A Magazine for Specifiers and Engineers

precast solutions

SUMMER 2013

GREEN ISSUE

In this issue:

NEW!

Microbial Induced Corrosion Defense

Break the Chain with...

ConBlock MIC

Why does MIC occur?

A particular chain of events is necessary in the development of an environment for micbrobiologically induced corrosion to occur. During this chain of events, an acid generating bacteria - Thiobacillus - will thrive on the surface of concrete. The excreted acid will begin to corrode the concrete, and harsher bacteria strains will continue to develop. ConBlock MIC breaks this chain of events by creating an environment that is unihabitable to these organisms, protecting concrete from microbiological corrosion.

How does ConBlock MIC work?

Whether integrated throughout the matrix of concrete when used as an admixture and/or directly applied to the concrete as a surface treatment; ConBlock MIC inhibits the growth of bacteria, fungi, mold, and algae. The unique chemistry of ConBlock MIC creates a chain of molecules, attracting the organisms towards a Nitrogen ion that provides an ionic shock - puncturing the organism's outer cell upon contact. Thus, the concrete surface becomes uninhabitable to microbiological organisms.

Have a problem? **Don't Just Seal It, ConSeal It!**

ConSeal™
Concrete Sealants INC.

NPCA

American Concrete Pipe Association

ASTM MEMBER

- ISO 9001:2008 Registered Company
- Controlled Expansion Waterstop Sealants
- NSF Listed & Fuel Resistant Butyl Sealants
- Polyolefin Backed Exterior Joint Wrap
- Butyl Rubber Tapes
- Water Based Coatings
- Surface Treatments
- Antimicrobial Admixture

www.conseal.com
1.800.332.7325

SUMMER 2013
VOLUME 11 | NUMBER 3

precast solutions®

GREEN ISSUE

4 | Double Parked

A parking garage doubles as an athletic field at Pomona College, a winning project in the first NPCA Sustainability Awards.

By Claude Goguen, P.E., LEED AP

8 | PRECAST ABROAD

A brief look into some overseas precast concrete projects that are making news.

By Kirk Stelsel

photo credit BCI

10 | Precaster Goes To Bat To Save Species From Extinction

A custom precast cave is hoped to slow a white killer that may lead to the rapid extinction of our only flying mammal.

By Sue McCraven

16 | Precast Passage: Restoring Natural Habitats

Precast concrete box culverts are restoring essential connectivity for aquatic life in the Great Lakes Basin.

Emily Clegg, The Nature Conservancy

24 | Saving The Hellbender

A simple, elegant precast solution could help bolster an endangered species.

By Bob Whitmore

28 | Trench Warfare

How does reinforced concrete pipe comply with the Clean Water Act and stand up against corrugated metal pipe on the front lines of contract bidding?

By Michael D. Kusch

ON THE COVER:
Before installation of this arched precast concrete culvert, a perched conduit had altered the streambed and blocked all fish passage under a state road in northern Michigan. The precast culvert re-established the natural riverbed passage. Turn to page 16 for other examples.

Photo courtesy of Jason Whalen with special thanks to the Conservation Resource Alliance. www.michigan.gov/dnr

Precast Solutions (ISSN 1934-4066 print, ISSN 1934-4074 online) is published quarterly by NPCA, the association of the manufactured concrete products industry.

Publisher: Ty Gable
Executive Editor: Bob Whitmore
Managing Editor: Ron Hyink
Editor: Sue McCraven
Associate Editor: Kirk Stelsel
Graphic Designer: Deborah Templeton
Advertising: Brenda C. Ibitz
Vice President of Development & Member Services
(317) 571-9500 • (317) 571-9941 (fax)
bibitz@precast.org

NPCA
Precast Solutions
1320 City Center Dr., Suite 200
Carmel, IN 46032
(800) 366-7731
(317) 571-9500 (International)
Fax: (317) 571-0041
E-mail: npca@precast.org

NPCA
Precast ... The Concrete Solution

Double Parked

A parking garage goes green as it combines with an athletic field at Pomona College.

By Claude Goguen, P.E., LEED AP

Since its inception in 1887, Pomona College in Claremont, Calif., has grown to become one of the nation's premier liberal arts colleges. With 1,500 students, Pomona College offers a student-faculty ratio of eight-to-one.

Among their many sustainability goals, college planners wanted to make the campus more pedestrian-friendly. They also wanted to free up space for further campus expansion by using old lots for new building sites and open green spaces.

The answer was to build a parking garage that did not look like a parking garage. Ehrlich Architects, Culver City, Calif., partnered with Watry Designs, Redwood City, Calif., to design a two-story, 318,000-sq-ft parking garage for 608 vehicles on the south campus. The garage was built on sloping land so that the structure is partially underground with only one side exposed. Not only was the southeast corner of the garage bermed so that it fuses into the campus, the architects also placed a synthetic-turf athletic field on the roof.

By undertaking this project, Pomona College ended up with not only a durable and aesthetically pleasing garage, but also one that matches up with the ongoing campus initiative to go green and to become a more pedestrian-friendly campus.

The future of parking garages

There are reportedly more than 500 million surface parking spaces in the United States, and the number grows daily. In some cities, parking lots make up more than a third of the land area! But the basics of parking design haven't changed much since the 1950s.

Some cities, engineers and architects have taken the initiative to push parking garages underground or reinvent them for dual uses. A trend started in Miami in 1996 as the Ballet Valet Parking Garage on South Beach was built with an art deco facade incorporating vertical vegetation. A few years later, 1111 Lincoln Road was built. This Miami parking garage is such a hotspot, it has even hosted weddings! Constructed of concrete and glass, it is visually stunning and incorporates many uses, including residential and commercial.

Pomona College's garage is yet another example of this continuing and emerging trend. Michelle Wendler of Watry Designs, the structural engineer and executive architect for the project, says that besides serving multiple purposes, the garage checks off another trend: the seemingly counterintuitive one of integrating parking structure within their environments.

Precaster

StructureCast of Bakersfield, Calif., has been manufacturing a wide range of precast concrete products for more than 30 years. Its facility is midway between the Los Angeles Basin and the Northern California population centers. StructureCast, whose Pomona College work was a winning entry in the inaugural 2013 NPCA Sustainability Awards, supplied 165 architectural precast panels for this LEED Platinum project. The company worked with designers at the

beginning to come up with textures and colors that would blend best with the area's natural environment and terrain. The panel finishes had a medium acid-etched exposure and used a specially selected natural stone and a tan color pigment.

In addition to the panels, StructureCast manufactured unique roof-level spandrels with integrated benches that allow spectator seating for the rooftop field. These structures contributed to LEED credits because of the recycled content of the reinforcement, as well as the relatively short distance between extraction of raw materials to the plant and the distance from the plant to the job site.

Sustainability Awards

In keeping up with the demands of the construction industry, many NPCA members, such as StructureCast, have adopted sustainable practices in their purchasing, manufacturing and shipping operations, and have helped projects achieve sustainability-related goals. The precast concrete industry has benefited from their actions, and it is in this spirit that NPCA's Sustainability Committee created the NPCA Sustainability Awards. The goal of this award program is to reward excellence in sustainable products, practices and operations within NPCA membership, and to publicize the overall progress of the precast concrete industry toward sustainability.

The inaugural NPCA Sustainability Awards were handed out at The Precast Show 2013 in Indianapolis. Of the 13 entries submitted, four winners were chosen in four categories: Associate Product, Associate Plant, Producer Project and Producer Plant. StructureCast won both producer categories, including the Producer Project category for "Pomona College South Campus Parking Garage."

First Place - Sustainable Project, "Soccer on the Roof" by StructureCast

Other winners and entrants

Nycon Corp., Fairless Hills, Pa., won in the Associate Product category with its Nycon-G Fiber, a product that can be used in fiber-reinforced concrete. In an effort to create a greener fiber product, Nycon-G was invented using 100% reclaimed post-consumer and post-industrial waste carpet. The timing was favorable, as the federal government and nylon manufacturers were working to develop a way to increase their recycling efforts.

Nycon-G can be used for decorative and construction purposes. The fiber was used in a large-scale project at the Heldrich Hotel and Conference Center in New Brunswick, N.J. The 500 precast concrete panels used in

First Place - Associate Product, "Carpet to Concrete" by Nycon Corp.

the project were produced with concrete that included the Nycon-G fiber.

The use of this fiber offers excellent crack control, improves the concrete's resistance to plastic shrinkage and abrasion, and helped the project achieve LEED Platinum certification.[1]

M.A. Industries, Peachtree City, Ga., won in the Associate Plant category with its implementation of a new recycling program. M.A. Industries' manufacturing plant was generating excessive amounts of waste and was in need of a recycling program. All waste was classified as trash and hauled away in a 30-cu-yd dumpster, including items that could have been recycled. This resulted in costs of about $55,000 a year. Reducing the amount of trash by separating the recyclables would reduce the yearly cost of waste removal.

A core team was formed to take on the task of developing a project to reduce waste cost by 25% through the recycling of paper and cardboard products. They developed a timeline with a targeted completion

date of February 2012. Working with M.A. Industries employees, the team collected data on waste generation and disposal. First, they replaced cardboard containers with self-dumping hoppers, which reduced waste by minimizing the amount of discarded cardboard. Also, recycling bins were provided throughout the office for personnel to use and participate in this initiative. Cardboard, cellophane and clean paper products were segregated from other waste for recycling.

The old dumpster was emptied two to three times at a rate of $375 each time. As a result of the recycling efforts, the 8-yd replacement dumpster is emptied once a week at a rate of $100 per month. This not only resulted in a more sustainable and environmentally friendly operation, but also saved M.A. Industries $53,400 annually.

StructureCast won a second award in the Producer Plant category with its material recycling center. StructureCast set up a crushing and screening plant primarily to recycle the return concrete from three concrete plants (StructureCast and two others) and their washout. In 2010, the four-acre facility began to accept waste concrete and asphalt from construction projects. The processed product is then resold (about 10,000 tons per month) as road base to paving contractors, and the recycled steel goes to scrap iron centers. The project is operated by three men about 15 days per month.

The recycling project is welcomed by state and local agencies, as 100% of the recycled materials are reused in right-of-way construction. Sustainability benefits include reuse of waste, less construction waste entering landfills, less need for mining of new materials, and lower emissions. Transportation costs were reduced, as the recycling site is four miles from the city center, while the area's rock deposits are 40 to 60 miles further away. ps

Claude Goguen, P.E., LEED AP, is NPCA's director of Technical Services and Sustainability.

[1] For more information on this product, check out their web site at: http://www.nycon.com/ncwp/product/nycon-g/

SUSTAINABILITY AWARDS ASSOCIATE CATEGORY

FIRST PLACE - Associate Product

CARPET TO CONCRETE

Making Fibers From Waste Carpet

Nycon Corporation, Fairless Hills, Pennsylvania

Nycon-G Reinforcing Fiber for Precast Panels

FIRST PLACE - Associate Plant

RECYCLING FOR DOLLARS

New Program Saves Big Money

M.A. Industries

Implementation of a New Recycling Program

HONORABLE MENTION

BASF, Concrete Mix Optimization Program

Hill & Griffith Company, Rainwater Harvesting

Hill & Griffith Company, GRIFCOTE LV-50 Form Release

SUSTAINABILITY AWARDS PRODUCER CATEGORY

FIRST PLACE - Sustainable Project

SOCCER ON THE ROOF

LEED Platinum Parking Structure

StructureCast, Bakersfield, California

Pomona College South Campus Parking Structure

FIRST PLACE – Sustainable Plant

WASTE MAKES BASE

Recovering Scrap Concrete and Steel

StructureCast, Bakersfield, California

Material Recycling Center

HONORABLE MENTION

Arto Brick California Pavers, Port of Los Angeles World Cruise Center, Photovoltaic Array

Lindsay Concrete Products, Precast Concrete Solar Skid Shelters

Mountain West Precast, I-15 Concrete Pavement Rehabilitation

Smith-Midland Corp., Single Stream Recycling Program

Smith-Midland Corp., Wall Panels/U.S. Army Legal Service Agency Admin. Building

Utility Concrete Products, Baha'i House of Worship Rainwater Harvesting Project

First Place - Associate Plant, "Recycling for Dollars" by M.A. Industries

First Place - Sustainable Plant, "Waste Makes Base" by StructureCast

Precast Abroad

A brief look into some overseas precast concrete projects that are making news

By Kirk Stelsel

Precast concrete has long been a staple building material in North America for everything from infrastructure products to architectural building materials. Beyond our shores, though, a thriving and innovative global precast concrete industry can lend ideas to designers and builders here at home.

Stockholm, Sweden

In Stockholm, one of the newest additions to the skyline brings to mind an iconic structure in New York City. That's because the wedge-shaped building is a sort of 21st-century reboot of the famous Flat Iron Building. While the Swedish version may share a name and some design cues, that's where the similarities end.

The Swedish exterior has a distinctly modern feel that stands in stark contrast to the New York version, which is punctuated by lions' heads, faces and terra cotta – a look that *New York Magazine* described as reminiscent of "an Italian Renaissance palazzo." The modern facade of the Swedish version is wrapped in precast concrete panels, which added a number of attributes to the building. In addition to the exterior panels, the contractor used precast concrete hollow-core slabs and interior wall panels throughout the building.

With a short construction timeline, precast allowed Skanska, the building contractor, to increase efficiency and get the building to the rental market as quickly as possible. The facade panels were delivered to the site with preinstalled windows, eliminating the need for bulky, expensive scaffolding during construction. With the urban location, space for building material storage was also limited, making the just-in-time delivery of the precast elements an absolute necessity for the contractor. According to Skanska, the precast also provided the desired modern look and a high range of architectural and design options, and will offer reduced management and maintenance issues throughout the building's life cycle.

Designed with sustainability in mind, the Swedish building earned a LEED Gold certification as well. The natural thermal mass of the precast panels allows for more efficient heating and cooling of the building, contributing to the eco-friendly assets of the building. The concrete also acts as a sound barrier between a rail depot bordering one side of the building and a residential area on the other.

Flat Iron Building
Photo courtesy of Hans Nerstu

Tel-Aviv, Israel

A stunning example of how precast concrete can be used to define a design, not just support it, can be found at a recent expansion to the Tel Aviv Museum of Art. The structure was designed by Preston Scott Cohen, owner of Preston Scott Cohen Inc. in Cambridge, Mass. Cohen also serves as chair of the Department of Architecture and the Gerald M. McCue Professor of Architecture at the Harvard University Graduate School of Design.

The expansion includes an exterior shell made of 460 precast concrete panels. Each panel has four sides, but no two have the same shape or size. The panels, some as large as 30 ft on one edge, were cast using flexible-edge molds that were adjusted to the individual angles and dimensions. With so many different shapes, the need to drill holes in the casting table to bolt down the forms for pouring was eliminated by using powerful magnets the keep the sides in place.

Glasgow Parking Garage
Photo courtesy of SCC Ltd.

Glasgow, Scotland

At the 2014 Commonwealth Games, which will take place in Glasgow, precast concrete will be on full display. Decomo UK Ltd. was awarded a contract to provide 32,292 sq ft of architectural precast cladding for the Emirates Arena and the Sir Chris Hoy Velodrome.

The precast, featuring a black exposed-granite aggregate finish achieved through acid etching, creates a look that evokes the heritage of the region's coal mining past. The 398 panels were used on the external facade of the two buildings and the interconnecting hub between them. Precast was specified for its durability and design flexibility, as well as inherent acoustic and thermal qualities.

In addition, SCC Ltd., also located in the United Kingdom, contributed precast for a 1,600-space parking garage. The garage utilizes SCC's newly developed inverted frames, named IPCs (Integrate Precast Components), and its PFV (Precast Finished Voided) flooring system. Two semicircular ramps on the north end of the garage are also made of precast manufactured by SCC, and are thought to be the first of their type to be constructed in this way. PS

Kirk Stelsel is NPCA's director of Communication.

Precast panels are installed on the Emirates Arena in Glasgow, Scotland.
Photo courtesy of Decomo UK.JPG

Precaster to Save Species

A custom precast solution is being used to slow a creeping white killer that is eliminating bats faster than the 19th-century eradication of the American carrier pigeon.

By Sue McCraven

It looks like they'll all die.

Inside dark caves, a creeping white death blankets the tiny faces and furry wings of bats while these warm-blooded animals sleep or slip into hibernation. Come springtime, the weakened bats emerge to face a hideous death of thirst and starvation while the insidious fungus marches on to new killing fields, leaving behind a permanently destroyed habitat and a species headed for extinction.

In just five years, with its 90% kill rate, this cold-

Photo by Merlin D. Tuttle, Bat Conservation International (www.batcon.org)

Goes to Bat from Extinction

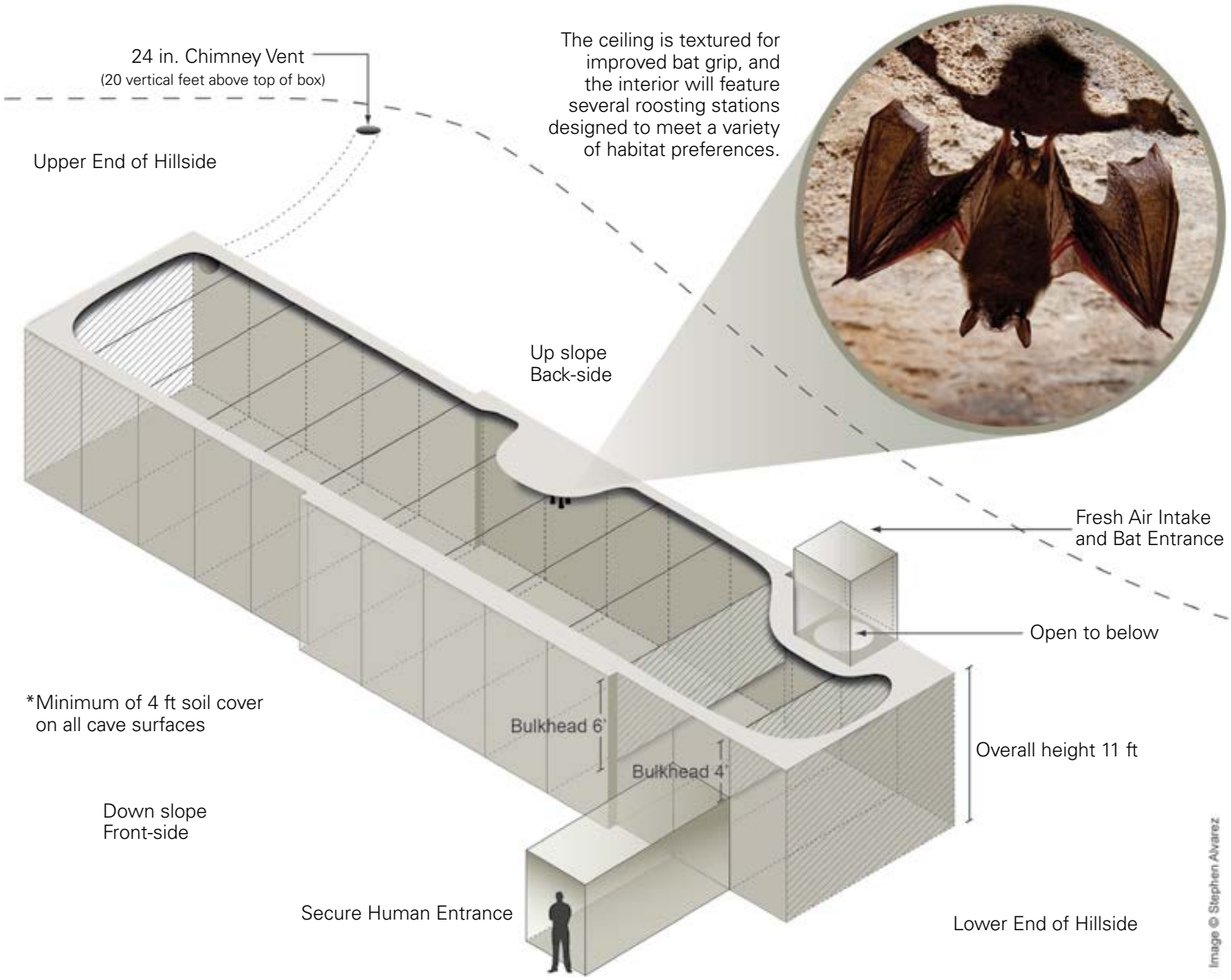
loving, cannibalistic fungus called White Nose Syndrome (WNS) has wiped out 6 million bats in the eastern United States and is swiftly spreading cross-country. Wildlife biologists and scientists are stunned by the exterminating power and rapid spread of *Geomyces destructans*,[1] first found in New York caves in 2007. There is no known treatment or cure.

The Little Brown Bat, particularly devastated by WNS, is the most common bat species in North America. With accurate projections based on recent mass fatalities, experts say the Little Brown Bat will vanish in 15 to 20 years. We will be witnesses to the most rapid mammal extinction in North American history[2] if no method to combat WNS is found. It turns out that the best hope for the Little Brown Bat may be artificial hibernacula:[3] precast concrete bat caves.

Custom, precast concrete concept to the rescue

Concrete is so much more than the best infrastructure material. In World War II, concrete bunkers protected soldiers in battle.[4] Today, at dangerous Middle East checkpoints, terrorism barriers made of heavily reinforced precast concrete continue to bulwark U.S. soldiers.

Concrete is, in essence, man-made rock with tremendous design flexibility for innumerable applications. So it makes sense that a precast concrete



Schematic provided by The Tennessee Nature Conservancy (www.nature.org)

solution could be designed to help defend the Little Brown Bat from WNS with a cleanable cave. Wildlife biologists hope that precast concrete caves can be effectively cleaned of WNS and its fecund spores when bat colonies leave the structure in warm weather.

David Phillips at Summit Constructors Inc. first contacted Larry Taylor at Oldcastle Precast in Lebanon, Tenn., about their ideas for a precast structure to help save bats. "Summit got the job with Panattoni Construction Inc., The Tennessee Nature Conservancy's (TNC's) contractor," says Spencer Jones, plant manager.

Jeff McKinley, Oldcastle Blue Grass regional sales manager, believed that the bat cave project was good for the environment and the precast industry, "even though we'd likely lose money on the job," says Jones. "All of us here at Oldcastle thought this whole idea to help save the bats was pretty cool and a really unique challenge. You don't get many chances to help the planet, to give back. We went at it with the best of our ability."

At Oldcastle, the designers and production crew started hashing out feasible ideas, continues Jones. "We knew there was an above-ground cave in Texas, but could we build an underground cave? We had to consider the specific habitat needs of bats, including cave temperature, humidity, water source, ventilation and human access for the bat scientist," he says.

A bearded spelunker and wildlife scientist, Cory Holliday is TNC's cave and karst[5] program manager, the project's chief technical consultant and a renowned bat expert. "This artificial cave not only has the potential to save a large colony of bats from White Nose Syndrome," says Holliday, "but also serves as a model that could be replicated anywhere WNS threatens to destroy a significant colony of hibernating bats."

Contractor installs human ingress sections of precast concrete bat cave in Tennessee.
Photo courtesy Oldcastle Lebanon (www.oldcastleprecast.com)

A renowned bat expert, Cory Holliday, cave and karst program director for the Tennessee Chapter of The Nature Conservancy, stands at the entrance to Hickman County cave, TN.
Photo by Kristin Bobo and provided by The Tennessee Nature Conservancy (www.nature.org)

Completed precast concrete bat cave installed, backfilled and reseeded. Completed during Tennessee's summer months, the warm soils of the backfill kept the cave temperatures higher than optimum for the Eastern Brown Bat during 2012-to-2013 winter hibernating season.
Photo courtesy of The Tennessee Nature Conservancy (www.nature.org)

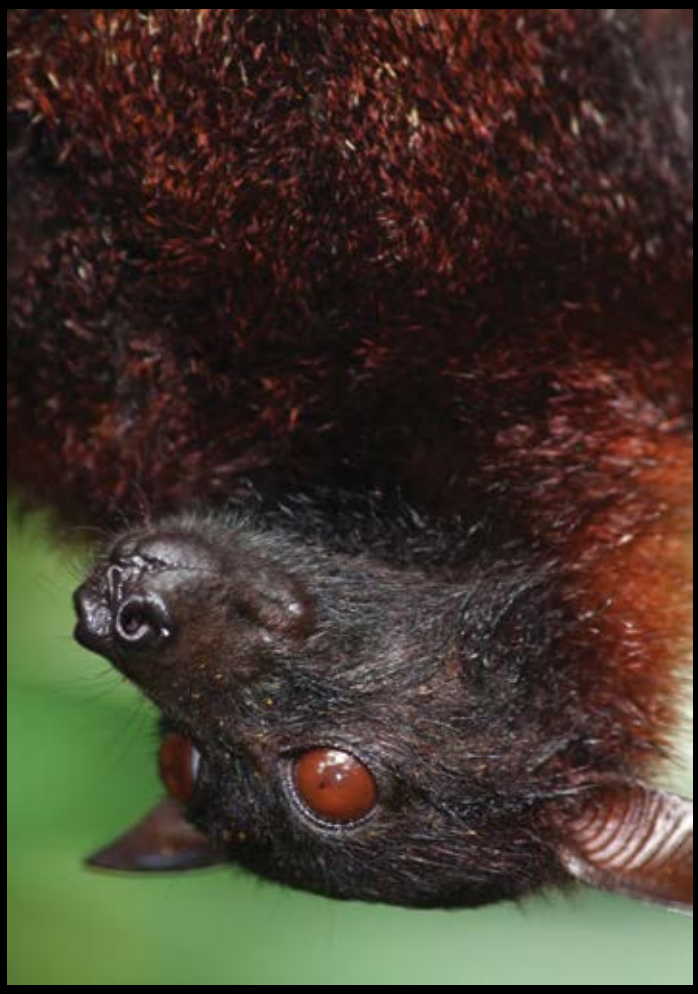
Cost limitations & finicky fliers

Because bats hang upside down by their feet when sleeping and hibernating, the precast top slab's inner ceiling had to simulate the varied surface of a natural cave. Oldcastle used 4 ft by 8 ft pieces of polyurethane forms with an irregular surface on one side to create a roosting grip for bats on the ceiling.

"Because this project was one-off on a limited budget, Tony Ziend and Nicholas Krug, Oldcastle designers, had to minimize fabrication costs by working with our

Bat Facts to Surprise and Astound

1. Bats are the only mammals that can fly.
2. While hibernating, a bat's body temperature drops, its metabolism slows, and the bat is much more susceptible to attack by the deadly White Nose Syndrome.
3. Bats drink on the wing like swallows, sipping as they swoop over streams.
4. Most mother bats bear and carry a single baby, called a pup, until it can fly.
5. If a pup makes it to adulthood, some species can live into their 20s or longer.
6. Thailand's bumblebee bat is the world's smallest bat at 1.2 in. long, and flying foxes – handsome bats from Indonesia – can have 6-ft wingspans!
7. Bat wings are made up of two layers of almost-transparent skin that stretch over their delicate finger bones.
8. Bats make up 25% of all mammals on earth.
9. At night, bats have amazing aviation accuracy; some zero in on flying insects and others fly to blooming flowers (bats are effective pollinators) or ripe fruits. Vampire bats are the only mammals that feed exclusively on blood.[6]
10. Bats are tremendously beneficial to humans, because they feed on disease-carrying mosquitoes and crop-destroying beetles and other pests.



One of the largest of the megabats, the Flying Fox of the South Pacific feeds off flowers, nectar and fruit. Weighing in at 2 lbs, this handsome bat has a 5 ft wingspan. If you look closely, you can see orange pollen on her face.
Photo courtesy © Boaz Yunior Wibowo | Dreamstime.com

existing forms. Summit Constructors provided the ceiling form liner," says Jones.

"We thought a 6 ft by 12 ft, three-sided culvert mold could be used. We'd stack one atop another and lay them together lengthwise to make a long precast tube," adds Jones. "It had to have an air chute and a 4-ft by 6-ft opening cut into the box for the bats, and another entryway for the scientists."

Bats are very finicky creatures. "From all the required specifications Cory gave us, we figured out the overall dimensions and openings of the precast cave," says Jones. "We designed 1-ft-thick end walls and top slabs to resist the high earth loads. Internal baffles were fabricated to create variations in internal temps for the – hopefully – various bat species."

In Tennessee's Montgomery County, cranes set the U-shaped precast concrete pieces in an excavation not far from an existing bat hibernation cave on property owned by the state's Wildlife Resources Agency. At 78 ft in length, the precast "hibernaculum" is 16 ft wide and 11 ft high and was completed in September 2012.

The result? Over the 2012-2013 winter, "Several bats checked out the cave, and a few even roosted there for a short time," says Holliday. But a bat colony didn't select the manmade cave for overwintering. "Bats are very particular about temperature for hibernation and the cave was backfilled during a hot Tennessee summer," says Jones. It is thought that residual heat from the backfill soils kept the precast cave from dropping to a bat-preferred temperature.

Holliday expects better results in the future, saying, "It did take several months for our concrete cave to cool down, but by January we were observing stable temperatures between 41 and 48 degrees. This is already colder than the natural cave next door. We are very optimistic about our ability to save bats with this cave." ps

Sue McCraven, senior NPCA technical consultant and Precast Solutions editor, is a civil and environmental engineer.

Spencer Jones, Oldcastle Lebanon Plant Manager
Photo courtesy of Oldcastle Lebanon (www.oldcastleprecast.com)

The spread wings of this Hoary Bat show the arm, hand bones and delicate skin of its wings – body parts similar to those of humans.
Photo courtesy of Cory Holliday

(Endnotes)
[1] Visit: www.whitenosesyndrome.com

[2] Passenger pigeons, once outnumbering all U.S. birds, were exterminated in less than 100 years by 19th-century overhunting and wanton killing. See: www.damninteresting.com/extinction-of-the-passenger-pigeons

[3] Hibernacula are shelters for hibernating animals.

[4] Cory Holliday: "A group in Maine is attempting to convert old military bunkers into hibernacula."

[5] A karst is a large limestone formation with long fissures, sinkholes, underground streams and caverns created by natural erosion.

[6] Luckily for us., the vampire bat (it approaches its prey from the ground, on all fours) inhabits the tropics of Mexico, Central America, and South America. See: http://animals.nationalgeographic.com/animals/mammals/common-vampire-bat/

Precast Passage:

Restoring Natural Habitats

Precast concrete box culverts are restoring essential connectivity for aquatic life in the Great Lakes Basin by eliminating manmade obstructions in rivers and streams.

Emily Clegg, The Nature Conservancy

In stewarding our natural resources, we can't be too cautious about protecting the aquatic life in our rivers and streams. Indeed, thousands of manmade dams and stream diversions have seriously degraded and obstructed the natural habitat of our native fisheries. But that's precisely where precast concrete can help.

A case in point is the Great Lakes Basin. This vast area is home to more than 30 million people in the United States and Canada, covers about 295,000 square miles, and contains about 354,800 miles of rivers and streams. The five Great Lakes hold one-fifth of the

Photo Credit:
Conservation Resource Alliance

10 (see text on page 22)

world's freshwater surface, making this area one of the most valuable natural resources in North America. The Great Lakes commercial and recreational fishery alone is worth more than $4 billion per year and is home to more than 150 species of fish.

Many of these species of fish and other organisms rely upon moving freely throughout the Great Lakes and their tributaries to access habitats for spawning and rearing. Therefore, ensuring the connectivity of these systems is vital. Recent estimates indicate that more than 275,000 manmade dams and stream crossings exist in the Great Lakes Basin. That equates to a manmade structure approximately every 1.25 river miles in every river and stream flowing into the Great Lakes![1]

Obstacles to natural flow

Several environmental agencies and organizations have identified aquatic connectivity, or lack thereof, as one of the top threats to the Great Lakes. Connectivity is fragmented or interrupted when barriers obstruct rivers and streams, altering ecological processes such as the transportation of nutrients and natural water flows, and restricting migratory aquatic organisms like fish, insects, mussels, amphibians, reptiles and some mammals, often causing population fragmentation or isolation.

There are three significant ways that manmade structures can become obstacles to the natural flow of rivers and streams:

Perched culverts. Dams and perched culverts remain the most obvious barriers to the upstream movement of organisms. At the downstream end, perched culverts often create a waterfall with a large pool that forms a physical barrier to organisms. Upstream, perched culverts often increase water levels and temperatures by confining the water flow, making a wider channel and slowing the flow, which deposits sediments.

Undersized structures. Other less common characteristics of barriers include undersized structures, which cause an increase in the velocity of the river or stream that is too swift for some animals. When structures are too long, animals may feel deterred to enter them. If there is a debris blockage, too much sediment, or not enough water in the culvert during low-flow times, organisms cannot pass through at all.

Other characteristics of manmade barriers. Several key characteristics influence the passage of fish, insects and other animals, and require consideration when designing structures. These include water temperature, swiftness or velocity, turbulence, structure sizing, slope, angle to the road, length and localized amounts of light, and debris and sediment.

Three-sided precast concrete culverts are rapidly becoming part of the solution to this looming issue in the Great Lakes.

Precast concrete culverts ensure natural connectivity

Many types of structures can address connectivity issues, but one of the easiest and most effective ways to ensure connectivity is to use three-sided precast concrete box culverts or arches. They allow water and debris to pass freely, saving on maintenance costs, and they are less likely to fail or wash out, substantially extending service life.

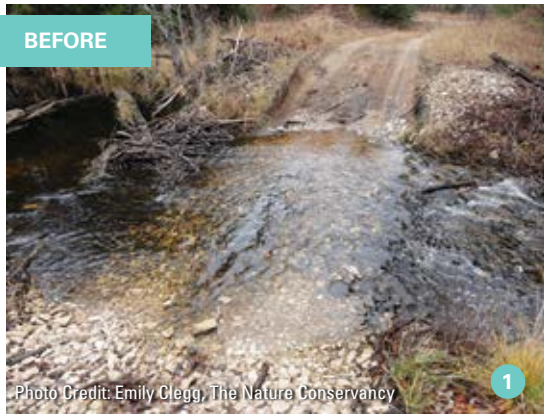
Many state, provincial and federal infrastructure agencies and local organizations that have specified three-sided precast concrete box culverts or arches to achieve connectivity goals, such as fish passage, have also started seeing other benefits during extreme weather events like Hurricane Irene (August 2011) and Hurricane Sandy (October 2012).

For example, during Hurricane Irene, Green Mountain National Forest received up to 12 in. of rain in less than a day.[2] The Forest Service found that recently replaced stream crossings with a natural bottom designed and built as wide or wider than the river's bank incurred virtually no damage to the structure. In comparison, crossings with undersized, poorly aligned culverts experienced severe damage.[3]

Lack of connectivity is one of the greatest identified threats to the Great Lakes, yet may also be the easiest to fix. Rather than replacing stream crossings with the lowest cost option or the same type of structure that previously existed, many government agencies are now considering connectivity and aquatic organism passage when designing new structures.

Natural-bottomed precast concrete structures have proven to be an extremely important and effective tool in the restoration of aquatic connectivity in the Great Lakes Basin by allowing for natural flow regimes, transporting nutrients and restoring access to key aquatic animal habitats.

5 Case Studies of Precast Concrete Solutions



EXAMPLE A Lake Superior Basin – Repairing a ford with precast concrete landscaping blocks for easy movement of a portable bridge in the Two Hearted River Watershed, Mich.

1 A ford located in the Lake Superior Basin across the West Branch of the Two Hearted River (a renowned trout stream made famous by Ernest Hemingway) near Newberry, Mich. The ford was a barrier to fish and other aquatic organisms during low flow periods, confining water upstream and creating steep rapids downstream with a large sediment plume from too much sediment running down the road into the river.

2 In 2010, with funding from the Great Lakes Restoration Initiative, The Nature Conservancy removed the ford across the West Branch of the Two Hearted River down to the original stream channel, stabilized the banks with field stone, and used 2-ft by 2-ft by 6-ft precast concrete landscape blocks to create staging pads for the later use of a portable bridge. The bridge can be moved between two other similar sites in the Conservancy's Two Hearted River Forest Reserve to accommodate timber harvesting. The use of portable bridges in forest operations has resulted in 98% less sediment entering the stream than if a culvert had been installed.[4]

3 A portable bridge used for timber harvesting operations over Chapel Creek near Munising, Mich. (Lake Superior Basin). Portable bridges reduce impact to streambed disturbance, accommodate large water volumes, reduce the amount of sediment into the stream and allow for full aquatic organism passage.

AFTER

Photo Credit: Dale Higgins, USDA Forest Service

5

Photo Credit: Dale Higgins, USDA Forest Service

6

BEFORE

Photo Credit: Dale Higgins, USDA Forest Service

4

EXAMPLE B Lake Michigan Basin – Repairing an undersized and damaged four-sided box culvert with a three-sided precast concrete box culvert in the Pine River Watershed, Wis.

4 A stream crossing of Forest Road 2168 over the Long Lake outlet, a tributary to the Pine River, in the Chequamegon-Nicolet National Forest near Florence, Wis., was a four-sided concrete box culvert. The crumbling culvert proved too narrow for the outlet, so as it came time for replacement, the Forest Service designed a new wider structure with a natural bottom.

5 The Forest Service replaced the Long Lake outlet and Forest Road 2168 crossing in 2011 with a 20-ft span and 4-ft rise, open-bottom precast concrete box with wing and headwalls. This wider span allows for a natural flow regime out of the lake.

6 The Long Lake outlet three-sided concrete box culvert has a natural bottom with designed rock veins to reduce stream swiftness, create more natural pool and riffle formations, enhance in-stream habitat for aquatic organisms, and prevent erosion. During low and normal flow, dry banks under the structure allow for small terrestrial animal passage as well as aquatic passage.

EXAMPLE C Lake Michigan Basin – Replacing three undersized perched culverts with a precast concrete arch with a natural bottom in the Popple River Watershed, Wis.

7 The Little Popple River and Popple Road crossing located in the Chequamegon-Nicolet National Forest near Florence, Wis., consisted of four 48-in.-diameter, undersized, perched culvert pipes.

8 The Forest Service removed the four culvert pipes in 2010 and replaced them with an attractive precast concrete arch having a 24-ft span, 7-ft rise and 10-ft wing walls. A natural bottom was designed with streambed material and shaped to mimic a natural stream channel and banks, with rock veins at the inlet and outlet to create pool and riffle formations.

AFTER

Photo Credit: Conservation Resource Alliance

11

BEFORE

Photo Credit: Conservation Resource Alliance

9

EXAMPLE D Lake Michigan Basin- Replacing a perched and undersized culvert that was a complete barrier with a three-sided precast concrete box culvert in the Pine River Watershed, Mich.

9 The Silver Creek and State Road crossing located near Cadillac, Mich., consisted of a perched 6-ft by 8-ft elliptical culvert. This inadequate crossing blocked all fish passage from the Pine River into Silver Creek, a cold-water tributary and nursery stream for rainbow, brown and brook trout.

10 The undersized, perched culvert was replaced in 2009 with a 12-ft by 10-ft, three-sided precast concrete structure. Photo on page 17.

11 A new three-sided precast concrete structure also allowed for approximately 10 ft of elevation change in 400 ft within the channel to accommodate stream stability and aquatic organism passage.

EXAMPLE E Lake Huron Basin – Replacing two unsightly perched-barrier culverts with a precast concrete box culvert in the Tawas River Watershed, Mich.

12 The Silver Creek and Monument Road crossing near Tawas City, Mich., with two 48-in.-diameter by 53-ft-long culverts perched at the outlet, was a barrier to aquatic organism passage and caused a large scour pool just downstream of the road/stream crossing.

13 As a joint project between the Huron – Manistee National Forest and Iosco County Road Commission, the two perched culverts were removed and replaced with a precast natural-bottom culvert that allows for aquatic organism passage. ps

Emily Clegg has spent the past 10 years studying and working in freshwater environments in the Great Lakes and Columbia River Basins. She is currently the manager of the Two Hearted River Connectivity Project and a member of Great Lakes Project's Watershed Connectivity Strategy Team. Contact her at eclegg@tnc.org.

Emily Clegg

(Endnotes)

[1] Stephanie R. Januchowski-Hartley, Peter B. McIntyre, Matthew Diebel, Patrick J Doran, Dana M. Infante, Christine Joseph, and J. David Allan 2013. Restoring aquatic ecosystem connectivity requires expanding inventories of both dams and road crossings. Frontiers in Ecology and the Environment 11: 211–217. http://dx.doi.org/10.1890/120168

[2] Franks Taylor, R., et al. 2010. *The Sweetwater Sea: An International Biodiversity Conservation Strategy for Lake Huron - Technical Report.* A joint publication of The Nature Conservancy, Environment Canada, Ontario Ministry of Natural Resources Michigan Department of Natural Resources and Environment, Michigan Natural Features Inventory Michigan Sea Grant, and The Nature Conservancy of Canada. Lansing, Michigan.

Pearsall, D., et al. 2012a. *Returning to a Healthy Lake: Lake Erie Biodiversity Conservation Strategy.* Technical Report. A joint publication of The Nature Conservancy, Nature Conservancy of Canada, and Michigan Natural Features Inventory. Lansing, Michigan. 340 pp. with Appendices.

Pearsall, D., et al. 2012b. *Michigami: Great Water. Lake Michigan Biodiversity Conservation Strategy.* Technical Report. A joint publication of The Nature Conservancy and Michigan Natural Features Inventory. Lansing, Michigan. 313 pp. with Appendices.

Lake Ontario Biodiversity Strategy Group. 2009. *The Beautiful Lake: A Binational Biodiversity Conservation Strategy for Lake Ontario.* A joint publication of The Nature Conservancy, Nature Conservancy Canada and U.S. – Canada Lake Ontario Lakewide Management Plan. Ontario. Canada.

[3] Gubernick, Robert. 2011. Flood Damage Assessment Green Mountain National Forest.

[4] Michigan Department of Natural Resources and Michigan Department of Environmental Quality. 2009. Sustainable Soil and Water Quality Practices on Forest Land. IC4011. Chapter 8 Stream Crossings.

Saving the Eas Hellben

A simple, elegant precast solution could help bolster an endangered species.

By Bob Whitmore

You may not spend a lot of time thinking about the Eastern Hellbender Salamander, but Greg Lipps sure does. Lipps, an independent consultant to the Ohio Department of Natural Resources, has spent years studying this completely aquatic salamander – an amphibian that has been categorized as an endangered species by the Ohio Division of Wildlife. The Eastern Hellbender is found in swift-flowing rivers and streams in the eastern United States. In Ohio and Missouri, where most of the research has been done, the population has declined 82% since the 1980s, Lipps said.

Hellbender habitat

Lipps is one of a small cadre of biologists who have been working to find ways to rebuild the Eastern Hellbender population, and he may have found an answer – in a custom-designed, precast concrete habitat. The solution resulted from collaboration among Lipps, Bluffton Precast Concrete Co. and Norwalk Precast Molds Inc., both of Ohio.

The natural habitat for an Eastern Hellbender is a large rock embedded into the substrate of a river that has a small opening where the salamander can weave its way into a cavity and lay eggs. The small opening

STERN
NDER SALAMANDER

allows the male salamander to defend its nest from predators such as fish. As residential and commercial development occurs near the water, those large rocks are often silted over, destroying the habitat. Lipps said there is no research to provide a direct link between the availability of the boulders and the decline of the Hellbender, but he would like to find out.

One way to test the theory would be to supplement the habitat, and that's where the precast concrete solution comes in. A colleague of Lipps' at the Missouri Department of Conservation, Jeff Briggler, began creating his own artificial Hellbender habitat using chicken wire and concrete. "Jeff built some of them and gave them to the St. Louis Zoo," Lipps said. Briggler's artificial habitat soon harbored some happy Hellbenders. "Once you give them the right conditions, they start breeding in captivity, and now they've been breeding for two years in a row," Lipps said. Briggler has also documented their use of artificial habitat in the wild.

Lipps wanted to build on Briggler's work by formalizing the design and creating an artificial habitat that could be placed directly into the river or stream. He searched precast.org for a precast concrete manufacturer located nearby and landed on Bluffton Precast, an NPCA-certified plant.

A life-sized model of the Eastern Hellbender Salamander is placed next to a finished precast hut, which had to be dipped in muriatic acid to reduce the pH level from over 14 to a range of 7 to 9 to meet habitat requirements.
Photo courtesy of Gregg Lipps

Bluffton Precast Concrete plant worker Jermey Cameron inspects the custom formwork for the Eastern Hellbender habitat hut.
Photo by Sue McCraven

An odd request: "Are you serious?"

"I called them up and told them I had a rather odd request," Lipps said. "They said it looked like something they might want to tackle."

Lipps started working with David Akin, president of Bluffton Precast, showing him pictures of the chicken wire structure and adding his own specifications to the structure. Akin then contacted Eric Hudberg, vice president at Norwalk Precast Molds, to add Norwalk's expertise to the team.

"We were not sure if they were serious or not," said Eric Hudberg, Norwalk Precast Molds vice president. "Dave was asking, 'Hey, do you think we can build this thing?' We looked at it and figured, well, why not?

"I talked with some of our engineers here," Hudberg continued. They looked at the photos of Briggler's homemade hut along with the additional specs that Lipps wanted, like a removable lid, no light leaks, and a knockout in the base where the river bottom would be exposed. An additional modification was a port for the insertion of a water quality monitoring device and a small camera.

"After we got into it, it wasn't terribly challenging once we broke it down and got into the components," Hudberg said. "We ended up with a three-piece mold set."

Lipps worked with his new collaborators at Bluffton and Norwalk and made several modifications to the design. The entry is a tapered tunnel about 20 in. long that leads to a cavity where the eggs can be laid. The hut weighs about 150 lbs and should sit down firmly into the substrate of a river or stream.

"It needs to be big," Lipps said. "If you think about what a stream potentially goes through every year with ice sheets and floods, it can't be something that will be pushed around. It needs to be able to stay in place."

What seems big to a biologist may look tiny to a precaster. Casting of the first salamander hut wasn't technically difficult, said Akin. One of the challenges was actually its small size. "When you're used to making things that are up to 20 tons apiece, this is a little different," he said. "We used our burial-vault wire and hand-formed a cage for the top section and another for the base piece. We used our 5,000-psi burial-vault mud with fiber, and then actually poured both pieces on top of a panel form."

The first finished Hellbender Salamander habitat hut rolled out of Bluffton in late January, and Lipps took it to a meeting at the Toledo Zoo the next day. The group made a few modifications that Norwalk and Bluffton incorporated into the next version of the new product.

Word of the precast salamander hut has circulated in the salamander community, and Lipps is looking forward to taking one of the huts to a conference in Chattanooga, Tenn., later this year. Financial support for the development and production of the Hellbender huts came from the Ohio Division of Wildlife, the Columbus Zoo and the Toledo Zoo.

Endangered salamander needs pristine streams

If the Hellbender hut is successful, it could be used for research, for rebuilding of the population where it has become endangered across the country, and also for mitigation projects. When a stream is disturbed, the developer is often required to mitigate the damage by restoring the stream as closely as possible to its natural state. The hut could prove to be a sensible, less costly way to provide the needed mitigation, Lipps thinks.

Why is it important to save a species? The

Hellbender salamander grows up to 2 ft long and can weigh in at more than 2.5 lbs. They survive up to 50 years in the wild and are among the most ancient amphibians on earth, according to Lipps. Like the canary in a coal mine, they provide biologists with an indicator of the health of a stream. Where they are present, the stream is likely to be fairly clean and well-oxygenated. And that's good news for smallmouth bass fishing enthusiasts, for example, because the bass requires a similar habitat.

"If you have healthy streams for Hellbenders, you'll have good smallmouth bass fishing," Lipps said. The Hellbender is different from a mayfly, he added. If a stream is degraded, the mayfly population may disappear for awhile, but the mayfly will always come back. "With the Hellbender, once they're gone … they're gone."

In Japan, precast concrete has been used for years to provide habitat for a larger salamander species known as Hanzaki, Lipps said. "They have Hanzaki blocks placed onto retaining walls in Japan to help them bolster their Hanzaki population," he said. The Hanzaki blocks may have formed the genesis of Lipps' idea to contact a precaster to provide him with a suitable salamander structure. He wasn't sure if he would find anybody to take on his unusual customized request. But he didn't know about the can-do culture of precasters. "I thought I'd be calling precasters for weeks, so I feel pretty lucky that Bluffton was willing to take on the project," Lipps said.

The Hellbender salamander hut project has provided a little variety for Bluffton's production team, Akin said. "It's been a blast! We've been back and forth with different drawings. I've gone from never having heard of the darn thing to being pretty intimate with it."

The folks at Norwalk concur. "It's nice to be involved in something unique that could potentially have some impact," said Hudberg. "It's something different from the usual septic tank or burial vault type of project. We did a lot of custom jobs in 2012, so this was a perfect way to end the year." In the process, the Norwalk team has become fans of the salamander, Hudberg added. "I think we're going to have to get some Hellbender salamander T-shirts made." ps

Bob Whitmore is NPCA's vice president of Communication and Public Affairs.

Because Eastern Hellbenders are extremely sensitive to changes in water quality, biologists view the salamanders' decline or loss as a reliable indicator of stream pollution and habitat degradation.
Photo courtesy of Gregg Lipps

Trench Warfare

The battle of reinforced concrete pipe and flexible pipes rages on the front lines of contract bidding as growing environmental regulations add to the fray.

By Michael D. Kusch

How stormwater detention systems are designed and installed determines compliance with the objectives of The Clean Water Act.[1] As stormwater regulations tighten in the months ahead, along with many new municipal combined sewer overflow (CSO) projects, precast concrete underground products – compared with competing materials – are the best choice for the environment. This study of the installation of a stormwater detention system in Tennessee is a case in point.

A four-barrel, 96-in.-diameter reinforced concrete pipe (RCP) was designed for a Lexus automobile dealership in Nashville, Tenn., as part of an Underground Stormwater Detention System (UGD). Each of the barrels is 160 ft long and connected with RCP and a precast concrete junction-box manifold system. The barrels were connected with 24-in. equalization pipe. Stormwater had to be detained on site then drained very slowly through a quality stormwater unit. The system had nearly 33,000 cu ft of stormwater storage capacity.

So what is the need for this well-designed UGD system? Easy answer: It's the law to protect the environment!

Environmental stewardship informs stormwater designs

Stormwater is rain runoff from surfaces such as rooftops, paved streets, highways and parking lots. As water runs off these surfaces, it can pick up pollutants such as oil, fertilizers, heavy metals, pesticides, soil, trash and bacteria. From here, the water might flow directly into the local watershed comprised of streams, creeks, rivers, lakes or wetlands. Or, it may go into a storm drain and continue through storm pipes until it is released untreated into these waterways.

In addition, large, impervious surfaces in urban areas, like this Lexus dealership site, increase the quantity of peak runoff flows. These in turn cause adverse hydrologic impacts such as scoured streambed channels, in-stream sedimentation and loss of habitat.

Thus, underground precast UGDs, such as the one discussed here, are used to pretreat and slow the discharge volume of stormwater to an acceptable, healthy level.

It is good environmental stewardship to control the quantity and quality of stormwater discharge from developed sites to protect human life and property. Responsible stormwater designs help to maintain overall watershed quality and comply with EPA, state and local government regulations under The Clean Water Act.

How to compare RCP with CMP stormwater systems

After the Lexus project was bid, an alternative design was presented to the general contractor by the flexible CMP (corrugated metal pipe) distributor. Because this CMP distributor considered only volume capacity in the design, this alternative had lower capital costs.

To strengthen the benefits of the engineer's original RCP design, Sherman-Dixie Concrete Industries presented a valid analysis (comparison) of a CMP versus an RCP detention structure. The general contractor needed to compare the options of the two pipe materials based on sound engineering – not on a bid's price point or a polished sales pitch.

The comparison focused on service life versus design life and the performance of materials according to design standards. It is not enough to consider only stormwater storage capacity. Other critical factors include structural integrity, load-bearing capacity and maintenance costs over the design life of the system.

Post-installation CMP durability and strength considerations

To determine durability of CMP, you must evaluate the pH and the resistivity of the soil. CMP service life (years to perforation) is a function of delaying inside abrasion and corrosion as well as the harmful effects from aggressive (acidic) soils surrounding the pipe. The

"Handbook of Steel Drainage & Highway Construction Products"[2] contains very helpful information for selecting the proper gauge of steel and protective coating. To determine the structural strength of the CMP system, you must evaluate the gauge of the pipe along with the type and placement of the backfill needed to help the flexible pipe attain its design strength and ability to carry the load.

- Steel gauge – The gauge of the steel determines pipe stiffness. All steel will rust. A heavier gauge (greater wall thickness) is required to allow the pipeline to function for its design life. The supplier of the alternative pipe material suggested 14-gauge (very thin) steel and only a plain galvanized (the minimum) coating. Who would want to risk millions of dollars worth of Lexus inventory parked over a huge paved footprint of 96-in. diameter flexible CMP? It is a fair question, and one that Sherman-Dixie proposed to the project's engineer of record, John Gore, P.E.
- Service life – A conservative assumption of a soil pH of 6.0 and a resistivity of 5,000 Ω-cm indicates that 16-gauge, galvanized metal will last 20 years before the first sign of perforation (small holes through the steel caused by abrasion). If the design life is 50 years, a 10-gauge galvanized metal thickness is required for a design life of 46 years (multiply 2.3 times 20 years).
- CMP installation requirements – The CMP structure proposed would require the extra cost of additional 12-in. depth of crushed stone over the top of the pipe. By comparison, the built-in strength of RCP would require a crushed-stone backfill only to the spring line – or center – of

the pipe, and would provide the owner with RCP service life of 100 years. The CMP proposal was under-designed and destined for replacement long before a stronger and more durable 100-year precast concrete UGD. For the Lexus owner, premature replacement would translate into replacement costs and loss of business.

- EOR's decision – A report from the RCP producer supported the engineer's original design for a precast concrete stormwater system by detailing the required CMP design specifications mentioned above. Because these required specifications were not originally considered in the CMP bid, the engineer of record denied approval of the CMP submittal.

Consequently, Sunrise Contracting of Nashville installed 644 ft of 96-in.-diameter RCP, supplied by Sherman-Dixie Concrete Industries, in about 12 hours. ps

Stormwater Regulations Tighten

As state and national stormwater regulations tighten in coming years, designers will be charged with designing sites that capture and hold the first inch of rainfall and keep it on site. This opens up similar projects – like the Lexus case study – for underground detention or retention systems manufactured of precast concrete pipe, precast box culverts or precast vaults.

Michael D. Kusch, technical marketing director for Sherman Dixie Concrete Industries, Nashville, Tenn., has a bachelor's degree in environmental design and has been involved in the promotion of precast infrastructure products with Sherman-Dixie Concrete Industries for 21 years. Contact him at mkusch@shermandixie.com

Michael D. Kusch

Note: A similar version of this article appeared in *Stormwater Solutions* in April of this year: http://www.estormwater.com/calling-reinforcements

(Endnotes)

[1] The Clean Water Act is a series of legislative acts that form the foundation of U.S. water resources. For more information, visit epa.gov.

[2] Corrugated Steel Pipe Institute (CSPI), the association of Canadian CMP manufacturers; visit cspi.ca/node/158

THANKS TO OUR SPONSORS

FOR SUPPORTING THE AIA SEMINAR "ARCHITECTURE AND PRECAST CONCRETE" AT THE PRECAST SHOW IN INDIANAPOLIS.

EASI SET WORLDWIDE
Your Partner for Precast Product Diversification

SMITH-MIDLAND
EXCELLENCE IN PRECAST CONCRETE

Visit precast.org for more information on the many benefits of specifying precast concrete in both above-ground and underground applications

CONTINUING EDUCATION AIA

NPCA
Precast ... The Concrete Solution