Dear Colleagues,

Nothing heralds urban expansion better than a Tower Crane. Tower cranes are visible all across our city's skyline. From the roof of Gewirz Residence Hall, one can see twenty tower cranes dancing across the sky, changing the urban landscape and the rhythms of life in the District of Columbia. If you view the WASHINGTON BUSINESS JOURNAL *Crane Watch* website, http://www.bizjournals.com/washington/datacenter/crane-watch.html you can learn a little about the one hundred and five major projects, creating "16,000 residential units, roughly 5 million square feet of office space, more than 1,500 hotel rooms, hundreds of thousands of square feet of retail, and multiple sports, entertainment and cultural centers" currently underway in the District of Columbia,.

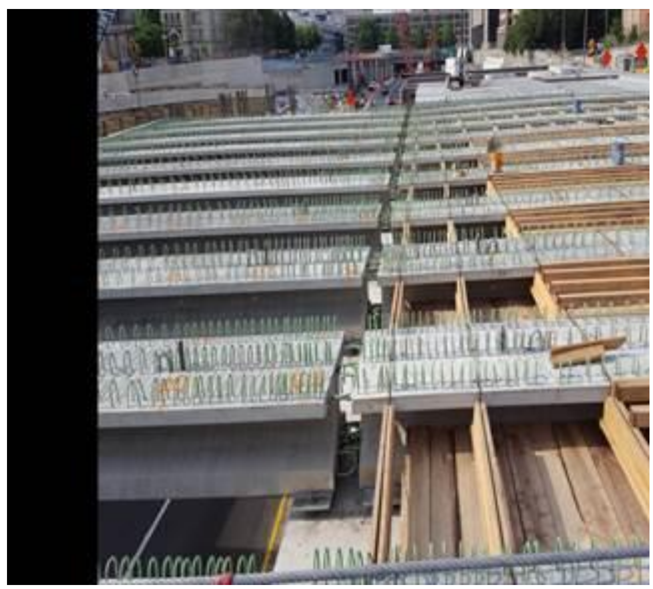
The tower crane for the Capitol Crossing Project, one reaching higher than the Gewirz Residence Hall, went up last weekend. If you loved playing with Legos, Tinker Toys, or Erector Sets as a kid -- or still do -- you would have loved to be here with me watching the crane go up. The concrete foundation base for the crane was set in place a couple of weeks ago and the crane itself began to rise above the surface of the platform on Friday, June 11. By late Saturday, it was standing -- tall, strong, and proud.

The tower crane signals the start of the vertical construction of the Capitol Crossing Project. All we have witnessed for the past two years has been prologue, though a very complicated engineering and construction prologue. But now we can begin to see how the neighborhood will change; to imagine who our new neighbors will be; to wonder about visitors brought to the neighborhood by new businesses; and to anticipate how the new shopping and entertainment venues will enliven and enrich our lives. By June 21, the concrete columns and decks for the northeast building -- 200 Massachusetts Avenue NW -- will begin to rise. The forms are already being erected. By mid-2017, the glass curtain wall (the exterior wall) installation will begin, and by 2018, the building will be fully operational. If you want a glimpse of what it will look like, visit http://capitolcrossingdc.com/

Much has been happening since my last CONSTRUCTION NOTE. The topping slab on the North Block platform has been poured and is awaiting the construction of the columns and decks for 200 Massachusetts Avenue. The BBC construction trailers and buildings at 3rd and Massachusetts have been torn down or moved. BBC's headquarters will relocate to Cobb Park

The North Block Platform The New Massachusetts Avenue Portal

on the north side of Massachusetts Avenue next week. After the move, construction of the Capitol Crossing underground garage will begin on the former BBC site. The new Massachusetts Avenue entrance to the highway is completely excavated between 3rd Street and the highway surface, while white ceramic tile is being installed on the highway's concrete walls and alcoves. The concrete roof over the East Concourse -- the storage and utility area for the project -- has been poured and utilities, waterproofing, and electrical rough-in have begun. Cars are now exiting the highway onto 2nd Street on one lane of the new ramp, as fire-proofing,

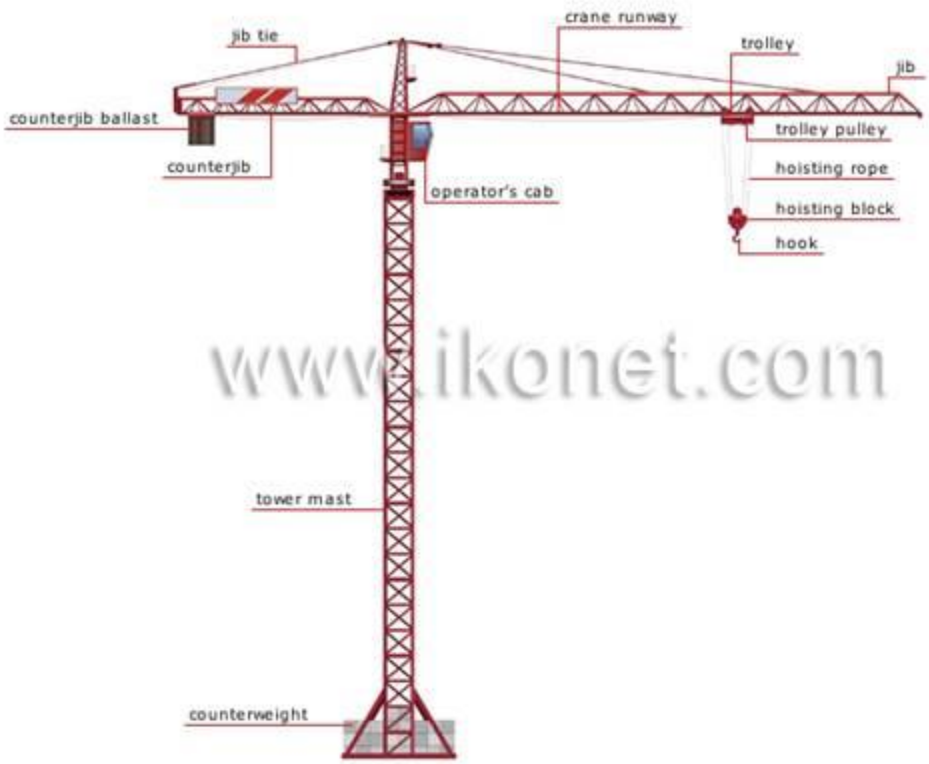


Mass. Ave. Highway Entrance Bulb T Girders for the G Street Bridge plumbing, lighting, and temporary power are being installed. The Bulb T (pre-cast concrete) girders on the west side of the G Street Bridge have been set in place by the mighty Manitowoc crane, and installation of the Bulb Ts on the west side of the F Street Bridge will begin in about two weeks. Installation of the pre-cast concrete slabs that form the platform for the Center Block, the block directly across from McDonough Hall, has begun. During the coming months, the platform will be completed along the west side of the highway all the way to E Street. Once the west side is completed, the crews will move to the east side and finish the deck around November. At that point, the highway will be completely enclosed. The old East End will again be knitted to the downtown.

Utility work continues at the corner of 2nd Street and Massachusetts Avenue and on the west side of the platform. PEPCO, Verizon, DC Net, and Comcast continue to outfit their vaults with cable and other communication equipment. BBC is also working in the tunnel north of Massachusetts Avenue. Although the old tunnel is not truly a part of the Capitol Crossing Project, the Department of Transportation is requiring upgrades to the lighting and other equipment in the north tunnel to integrate the life-safety features of the two tunnels.

So much is going on. The army of workers on the platforms increases daily, but it is the tower crane that draws our eyes. These lopsided yet graceful T-shaped steel structures possess both the stability and the strength to lift and move concrete, steel, and equipment from place to place within a construction site. Although mobile cranes serve many of the same purposes -- the Manitowoc and a telescoping crane are still lifting their loads daily at the site -- tower cranes are more practical in the restricted footprints of urban building sites.

Tower cranes are composed of several distinct parts. The base of the tower is set into a concrete pad. The mast is the large vertical section that connects to the base and rises to a height taller than the building it will erect. It is also taller than the buildings that surround it so that its load swings unimpeded. Near the top of the mast is the slewing unit (the turntable) which holds the gears and the motor that permits the crane to rotate to the position of the lift or the deposit. Three parts sit above the slewing unit. The horizontal working arm, sometimes called a boom but more often a jib, carries the load horizontally by way of a trolley so that it can be placed at any spot along the length of the jib. Opposite the jib is the shorter machinery arm or counter-jib which holds the counterweights -- usually concrete slabs -- that serve to balance the load and prevent the crane from toppling over while carrying materials from the tower mast to the end of the jib. The counter-jib also houses the hoist unit which contains the hoist drum, gear box, gear shift, brake, and supporting components that serve to raise and lower the load via a hoist line. A lifting hook is connected to the hoist line and the trolley that



travels along the jib to position the lift. All of the component parts are held together by pins and bolts. The crane's operator sits in a cab perched to the side of the slewing unit, coordinating the gears and cables so that the loads are safely raised from one area of the site and deposited in another. A ladder up the middle of the mast provides access to the cab. The operator climbs to the top crane each morning and usually remains in the cab for an entire shift. You can get a better sense of the various parts of the tower crane at http://www.morrow.com/crane101 and a little insight into the life of the crane operator in a Washington Post article at https://www.washingtonpost.com/business/economy/the-indispensable-crane-hoists-the-economy-along-with-steel-concrete-and-toilets/2016/06/12/89f2beba-2cd7-11e6-9b37-42985f6a265c_story.html

A tower crane is essentially a cantilever subjected to compressive and tensile forces and bending moments that shift and reverse. Even though the crane is stable, the mast and jib actually sway and bend from the weight of the loads and from the power of storms and winds. During normal operations, a crane mast can sway more than two feet. While sitting at the top of a tower crane, I have actually experienced a sway of more than a foot and one-half off center. Because of these various forces, engineers have to account for weight loads, counterweights, and local wind velocities while planning and erecting a crane. The base must be solidly anchored and the possibility of ground settlement must be taken into account. The base for the BBC tower crane is a concrete bunker, thirty feet by thirty feet and six to nine feet deep.

It is built with eleven thousand three hundred and ninety-four cubic feet (four hundred and twenty-two cubic yards) of concrete, and packed with reinforcing steel. The mast must be plumb, that is, precisely vertical. Deviations from plumb can cause extreme distortion as the various forces act on the mast and jib. Skilled engineers, of course, are aware of all these factors and design cranes to specific standards to account for these forces. For example, a mast may deviate from plumb by only one inch every three hundred feet, and most tower cranes are designed to withstand ninety-four miles per hour winds, although regional adjustments are taken into account. Even under normal operations, the crane's pins, bolts, and cables must be periodically checked for stress fatigue, and unbalanced loads must be avoided during operations. At its most acute point of stress, these various forces can cause the crane to fail and tip over. Crane failure, however, is a rare occurrence because the erection of a crane is a well-planned process.

In my first CONSTRUCTION NOTE about cranes dated March 3, 2016, http://www.law.georgetown.edu/campus-services/facilities/construction-info/index.cfm.I traced the history of lifting devices through the fifteenth century. Today I will move the history into the present. Medieval cranes were stationary, with loads being raised and set by a crane directly above the placement site. Workers were able to move a load laterally using a rope attached to the

Tower Crane at the Inland Harbor of Trier in 1413   Crane at the Harbor in Copenhagen in 1742

load; however, lateral movement was minimal. Modern tower cranes owe their design to early Renaissance engineering. Slewing cranes began to appear in the fourteenth century and were used mostly on docks to load ships. Cranes used in Flemish and Dutch ports generally were gantry cranes, while German harbor masters employed tower cranes with treadwheels set in the tower to rotate the jib arms and roofs.

The first modern cranes were developed during the industrial revolution in England. Sir William Armstrong invented a water-powered hydraulic crane in Newcastle that was designed to load coal onto barges moored to the harbor docks. Armstrong's cranes spread throughout

Armstrong Mitchell hydraulic crane in the Arsenale Harbor in Venice

England and Scotland and by the 1860s, his company employed more than four hundred workers who were producing more than one hundred cranes per year. One of his cranes, Number 2919, still stands alongside the docks in the Arsenale Harbor in Venice. It was commissioned by the Italian Navy and installed between 1883 and 1885 to load provisions onto their then newly-built ironclad battleships. The Armstrong/Arsenale crane is the only one of its kind left in the world. I visited it several years ago without understanding its importance to the history of engineering and architecture. As its website states, it is a "unique and … spectacular sculptural piece of engineering which soars above the roofline of the most historic dockyard in the world." Sadly, it is in a state of disrepair and is decaying rapidly. If you want to help preserve it, you can contribute at *Venice in Peril*, http://www.veniceinperil.org/projects/armstrong-mitchell-crane

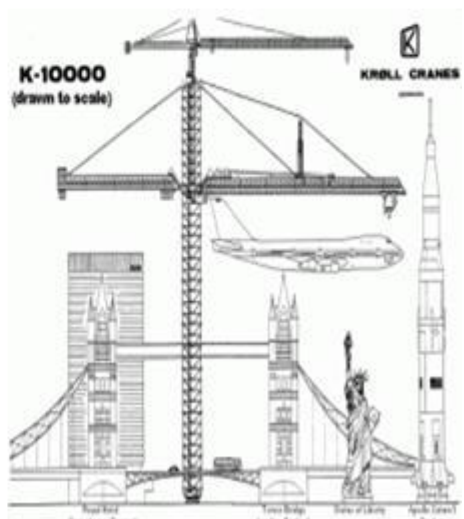
In the latter part of the nineteenth century and early part of the twentieth century, steam and internal combustion engines replaced hydraulic water power, and cast iron and steel replaced wood and brick. During those years, the use of tower cranes became more prevalent, especially in Europe where building sites lined old and very narrow streets. Indeed, even in the early twentieth century, tower cranes held sway in Europe while mobile cranes permeated the North American construction trades. In 1908, the

German company Maschinenfabrik Julius Wolff & Co., developed a series of tower cranes specifically for the construction industry. Especially useful in shipyards, more than ten thousand of these cranes were built and their basic design remained in production until the 1960s. Still, the cranes were extremely heavy and difficult to erect and dismantle. As late as 1948, no easily-assembled tower crane existed. But in 1949, Hans Liebherr developed a bottom-slewing tower crane with a horizontal jib at the top. Though it measured only thirty-feet tall, it could be folded up and carried away. His crane revolutionized the construction trades. Not only could it be easily erected and disassembled, it could deposit loads precisely to the point of need, eliminating manual transport from the point of the drop to the point of need. Throughout the 1950s and 1960s, technology advanced, crane manufacturers multiplied, and designs became more specific to the sites at which the cranes would be used. The post-World War II prosperity, first in the United States and then throughout Western Europe, spurred the demand for even more sophisticated equipment. Liebherr and the Potain Company in La Clayette, France led the way. Both still exist. The Liebherr Group remains a family-owned business, operating more than one hundred and thirty separate companies; it is the largest crane company in the world. The BBC tower crane and the Manitowoc were both fabricated by Potain.

Today there are several types of tower cranes. Some are self-erecting. They have the capacity to lift and set in place new sections of themselves, on the ground or in the air, using jacks or the crane itself to set telescoping sections into the mast. This permits a new section of the tower to be inserted as the building itself grows. Some cranes attach to a building rather than being built from a base. They also climb the building as it is erected. Telescopic cranes have tubes fitted one inside the other that are extended or retracted hydraulically to the desired length of the boom. Some tower cranes operate without a counter-jib, using counterweights at ground level connected by a cable to the jib to balance the crane. One is in use on Georgetown’s main campus today to build the new John Thompson Jr. Intercollegiate Athletics Center.

Self-erecting Tower Crane Telescoping Tower Crane

The extreme height of modern buildings requires even taller tower cranes. The largest, tower crane was developed by Kroll, a Danish Company, in 1975. The K-10000 stands three hundred and ninety-four feet tall, three times as tall as the Statue of Liberty. Using a long jib rather than its standard jib, it can lift ninety-four tons to a radius of three hundred and thirty



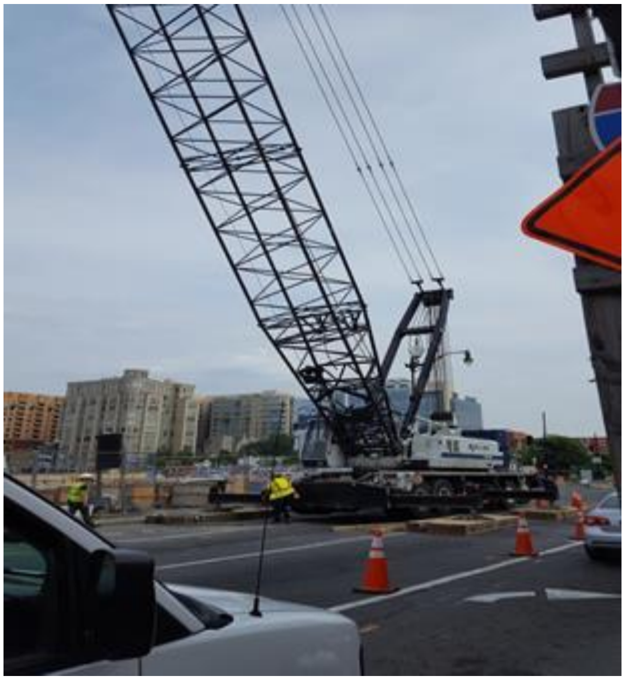
The Kroll 10000

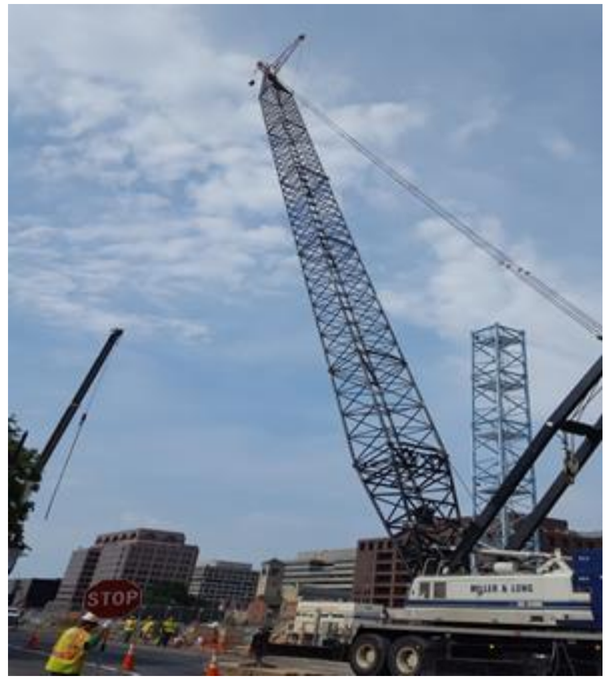
feet, and has an operating range of seven and one-half acres. Its counterweights total 100 tons. You can get a sense of its height and watch the Kroll 10000 being dismantled at https://www.youtube.com/watch?v=lkmyBaZ3OsI It weighs one hundred tons. The iconic Norfolk hammer head crane, built in 1940 and once a mainstay of World War II shipbuilding, weighs five million pounds. At one point, it was the largest crane of its type on the east coast.

The Norfolk Hammerhead Crane Built in 1940

It generally takes several days to assemble a tower crane. The construction of the BBC crane was fascinating. Because the BBC tower crane was not self-erecting, it took two smaller cranes to build the tower crane. A smaller

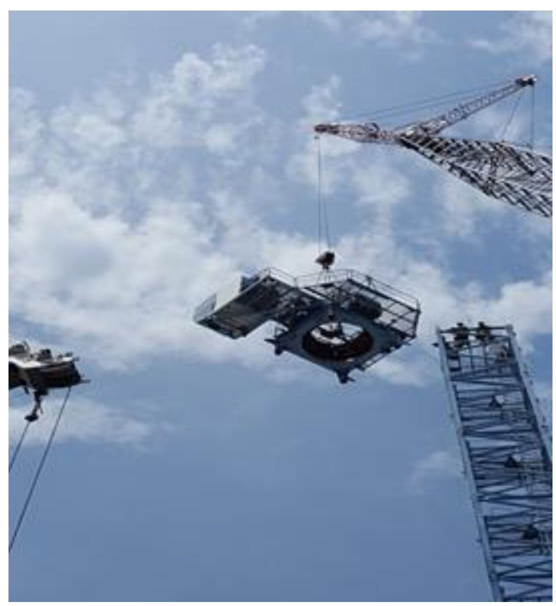
Crane Parts Arrive By Truck | Lifting the Boom Into Place





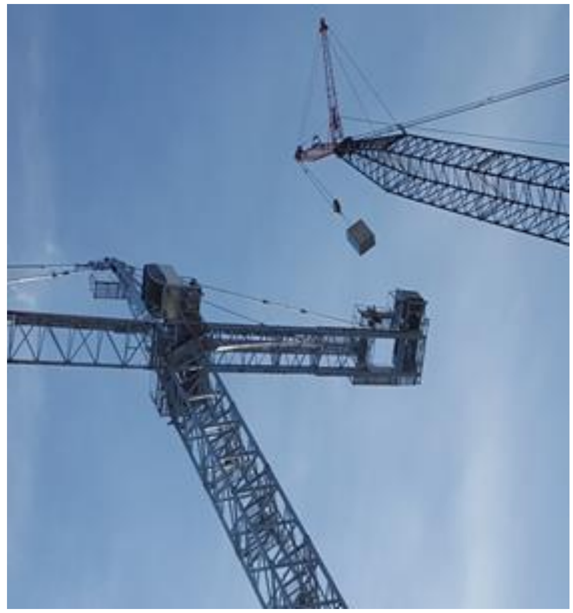
The 200-Ton Mobile Crane That Built the Tower Crane

telescoping crane began the process by helping another mobile crane build itself. The boom sections of the mobile crane arrived by truck. They were then lifted by the telescoping crane and placed into position on the crane that built



Tower Crane Section Being Lifted

Slewing Unit and Cab Being Lifted.



Counter-jib Being Hoisted

Counterweights Being Installed

the tower crane, and fastened to a previous section with heavy pins and bolts. Once all of the boom sections are in place, the mobile crane was ready to build the tower crane. At that point, the main boom of the mobile crane measured two hundred and thirty feet and the luffing boom added another thirty feet, giving that crane a maximum lifting height of two hundred and sixty feet. Sections of the tower crane then began to arrive by truck. Once on site, they were lifted high in the air by the mobile crane and set in place by workers at the top of the tower crane. When the mast reached its maximum height, the jib and counter-jibs were hoisted into place, and electrical connections and motors, cables, pulleys, and hooks were installed. Once the counterweights were loaded onto the counter-jib, the tower crane became operational.

Unsupported tower cranes can rise to a height of two hundred sixty-five feet. In larger buildings, the crane is secured to a core in the building so that it can grow even higher. The BBC tower crane, including the rooster -- the pointy section at the top through which the cables run -- reach a height of two hundred and twenty feet from its base and one hundred and ninety-seven feet from the surface of the platform. For reference, the Washington Monument rises to about five hundred and fifty-five feet, and the dome of the U.S. Capitol is about two hundred and eighty-eight feet from the ground. Crane jibs can extend up to two hundred and thirty feet in length from the mast. The jib, called a saddle jib, on the BBC crane is one hundred and ninety-seven feet long. At its tip, it can lift fourteen thousand two hundred and twenty-one pounds. At a position close to the cab, it can lift slightly more than forty-four thousand pounds. Its thirty-five thousand two hundred and seventy-four pound counterweight keeps it from tipping when it lifts and moves loads.

Now that it is built, the BBC tower crane will pour concrete (two cubic yards per bucket is typical); lift formwork, plywood, and framing lumber; set reinforcing steel; unload material from trucks; and move those materials to the building decks or floors as they are being formed and poured. It may also be used to set some of the structural steel, announce the project name, Capitol Crossing, and the crane company name, Miller and Long, on its jib. And of course, it will fly the flag. Today, you can watch the crane doing its job as 200 Massachusetts Avenue begins to rise.

Our neighborhood is rapidly changing. Years ago, the East End was sparsely settled swamp and farmland on the edge of the newly created Capital of a rapidly emerging yet divided nation. After the Civil War, it became a thriving neighborhood -- home to people of all races and many nationalities -- living in relative tranquility with one another and pursuing the American dream of family, home, work, and worship. Many, indeed several generations of those early residents, lived their entire lives in the East End. And then the highway came. African Americans, Italians, Irish, Eastern and Central European Jews, Germans, and Greeks were all forced to abandon their neighborhoods to make room for a different kind of American dream – a dream of prosperity and high speed mobility and the freedom of the automobile. That dream did not destroy the people themselves, but it did destroy their neighborhood culture and dispersed the old East End communities throughout the suburbs. In time, all that was left was an urban scar and a highway to nowhere. For forty-five years, Georgetown Law Center stood sentinel on what was left of this neighborhood, holding a lonely vigil for much of that time. For decades we have kept watch, waiting for a renewed and living East End, where people live and children learn and play. Now it is coming; our vision will be rewarded; our sometimes solitary vigil is about to end.

Wally Mlyniec

Special thanks go to BBC employees Shawn Osika, who helped me understand the crane construction process, and Mackenzie Delaney, who provided statistics to fill out the crane description. Thanks as always to my editor, Abby Yochelson. (This one was a little harder to edit than usual)

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