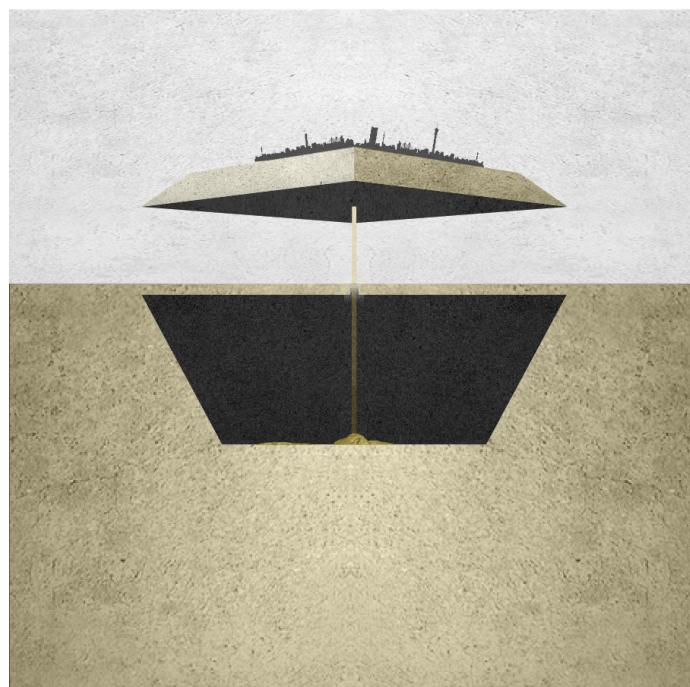


Terra (in)Firma: an architecture of extraction

CLAIRE KUANG, advised by ANDREW WITT



1

CAPITAL, COMMODITY, AND INFRASTRUCTURE

The narrative of post-industrial capital, in so far as it is capable of transforming at scale the material landscape of wealth into self-reinforcing structures of organization and power, is reaching a critical point with the advent of modern urbanization. As succinctly surmised by Mark Weiser in his 1991 essay in *Scientific American*, “the most profound technologies are those that disappear... they weave themselves into the fabric of everyday life until they are indistinguishable from it”. Contemporary infrastructures in this sense are radically reshaping the processes, politics, and aesthetics of commodification and commodity fetishization that have been the hallmark of capital accumulation in the 20th century. In looking at the material foundation of capital and currency following the industrial revolution, this thesis nosedives into the relationship between power, capital, and the built environment through a case study of the global dynamics surrounding the implementation of the gold standard in the early 1800’s, and the unprecedented metamorphosis of Johannesburg’s urban landscape that resulted in the following century.

Value, in perpetuity

To situate the terms ‘capital’, ‘commodity’, and ‘infrastructure’ within a Marxist framework, capital is defined as the accumulation of wealth specifically through the process of circulation - a dynamic driven by the difference between a commodity’s use value and its exchange value. The capitalist then understands this value as being in constant motion, where profit is generated through perpetual reinvestment and consequent augmentation of exchange value. The nature of this value-added exchange is

then contextualized through how one chooses to define the term ‘commodity’; and indeed, the chasm between commodity as it first appears in *Das Kapital* and as it is currently understood in the global markets is quite extensive. To Marx, commodity was “an object outside us, a thing that by its properties satisfies human wants of some sort or another”, and where “the nature of such wants, whether, for instance, they spring from the stomach or from fancy, makes no difference...neither are we here concerned to know how the object satisfies these wants, whether directly as means of subsistence, or indirectly as means of production”. This definition is metaphysical in disposition, and is concerned less with the tangible qualifications by which a specific externality is commodified than it is with the understanding that commodification is a process implicitly tied to human desire. As such, desire being a fickle beast, the commodity is monadic as a unit endowed with perceptual virtue, and it is this appended quality that gains in value through transformations of exchange by social and political forces.

Consumptive futures

Contemporary economics, however, defines the commodities trade far more tangibly: such objects are typically uniform in pricing across many markets, are used in the production of other goods, and can be extracted or grown and traded in sufficiently high quantities. These traits allow them to support extremely liquid markets in which futures and options are often sold to protect both producers and consumers against fluctuations in price. In this context, the commodity necessarily exists on a global scale, and its value in trade is defined not by a consistent growth in exchange value but rather by the ease with which they



1.1 Late afternoon shadows cast by a 1st c. Roman aqueduct in Plaza Azoguejo, Segovia.

can be converted into money through their use in other, more refined products. Thus cocoa, copper, wheat, oil, and coal qualify whereas diamonds, due to their inconsistencies in quality, and natural gas, due to its predisposition for price determination through long term regional contracts, do not. The modern commodity exists in material form only briefly; its primary purpose is to be liquidated as quickly as possible for as much as possible. The selling of futures - the functional equivalent of the Marxist exchange value - is now complete in its disembodiment from the physical realities of the object itself, acting as a stand-in independent from the actual volume of material being extracted or produced. Where the Marxist perspective portrays the commodity as an object with appended metaphysical value, in perpetual circulation, the economics of today suggest they are transient one-way pipelines from production at scale to diversified, globalized consumption.

Material mediators

In this discourse, the term 'infrastructure' exists purely in relation to the flows that enable capital accumulation through the production and consumption of commodities. Maria Kaika and Erik Swyngedouw identify technological networks as the "material mediators between nature and the city; they carry the flow and process of transformation of one into the other"¹. The process of assigning market relations to socially metabolized goods is fundamentally dependent on the process of fetishization, which in the Marxist sense is the quantification of the qualitative that allows for abstraction to take over. The fetishized commodity supplies its own ideology in the market, and allows for augmentations of its exchange value without revealing the socioenvironmental circumstances of its production.

¹ "Fetishizing the Modern City: The Phantasmagoria of Urban Technological Networks". *International Journal of Urban and Regional Research* 24.1(2008).



1.2 R. C. Harris Water Treatment Plant interior in Toronto, 1941.

First monumental, then mundane

Commodity fetishism in the modern era merged economics, politics, and culture to materially enact an ideology of progress, resulting in behemoth infrastructures which served as monuments to engineering and technological progress. In the span of a decade from 1904-1914, the construction of the Panama Canal resulted in the excavation of more than 130 million cubic meters of earth. The Great Depression gave birth to the Hoover Dam, impounding Lake Mead for hydroelectric power and containing more than 3.3 million cubic meters of concrete. These megastructures operated at a scale unfathomable to the human body, iconic in both size and impact. With the abandonment of this techno-optimist ideology following the abysmal living conditions characteristic of post-industrial cities and the mechanical destruction of the two world wars, came the erasure of urban networks from

visible, physical space; a transition from the monumental to the mundane. Contemporary urban infrastructures are invisible: pipes, cables, electronic waves that sever the connection between the social transformation of nature and the process of urbanization. In this sense, physical infrastructures are the residue, the material byproducts of the process of capitalism, viewed only as instruments in the service of additional value extraction, and can be extended to include the material city itself - and embedded in this material manifestation are power dynamics which facilitate the flow of capital, often in service of those with purchasing wealth. In our globalized economy, these flows transcend geographic and political boundaries, directionally fixed from sites of extraction to territories of mass consumption.



1.3 Summer vacationer in front of the Hoover Dam, 1957.



1.4 Standing in a Panama Canal lock, 1912.

Infrastructure in motion

Here we stumble upon a fundamental paradox of capital as it relates to infrastructure: how does one reconcile the dynamism of capital in perpetual motion and fluctuation with infrastructure that is static and immobile in space? One could argue that this tension manifests as the creative destruction of the built environment and ceaseless restructuring of scale economies, characteristic of the cityscape in advanced capitalism. Instability, in the urban context, thus occurs when a paradigm shift in capital flow commands a radical restructuring of the physical infrastructures that must adjust to enable its realization. From this several questions arise: how does the erratic flow of capital affect the colonization of nature? How can one intervene in the static, built environment to influence these flows, either to stabilize or stimulate its corresponding capitalist system? How will infrastructure's legacy manifest itself both materially and aesthetically upon future cityscapes?

Identifying infrastructures as being primary, secondary, or tertiary respective to its corresponding role in extraction, commodification, and information distribution, then commodification with the emergence of late capitalism shows tertiary infrastructures with ever increasing scale and scope, inversely related to their presence in physical space. The long timescales and inertia of built infrastructure, when contrasted with the immediacy and rapid evolution of digital information and boom/bust cycles poses significant point of investigation for this project. In looking at the post-industrial evolution of currency from the gold standard to the digital, we can perhaps draw some conclusions about how modern societies can develop resiliency in the face of rapid capital flows as we mature through the age of information.

The Gold Standard

Arguably the most classically transformative paradigm shift in the history of currency, the establishment of a formal gold standard among the major trading nations during the 19th century reveal the scale and scope to which capital flows can reshape the urban and its subsidiary landscape. Gold has existed as a form of currency since as early as 610BC, but it wasn't until the era of colonization and rapidly expanding global markets that the metal became incongruously cumbersome to transport across vast distances. Where before the value of the gold coin was embedded in the material of the coin itself, the introduction of the gold standard allowed for a more efficient representation of value- in this case, paper currency - that was still fixed upon some definite quantity of gold.

This new mode of representation not only facilitated the global trade by establishing trust between governments which could redeem any amount of paper money for its value in gold, but it also kickstarted a global feedback loop between gold mines, gold markets, and government. Burgeoning multinational trade heightened demand for gold to back the standards in the US and Europe, especially gold which could be mined as cheaply as possible to maximize the profits of colonizing nations. In turn, as their wealth grew so too did the volume of trade, propelling the demand for gold ever higher. Britain was the first to adopt a gold specie standard in 1821, followed by the United States and Germany in 1873.

Critical instabilities

This system, however, proved unstable as each injection of new gold into these economies also meant a drop in the value of gold and their corresponding currencies. Instability reached critical thresholds with the advent of the first world war, when the standard was suspended to enable bulk printing of paper currency to fund military involvement - instigating a period of hyperinflation as the value of currency was no longer stabilized to a regulated material form. The standard failed once again during the Great Depression, as investors began trading in currencies which subsequently raised the value of gold and promoted widespread hoarding during the fallout of trust in American banking institutions following the stock market crash. An equally powerful counterswing instigated by Roosevelt, in an attempt to stymy depletion, then resulted in the largest global consolidation of gold stock in the Federal Reserve. Because of this majority share, the US dollar had become the de facto world currency by the 1944 Bretton Woods Agreement, which fixed all exchange values in terms of gold.

This marked the beginning of a new dynamic in gold's role as a commodity: where before its use value lay in the ease with which it could be liquidated (exchanged for cash), this function has now been replaced by cash itself. Instead of stockpiling gold, other countries began stockpiling the US dollar, thus turning a paper currency into a commodity, where its value is not fixed to some quantifiable material but rather to the scale and scope in which it is used. Though the gold standard officially ended on August 15, 1971 when the ballooning value of the US dollar due to its role as the linchpin of the world economy could no longer be backed by its gold reserves, and the Fed could no longer redeem dollars

with gold, the metal continues to embody an asset of real value in the global social conscience, as exemplified in its purchase during periods of recession and inflation.

2

CITY OF GOLD

The ramifications of a globalized gold market as geopolitical infrastructure at the source of extraction and production are profound. A fascinating dive into the gold supply chain during the first four decades of the 20th century pinpoint the Transvaal region of South Africa as the supplier of 35% of the world's gold production, and the approximately 50,000 tons of gold extracted since the end of the 19th century account for almost half of all gold ever mined through the course of human history². The transformations in this area, in particular the rapid conversion of a primarily agrarian society into the largest and richest metropolis of South Africa and the violence exacted upon its land and people, are inextricably tied to the politics behind the establishment and subsequent turbulences of the gold standard.

As Above, So Below

In the summer of 1886, prospectors struck gold on a small farm called Langlaate. This was the Witwatersrand Reef, which extends east-west for 400 kilometers and runs for some 5,000 meters below ground. Soon prospectors and migrant workers came and set up small mining camps wherever gold was struck, and Langlaate merged with clusters of other camps to form what is now the city of Johannesburg. Growth was explosive: in the year following discovery, the Reef in its entirety was estimated to contain some 7,000 people, less than half of which lived in Johannesburg itself. Not four years later, Johannesburg's population had multiplied ten-fold, and by 1891 approximately 102,000 people resided in the city. The circumstances of Johannesburg's formation, and the exponential growth that

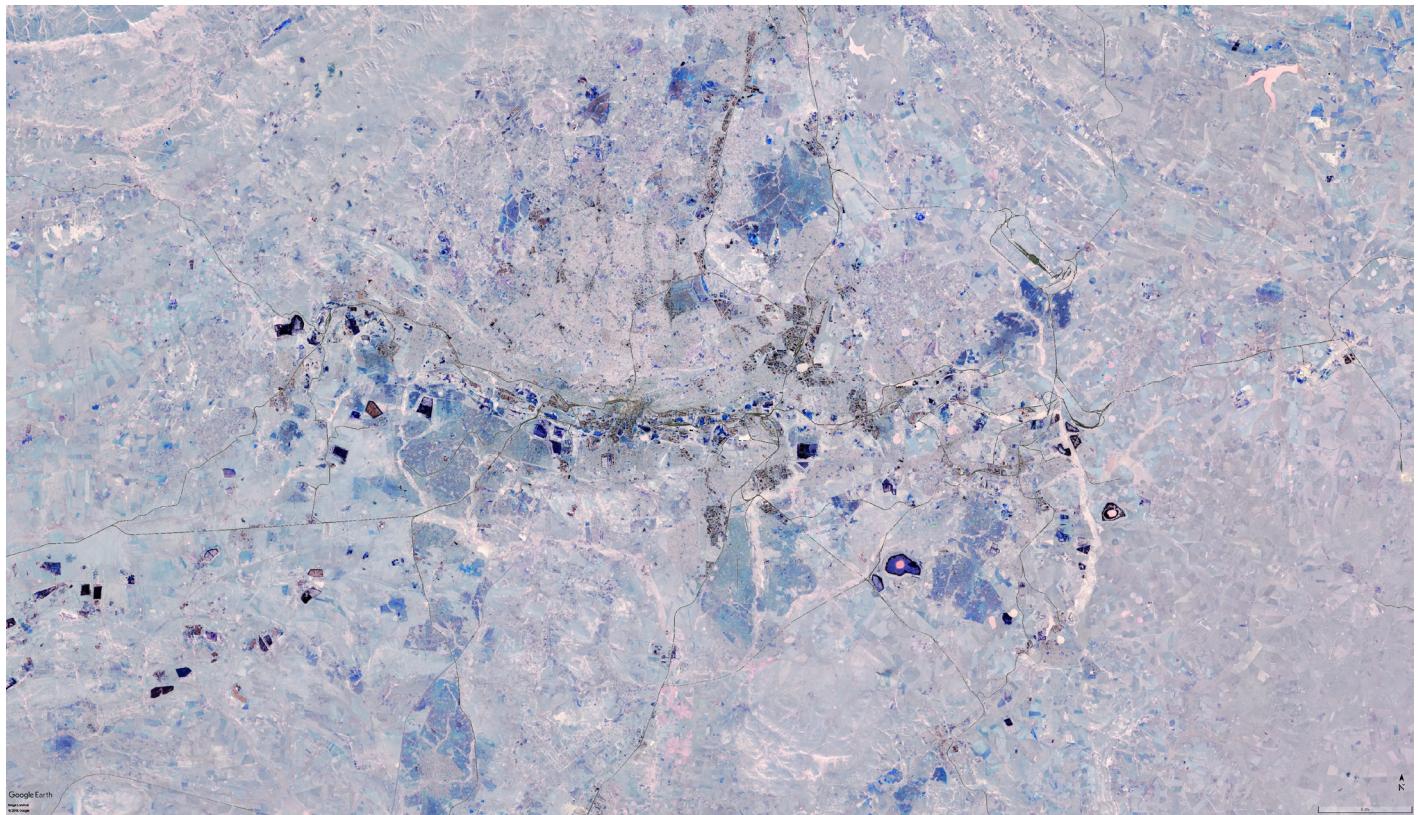
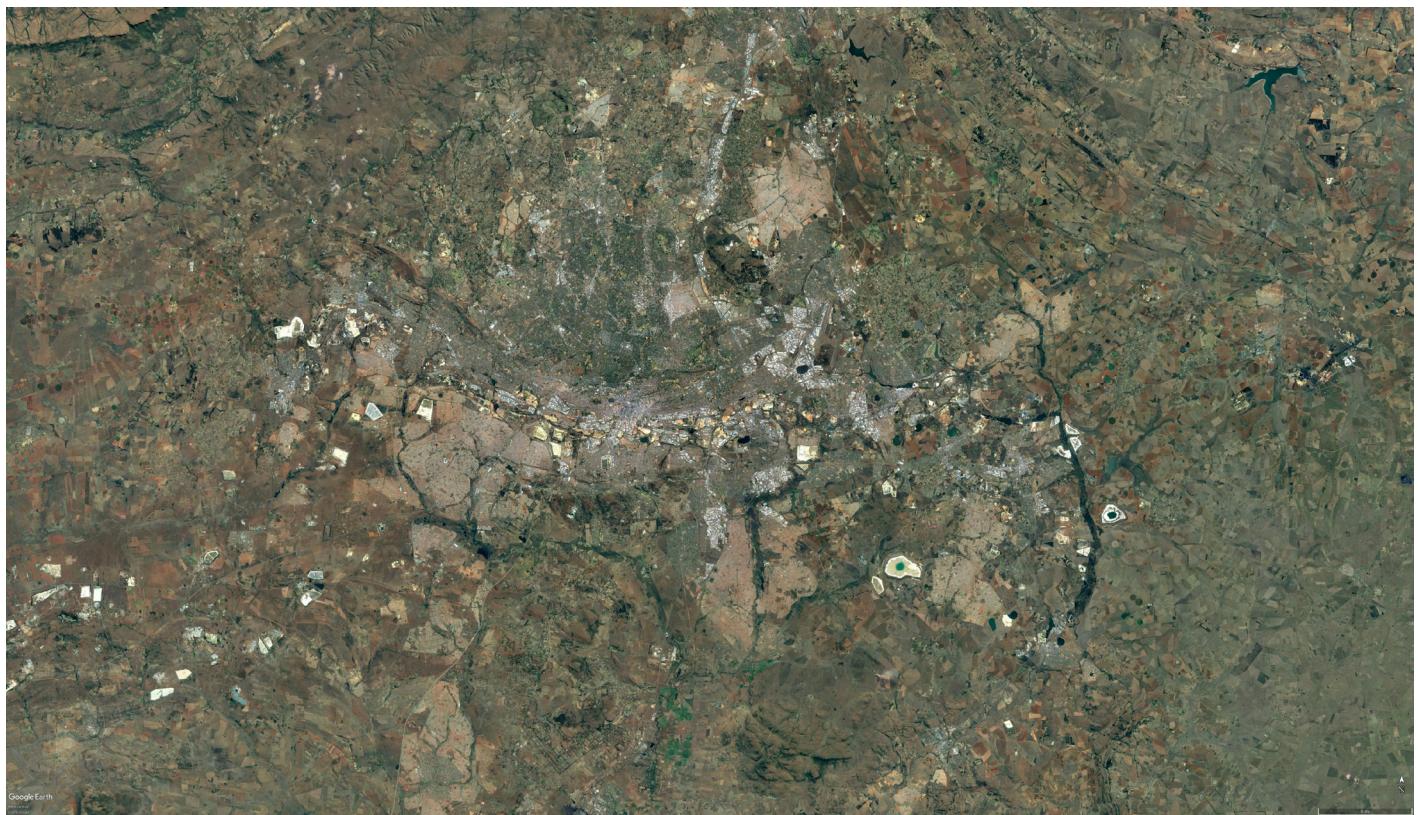
followed, is written permanently into the urban fabric. Previous gold discoveries in the Transvaal were all alluvial and thus transient in nature, and so the original subdivision of land in Johannesburg's first camp clusters were closely spaced, typical of 19th century mine camp planning. By the time it became known that the Reef ran both deep and wide, the burgeoning class of migrant workers had already drawn lawyers, shopkeepers, and traders that converted the camps into more permanent buildings, crystallizing the original partition scheme into what is now Johannesburg's central business district.

Transportation and other infrastructures materialized quickly within this period, with piped water, electricity, and telephones appearing in the first two years, and South Africa's first railway system inaugurated by the beginning of 1890. Initially servicing the predominant east-west run of the Reef, these infrastructures soon had to negotiate the mining waste dumps, sometimes deposited just meters away from the mine entrances due to the initial ad hoc zoning restrictions, that resulted from a shift into deep-level mining after surface outcrops ran low. The problem of waste was further exacerbated by the low grade ore that characterized much of the Witwatersrand Reef, with some companies producing up to 200,000 times as much waste as gold: an issue that only worsened as time progressed and deeper excavations were made to reach new deposits.

Landscapes of waste

Today, south African mining companies remove up to 7,500 tons of earth to produce one standard gold bar's worth of product. Put into perspective, given that Johannesburg roughly produced a

² Norman, N., Whitfield, G. (2006) "Geological Journeys". p. 38-49, 60–61. Struik Publishers, Cape Town.



2.1 Satellite image of Johannesburg (Google Maps 2017). East-West mining belt (above), and its negative with waste deposits in blue (below).

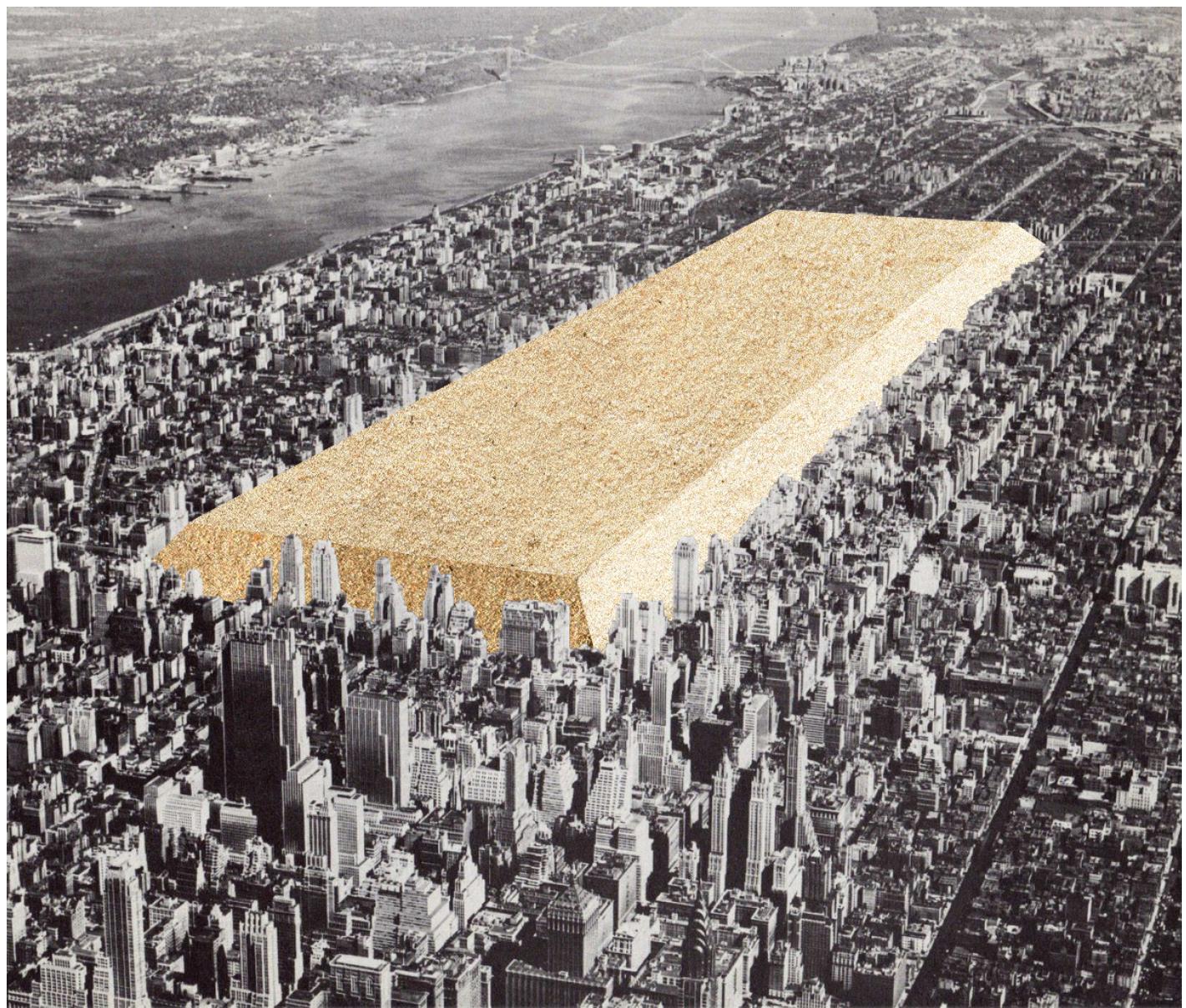
hypothetical 40% of the gold in the US reserve at its peak, the equivalent waste mound would cover the entire footprint of Central Park with the height of One World Trade Center, four times over. As railway and automobile infrastructures continued to mature over the next few decades, connecting the sites of gold extraction with the major ports of South Africa for export, the tight weave of transit networks and waste formed a permanent and prominent belt along the east-west axis of the city and its subjugate landscape, splitting it into two distinct, unequal halves.

The material residue of gold mining in Johannesburg in turn shaped the geospatial division of socio-economic class, as delineated through the restructuring of power during the Second Boer War in 1899 and the apartheid era politics that followed. At the crux of these political upheavals was a fundamental economic problem: how to make the low grade ore profitable? Deep-level mining required advanced knowledge and expensive machinery, which shifted the landscape of extraction from small scale manual panning by opportunists at the onset to large scale mining operations often owned by wealthy corporations abroad. As the extent of Witwatersrand Reef became clear, so too did political tensions over who would gain control of the lucrative resource, especially with the adoption of the gold standard. Established by the Boers after Great Britain annexed their Cape Colony during the Napoleonic Wars, the Transvaal and Orange Free State initially drew many foreigners to its borders with the discovery of diamonds at Kimberley in 1866. Soon after the discovery of gold in 1886, the Boers understood that they lacked both the manpower and the industrial expertise to develop the resource, and so reluctantly allowed the immigration of foreigners, called uitlanders, to the Transvaal. Many of these immigrants were English-speaking men from Britain, and soon

their population challenged and potentially exceeded that of the original Boer settlers, which precipitated tensions between the two groups. In part driven by expansionist ideology, a notable proponent of which was mining magnate and early gold investor Cecil Rhodes, as well as attempts to obtain full voting rights for the uitlanders, the British attempted to raid the city in 1895 and finally gained control of the Transvaal and its allied Orange Free State in 1902.

Labor politics

With political ownership of Johannesburg's gold established, it became clear that a profitable enterprise would not have been possible without an abundance of cheap, unskilled labor from disenfranchised migrant workers. The gold standard meant that pricing was internationally controlled, and so any increases in operational costs could not be passed down to consumers through price increases. The United States and other major European powers were major gold importers, and it was also in their best interests to keep the price of gold low; thus, maintaining a constant supply of cheap labor became a primary focus for both the Boer and British governments as well as the mine owners. The following decades oversaw the political, social, and economic control of a huge population of black Africans for this singular purpose. Through governmental and white acquisition of land, harsh property taxes, and militaristic destabilization of neighboring African nations, the development of the mining industry destroyed independent farming as a way of life and completely reconfigured the socioeconomic structures of South Africa. A host of governmental policies spanning the first four decades of the 20th century, ranging from the criminalization



2.2 Gold waste if deposited in Manhattan, proportionally to city GDP and the amount of South African gold in the US Federal Reserve...

of job desertion and the issuance of black passes to municipal segregation and the prohibition of blacks from buying or renting land outside of designated zones, were put in place to prevent upward mobility and to promote unemployment among the native African communities.

These policies also, by necessity due to the growing ratio of poor black laborers to white owners and officials that by 1913 already more than doubled, created a distinct spatial separation of the groups by discouraging interracial interaction outside of the mines themselves - a spatial pattern strongly reinforced during the Apartheid era that followed. By the 1930's, various black-only townships were established on cheap land as a result of forced reallocation. Until that point, the lack of adequate housing for Johannesburg's vast working class resulted primarily in underserved, mixed race shantytowns near the city center that have been earmarked for removal. The Great Depression then sparked a period of brief economic expansion, when the price of gold shot up due to the increase of global demand with the abandonment of the gold standard, providing the South African government with the funds necessary to separate and reallocate entire populations of black laborers. The largest resettlement became what is today the township of Soweto, located just south of the central business district, downwind from the massive mine dumps that divided the city. Here, land was cheap due to the lack of transportation infrastructure, and as a result of the environmental hazards of living near toxic waste dumps.

The next decades of Apartheid reinforced this pattern of isolating the wealthy, predominantly white community into well serviced and well developed urban areas upwind of the waste belt, and relegating the poor, black working class to sprawling shantytowns

south - sometimes on top of the mounds themselves. And just as racial segregation was territorialized within the urban and periurban areas, the separation between urban and rural also became incredibly pronounced: stripping agricultural land of its male workers and leaving their families to be supported by low mine wages in effect created a dynamic where mine profits are maximized by policies that caused long term rural underdevelopment and poverty still in existence today.

Material erasure

South Africa's economy, created from and dependent upon its gold mines, is now suffering from exhausted deposits, increasingly expensive excavations, and extreme groundwater and air pollution from the resulting waste. The large mining monopolies of the 20th century have dissolved into smaller South African enterprises that, with new and more advanced refinement technology, have begun to remine the waste dumps which contain small particulate gold unsuccessfully harvested in the century prior. Where the original commodification process left distinct spatial geographies as delineated by these waste dumps, their removal will instigate new dynamics within the urban and periurban fabric. Without process regulation, all of the generated wealth will continue to flow into global markets while the original mounds will be processed outside of the city and dumped in the periurban territory south of the low income communities. Due to the waste belt's proximity to the central business district, and with the removal of waste leading to more favorable living conditions, the real estate value of the land will rapidly increase and the nearby communities will gentrify. This land will most likely be developed into higher income housing, and with the absence



2.3 Krugersdorp dumps manually remined with pressurized water, Johannesburg 2013. Photos by Jason Larkin.

of biohazard waste to keep landvalue low, new urban lines will be drawn as the previous poor communities who lived on and around the mounds will eventually relocate even further outside the city to south of the new waste mounds.

Here is an opportunity for policy regulation and the built environment to respond to such a large scale re-extraction of natural resources: by fixing the waste in place and rehabilitating it, this power dynamic would be stabilized to create value for the poor communities while providing a buffer for the rich, thus generating a more even distribution of wealth between the two communities while maintaining urban densities. Thus the lesson from Johannesburg is through the material regulation of extractive processes to fix them in place, which would reduce the turbulence of the existing socioeconomic geography. By keeping the waste dumps where they are, but allowing for in situ

infrastructural construction within them, the waste belt would be less of a wall and more of a mediator between the existing communities. The original infrastructural problem was a direct result of Johannesburg's rapid materialization, at enormous scales due to global demand for gold. To avoid this mistake again, one must phase the remining process and allow it to happen heterogeneously through space and time.

Resilient futures

The instability of the gold standard is at its core based on the nature of commodification, where the separation of use value and exchange value enables a flip flopping between their relative strengths. The emergence of a gold standard thus coincided with the carving of new geographies of power, and each subsequent



2.4 Mountainous tailing mounds in N8 Soweto (left); a drive-in theater on the Top Star dump in Booysens (right). Johannesburg, 2010.

turbulence in value reverberated down its infrastructural pipelines to its territories of extraction and production. To effect change and to build resiliency into existing infrastructures, one must regulate the process by which material extraction proceeds into capital.

What can we learn from the infrastructural instabilities in Johannesburg as a result of the capital flow during the gold standard? In order to prevent the ad hoc rapid remining and large scale redevelopment processes from destabilizing the socioeconomic structure of the city, one potential solution is to allow for the phasing of remining to occur concurrently with development at various stages over time, while also regulating the process to happen heterogeneously in space. The era of centralized infrastructure is coming to an end; material stability must begin to rely on the redundancies of distributed systems to survive our faster future.

"Isaura, city of the thousand wells, is said to rise over a deep, subterranean lake. On all sides, wherever the inhabitants dig long vertical holes in the ground, they succeed in drawing up water, as far as the city extends, and no farther. Its green border repeats the dark outline of the buried lake; an invisible landscape conditions the visible one; everything that moves in the sunlight is driven by the lapping wave enclosed beneath the rock's calcareous sky."

- Italo Calvino, *Invisible Cities*

3

A MANIFESTO

As systems-based thinking gradually reforms the domain of technical knowledge in the 21st century, architects largely continue to abstract the building as an object unto itself: distinct from and not beholden to the processes, materials, people, and consumptive forces with which every built structure is in dialogue. This erasure of material memory leads to an accumulation of infrastructural residue as old systems pass into obsolescence and extractive violence upon the landscape begins anew, leaving behind an unintentional city and blind inhabitants.

Birthed upon gold reefs, their mined detritus monumental within the urban fabric, Johannesburg is perfectly situated to negotiate processes of extraction with those of construction as these artificial mountains are now being hydrologically excavated for redevelopment. This project is a functional choreography of the regimens found in everyday life with the infrastructure of resource production - of water and gold - upon which these rituals are built, in an attempt to materialize through architectural agency the conditions of extraction that are typically unseen.



FNB stadium
910,000 sqft.

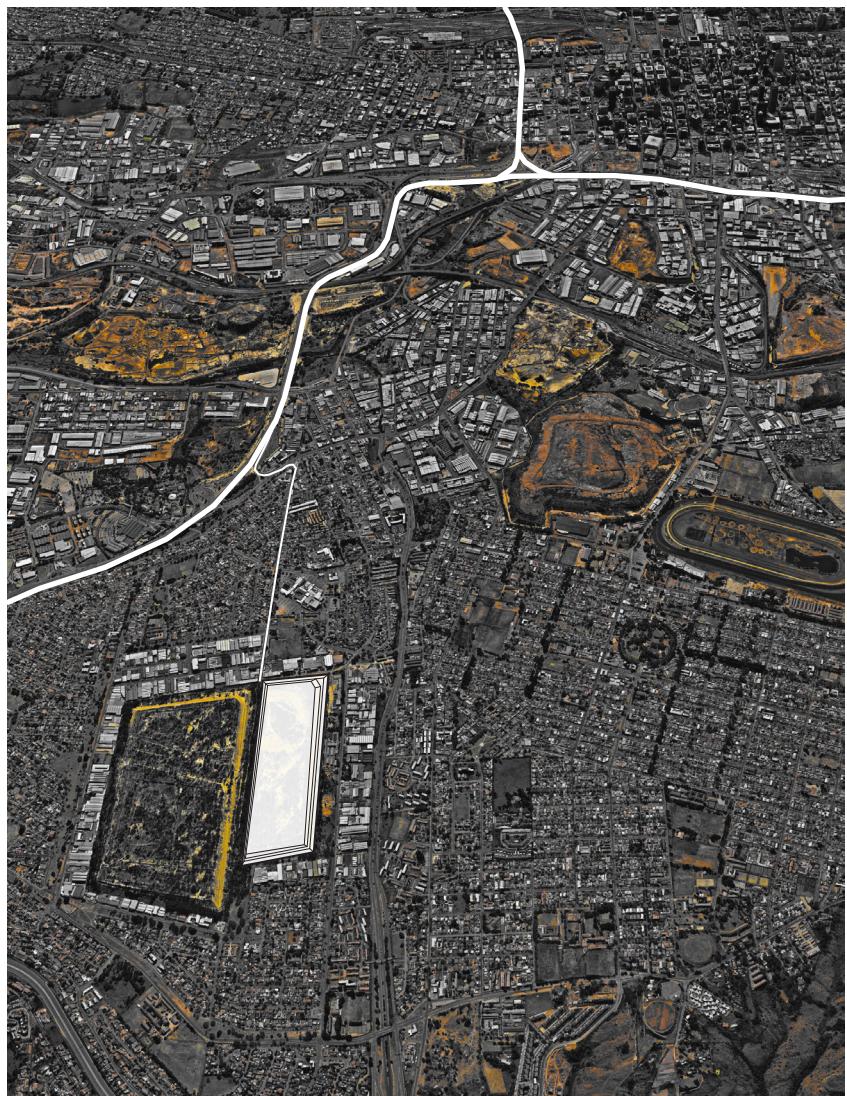
tailing dam
170,000 sqft.

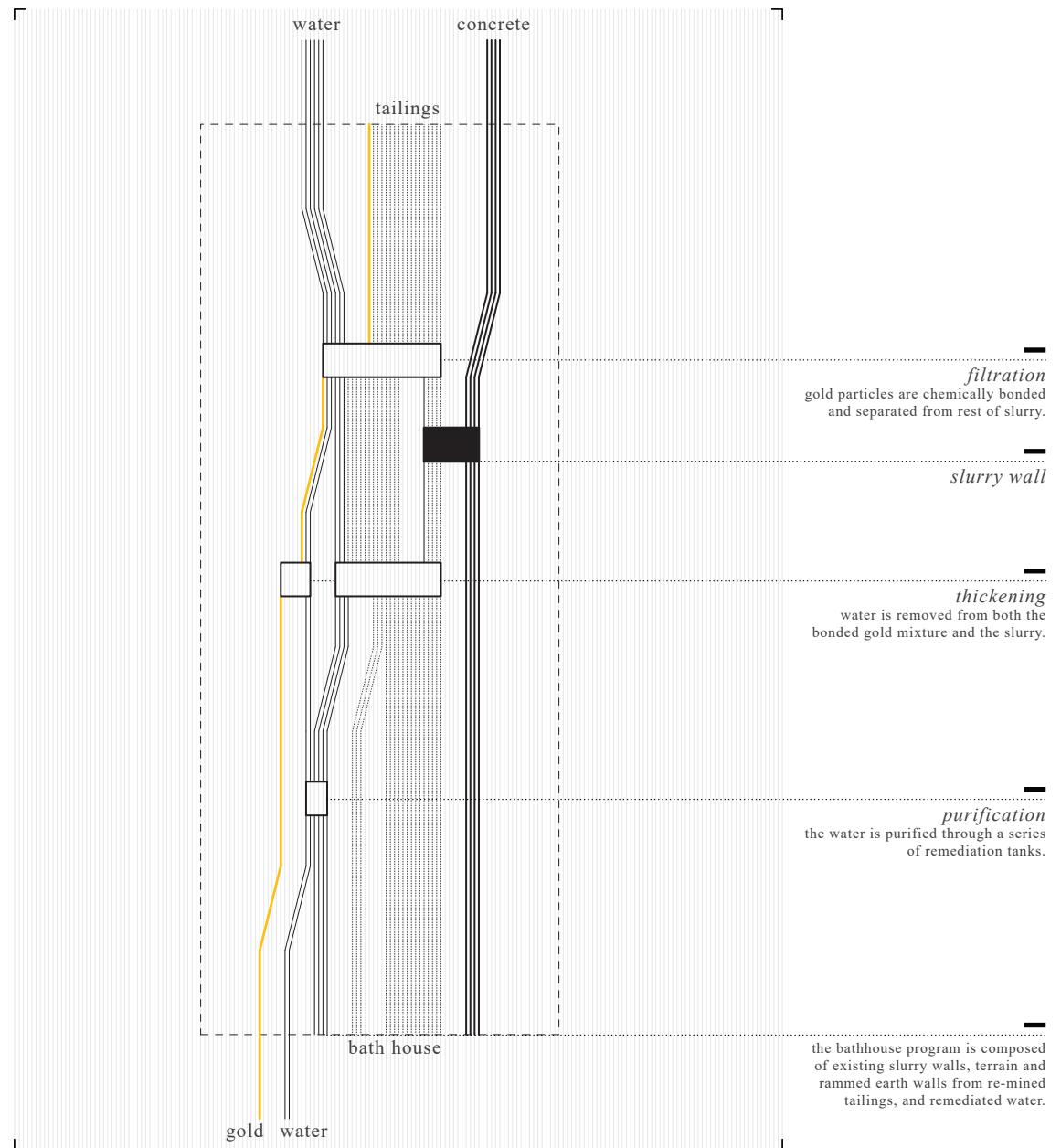
residential unit
1,300 sqft.

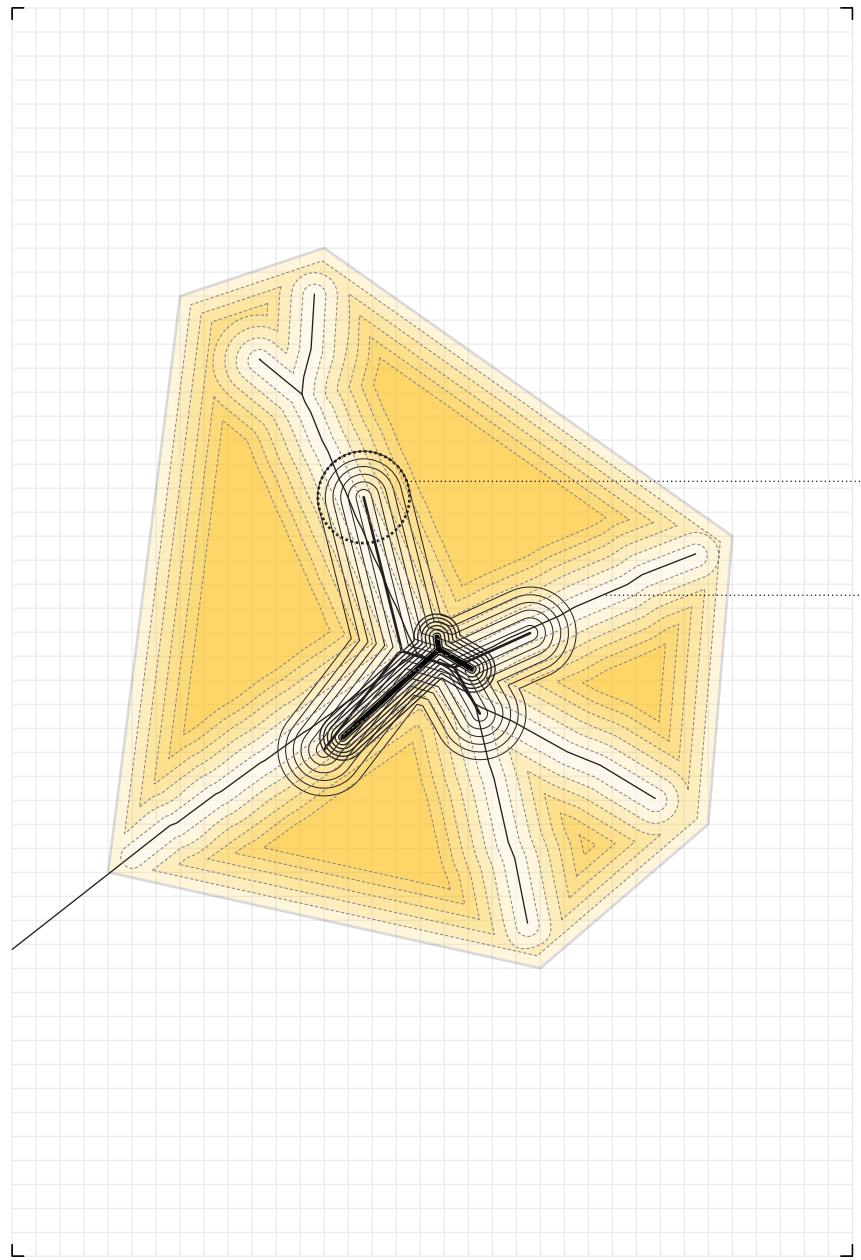


tailing mound
14,500,000 sqft.

aeroton steel
100,000 sqft.







catchment
area

polygon
skeleton

