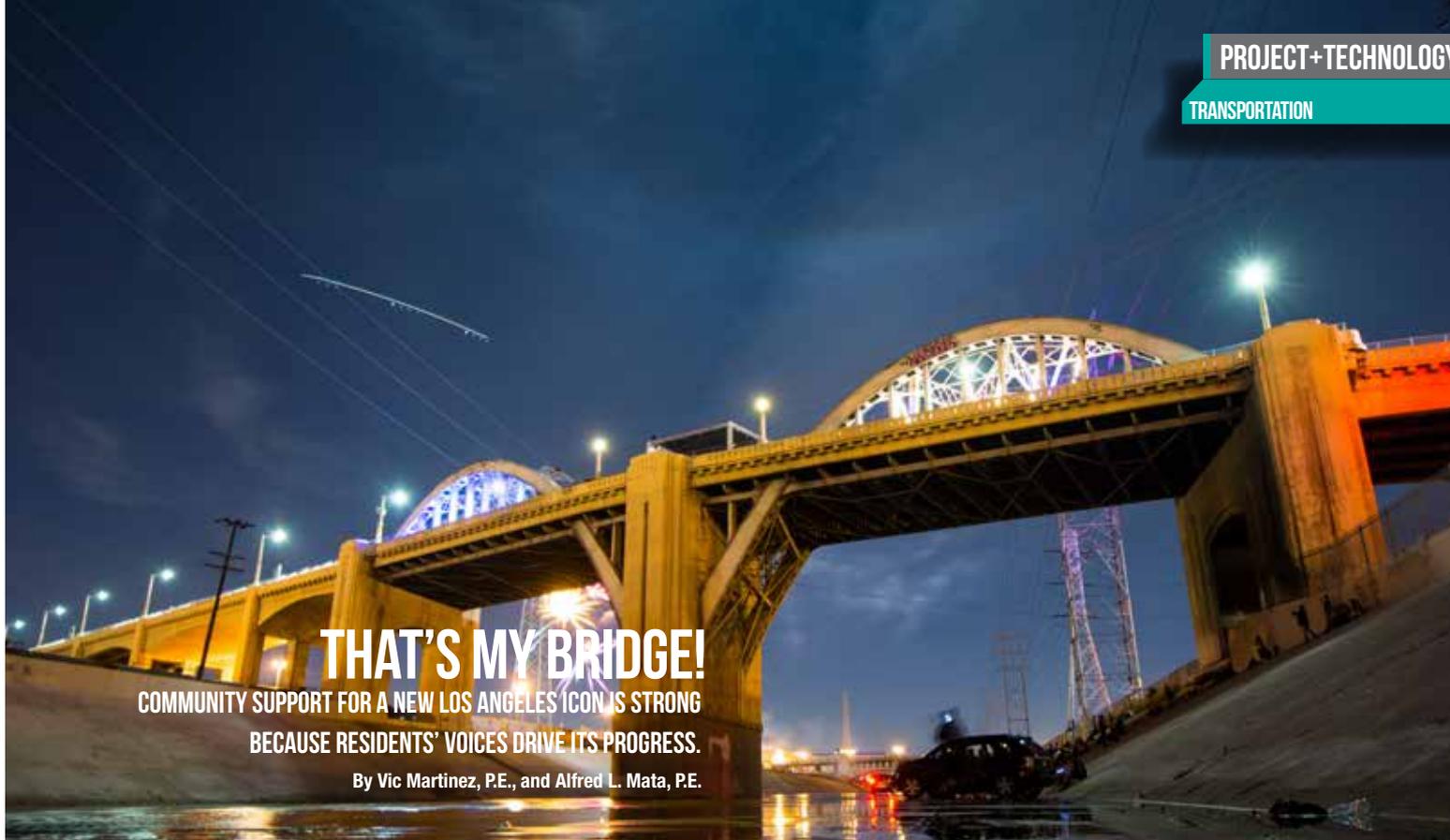
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THAT'S MY BRIDGE!

COMMUNITY SUPPORT FOR A NEW LOS ANGELES ICON IS STRONG
BECAUSE RESIDENTS' VOICES DRIVE ITS PROGRESS.

By Vic Martinez, P.E., and Alfred L. Mata, P.E.

The 84-year-old Sixth Street Viaduct in Los Angeles is considered a community treasure, but deemed unsalvageable because of damage from alkali silica reaction and seismic vulnerability.
Photo: Eric Solis, HNTB

THE SIXTH STREET Viaduct in Los Angeles is one of the city's — and the country's — most loved and recognized bridges. It is a vital link between Boyle Heights on the east side of the Los Angeles River and the burgeoning Arts Districts on the west side. Opened in 1932, it is the longest of seven bridges across the river.

Over the years, the Sixth Street Viaduct became a treasure. It provided access and created a sense of community. It's been documented in numerous movies and television shows and has become a symbol of community pride. It's not uncommon to hear, "That's my bridge," when residents show visitors around town or watch a film. It is a structure that the community, and Los Angeles residents in general, truly own.

Yet, the stature that the original Sixth Street Viaduct afforded Los Angeles is not one of eternity. Alkali silica reaction has long eaten away at it and a 2004 seismic vulnerability study affirmed it must be replaced. There was immediate pushback from the community, including the city councilmember who represents the district. The prospect of losing the bridge was unfathomable. After experts from around the world studied the bridge and confirmed it was unsalvageable, its eventual loss began to sink in, but reality hit hard.

A community involved and excited

Communities near the bridge have embraced it for more than eight decades, so it was crucial that residents be part of its renewal. From day one, the Bureau of Engineering with the City of Los Angeles, city

officials, and designers took steps to ensure every voice was heard and every idea considered.

As it came time to consider a replacement for the beloved bridge, an international design competition kicked off with a news conference by then-mayor Antonio Villaraigosa. Excitement built immediately. Nine proposals were received from design firms. Six of those were selected for interviews. Three finalists were then selected, including HNTB Corporation. Each firm presented its design concept as a model during four community meetings. Teams from finalist firms conducted extensive research on the bridge. In addition, firms each hosted meetings with community members to understand what they truly wanted from a new bridge.

Input flowed faster than the Los Angeles River after a downpour. Community involvement leading up to the release of the RFP, during design firms' preparation for it, and during final concept presentation was unprecedented. Residents' ideas kept flowing.

Between 2006 and 2011, the city hosted more than 50 community meetings. In the last year alone, city representatives have been involved in at least 25 meetings, including neighborhood councils, chambers of commerce, and business improvement districts.

The resulting approved design by Los Angeles architect Michael Maltzan is heralded as the "Ribbon of Light." It features 10 pairs of arches canted at 9 degrees, an industry first. There's a 60-foot arch

over railroad tracks on the west side, a 30-foot arch over the river, a 60-foot arch over railroad tracks on the east side, a series of 30-foot arches, and a 40-foot arch over U.S. Highway 101. LED lights will illuminate each arch. HNTB also designed an LED-lighted barrier between bike lanes, sidewalks, and roadways.

Public involvement in the design process brought out the need to better connect communities on both sides of the bridge. The idea of adding stairs from the ground level to the deck and accentuated lighting on the arches are two examples of what community members suggested would add to the connectivity and beauty of the bridge. Input even guided the planning for eight acres of land underneath the bridge. Soccer fields will be built on the Boyle Heights side and a performance area will grace the Arts District.

The impact of this input on the design process hasn't gone unnoticed by officials. Alfred Mata, deputy city engineer with the Bureau of Engineering, City of Los Angeles, noted this atypical process continues to yield worthwhile results.

"The design competition is not something we typically do, but we don't have jobs like this very often," he said. "I appreciate how this process challenged these teams to develop concepts that are better than if we had done things otherwise. If a team wanted to win, it had to create a concept that addresses infrastructure in a modern way, rather than plan a bridge to get people from Point A to Point B. This process took urban planning into the future and really focused on the interconnectivity of the neighborhoods and included biking, walking, and driving."

Unique delivery process

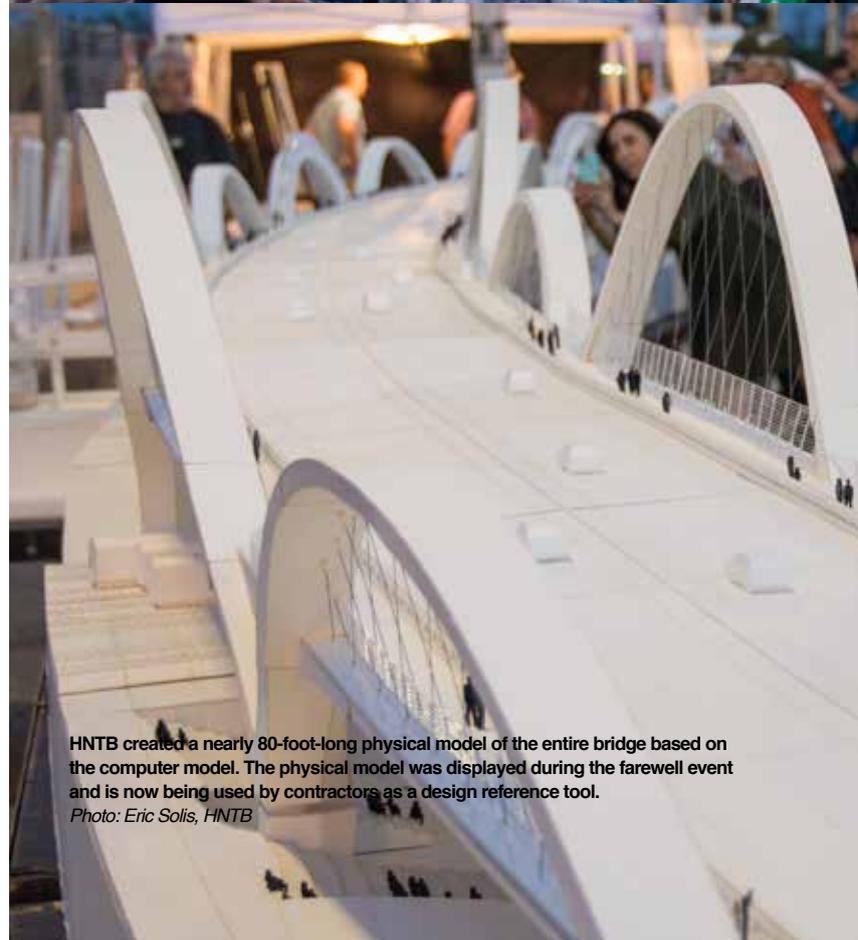
Construction Manager General Contractor (CMGC) is the delivery method chosen for the project, a first for the Bureau of Engineering. This is also the largest project the bureau has undertaken. The project team is made up of city officials with HNTB as a designer under direct contract. The CMGC firm selected provides construction input during design phases as all parties collaborate throughout completion.

The CMGC arrangement is helpful because this project crosses many properties, streets, the LA River, two major railroad corridors, and a freeway. Plus, there are properties to acquire and utilities to be relocated. Contractor involvement all along the way ensures reality checks are accounted for during planning and cost estimating.

Three out of six packages, or phases, of the work are in progress or have been completed. They include:

- intersection improvements on both sides of the river to help traffic flow more smoothly when Sixth Street is closed, new traffic lights where needed, and ADA-compliant curb ramp at crosswalks to enable pedestrians and drivers to better get where they need to be;
- a cast-in-drilled-hole concrete pile for foundation load testing; and
- demolition of the existing viaduct structure.

The three remaining packages include foundations, main viaduct construction, and landscaping.



HNTB created a nearly 80-foot-long physical model of the entire bridge based on the computer model. The physical model was displayed during the farewell event and is now being used by contractors as a design reference tool.

Photo: Eric Solis, HNTB



Hundreds of community members attended a farewell event for the old Sixth Street Viaduct. Photo: Eric Solis, HNTB



Excellence in Infrastructure Award

HNTB received the third place prize in the Autodesk Excellence in Infrastructure 2015 Awards for its work on the Sixth Street Viaduct project. The Sixth Street Viaduct will be the first bridge in California to rely on continuous unbraced tied network arches as a structural system. Each arch will be supported by columns set on their own isolation bearings, which will greatly enhance seismic performance.

In a seismic event, the deck, arches, and upper portions of bents are seismically isolated from the bottom of the bents. This configuration improved not only the seismic performance of the bridge, but also the economy of the bridge by eliminating the need to design for large seismic forces in the unbraced arch ribs. The bearings also act as self-centering devices and return the upper columns to the neutral position after a large seismic event. This system minimizes damage and costly repairs to the structure.

HNTB realized that the complexity of the bridge would require sophisticated analysis and simulation along with accurate visualization. Given the demands of the project, the design team chose a model-based workflow and a BIM process from the earliest stages of the project. With the initial models developed in Autodesk Revit, the team decided to enhance its ability to model the geometry of the bridge with Autodesk Dynamo Studio. Dynamo helped the team control and understand the parameters of the bridge. Throughout the process, the team was able to analyze the complex forms and unique shapes called for in the design for aesthetic effect, structural loads, wind loads, drainage, and more.

Integrated analysis allowed the project to realize the impact of infrastructure systems outside of an isolated object. The bridge design is comprised of many unique shapes — from the curving forms of the concrete arches and piers to the complex intricacies of the stair railings. Throughout the design process, all of those forms were regularly analyzed for structural loads, wind loads, electrical requirements, drainage, foundation locations, etc. Having all the systems available in BIM allowed for a more holistic approach to the analysis.

Source: HNTB's submission to the Autodesk Excellence in Infrastructure 2015 Awards

It's time

The Sixth Street Viaduct officially closed the last week of January, a milestone marked by the spontaneous appearance on the bridge of hundreds of Angelenos who came out to say a final farewell. Demolition began in February. Years of planning, receiving input, and incorporating community ideas into the bridge design are taking real form. This could not have come about without the perspectives of residents evolving.

By the numbers

The new Sixth Street Viaduct — Ribbon of Light

- Bridge length: 3,050 feet
- Project length: 3,500 feet
- Two travel lanes in each direction with an 8-foot median
- Improved traffic flow and better visibility for motorists
- Two striped bike lanes
- 8- to 14-foot-wide sidewalks
- ADA-compliant pedestrian access
- Barrier-protected pedestrian walkways with direct access from the ground at multiple locations and in both directions
- Staircases and viewing deck for a never-before-seen view of downtown Los Angeles
- A new landscape area below the viaduct increases recreational green space available to Boyle Heights residents
- An arts plaza will become a dynamic urban gathering place and a catalyst for economic growth, as well as provide expanded opportunities for public art, including digital murals from local schools and artists
- Improved access to the Los Angeles River for pedestrians and bicyclists

There was natural resistance to the early message that the bridge must be replaced. Even then, some wanted a replica to replace the existing bridge if demolition was the only option. Hundreds were worried about how demolition would affect their communities on both sides of the river. As demolition moved closer, city officials were willing to go into the communities over and over again to answer concerns.

Over time, exchanges during community meetings, kickoff events, and ongoing dialogue has helped morph this resistance into excitement. We've celebrated the end of the bridge. People have taken photos and videos. In these final weeks there is closure and they are ready for their new bridge to be built.

Construction is scheduled to run through 2019. There'll be more questions during this time. Mary Nemick, director of communications for the Bureau of Engineering, assures the community that outreach will be ongoing. We've created a project to which people are personally connected. We're committed to keep the communication going through to the end.

We know people love the old Sixth Street Viaduct. We also sense the excitement about the new Ribbon of Light because, through their input, residents have already told us, "That's my bridge!"

VIC MARTINEZ, P.E., is vice president with HNTB Corporation (www.hntb.com) and **ALFRED L. MATA, P.E.**, is deputy city engineer, City of Los Angeles (<http://eng.lacity.org/index.cfm>). View the Sixth Street Viaduct project website at www.sixthstreetviaduct.org.



Demolition of the old Sixth Street Viaduct began in February 2016, as well as construction of a cast-in-drilled-hole concrete pile for foundation load testing.

Photo: Terence Pao, HNTB

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SAFE USE OF STORMWATER AND GRAYWATER

GUIDELINES AND RESEARCH ON RISK TO PUBLIC HEALTH ARE NEEDED TO SUPPORT REUSE SYSTEMS.

IN THE FACE of drought and major water shortages, the United States is increasingly turning to alternative water sources such as stormwater and graywater. However, guidelines and research on their risk to public health and the environment are needed to support decisions for safe use, according to a new report from the National Academies of Sciences, Engineering, and Medicine.

Graywater — untreated wastewater from bathroom sinks, showers, tubs, washers, and laundry sinks — and stormwater could significantly supplement traditional potable water supplies using existing technology to capture and treat the waters, but there is currently limited information on the costs, benefits, risks, and regulation of such projects, the report concluded. Additional research and changes in infrastructure will be necessary to take full advantage of the potential of graywater and stormwater.

These types of water can be collected and treated for non-potable uses including irrigation, toilet flushing, and laundry and outdoor washing. The committee that conducted the study and wrote the report undertook a comprehensive analysis of the risks, costs, and benefits of various uses of graywater and stormwater, as well as their capture and use at household, neighborhood, and regional scales.

More research and data on stormwater and graywater quality are necessary to assess the risks under various human exposures, particularly on the types and concentrations of pathogens that are likely to occur, the report said. Additional information is also needed on the organic chemicals in stormwater and their consequences for various uses.

The report recommends best practices and systems for the capture and use of stormwater and groundwater. In locations where it can be stored in aquifers for use during drought or dry seasons, stormwater captured at neighborhood and larger scales can significantly contribute to urban water supplies. Stormwater infiltration — groundwater recharge — is commonly practiced, but the designs and regulations may not adequately protect groundwater quality, particularly for urban stormwater.

Graywater reuse for non-potable uses such as toilet flushing and subsurface irrigation may provide arid regions such as Los Angeles potentially substantial water savings and a steady water source during the summer months when there is little or no rainfall. However, larger irrigation systems and indoor reuse requires more complex plumbing and treatment systems that are typically more appropriate for new

WERF and WRRF plan to merge

The Water Environment Research Foundation (WERF) and the WaterReuse Research Foundation (WRRF) boards of directors unanimously agreed to take the steps necessary to merge and integrate. In a statement, the two organizations said that they recognize and value their history and respective missions, and believe that merging will create synergies, reduce future water research redundancy, further the evolution toward a unified voice for water, and increase the value proposition to their respective subscribers by enhancing and leveraging investments.

“The water industry is currently at a critical juncture as it relates to acceptance and implementation of reuse — driven by demand, environmental needs, and the creation of a local, sustaining water supply,” said Doug Owen, chairman of the WaterReuse Research Foundation. “The merger has the opportunity to strengthen the value of water that was historically used only once.”

To date, both organizations conduct research in a clearly defined and complementary niche. WaterReuse focuses on water reuse and desalination, while the Water Environment Research Foundation focuses on resource recovery and water quality impacts from wastewater and stormwater.

“Our organizations share a common commitment to making the most of the water we use,” said Kevin Shafer, chairman of the WERF board of directors. “Merging will strengthen that commitment as well as increase the return on investment in research for our members and the industry as a whole.”

The WaterReuse Association, as well as other critical partners including Water Environment Federation (WEF), American Water Works Association (AWWA), National Association of Clean Water Agencies (NACWA), Association of Metropolitan Water Agencies (AMWA), and Water Research Foundation (WRF), among others, will continue to play a critical role in advancing research-based policy that turns scientific discovery into common-sense laws and regulations for water reuse and resource recovery, and in helping establish the research needs of the industry.

multi-residential buildings and developments and for future urban planning.

Irrigation at the household scale can be achieved with simple systems that require little energy and maintenance, but the report noted that neither graywater nor stormwater should be used in arid regions to support landscaping that is not sustainable in the long term. If water conservation is the primary objective, alternative strategies like designing water-efficient landscapes to reduce or eliminate irrigation should first be examined and would provide much larger reductions in water demand in arid regions.

The report also noted that little is known about the impact of installing onsite water systems on homeowners' water-use behavior. This points to a need to study behavioral responses to conservation measures.

One of the greatest hurdles is the absence of risk-based guidelines that ensure water quality protects public health, the report said. Rigorous, risk-based guidelines could improve safety, reduce spending on unnecessary treatment, and assist communities that lack an existing regulatory framework for onsite water supplies. The committee recommended that the U.S. Environmental Protection Agency (EPA), a collaboration of states, or a collaboration of U.S. water organizations working with EPA develop these guidelines.

Currently, there is substantial variation in onsite graywater and stormwater regulations at the state and local levels. Regulations have not evolved quickly enough to keep up with advances in technologies and their use, hindering the capacity for graywater and stormwater to expand the nation's water supplies significantly. Additionally, laws concerning allocation of water, particularly surface water, determine who owns the rights to stormwater and graywater and thus can significantly influence the harvesting and use of that water.

The report's authors identified the following legal and regulatory constraints that hinder the capacity for graywater and stormwater to significantly expand the nation's water supplies:

- In most western states, acquisition of water rights is a requirement for large-scale stormwater capture and use projects, and water rights may limit widespread implementation of smaller-scale stormwater and graywater projects for consumptive uses.
- There is substantial variation in onsite graywater and stormwater regulations at the state level with respect to design and water quality for household-scale projects, which leads to varying exposures and risk.
- The lack of authoritative, risk-based guidelines for the design and potential applications of graywater and stormwater in the United States is a major impediment to their expanded use.

The study was sponsored by the EPA; National Science Foundation; Water Research Foundation; Water Environment Research Foundation; Los Angeles Department of Water and Power; WaterReuse; City of Madison, Wis.; and National Water Research Institutes. Through the Academies'

Presidents' Fund, support was provided by the Arthur L. Day Fund, W.K. Kellogg Foundation Fund, and George and Cynthia Mitchell Endowment for Sustainability Sciences.



Download the full report, *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits*, at www.nap.edu/21866.

Information provided by the National Academies of Sciences, Engineering, and Medicine (<http://national-academies.org>).

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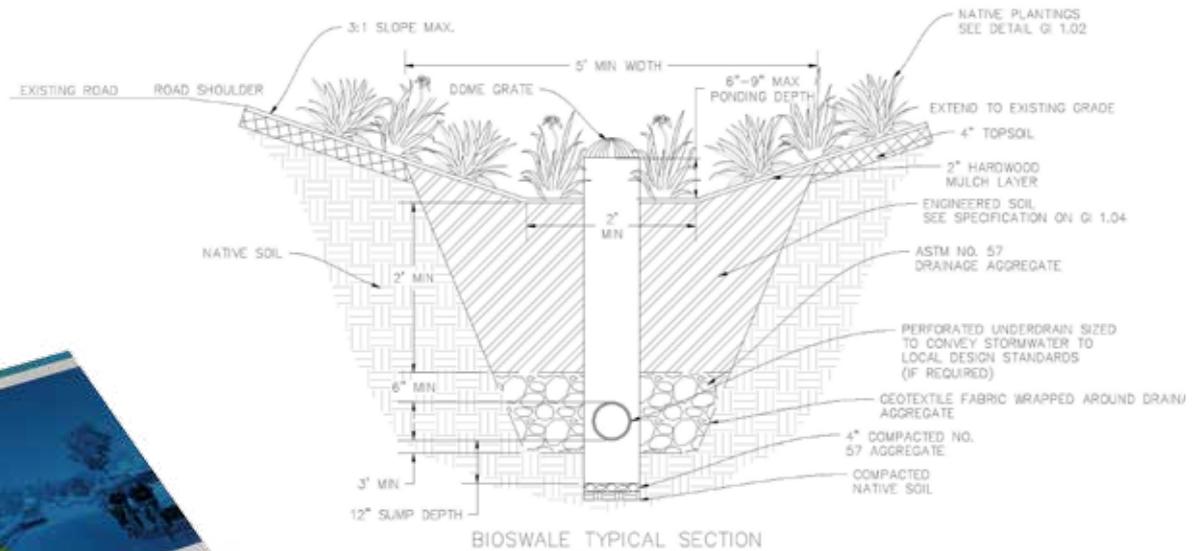
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Technical drawings provide details and cross-sections for rain gardens, stormwater planters, permeable pavement, underground storage, and bioswales.



Delta Institute and Guidon Design, Inc., created free green infrastructure design templates for the Midwest and Great Lakes region.

TOOLKIT FOR GREEN INFRASTRUCTURE DESIGN

DOWNLOAD TECHNICAL DRAWINGS, CONSTRUCTION NOTES, AND COST AND MAINTENANCE INFORMATION.

AS COMMUNITIES ACROSS the Midwest seek solutions to reduce sewer and basement back-ups and other costly effects of urban flooding, a collaboration in Chicago has produced free green infrastructure design templates for the Midwest and Great Lakes region, vetted and designed by experts, and now available online.

Delta Institute and Guidon Design, Inc., created the design templates, which provide technical drawings (details and cross-sections), construction notes, and cost and maintenance information for five types of green infrastructure:

- rain gardens,
- stormwater planters,
- permeable pavement,
- underground storage, and
- bioswales.

The design templates are part of a toolkit — Green Infrastructure Designs: Scalable Solutions to Local Challenges — that also includes a decision-making rubric to help municipal managers and decision-makers start the process of implementing green infrastructure in their community.

“Green infrastructure is often an important part of the solution to urban flooding, but whether and how to build it can be a stumbling block for communities,” said Eve Pytel, director of strategic priorities, Delta



A stormwater planter is a linear infiltration basin that typically sits between a street and a sidewalk in the right-of-way and is surrounded by vertical curbing. Rainwater runoff flows to the gutter in the street and drains into the stormwater planter through openings in the curbing.

Institute. “This toolkit provides users with a clearer understanding of how to identify opportunities for green infrastructure implementation, which green infrastructure treatments are most suitable for a specific site or purpose, and how to make informed decisions based on reasonable cost estimates.”

In response to requests for technical assistance from communities, Delta Institute applied for and received funding for the design templates in April 2014 then worked with the Calumet Stormwater Collaborative to shape the project. The Collaborative has been improving communication and coordination between municipalities, government agencies, planners, designers, and other key stakeholders in stormwater management since 2014. Delta Institute is one of more than 30 active members of the Collaborative, which is facilitated by the Metropolitan Planning Council (MPC) and is also a priority of the Millennium Reserve, a broader partnership of communities, governments, and businesses advancing economic, environmental, and community goals on Chicago’s southeast side, the Southeast lakefront, and 37 south suburban municipalities.

“From costly flooding to poor water quality, many cities and regions across the Midwest, including Chicago’s Calumet region, are confronting increasing challenges with stormwater management,” said MPC director Josh Ellis. “By coordinating, the many groups involved in the Calumet Stormwater Collaborative are developing better, faster solutions to these challenges, such as the new green infrastructure design templates, which will make it easier and less expensive for communities in our own area and in places with similar climates to build green infrastructure.”



Download Green Infrastructure Designs: Scalable Solutions to Local Challenges at <http://delta-institute.org/tools/#section-publications>.

Information provided by Delta Institute (www.delta-institute.org) and Guidon Design, Inc. (www.guidondesign.com).

EVALUATING INVESTMENTS IN COMMUNITY RESILIENCE

COMMUNITIES WEIGHING CHOICES for capital improvement projects intended to improve their resilience to severe weather, wildfires, earthquakes, or other types of hazards now have a new guide to help them sort through the costs and benefits of each when deciding which investment is best for their particular circumstances. Prepared by National Institute of Standards and Technology (NIST) economists, the Community Resilience Economic Decision Guide for Buildings and Infrastructure Systems details steps for evaluating the “economic ramifications” of contemplated resilience investments as well as the option of maintaining the status quo.

The new publication complements NIST’s recently issued Community Resilience Planning Guide for Buildings and Infrastructure Systems. That guide lays out a practical six-step process that communities can follow to develop resilience plans that help them prepare for hazards, adapt to changing conditions, and withstand and rapidly recover from disruptions (Figure 1). Community-developed resilience plans help governments, utilities, service providers, and other organizations set priorities and allocate resources for mitigating damage, maintaining vital services, and if a hazard does strike, building back better.

The new economic guide helps communities nail down critical elements of these proactive, long-term plans — the capital investments most likely to yield the greatest returns, the sum of net cost savings, damage avoided, and secondary benefits reaped by the community. It provides the basis for comparing and contrasting alternate investments during development of the resilience plan, the fourth step in the process laid out in the planning guide.

In addition, the approach described by the NIST economists enables evaluation of prospective resilience investments in the broader context of other community goals such as economic development and emergency management. Identifying and including secondary “resilience dividends” — more reliable utility systems, for example — should help to “mainstream resilience into community decision-making and, ultimately, help to make communities less vulnerable to long-term disruptions that jeopardize their futures,” NIST economist David Butry said. He noted that, in addition to overlapping benefits, some of these interacting effects also may impose secondary costs, which should be recognized early on as well.

Following the approach described by Butry, lead author Stanley Gilbert, and their colleagues, communities will establish planning horizons, constraints, risk tolerance (or aversion) and discount rates — or opportunity costs for investments forgone. The economic guide also details how to do an accounting of anticipated costs and benefits as well as noneconomic considerations such as environmental, social,

SIX-STEP GUIDE TO PLANNING FOR COMMUNITY RESILIENCE



and cultural impacts that do not have a market-determined price tag. The economic evaluation also reckons with the challenge of uncertainty posed by hazard events that are likely over a particular planning period — yet unpredictable in terms of their timing and severity. It describes several methods that communities can use to estimate future costs, losses, and benefits in light of the uncertainty inherent in the process.

Yet, as the economic guide points out, “Experience shows that communities generally over-estimate their ability to successfully deal with hazard events ... It may also be that communities either underestimate risk exposure or assume that meaningful improvements are cost prohibitive.”

The economic guide draws on input received during a NIST-organized workshop in April 2015. The

more than 70 participants included planners, government executives, economists, engineers, experts in finance and risk analysis, and other stakeholders.



Download the Community Resilience Economic Decision Guide for Buildings and Infrastructure Systems at <http://dx.doi.org/10.6028/NIST.SP.1197>.

Information provided by the National Institute of Standards and Technology (www.nist.gov).

STUDY: ONLY 40 PERCENT OF LEED ND-CERTIFIED PROJECTS INCLUDE AFFORDABLE HOUSING

THE U.S. GREEN BUILDING Council’s Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) rating system fails to encourage developers to include affordable housing in new developments, according to Nicola Szibbo, Ph.D., a planner with the City and County of Honolulu. Szibbo reported her findings in the Winter 2016 (Vol. 82, No.1) issue of the Journal of the American Planning Association (JAPA).

In “Lessons for LEED-ND, Social Equity, and Affordable Housing,” Szibbo found that only 40 percent of LEED-ND certified projects include affordable housing. The rating system fails to deliver upon its three-leg sustainability goal of equity, economy, and environment. Since the affordable housing credit is optional, developers can forgo the credit and still achieve a LEED-ND rating.

“My research concludes that the affordable housing

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credit needs to be strengthened or critically reconsidered,” Szibbo said. “The existing optional affordable housing is not currently effective and offers little incentive for developers to include affordable housing.”

LEED-ND is the only rating system that attempts to address issues of sustainability at the neighborhood level. However, affordable housing is worth less than 3 percent of the overall rating system. The LEED-ND rating is attractive to developers as it increases a development’s marketability and is sometimes viewed as a way to fast track the approval process. Since its inception in 2007, no substantive changes or improvements in the LEED-ND affordable housing credit have been made.

Szibbo’s research included statistical evidence, survey research, and structured interviews. She surveyed 114 LEED-ND Accredited Professionals (APs) and conducted 20 personal interviews with developers and other LEED-ND APs. Among her findings:

- Among the 2009-2014 LEED-ND projects reviewed, 60 percent chose to ignore the specific affordable housing credit.
- Forty-one percent of survey respondents believe the existing rating

does not support social equity or social sustainability.

- There is opportunity for improving the LEED-ND affordable housing requirement, according to 63 percent of the survey respondents.
- Twenty-three percent of survey respondents want more points in the rating system for affordable housing, while 13.5 percent want the affordable housing credit to be mandatory.
- From the interviews with LEED-ND APs, 59 percent believe developers are reluctant to include affordable housing in LEED-ND projects due to potential lower profits or the social stigma of low-income housing affecting marketability.

Szibbo noted that the LEED-ND process has the potential to deeply affect low-income households by offering housing that is both green and affordable, providing a higher quality of life for residents.

Read the full article at <http://tandfonline.com/doi/full/10.1080/01944363.2015.1110709>.

Information provided by Routledge, a member of the Taylor & Francis Group (www.tandfonline.com), publisher of the Journal of the American Planning Association (www.tandfonline.com/RJPA).

2015 BEYOND GREEN AWARD WINNERS RECOGNIZED

THE NATIONAL INSTITUTE of Building Sciences Sustainable Buildings Industry Council (SBIC) recognized the 2015 Beyond Green High-Performance Building and Community Awards winners during Building Innovation 2016: The National Institute of Building Sciences Fourth Annual Conference and Expo. The Honor Award, the top prize in the High-Performance Buildings Category, went to the United Nations Headquarters in New York for its sustainable renovation project.

“This amazing, complex project set out to tackle multiple high-performance building attributes,” said Jim Whittaker, Beyond Green juror and president of Facilities Engineering Associates, during the jury’s deliberation. “In addition to addressing sustainability, the project naturally focused on historic preservation, safety and security, and accessibility. It certainly provides a glimpse into what is possible and, therefore, deserved an Honor Award.”

The United Nations Capital Master plan called for a complete renovation of the United Nations Headquarters in New York City. The renovation had three major goals: serve as an example for sustainable renovation projects; preserve the historic nature of the facility; and bring the facility up to current building code levels. Originally built in 1950, the UN campus suffered from aged and inefficient infrastructure, code compliance issues, and materials containing

asbestos. Construction on the renovation began in 2008 and was completed in June 2015. At its height, this \$2 billion renovation project employed more than 650 contractors and design/construction professionals.

The project achieved an overall Leadership in Energy & Environmental Design (LEED) Gold certification for the campus and LEED Platinum for the Secretariat tower. The campus is targeted to achieve 50 percent energy savings over existing energy use. Throughout the renovation, 50 percent of the campus remained occupied, requiring careful phasing of the new infrastructure.

“At the time it was built, it was a highly innovative building with the newest technologies. It hadn’t changed much in 50 years,” said Mike Thoresen, P.E., from Syska Hennessey Group, a contractor on the project. After the renovation, “it looks almost exactly the same. It was preserved, but upgraded,” he said.

The 2015 Beyond Green Award Jury also recognized two recipients to receive Merit Awards.

The Award of Merit in Category A: High-Performance Buildings went to the Center for Sustainable Landscapes (CSL) at the Phipps Conservatory and Botanical Gardens in Pittsburgh. “The utilization of an interdisciplinary design charrette to transform this environmentally degraded brownfield site into a highly visible demonstration of what is possible is impressive,” said Keith Diaz-Moore, Beyond Green juror and dean of the College of Architecture and Planning at the University of Utah. “The desire to capture and expand local design talent is commendable.”

The 24,350-square-foot CSL was conceived as a world-class building that provides both a home for administrative and classroom functions and a tool to further the institution's stated mission "to advance sustainability and promote human and environmental well-being through action and research." The result of a unique, facilitated integrated design process, the CSL generates all its own energy, captures and treats all water onsite, and is the first and only project to attain the planet's highest sustainable building certifications — Living Building Challenge, LEED Platinum, 4 Star Sustainable SITES, and WELL Platinum. The project transformed a dilapidated brownfield, once used as a fueling and supply station for the City of Pittsburgh's Department of Public Works, into a 2.9-acre site hosting one of the world's greenest buildings, a landscape of native plants, and a slate of science education programs.

The Award of Merit in Category C: High-Performance Initiatives went to the Efficient Homes Initiative of the Northwest Energy Efficiency Alliance (NEEA) and its utility partners. "This multi-state effort, focused on the expansion of energy-efficient homes, provides a model for potential programs of this nature across the country," said Mary Ann Lazarus, Beyond Green juror, and principal of MAléco. "While energy efficiency was the main goal, the initiative recognizes the linked benefits for health, water use, and sustainability."

Since 2012, NEEA and its utility partners sought to accelerate the market adoption of energy-efficient homes. Working with the U.S. Environmental Protection Agency, NEEA established a program that provides builders in the Northwest with regional marketing,

recruitment, and training support, and gives verifiers and raters the tools they need to verify and certify energy-efficient homes.

As part of the pilot program, an exclusive group of Northwest homes were designed to be more energy-efficient and then monitored for performance to identify the most cost-effective ways to achieve maximum energy savings in residential new construction. Since its inception, the home performance pilot has included more than 100 participating homes across Idaho, Montana, Oregon, and Washington. Once a pilot home is built and occupied, the program monitors it for 13 months to track its performance and ensure it meets desired efficiency goals. Pilot homes are at least 30 percent more energy efficient than homes built to state-specific energy codes, with many exceeding that number. The monitoring provides data that will push future building energy codes in the Northwest.

"We launched a high-performance pilot program," said Neil Grigsby, senior program manager for the Efficient Homes Pilot Video Campaign. "Since the inception of this program we've brought on close to 150 projects, achieving a 30 percent above-code performance target."

Visit the WBDG Whole Building Design Guide at www.wbdg.org/references/casestudies.php to view case studies of Beyond Green winners from previous years.

Information provided by the National Institute of Building Sciences (www.nibs.org).

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CELEBRATING EXCELLENCE IN WOOD DESIGN

WOODWORKS ANNOUNCES 2016 WOOD DESIGN AWARD WINNERS.

WOODWORKS, an initiative of the Wood Products Council, announced the winners of its 2016 Wood Design Awards. “WoodWorks Wood Design Awards celebrate projects and design teams that showcase the innovative use of wood as both a structural and finish material,” said Jennifer Cover, P.E., executive director of WoodWorks/Wood Products Council. “Ranging from mass timber to traditional wood-frame, this year’s winning projects exemplify wood’s many attributes, from structural performance and design versatility, to sustainability and cost effectiveness.”

National awards are being presented in the following nine categories:

- Multi-Story Wood Design
- Commercial Wood Design
- Wood in Government Buildings
- Institutional Wood Design
- Wood in Educational Buildings
- Beauty of Wood — Innovation
- Beauty of Wood — Craft
- Green Building by Nature
- Green Building by Design

Seven Regional Excellence Awards will be presented at regional Wood Solutions Fairs beginning with the North Central Wood Solutions Fair in Minneapolis on March 23.

Multi-Story Wood Design: The Radiator, Portland, Ore.

Architect — PATH Architecture

Structural engineer — Munzing Structural Engineering

General contractor — Kaiser Group, Inc.

At five stories, The Radiator is leading a surge of mid-rise mass timber buildings in the United States. The extensive use of wood begins with the building’s structure. Gravity loads are handled through a system of glulam beams and columns, and light-frame dimension lumber walls provide the structure’s shear capacity. A thick timber decking creates the structural floor diaphragm, and its lightness relative to other building materials translates into a more efficient and resilient overall structural system.

The Radiator is fully sprinklered, which allowed the design team to put the structural system on display. Beams, columns, and the underside of the floor decking are left exposed, contributing to the interior’s contemporary industrial character. Located in the Pacific Northwest, the Radiator’s moisture management system is comprised of fiberglass mat gypsum sheathing, a peel and stick water/air/vapor barrier, and rain screen. This Type III, 36,000-square-foot project was completed in 2015 for a construction cost of \$8.5 million.



The Radiator’s gravity loads are handled through a system of glulam beams and columns. Thick timber decking creates the structural floor diaphragm.
Photo: Caitlin Murry



Framework features four stories of Type V heavy timber-frame clad with an aluminum and glass curtain wall system. *Photo: Joshua Jay Elliot*



Commercial Wood Design: Framework, Portland, Ore.

Architect — Works Partnership Architecture
 Engineer — TM Rippey Consulting Engineers
 General contractor — Yorke & Curtis, Inc.

Completed in 2015, Framework was likened by its design team to a ship in a bottle — with its elegant wood structure visible to passers-by through its taut glass skin. With four stories of Type V heavy timber-frame office space over ground-level retail, it is structurally similar to neighboring 100-year-old buildings, except, instead of masonry walls, an aluminum and glass curtain wall system clads the timber frame. It is this combination of convention and innovation that contributes to its success.

The concrete base is carved, rising up to hold the framework display. Eighty percent of the wood is left exposed, and connections were custom designed to accentuate the framing system. In addition to Douglas-fir glulam columns and beams, Framework includes several other mass timber products and dimension lumber framing and decking. This 24,447-square-foot project was completed for a construction cost of \$2.95 million.

Wood in Government Buildings: Chicago Horizon, Chicago

Architect — Ultramoderne
 Structural engineer — Guy Nordenson & Associates
 General contractor — FH Paschen

A public pavilion for the Chicago Architecture Biennial, Chicago Horizon includes a cross laminated timber (CLT) roof supported on 13 glulam columns distributed in a radial pattern to address lateral loads and uplift. Elegantly crafted, the pavilion represents the first use of exposed CLT in the City of Chicago, providing local precedent for the approval and use of mass timber for government and public assembly applications. In addition, the two-way slab roof is the first of its kind, and raises the possibility of new CLT applications (such as office and assembly) due to the open-plan layout it affords.

The planned long-term use of the building as a commercial vendor and public assembly space is a significant and sustainable departure from the typical design exhibition model of temporary installations. The long-term plan justified the use of mass timber for durability, fire resistance, thermal mass, and negative carbon footprint. Chicago Horizon was completed in 2015 for a construction cost of \$300,000.

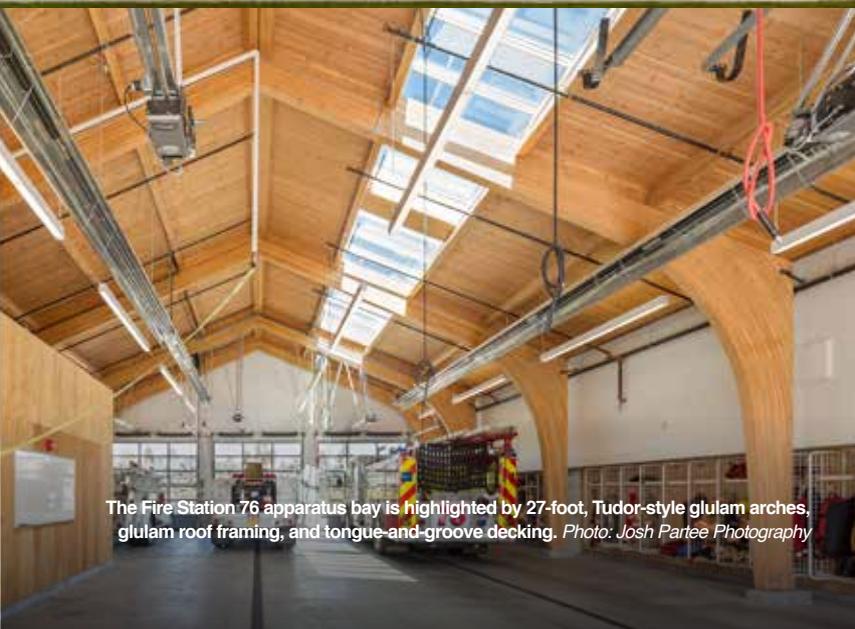
Institutional Wood Design: Fire Station 76, Gresham, Ore.

Architect — Hennebery Eddy Architects
 Structural engineer — Nishkian Dean Structural Engineers
 General contractor — Bremik Construction

Fire Station 76 is divided into two masses — a vaulted apparatus bay and living quarters — which make extensive use of wood for structure and finish in juxtaposed fashion. The apparatus bay is highlighted by 27-foot, Tudor-style glulam arches, glulam roof framing, and tongue-and-groove decking. Part of the structural system, the arches are designed to resist vertical and lateral loads with additional factors of safety required for Essential Facilities under the Oregon Structural Specialty Code.

Chicago Horizon includes a cross laminated timber roof supported on 13 glulam columns distributed in a radial pattern to address lateral loads and uplift.

Photo: Tom Harris, Hedrich Blessing



The Fire Station 76 apparatus bay is highlighted by 27-foot, Tudor-style glulam arches, glulam roof framing, and tongue-and-groove decking. *Photo: Josh Partee Photography*



Our Lady of Montserrat Chapel is comprised of a glulam post-and-beam structure with steel knife-plate connections. A wood window wall frames the view of a forest canopy.
 Photo: Josh Partee Photography

Attached to the apparatus bay, the living quarters are constructed with open web trusses and LVL I-joists at the roof, conventional wood-frame walls, and plywood shear walls as the lateral force-resisting system. Siding is reclaimed Douglas fir, treated using an ancient Japanese charring technique called Shou Sugi Ban. After milling, the siding was lightly burned on all sides, creating a hardened, carbonized layer that protects from moisture, decay, insects, and fire. The treated siding requires little-to-no maintenance and also performs well as a rain screen. This 10,120-square-foot, Type V project was completed in 2015 for a construction cost of \$3.24 million.

Wood in Educational Buildings: Our Lady of Montserrat Chapel, Seattle

Architect — Hennebery Eddy Architects, Inc.
 Structural engineer — Coughlin Porter Lundeen
 General contractor — Sellen Construction

Located on the campus of a Catholic Jesuit College and Preparatory High School, Our Lady of Montserrat Chapel is comprised of a glulam post-and-beam structure with steel knife-plate connections. A dramatic wood window wall frames the view of a forest canopy and a heavy timber shed roof floats above the chapel, orienting visitors skyward. To pay homage to the Jesuit tradition of building, the design team preferred a simple, warm, and timeless structural solution, making exposed heavy timber a desirable choice.

However, prescriptive code limitations brought on by the site — which is adjacent to and above an existing building of Type I-B construction — suggested non-combustible materials were required for structural applications. The project team appealed to the City of Seattle and was granted a code modification based on the well documented fire-resistance properties of heavy timber construction. The 1,600-square-foot chapel was completed in 2014 for a construction cost of \$1.4 million.



Beauty of Wood – Innovation: China Pavilion Milan Expo 2015, Milan, Italy

Architect — Studio Link-Arc, LLC

Architect — Tsinghua University

Structural engineer — Simpson Gumpertz & Heger

General contractor — Bodino Engineering

Designed as a temporary structure for Expo Milano 2015, the China Pavilion expands on the theme, Feeding the Planet – Energy for Life, with its focus on sustainability and the coexistence of nature and city. Although a variety of materials were considered, the team chose glulam to meet the challenges of the roof structure, including long spans and cantilevers, complex geometry, varying elevations, and exposed framing. Transitioning from sharp angles to soft waves, the roof profile is accomplished with regularly spaced rafters, each with a custom curvature to match the evolving roof geometry. Longitudinal purlins with exterior bamboo sunscreens connect the structure's sharp-edged rafters on the northern side to the soft waving rafters of the south.

The architect's vision of an open interior space was achieved by designing the long-span roof as a structural grid. To ensure the necessary stiffness, custom fixed-end connections were used between the purlins and primary timber rafters, while cable cross bracing within the grid offered additional strength. This 43,000-square-foot project was completed in 2015.

Beauty of Wood – Craft: Whitetail Woods Regional Park Camper Cabins, Empire Township, Minn.

Architect — HGA Architects and Engineers

Structural engineer — HGA Architects and Engineers

General contractor — Dakota County School District

Nestled into the hillside of a new regional park, three new camper cabins — built by county employees with the aid of high school students in a vocational training program — weave their way into a stand of pine trees. Built on concrete piers to minimize the impact on the surrounding wilderness, these beautifully detailed cabins hover between 14 and 16 feet above grade with trees almost at arms-reach, creating privacy and intimacy with the natural environment.

The China Pavilion uses glulam to meet the challenges of the roof structure, including long spans and cantilevers, complex geometry, varying elevations, and exposed framing.

Photo: Sergio Grazia



Whitetail Woods Regional Park Camper Cabins are built on concrete piers with a red cedar glulam chassis, cedar and pine framing, and red cedar cladding. Photo: Paul Crosby



Above the foundation, each structure is comprised of a red cedar glulam chassis, cedar and pine framing, and red cedar cladding. Dark cedar shingles on the exterior blend seamlessly with the beauty of the pine forest, while the interior is stained naturally to create an immersive warm environment.

For this project, the beauty of wood was complemented by its sustainability, cost efficiency, and ease of construction. The three 307-square-foot cabins were completed in 2014 for a combined construction cost of \$225,000.

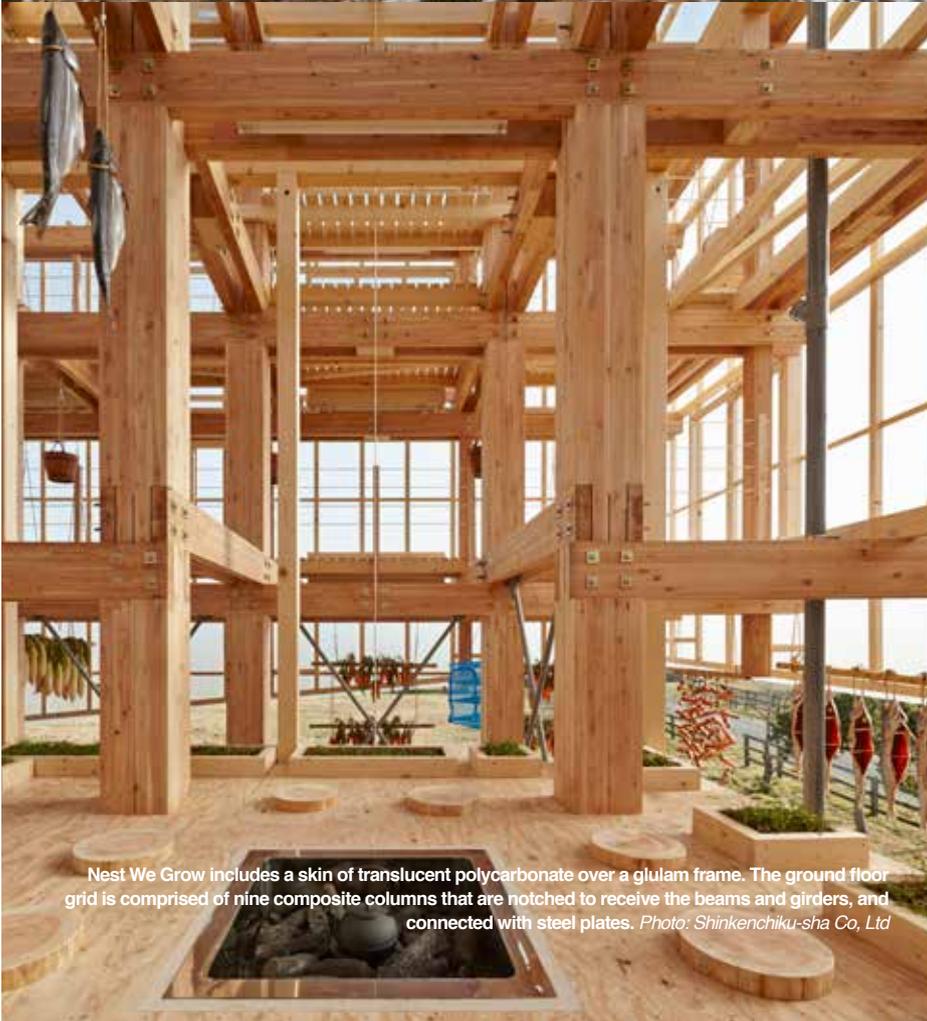
Green Building by Nature: Nest We Grow, Tai-ki-cho, Hiro-gun, Hokkaido, Japan

Designer — University of California, Berkeley, College of Environmental Design

Architect of record — Kengo Kuma Architects & Associates

General contractor — Takahashi Construction Company

Each year, Japan's LIXIL JS Foundation holds a university design competition focused on sustainable housing technologies. The 2014 theme was Productive Garden and the winning project, Nest We Grow, has since been constructed at the foundation's Memu Meadows Farm.



Described by the WoodWorks jury as an “intelligent structure,” Nest includes a skin of translucent polycarbonate over a glulam frame. The ground floor grid is comprised of nine composite columns, which are notched to receive the beams and girders, and connected with steel plates. Initial analysis called for both vertical and horizontal steel rod cross bracing due to strict building codes for seismic loads. However, the team was able to eliminate the horizontal steel cross bracing by using wood cross bracing in the two upper catwalks.

In addition to the carbon stored in the wood, the team reduced the carbon footprint of Nest by using locally harvested and manufactured wood products. This 1,577-square-foot project was completed for a construction cost of \$250,000.

Green Building by Design: Unitarian Universalist Fellowship of Central Oregon, Bend, Ore.

Architect — Hacker

Structural engineer — Walker Structural Engineering

General contractor — Kirby Nagelhout Construction Co.

In addition to reflecting the Unitarian principles of inclusiveness, exploration, community, and warmth,

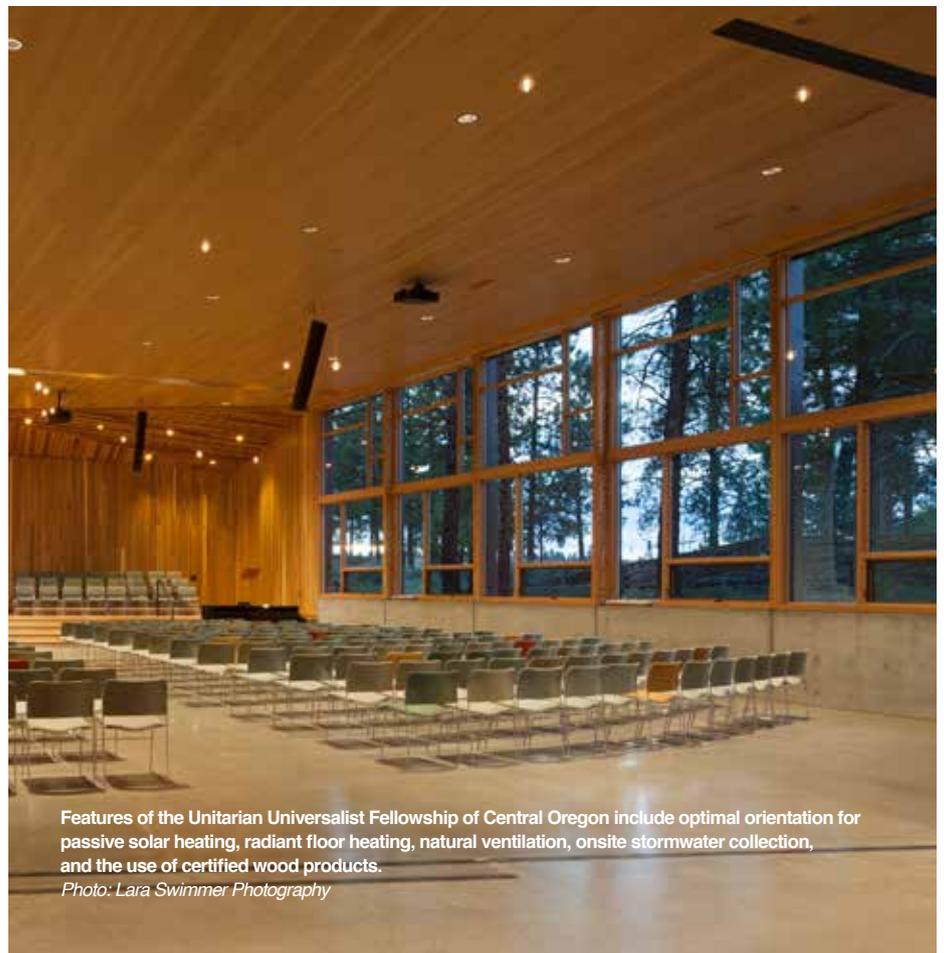
Nest We Grow includes a skin of translucent polycarbonate over a glulam frame. The ground floor grid is comprised of nine composite columns that are notched to receive the beams and girders, and connected with steel plates. Photo: Shinkenchiku-sha Co, Ltd

meaningful sustainability was a key goal for this wood-frame project. Features include optimal orientation for passive solar heating, radiant floor heating, natural ventilation, onsite stormwater collection, and the use of certified wood products.

The roof was constructed to hold enough solar panels to make the building net zero energy, and conduits have been installed so panels can be easily added at a later date. The project, which achieved Platinum Certification under the Earth Advantage program, consists of 2x exterior wall framing with a combination of manufactured gang-nail trusses and I-joists spanning to large glulam and steel wide-flange girders.

 Additional photos of the national and regional winning projects are available on the WoodWorks website at www.woodworks.org/project-gallery, along with a wide range of technical and educational resources for design and building professionals.

Information provided by the Wood Products Council (www.woodworks.org), which provides free, one-on-one project assistance as well as education and resources related to code-compliant design of non-residential and multi-family wood buildings.



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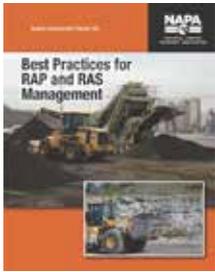
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Two free books from the National Asphalt Pavement Association help engineers make the most effective use of reclaimed asphalt pavement (RAP). *Best Practices for RAP and RAS Management* (Quality Improvement Publication 129) by Randy C. West, Ph.D., P.E., covers pavement milling, inventory management, processing, sampling, and testing of RAP and recycled asphalt shingles (RAS), as well as a discussion of production concerns. *High RAP Asphalt Pavements: Japan Practice — Lessons Learned* (Information Series 139) by West and Audrey Copeland, Ph.D., P.E., reports the findings of a 2014 industry scanning tour of Japan to study use of high levels of RAP in pavements and innovations for porous asphalt pavements.

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02. COLD-FORMED STEEL EPD

The Steel Recycling Institute released the first industry-wide Environmental Product Declaration (EPD) for Cold-Formed Steel Studs and Track manufactured in the United States and Canada. The EPD quantifies the “cradle-to-gate” life cycle environmental impacts of these products. The EPD, based on a peer-reviewed life cycle assessment, can help designers achieve the credits required for building certification within LEED and other green building rating programs. Environmental implications of steel reuse, recovery, and recycling are reported in a separate module in the EPD to give users the ability to factor in their own end-of-life assumptions.

STEEL RECYCLING INSTITUTE
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03. MOBILE APP FOR PVC PIPE STANDARDS

The Uni-Bell PVC Pipe Association released a mobile app that provides the most current PVC pipe products available meeting both AWWA and ASTM standards. The app is a useful reference tool to ensure that the most appropriate PVC pipes are specified for pipe projects. Included are PVC pipes in sizes from 4 to 60 inches for water mains, gravity sewers, sewer force mains, reclaimed water lines, storm sewers, and trenchless applications. The app provides available size ranges, joining systems, and applicable standards for each application; outside-diameter regimens for pressure pipes; and cross-section information and pipe stiffness values for sewer pipe.

UNI-BELL PVC PIPE ASSOCIATION
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04. PLASTIC NETTING HANDBOOK

Conwed, celebrating its 50th anniversary in 2016, launched its 2016 IDEA Book, a digital catalog that outlines the company’s capabilities, core products, and technologies. This new digital magazine includes a step-by-step description of how Conwed netting — used in filtration, landscape, and erosion control applications, as well as many industrial and consumer products — is made, the netting characteristics that can be customized, and how netting can be incorporated with other materials and substrates in diverse production processes. The Conwed IDEA Book was conceived as an e-handbook to guide prospects and customers when evaluating new materials.

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08. WOOD CONNECTION CALCULATOR

The American Wood Council's Connection Calculator App calculates single-fastener capacities for bolts, nails, lag screws, and wood screws based on the provisions of the National Design Specification for Wood Construction. The free app allows for quick calculation of fastener capacity with the flexibility to customize a connection for a wide-variety of configurations and environmental conditions. The calculator can evaluate connections loaded in withdrawal or laterally (in single or double shear configurations). For connections loaded in shear, the calculator presents results for each of the NDS-prescribed yield modes, and calls out the controlling result.

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07. FIELD CONTROLLER

Topcon Positioning Group announced the latest addition to its line of data controllers — the FC-5000. The 7-inch sunlight-readable display field controller is compatible with all Topcon GNSS receivers and total stations, operating MAGNET Field, Site and Layout software. It has two built-in cameras — an 8 MP camera with autofocus and LED flash for field photography and a 2 MP camera on the front for video meetings — and 64 GB of flash storage. Additional features include an optional 4G LTE cellular modem, internal GPS navigation, Bluetooth and Wi-Fi, and a battery life of more than 10 hours.

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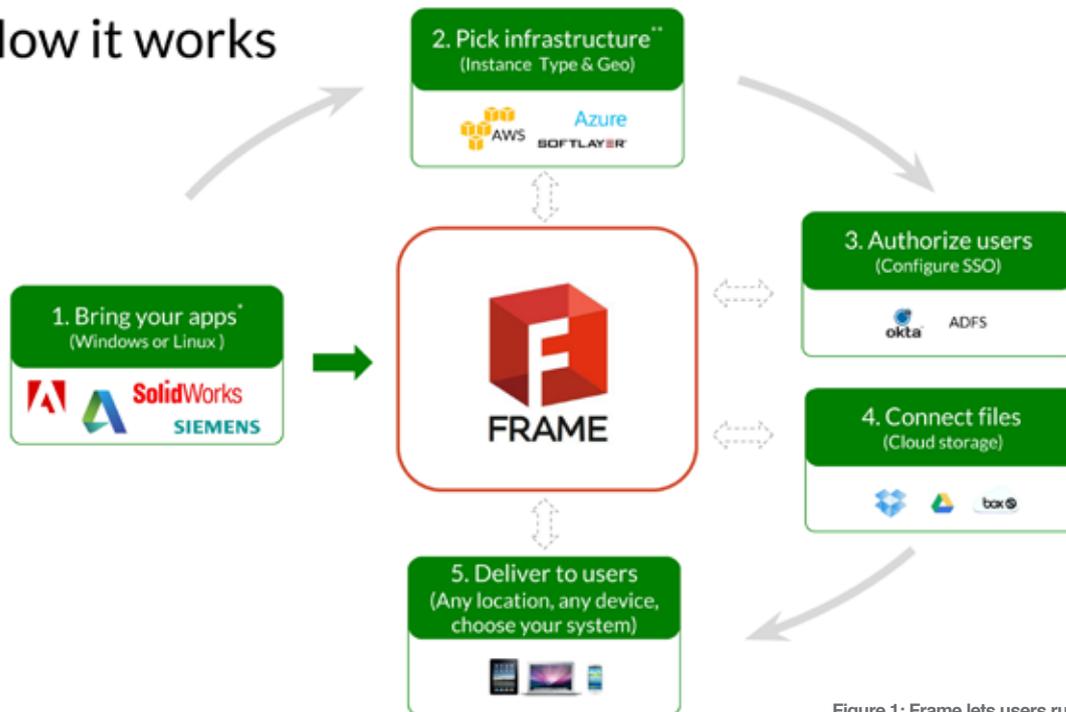


Figure 1: Frame lets users run licensed software applications in the cloud in an HTML5-capable browser

FRAME OFFERS ON-DEMAND ANALYSIS AND RENDERING POWER IN THE CLOUD

FRAME, A CLOUD SERVICE that lets users run any software in a browser, released its new system, Pro 64GB, that designers and engineers can use to run their most performance-demanding applications in the cloud. Frame Pro 64GB is optimized for modern, multi-core simulation and rendering applications. It offers more than 12 TeraFlops of multi-core processing power using two Intel Xeon CPUs, four NVIDIA GRID GPUs, 64 GB of memory (RAM), and 120 GB SSD storage in a cloud-based system that users can access on demand for less than \$4 per hour, the company said. Users only need an HTML5-capable browser such as Chrome, Firefox, Safari, or Explorer 11.

Frame runs users' licensed applications on servers in the cloud and delivers the user interface to their browsers as a video stream. The system works on a Mac, PC, iPad, or even a Chromebook without plugins, Java, or Flash. Mouse and keyboard actions are sent back to the Frame Visual Cloud in real time and the user interface updates so quickly it feels like the app is running locally, the company said. Frame works with Dropbox, Box, Google Drive, or users' own cloud storage as a hard drive (see Figure 1).

Frame users can select from options based on their geographical, technical, or regulatory needs — or use them all at the same time.

Frame lets users scale around the world, accessing multiple data centers on five continents on infrastructure from Amazon, Microsoft, Google, and other partners.

In addition, Frame provides collaboration within any Windows application. Click “Share session” and send the URL to a colleague to have them join a session from their browser. Both users see the same desktop app and can share the mouse and keyboard in real-time.

Frame scales on-demand, with new seats deployed in minutes, the company said. Subscribers to Frame Standard and Frame Plus plans can switch between systems — Air 4GB, Air 8GB, Pro 16GB, Pro 64GB — with the click of a button, depending on computing needs:

- Air 4GB is appropriate for general purpose applications such as MS Office;
- Air 8GB handles general purpose graphics applications including photo editing and 2D CAD;
- Pro 16GB works best for graphics-intensive applications; and
- Pro 64GB provides the power needed for rendering and simulation applications.

“Conventional rendering hardware and high-end virtualization solutions come with a very high price tag,” said Nikola Bozinovic, CEO of Frame. “Our new Pro 64GB offering allows designers to shift to powerful visual workstations on demand. Access to stunning interactive photorealistic rendering has never been easier.”

Information provided by Frame (www.fra.me).

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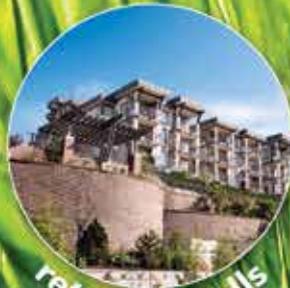
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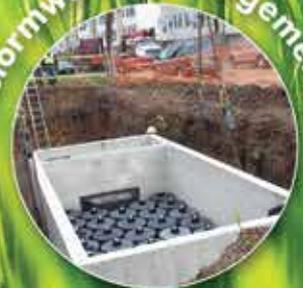
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