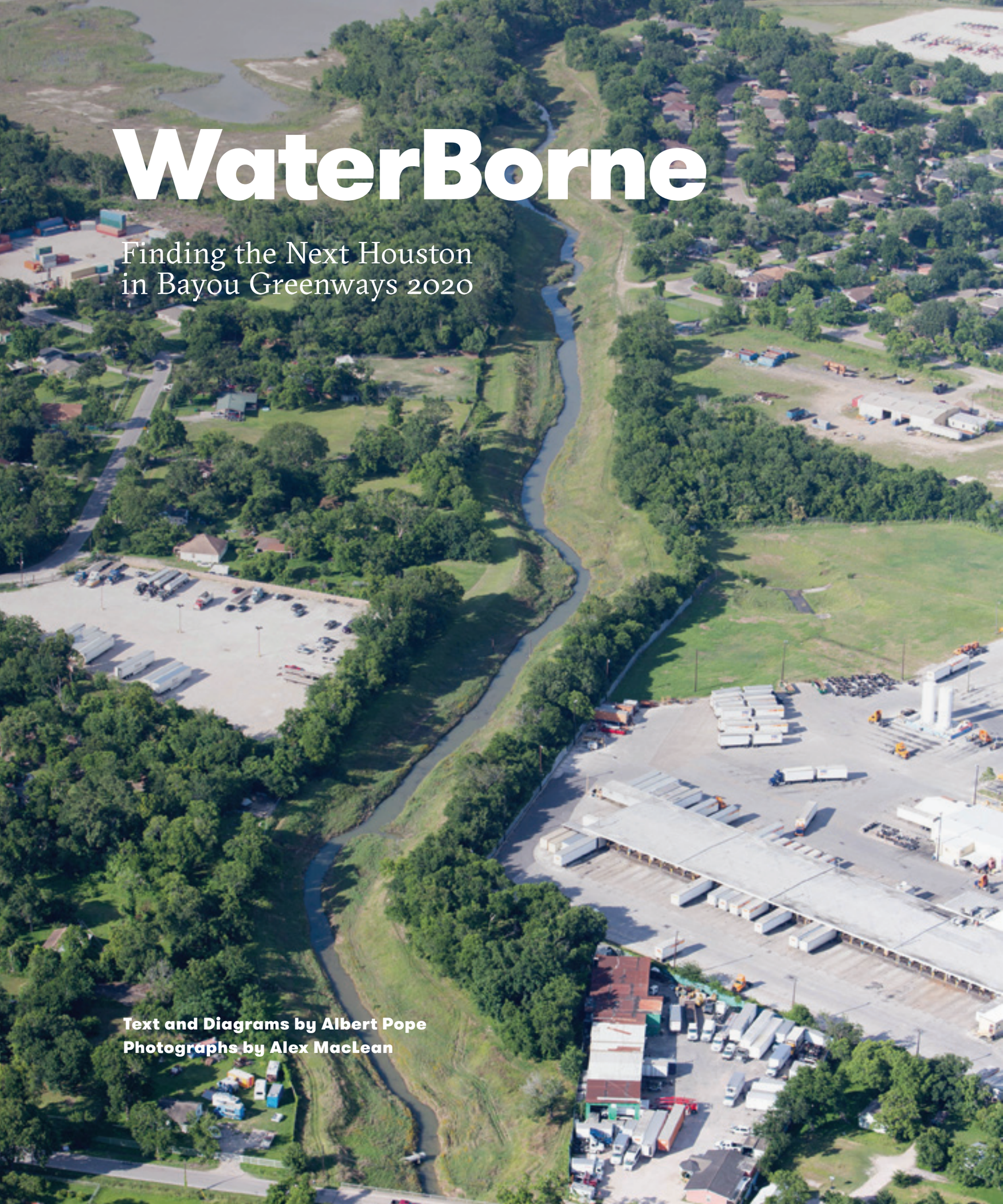

WaterBorne

Finding the Next Houston in Bayou Greenways 2020

Text and Diagrams by Albert Pope
Photographs by Alex MacLean

Control AND Accommodation

While we tend to regard cities as permanent and unchanging, they are constantly adapting and readapting their basic forms to their natural settings. Such adaptations have occurred since the beginning of urban history and usually take place, not over months or years, but over decades and centuries. The natural conditions that brought Houston into existence were an abundance of natural resources that put agricultural commodities (primarily cotton) in relative proximity to a protected port.

At the beginning of the twentieth century, it was the significant dredging of Buffalo Bayou that boosted Houston's port functions and turned the city into the second largest petrochemical complex in the world. Today Houston's network of bayous places it at the nexus of the global carbon economy.

As urban and natural systems continue to evolve, climate scientists tell us that they will do so with increasing speed and volatility due to the extraordinary amount of CO_2 that has been put into the atmosphere. Houston is threatened by this volatility in two distinct ways. The first threat concerns rising sea levels that will affect all coastal cities and put at risk the entire southeast quadrant of the city (including our petrochemical complex, which is situated only inches above sea level). The second and perhaps more significant threat concerns the extraordinarily high levels of per capita energy consumption in Houston (double that of European and Japanese cities). As the newest and most dispersed of all major American cities, Houston's infrastructure locks it into a high degree of energy consumption which, in the long run, will damage the city's viability. As the dual threats of low-lying inundation and high per capita energy consumption have become increasingly clear, big changes will be upon us, changes that will require a significant renegotiation between the city and its natural context.

In its first 179 years of growth, Houston's economy was built through the seemingly limitless exploitation of natural resources. Today, few of us believe that natural resources are unlimited, nor do we believe that their exploitation comes without cost. Where we once believed that natural forces could be fully controlled, we now recognize that control must give way to accommodation. The good news is that the outlines of that new recognition can already be seen in transformations that are taking place across the city today. This essay will outline one of these transformations as it relates to the underlying structure of Houston. Specifically, it will outline the city's transition from a concentric-and-dispersed, car-oriented city into a linear-and-dense, transit-oriented city that must be built over the next half century. This transformation is being spurred on by a remarkable new natural/urban network that has only recently come into existence: Bayou Greenways 2020.

CHANNELS AND VIADUCTS

In order to think through the city's changing relations to its immediate natural environment, a certain distance needs to be maintained. While we might want to enter into an analysis at a local level of the environment, we need to keep a focus on the big picture. The interaction between

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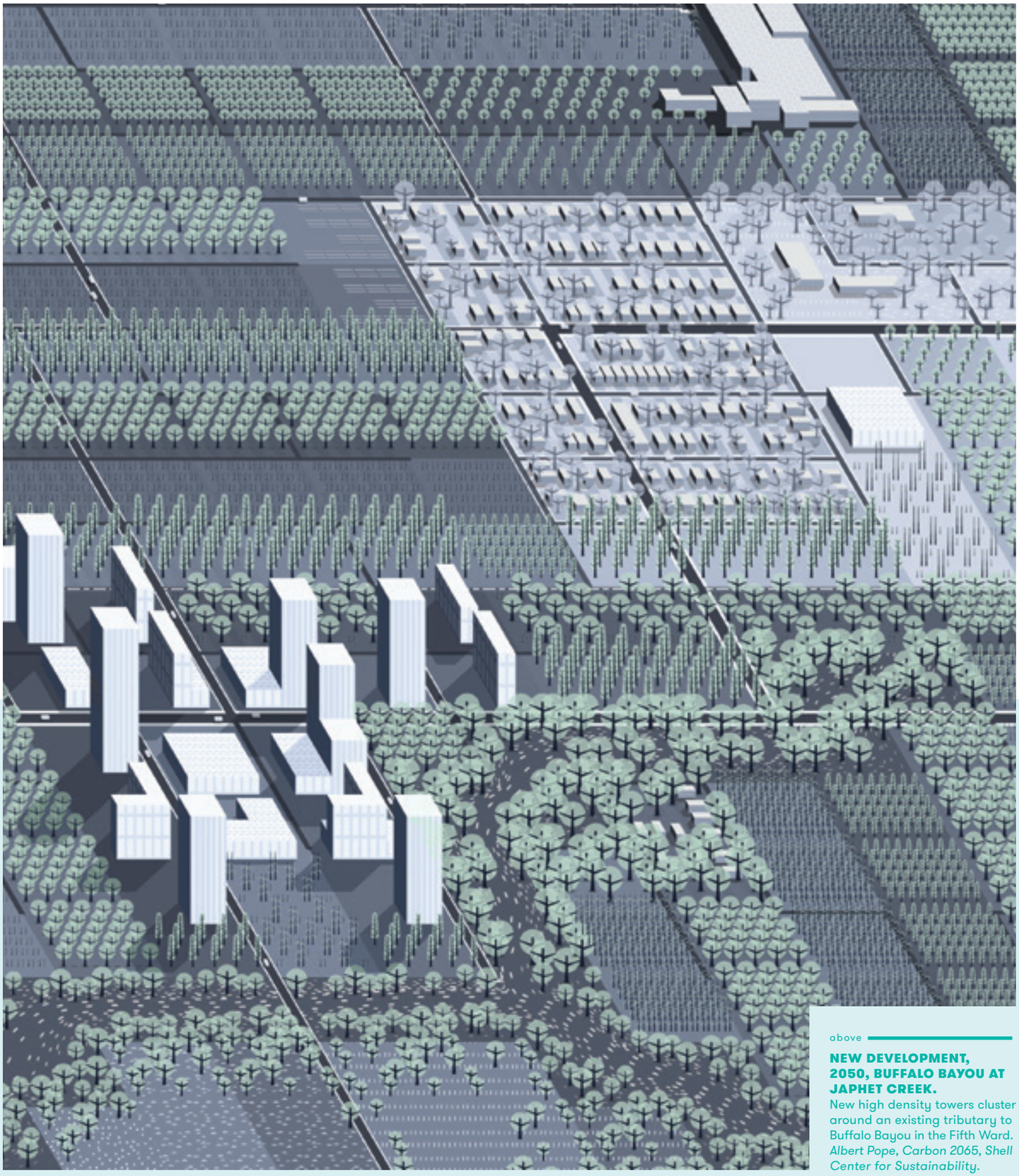
HUNTING BAYOU AT LOOP 610, NORTH.
Secondary bayou and reservoir in top left. Like many of the smaller bayous, Hunting has been stripped of vegetation and channelized but left unarmoured. In the near future, construction will be pulled back to accommodate a deeper, "rewilded" floodplain. The edge of this deeper floodplain will mark the site of new urban density. As green voids capable of accommodating water flow as it has for centuries, these smaller bayou corridors will play an equal or greater function in subsequent urban development than large surface streets.

urban and natural systems should not be overwhelmed by immediate details. Although those details determine our lived experience, it is important to step back and consider the large-scale, defining features of the city and its ecosystem. In the case of Houston, these defining features are the key urban transportation infrastructure and its extensive bayou network. In order to characterize the effects of these two networks, and the complex negotiations between them, it is necessary to examine the concentric, hub-and-spoke organization of the city's freeways and the banded, linear organization of the city's bayous.

This top-level organizational logic will be played off the photographic evidence of these systems as they actually hit the ground. The recent (2014) aerial photographs of Houston taken by Alex MacLean focuses on specific overlaps of the freeway and bayou networks. The photographs systematically document both the congruences and collisions of the two systems as the urban sometimes dominates and sometimes accommodates the natural conditions in which it exists. While the ostensible subject of the photographs might be superficially characterized as an ongoing battle between viaducts (freeways) and trenches (bayous), on second glance they reveal a far more intricate interrelation is revealed. These interrelations suggest an underlying shift from a narrative of domination or control of nature to a narrative that focuses on accommodation. More than any technical description, these photographs reveal an ongoing renegotiation between natural and urban systems in which the next century of Houston's growth can already be glimpsed. Beautiful as they are, however, the photographs alone cannot fully divulge evidence of the fundamental reorganization that is occurring beneath their surface appearance. In order to more fully describe what is seen in the photographs, we must turn to the larger logic that frames them.

above

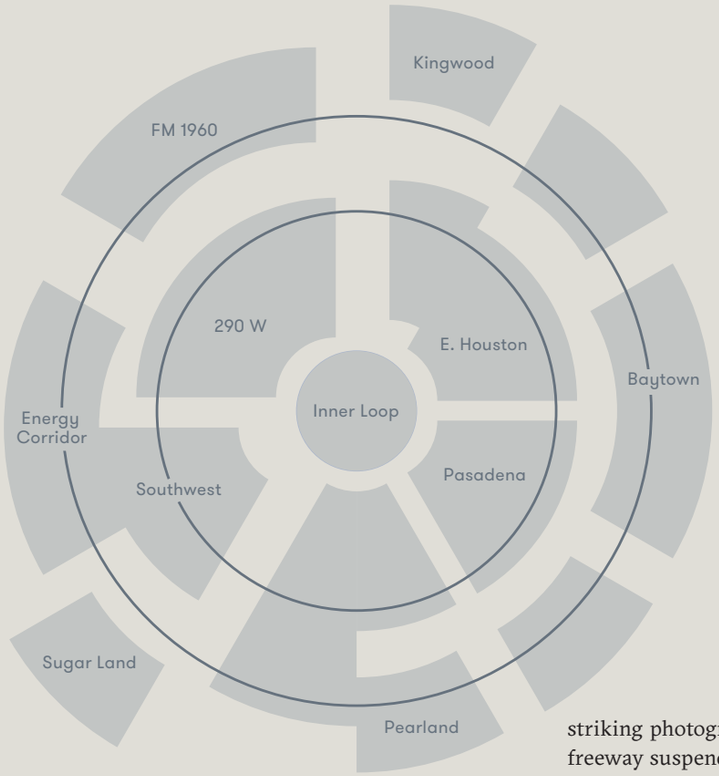
LITTLE WHITE OAK AT I-45. Looking south along I-45 toward Downtown, with Moody Park and Hollywood Cemetery in the foreground and the First Ward in the middle ground, shows the cleared but unchanneled Little White Oak Bayou as it winds through the landscape. Surrounded on three sides by bayou, this stranded piece of the Near Northside is emblematic of a "bayou city" laced through with a greenway network.



RENDERING BY ALBERT PAGE AND PETER STONE

above

NEW DEVELOPMENT, 2050, BUFFALO BAYOU AT JAPHET CREEK.
New high density towers cluster around an existing tributary to Buffalo Bayou in the Fifth Ward. *Albert Pope, Carbon 2065, Shell Center for Sustainability.*



BEYOND THE MONOCENTRIC

In the first 179 years of its existence, Houston's centralized pattern of urban organization was superimposed upon the linear, east-west logic of its natural organization. In other words, its symmetrical organization surrounding a single and dominant urban core had almost nothing to do with the predominantly asymmetrical, east-west organization of Buffalo Bayou and its tributaries. Though common to most cities, the concentric pattern of freeways is an emblem of Houston's presumptive dominion over the natural systems that made the city possible in the first place.

Even today this presumptive dominion holds sway. In many quarters, it would still seem absurd to presume that the hub-and-spoke logic of Houston's transportation infrastructure could ever be challenged by the natural order of Houston's bayous. Such presumption remains pretty much unchallenged until, of course, it starts to rain. It only takes one of our many flashfloods to understand that the linear network of bayous remains a potent if not dominant force upon the city as it wreaks havoc on the concentric system of freeways. It is indeed a measure of our presumptuousness that we rarely even consider that freeways could have been built around the logic of floodplains. Flooded out freeways are largely due to their concentric arrangement that requires them to be randomly built in and out of floodplains. If freeway placement were to more fully consider the logic of the bayou network, instead of an arbitrary, centralized pattern, flooding could doubtlessly be diminished.

Rather than reconciling the opposing forces at a top or systems level, engineers attempted to transform natural systems into something resembling the network of freeways. In the name of water management, the city's bayous were systematically transformed into a series of open storm sewers. As is rightfully lamented, vegetation was bulldozed, irregular topography was graded smooth, and a concrete surface was poured in order to transform the city's riparian biota into a highly engineered artifact. Many of MacLean's most striking photographs reveal a perverse equivalence of the freeway suspended above the ground on concrete viaducts and the bayou sunk below the ground in concrete trenches. Whether managing vehicles or managing water, the idea was that everything could be channeled and controlled, or so it was once imagined. In the meantime, it has become clear that armored channels are simply no match for the riverine system and the increasingly volatile climate of which it is an integral part. Each great storm unmasks a crippled infrastructure that is unable to recuperate from shocks to its system. In the meantime, the need for a system-level approach, such as pulling construction out of the 100-year floodplain becomes ever-more obvious.

If the failure of Houston's concentric system of organization to respond to the region's natural systems has become apparent, its failure to respond to contemporary urban forces are equally problematic if not more difficult to grasp. This failure is due to the simple fact that Houston has long outgrown its founding logic. Conceived as a monocentric city, Houston was imagined to grow from its single and dense center out to its edge. As the city grew, it was imagined that the core would also grow, maintaining its dominant position relative to the rest of the city. There is, however, a limit to which a single urban center can be expected to exert an influence upon a sprawling periphery. Covering an astonishing area of 650 square miles, the city limits of Houston can contain the cities of Orlando (101 square miles), Denver (155 square miles), Philadelphia (140 square miles), Las Vegas (112 square), Boston (47 square miles), and San Francisco (46 square miles) with room to spare. In spite of the fact that Houston can contain all six cities, it is important to note that each of them has an urban center that is equal to or larger than the center of Houston. In short, the "center" of Houston, with its relatively few number of city blocks and tall buildings, can no longer be expected to exert an influence over the vast expanse of

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CONCENTRIC DIAGRAM. The freeways of Houston are constructed in a concentric organization. The system includes 575.5 miles (926.2 km) of freeways arranged in a hub-and-spoke structure with three concentric loops. The innermost loop is Interstate 610, forming an approximate diameter of 10 miles (20 km) around downtown. Built throughout the 1950s, the 610 loop marks the line of demarcation between a prewar grid-based urbanism and postwar, spine-based (cul-de-sac) urbanism. The second loop, the Sam Houston Beltway, forms an approximate diameter of roughly 25 miles (40 km) concentrically equidistant from Loop 610. An ongoing highway project, State Highway 99 (The Grand Parkway), would form a third loop that currently lies outside Houston city limits. With a completed circumference of 170 miles, it will be the longest urban beltway in the U.S. Currently, a completed portion of State Highway 99 runs from U.S. Highway 290, northwest of Houston, to U.S. Highway 59 in Sugar Land, southwest of Houston, and was completed in 2013. In contrast to these three concentric loops, twelve spokes radiate either from downtown or from Loop 610. These are the north/south (cardo) spokes of I-45, and the east/west (decumanas) spokes of I-10. These four cardinal spokes are filled in by US 59 which runs from northeast to southwest. Single spokes that originate in the city include US 290 that fills in the northwest; US 288 that fills in the south; Westpark Tollway that fills in the west; Hardy Tollway in the north; and the Crosby and Pasadena Freeway fill into the east. In its simplest form, the top level transportation network contains three loops joined together by 12 connecting spokes.

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BUFFALO BAYOU WATERSHED SUPERIMPOSED ON BELTWAY 8 PERIMETER.
In contrast to the concentric organization of Houston's freeways, the bayou system is configured in a series of lines or bands that run east-west, from prairie to the coast. The city contains seven principal east-west bayous, which are themselves contained within the greater San Jacinto Watershed. Buffalo Bayou is the largest branch of the watershed that originates in the Katy Prairie and cuts through the center of the city on an almost due east-west axis, terminating in Galveston Bay. Branching off from Buffalo Bayou within the Beltway 8 limits are six principal bayous: Greens, Halls, White Oak, and Hunting Bayous in the north, and Brays and Sims Bayous in the south. These bayous all line up roughly east-west, dividing the city into a series of parallel zones that run throughout. Two other east-west bayous, Cypress and Clear Bayous, run just outside the Beltway to the north and south, respectively.

its 650-square-mile hinterland. Despite the centralization of its most vital transportation network, Houston ceased being monocentric decades ago.

In order to organize its vast extent, multiple centers have emerged throughout the city with no particular allegiance to Downtown. The Energy Corridor, Southwest, 290 and FM 1960 corridors, Sugar Land, Pearland are understood as slices of the concentric pie, yet they operate as autonomous units. In the place of its concentric network formed by a single dominant center, Houston has developed as a far more robust, polycentric network that is capable of structuring its extensive urban ground. Based on an ancient model of central/peripheral organization, Houston's hub-and-spoke transportation system is not responsive to the polynuclear organization that exists today and in the future. To put it simply, all roads lead to where only a relatively small number of people need to go. Given the city's polynuclear organization, the obvious question to ask is what pattern of transportation organization would be more responsive to this mode of distribution? If the existing system is designed to deliver traffic to a single, central point, what pattern would best deliver traffic to multiple points? One answer to this is an interlocking system of lines, not unlike the interlocking lines that make up the city's network of bayous.

BEYOND THE CORRIDOR

Houston's progress can be described as the transformation of a city organized by a single, dominant center, into a city organized by a number of dispersed and equivalent centers, to a city finally brought together by a banded/linear system that is rooted in the geometry of its most prominent natural features. In spite of its comprehensive geometry, Houston's centric pattern has never fully dominated the city. Since its founding, it has instead been driven by the give and take between this monocentric pattern, its polycentric build-out, and the linear logic of its natural systems. This give and take will continue to determine the city's subsequent growth with a marked shift in emphasis toward an accommodation of ever more volatile natural forces. This shift can be seen in transformations that are taking place in the city today, transformations that are nowhere more visible than in a remarkable new network that has recently been assembled under the name of Bayou Greenways 2020.

Bayou Greenways 2020 is an ambitious plan to unite the bayous within the city limits of Houston into a series of publicly accessible greenways. Adding 80 new miles to existing bayou parks, it will create a cumulative 150 miles of park space becoming the largest network of urban, off-street corridors in the country. (The second-largest system is Portland, Oregon with 78 miles.) In addition to the greenways themselves, 77 of Houston's existing public parks exist along the axes of the corridors. Quoting from the Houston Parks Board's introduction, "Bayou Greenways 2020 will create a network of connected, walkable nature parks and trails along nine of the bayous that run through every neighborhood within city limits. Upon completion, the project will add 1,500 acres of equitably distributed parkland, connect 150 miles of multi-use trails, and put 60 percent of all Houstonians within 1.5 miles of a public greenway." To state what may already be obvious, Bayou Greenways embodies the banded/linear system that is rooted in the geometry of a riverine network. It represents a significant reconciliation of an indifferent city to its natural systems. As such it is so much more than a "nature trail." Given the environmental limitations which we confront today, it is the scaffold upon which the next iteration of Houston will be built.

There are many aspects of the network that could be used to support such a broad claim; I will emphasize two. First, the Greenways describe a new mode of urban connectivity that is unique to the suburban situation out of which they were born. The key fact in this claim is that the Greenways will "connect 150 miles of multi-use trails and put 60 percent of all Houstonians within 1.5 miles of a public

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SHIP CHANNEL AT BELTWAY 8. Two enormous piles of petroleum coke (petcoke), a by-product of Shell's Deer Park Refinery, are just visible in the center. Brought over from the refinery by conveyor belts, the petcoke is being prepared for shipment as a high-value energy source. Per unit of weight, petcoke emits between 30 and 80 percent more CO_2 than coal.

greenway." This statistic should give pause inasmuch as it suggests that the Greenways represent more than a new recreational amenity, but an entirely new mode of urban connectivity. For all that "walkability" has been the holy grail of recent urban debates, it often translates into another naive and unexamined call for the transformation of Houston into something resembling Brooklyn. The idea of using a traditional urban template on a city as dispersed and fragmented as Houston is simply a non-starter. Over 75 percent of the city lives on a discontinuous, spine-based urbanism of the cul-de-sac—an altogether different DNA than that of traditional, grid-based urbanism. Because these differences are structural, the likelihood that a city like Houston could ever be turned into a city with a street-life like Brooklyn is close to zero. This fact, however, need not lead the conclusion that Houston's extensive freeway infrastructure has forever locked the city into an automotive transportation system. Given that 60 percent of the city's population is now within a twenty-minute walk of an extended public corridor, this is clearly not the case. Reduce this twenty-minute walk to a ten-minute bike ride and the Greenways become an instant mass transit system for a post-carbon economy offering a level of connectivity that no city has, never mind a dissipated city like Houston. Without this low density and cheap land prices that accompany it the network could never have been assembled in the first place. As opposed to measuring the city against traditional modes of pedestrian accommodation, the greenways produce walkability in a distinctly new, sub-urban mode, a mode that is, incidentally, unknown to urban history.

Perhaps more important than the new mode of connectivity is the role that the Greenways will play in a new model of dense urban development. Already in Houston, urban density gravitates toward open space. While office towers tend to gather around freeway corridors, residential buildings tend to gather around open natural features, like the high-rise towers surrounding Hermann Park or Buffalo Bayou just west of Downtown. By "upzoning" Houston's landuse regulations for the neighborhoods on either side of the greenways throughout the city, opportunities emerge for the creation of new high-density development with greater height, more dwelling units, and the inestimable amenity of being directly adjacent to an urban, open space network. If Houston begins to build in a denser fashion, as it must to bring down per-capita energy consumption, a new model of urban density emerges from the Greenways. As opposed to piling up building mass in the manner of Manhattan or Hong Kong, this model could produce a distributed as opposed to concentrated build up of urban forms outside of the urban center. Tied together by the network of distributed open space that penetrates the entire extent of the city, new development is related, not to the limitations of the old concentric model of urban organization, but to the linear network.

In the end, the greatest benefit from moving toward a linear model of organization is that all natural systems are aligned to it. This reconciliation between natural and urban systems is ultimately what assures the city's success in an uncertain environmental future.

CATALYST

> "The challenge is to build for the future, not steal from it"
> —Edmund G. Brown Jr., Governor of California, Inaugural Address, January 5, 2015.

What catalyst would ever challenge the dominant concentric order of loop, beltway, and parkway? While the tangible

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evidence for climate change remains thin—a few hundred-year storms, melting glaciers, and increasingly sober scientific reports—the extraordinary stakes involved already require a vigorous response. Such a response should be automatic, requiring no more from us than a relatively modest leap of faith in the kind of science that we routinely trust. What this science tells us, however, is far from routine. It tells us that our actions have so profoundly transformed the planet as to both compromise our immediate future and cripple generations to come. Furthermore, it offers us outrageous limits like a required 80 percent reduction in per capita energy consumption by the year 2050. This reduction is based on the need to contain a rise in surface temperatures to 2 degrees Celsius—the agreed upon maximum that avoids severe food shortages, inundated coastal cities and massive displacements of population. The number is outrageous because, at this point (2014) 565 gigatons of CO_2 is the remaining maximum carbon load the atmosphere can absorb and still limit warming to a 2 degree Celsius rise. At our present rate of emission it will take only 15 years until we reach this limit.

While it should be possible, if not also difficult, to respond to such numbers, one principal obstacle is daunting: the vast material infrastructure that encodes this high level of consumption into our way of life. These structures, which we call cities, represent nothing less than the accumulated wealth of the world. While to adapt, if not wholly reconstruct, this material infrastructure would seem the first line of response to the climate crisis, it has scarcely been put forth, even by those charged with its planning and construction. Beyond modest material interventions such as changing our light bulbs or shrinking our cars, the reform of our material environment seems almost unthinkable. It is easier to imagine absurd acts of geoengineering—seeding the stratosphere with light reflecting sulphur, growing carbon absorbing algae in the world's oceans, or painting the Russian Steppes white—than it is to imagine reforming our cities. (Strange as it may seem today, however, such reforms are inevitable.)

This inevitability is based on a last number that has yet to be digested. According to the Fifth Assessment Report of the UN-sponsored Intergovernmental Panel on Climate Change (IPCC), urban areas account for between 71 and 76 percent of CO_2 emissions from global final energy use. Inasmuch as cities count for two-thirds of the world's overall energy consumption they constitute a single, unified front on the war against climate change. In other words, no matter what route the response to climate change takes, it must go through our cities and address the patterns of high energy consumption that they presently require. If this is not quite apparent today, it will be in the near future. The IPCC's Report described the outsized role that urbanization will play in the climate crisis over the coming decades:

> "the scale and speed of urbanization is unprecedented: more than half of the world population live in urban areas and each week the global urban population increases by 1.3 million. Today there are nearly 1,000 urban agglomerations with populations of 500,000 or greater; by 2050, the global urban population is expected to increase by between 2.5 to 3 billion, corresponding to 64 percent to 69 percent of the world population. Expansion of urban areas is on average twice as fast as urban population growth, and the expected increase in urban land cover during the first three decades of the 21st century will be greater than the cumulative urban expansion in all of human history."

What the report tells us is that the frontier of climate change is not in the stratosphere, the oceans, or even the poles, it is the cities in which we live and the habits of consumption that are built into them. This is nowhere more true than it is in Houston. Where there once was no limit to the amount of energy we could produce and consume, we are now moving into a period in which such limits are likely to touch almost every enterprise that we undertake. Historically, Houston's negotiations between its natural and urban systems were based on how much energy we could produce; in the very near future, those negotiations will be based on how much energy we consume.