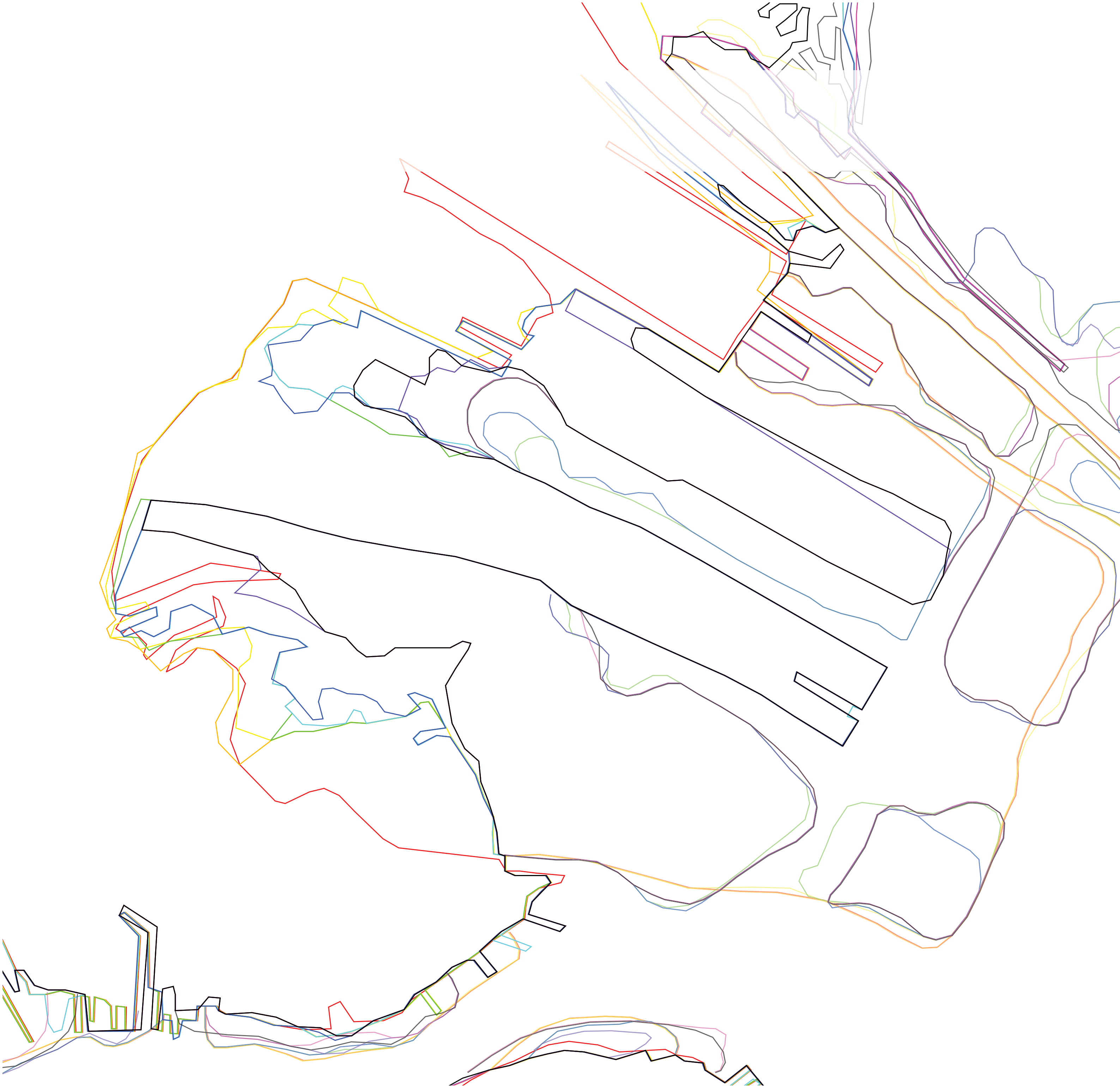


EDGE ATLAS

EDGE ATLAS

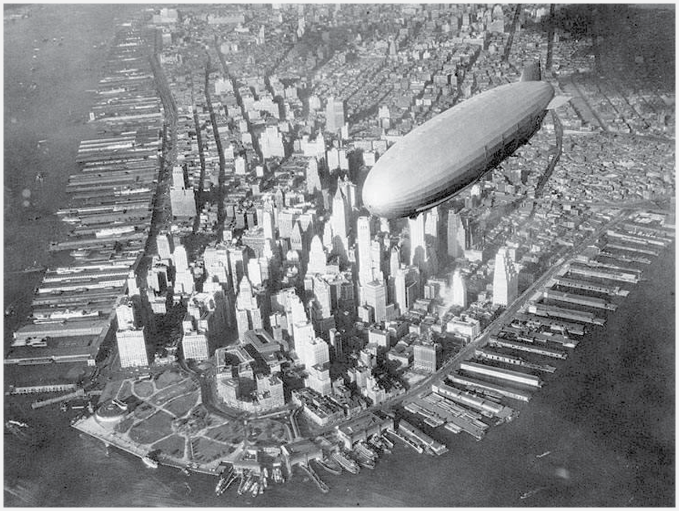
Be it at the hand of man or Mother Nature, the coastline of the New York-New Jersey Upper Bay is constantly being redrawn. Its current shape has been in the making for tens of thousands of years. The most legible changes occurred with the settlement and development of New York City and the surrounding metropolitan region. This section details our efforts to understand the transformation of the edge and to document its current state for comprehensive and scientific purposes.

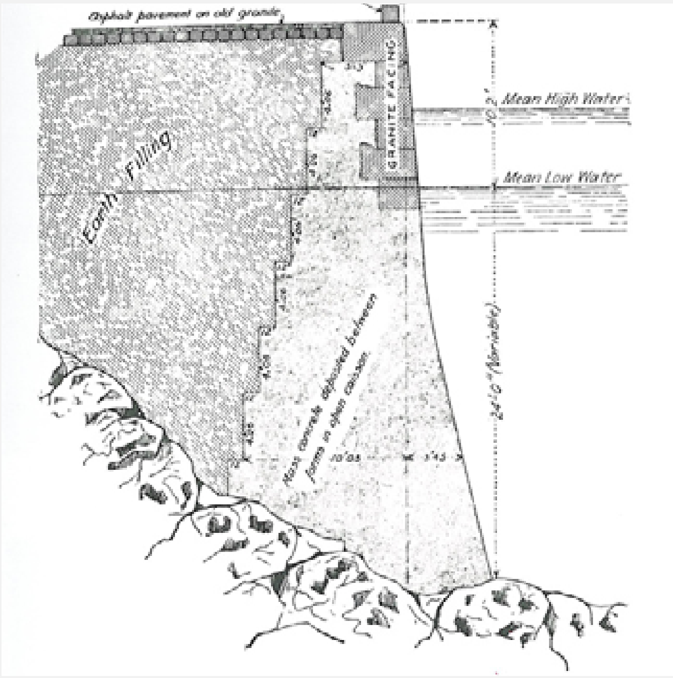
TRACING THE HISTORIC COASTLINE

In the past century or so, once gradual adjustments to the coastline due to geological and climatological processes gave way to more frequent and more dramatic adjustments due to artificial processes. It was during that time that the metropolitan New York region underwent a number of important changes including major growth in its population, the peak and subsequent decline of local industry, shifts in maritime use, and the establishment of the highway system.

With these historical changes to the urban environment, the coastline of the NY-NJ Upper Bay was likewise reshaped. The line drawing at right illustrates the state of the coastline and the shallow underwater flats decade by decade through the twentieth century. The years between 1918 and 1928 saw extensive construction of piers along the eastern waterfront of Staten Island and elsewhere around the harbor. By 1944 significant filling of land on the New Jersey side had begun, including the development of the Military Ocean Terminal, and throughout the harbor shoals and flats were made smaller or eliminated altogether by dredging. Between 1967 and 1977, the maritime industry recentered itself in New Jersey, resulting in the construction of a second large landfill pier in Bayonne and the removal of the piers lining Manhattan. The end of the century saw continued disintegration of piers in Brooklyn and Staten Island.

While the New York waterfront today remains a zone in transition, for our purposes, charting its current shape has been quite informative. But to fully understand the state of the current coastline one must look beyond the shape of the line itself both to its material qualities and its sectional characteristics.

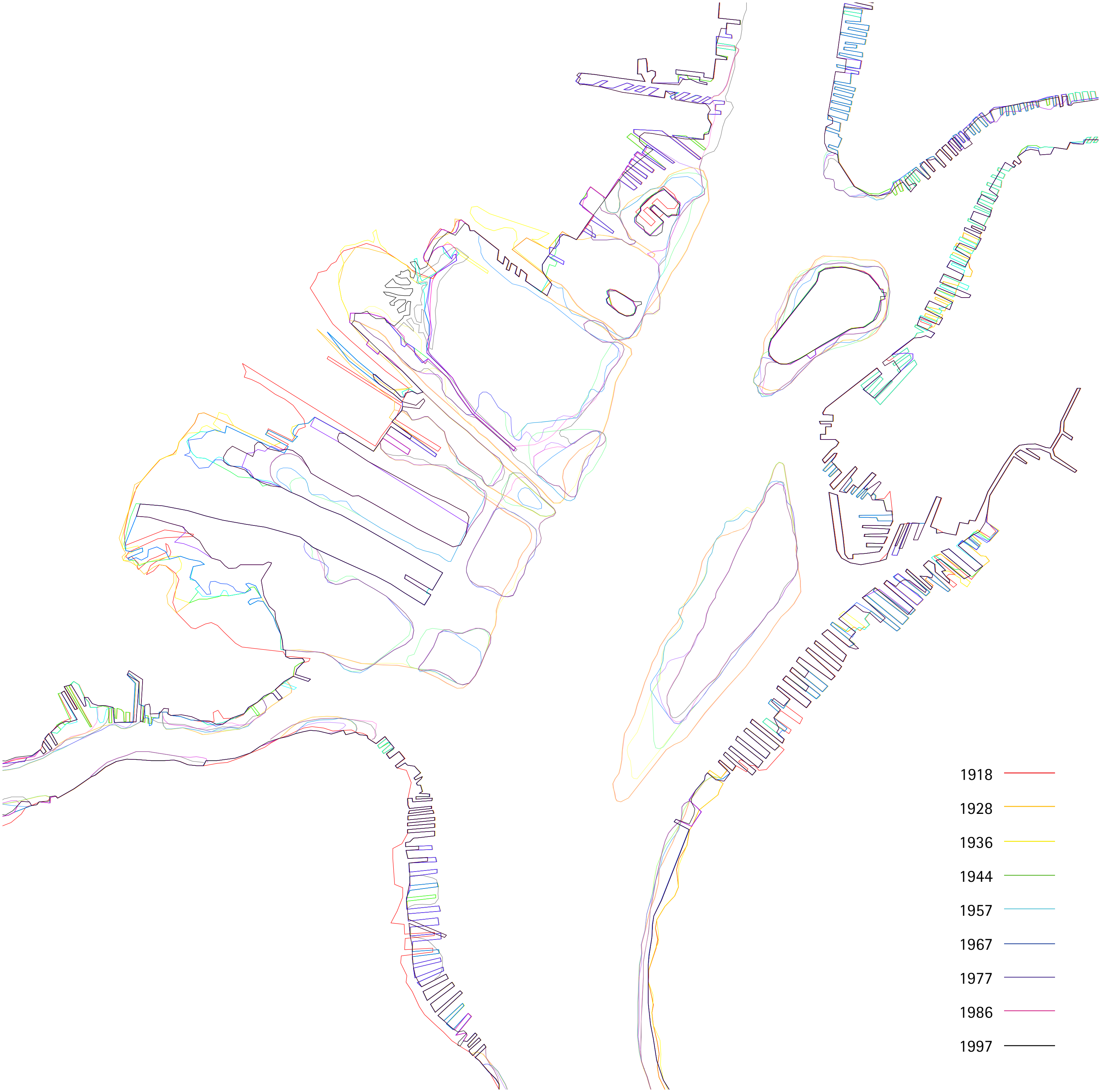




Aerial view of Lower Manhattan, Fairchild, 1931
Section, seawall

opposite
Upper Bay coastline through the twentieth century, traced from NOAA nautical charts

overleaf
Historical nautical charts, Office of Coast Survey, National Ocean Service, NOAA



1918
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1977
1986
1997

1917

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1967

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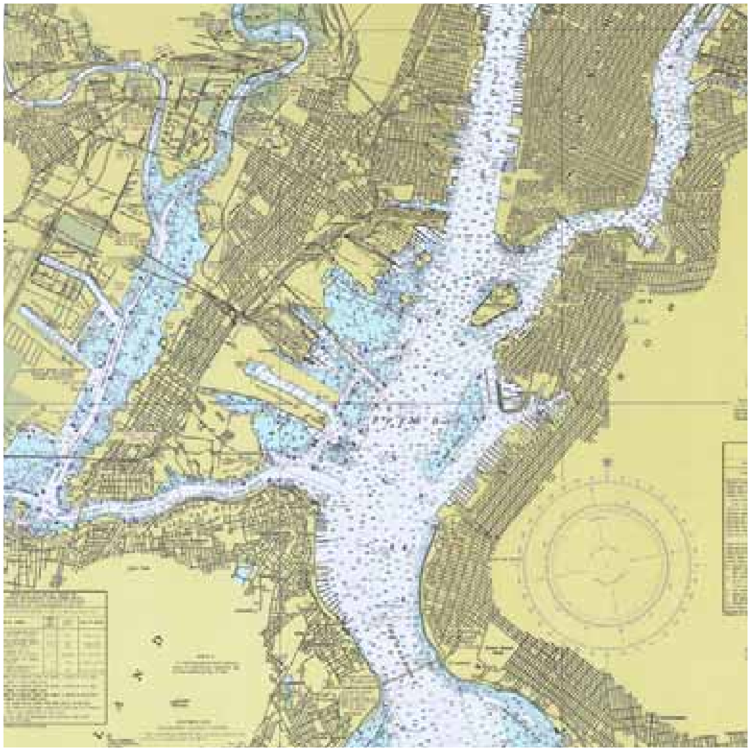

1936

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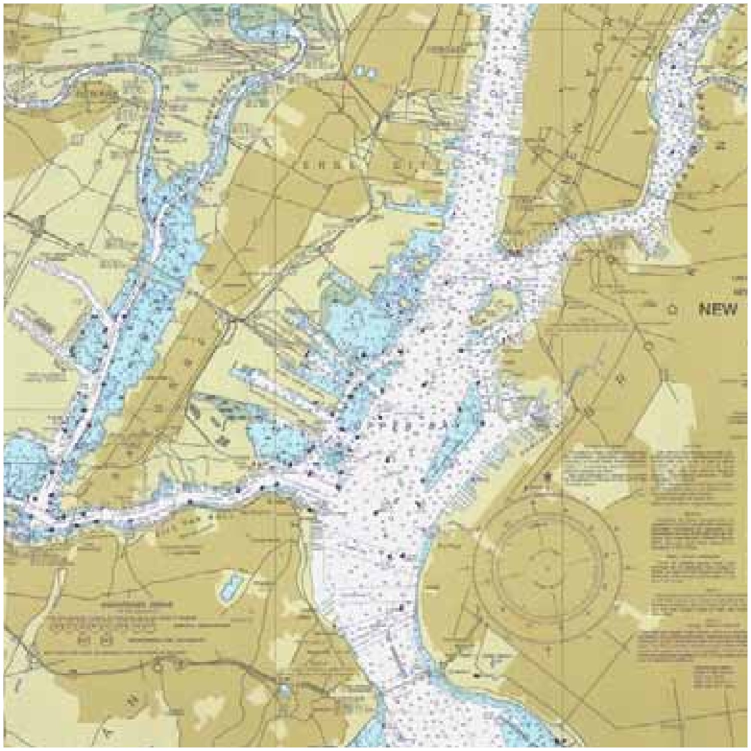

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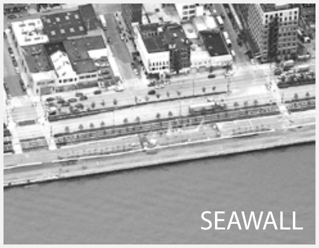
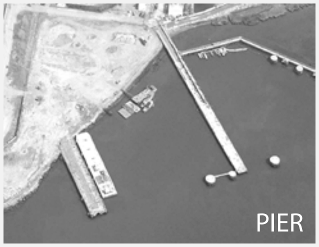




DESCRIBING THE EDGE

A more qualitative approach to documenting the coastline involved the use of high-resolution, two-dimensional aerial imagery and oblique aerial photography in order to identify various conditions along its length.

This pre-GIS analysis examines the edge of the harbor from the land side and the water side and designates areas as two categories, one for each "side." On the water side, a strip of coastline may be marked by a seawall, pier, or breakwater, or left visibly natural. On the land side, coastline may be paved, blanketed by buildings, covered in mud, used as parkland, or treated as natural wetland.

The most common condition found on the water side of the coastline is the seawall. On the land side, pavement and buildings cover the most area, especially in Brooklyn and Lower Manhattan.

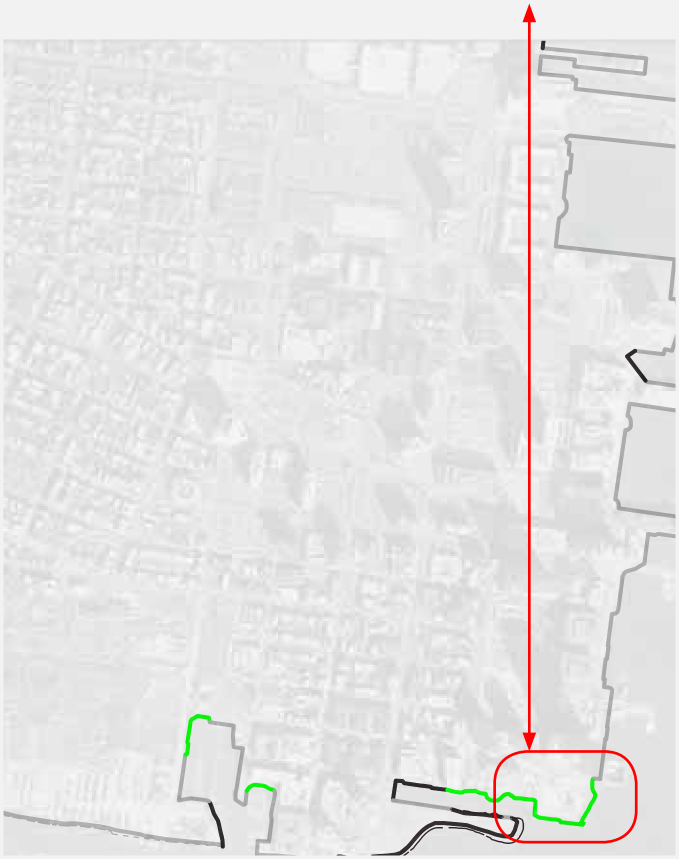
We see in the edge map that the line between water and land is often a fuzzy one. Conditions typically lie somewhere between a hard edge and a soft edge rather than at one end of the spectrum.

NEED FOR A QUANTITATIVE EDGE MODEL

Making accurate predictions about hurricane inundation levels requires a precise mesh for hydrodynamic modeling. In order to develop this capability, information about the edge of the Upper Bay needed to be integrated into the merged elevation and bathymetry models we developed in GIS.

Key of edge conditions

opposite
Map of edge conditions around the Upper Bay



PROCESS

The development of this new edge model began with the charting of the edge in plan. With aerial imagery of New York and New Jersey coastal areas (2007 USGS 0.5-m data) as an underlay, we traced the coastline in GIS. Once drawn, the coastline was then brought into AutoCAD for cataloguing.

Gauging the edge condition in section is a challenging process without direct on-site measurement. The use of GIS makes measurement in plan relatively straightforward and accurate, but in order to gather information like the heights of seawalls, we had to go beyond GIS data and establish a new methodology.

Our primary source of information for measuring the seawall height was oblique aerial photographs. Through these photographs, we traveled around the entire Upper Bay, estimating the height of seawall or identifying natural conditions where appropriate. These estimations were then checked using spot elevation data close to the edge.

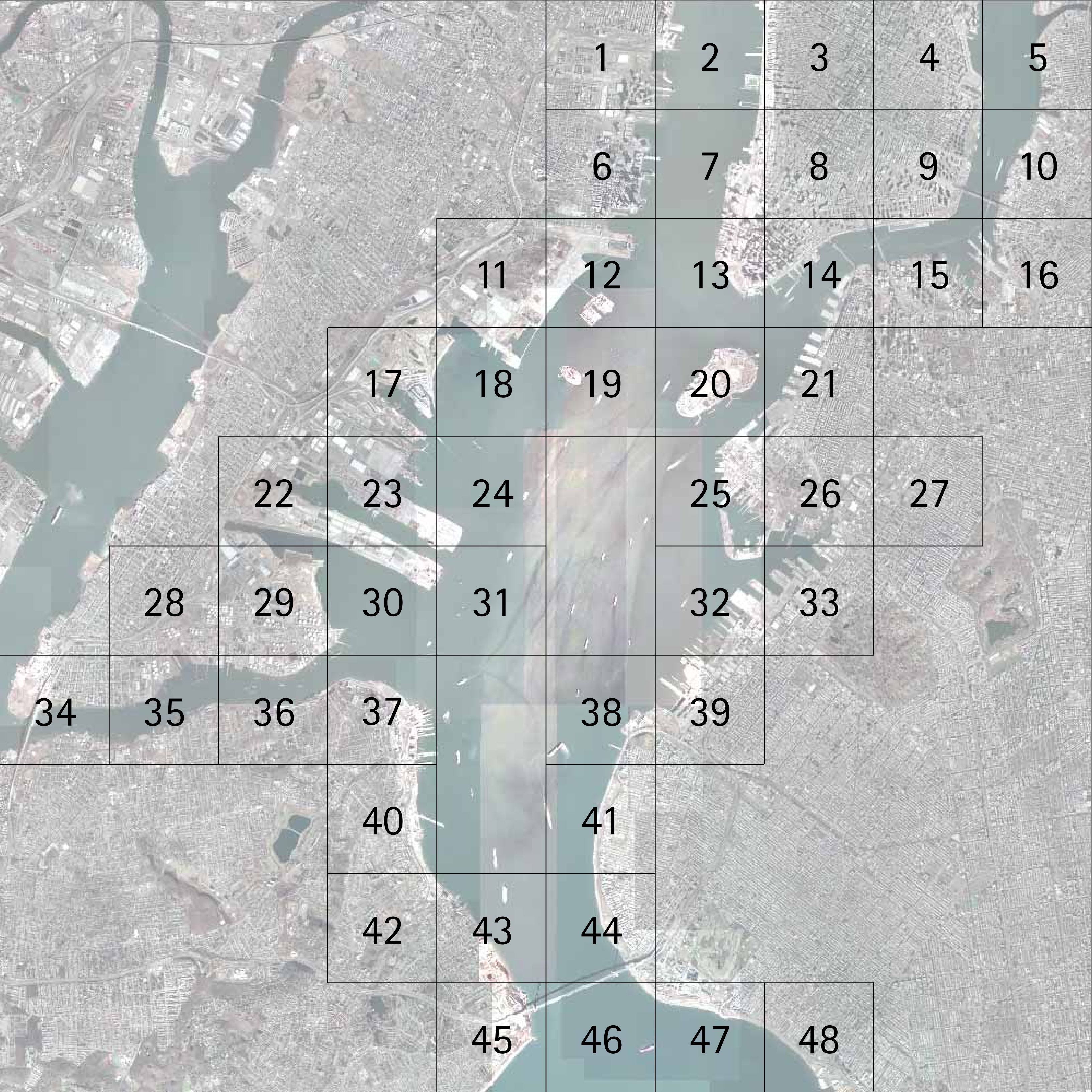
READING THE ATLAS

To display the information gathered for the hydrodynamic model at a legible scale, the map of the harbor was split up on a grid of ten squares by ten squares. Including only those squares containing the water-land edge led to a series of 48 individual maps. Each individual map square then represents a swath of the NY-NJ Upper Bay coastline and surroundings measuring 5400 by 5400 feet, with an area just over one square mile.

Each map contains a key to place the particular square shown in the context of the whole harbor at the top left of the page; an aerial photo of the square for reference at right; and a map with the edge condition line, the mark of the 100-year and 500-year floodplains, and the water at left.

SECTIONAL DIAGRAMS

The sectional diagrams illustrate the various edge conditions found around the Upper Bay, where white represents a seawall with heights in the 3-6 foot range, grey represents the 6-9 foot range, black represents the 9-12 foot range, and the heavy black line represents the 12-15 foot range. This thick black line can be found at only one point in the entire harbor, at the Staten Island Ferry terminal at the tip of Manhattan. The green line represents a "natural" edge condition. In the SMS model, no seawall is built up and the edge is treated as given in the topographic model. Finally, a dashed line represents revetment or riprap, rock material built up in a slope before a seawall.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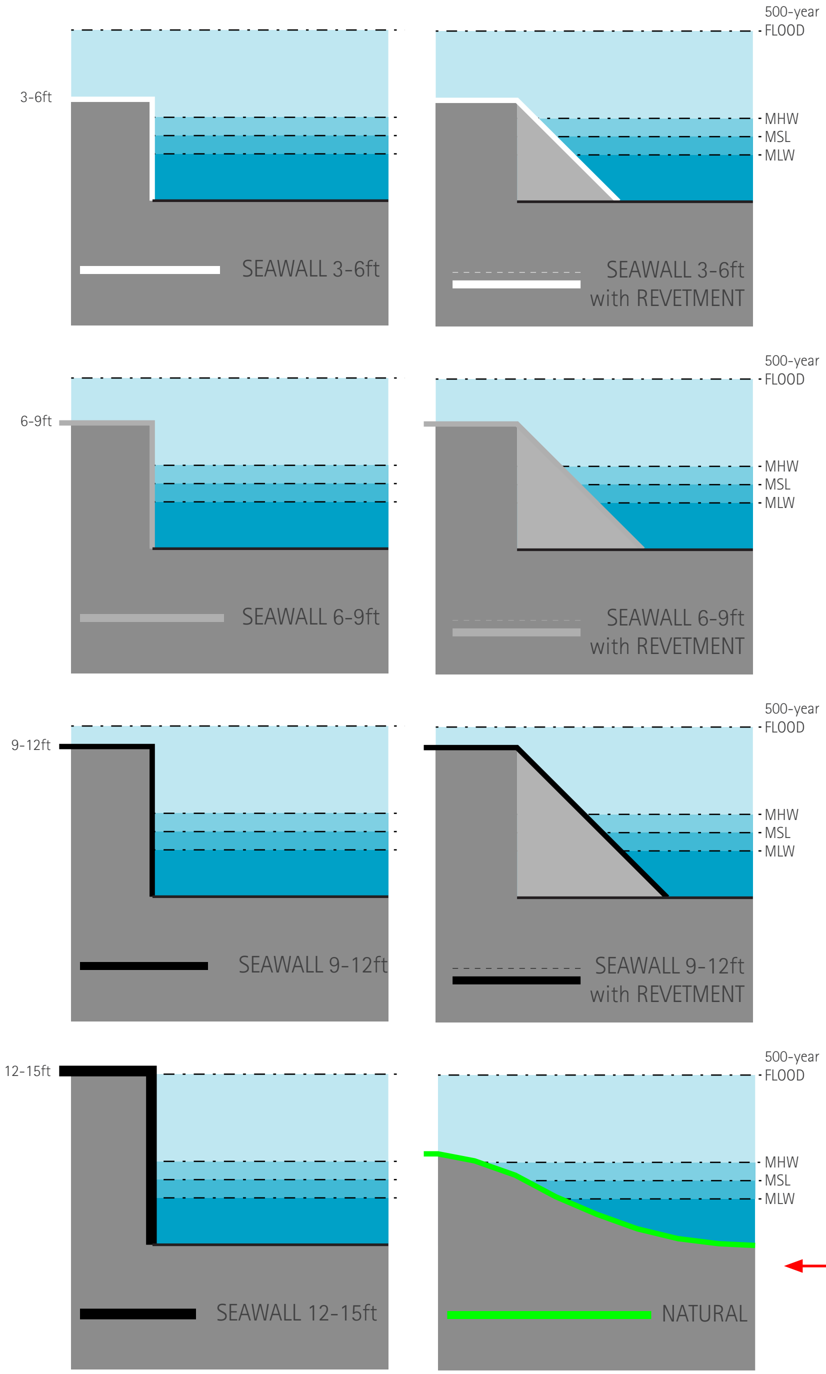


Note that these diagrams are simplified for ease of differentiation and the undersea condition varies throughout all of the categorical conditions. The water levels marked as Mean High Water (MHW), Mean Sea Level (MSL), Mean Low Water (MLW), and the 500-year Flood reveal the vulnerability of each seawall height to certain flood levels and hint at the planar registration inherent in each condition.

On the map, the light orange areas represent predicted inundation during the 100-year flood according to FEMA floodplain data. Similarly, light red areas represent inundation during the 500-year flood. Given the effects of future sea level rise and increasing severe storm frequency, these areas can also be understood as the 30-year and 100-year floodplains of the future.

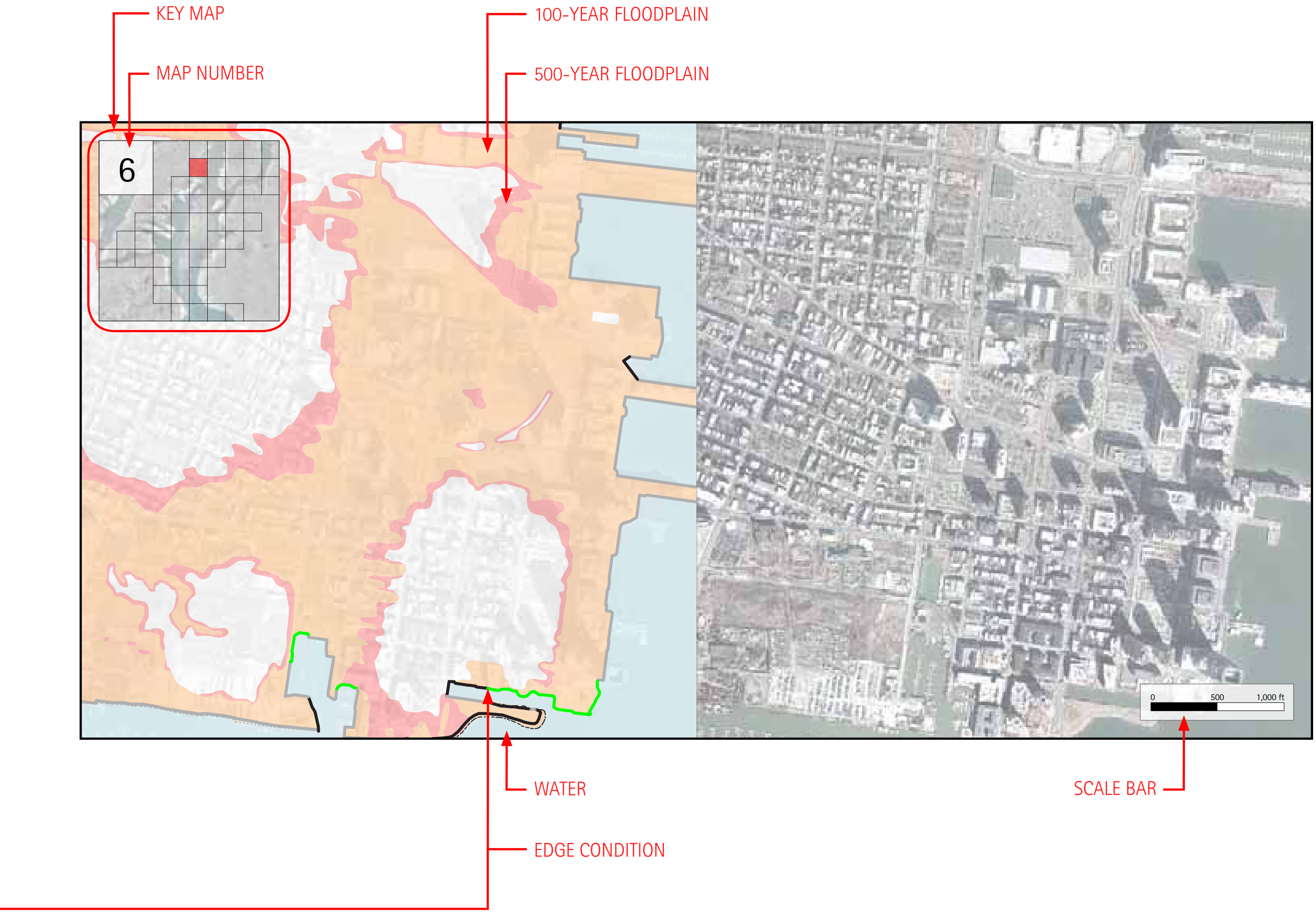
SOURCES OF ERROR

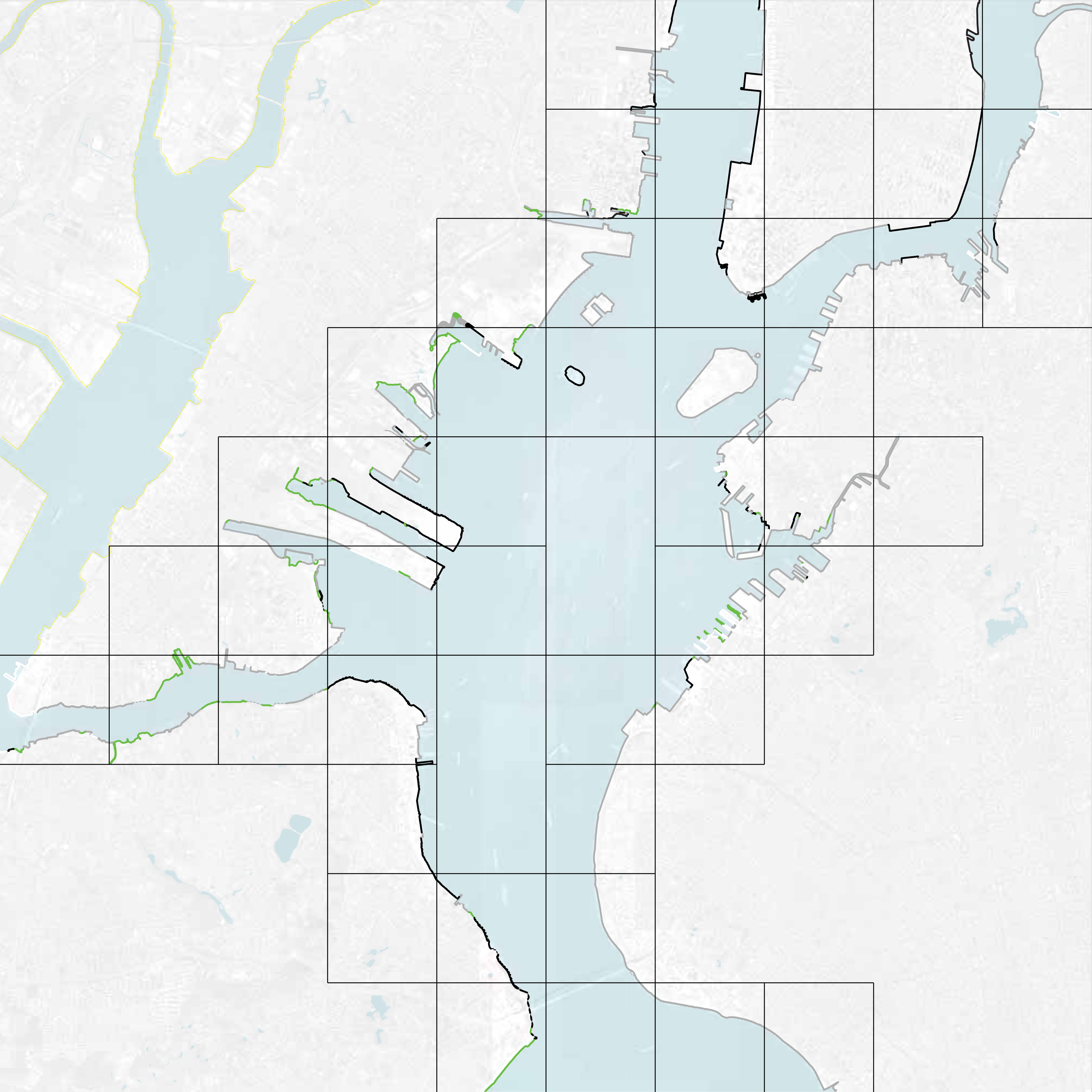
Probably the most significant source of error inherent in this methodology involves the limited information about the oblique aerial photographs used to gauge the seawall height. Because the times the photographs were taken are unknown, it becomes difficult to define the height of the water itself. Our assumption in this process was that the water level in all of the photographs was mean sea level. While it is unlikely that these photographs were taken at an extreme low tide or extreme high tide, as we checked for water marks in the photographs showing otherwise, error in either direction up to the tidal variation is possible.

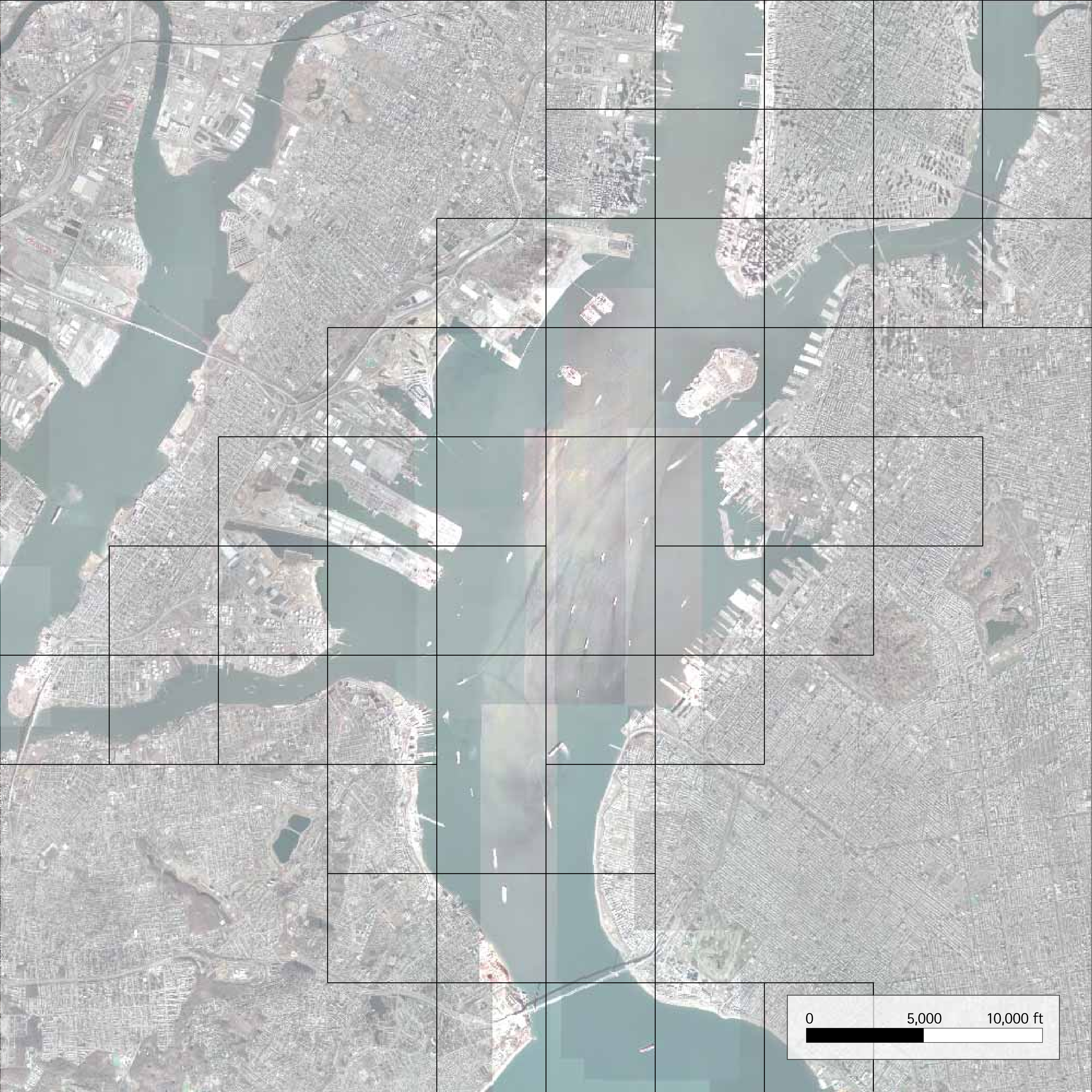
A second issue involved in the use of oblique aerial photography is foreshortening. To avoid this issue, objects in photographs used for scale were chosen as close as possible to the seawall itself.

In addition, translation from datum to datum and from a range of possible heights to an explicit height between the catalogued condition and the modeled one contribute to error.

A final source of error lies at the very beginning of the process. While less important than any sectional error, error in locating the coastline in plan may make a significant contribution, but only proportionate to the accuracy of the coastal area aerial photography data.


KEY MAP
MAP NUMBER
100-YEAR FLOODPLAIN
500-YEAR FLOODPLAIN
6
0
500
1,000 ft
WATER
SCALE BAR
EDGE CONDITION

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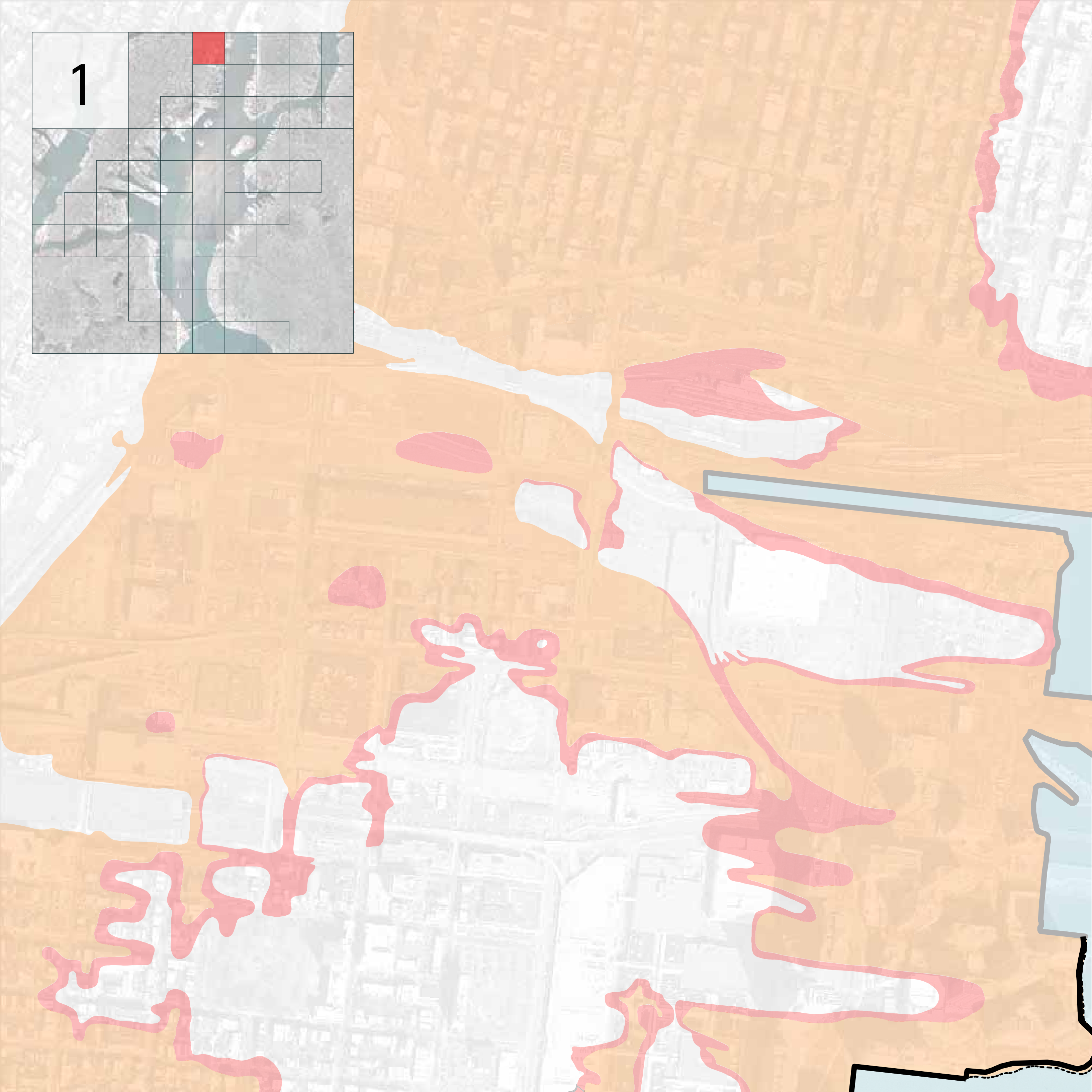
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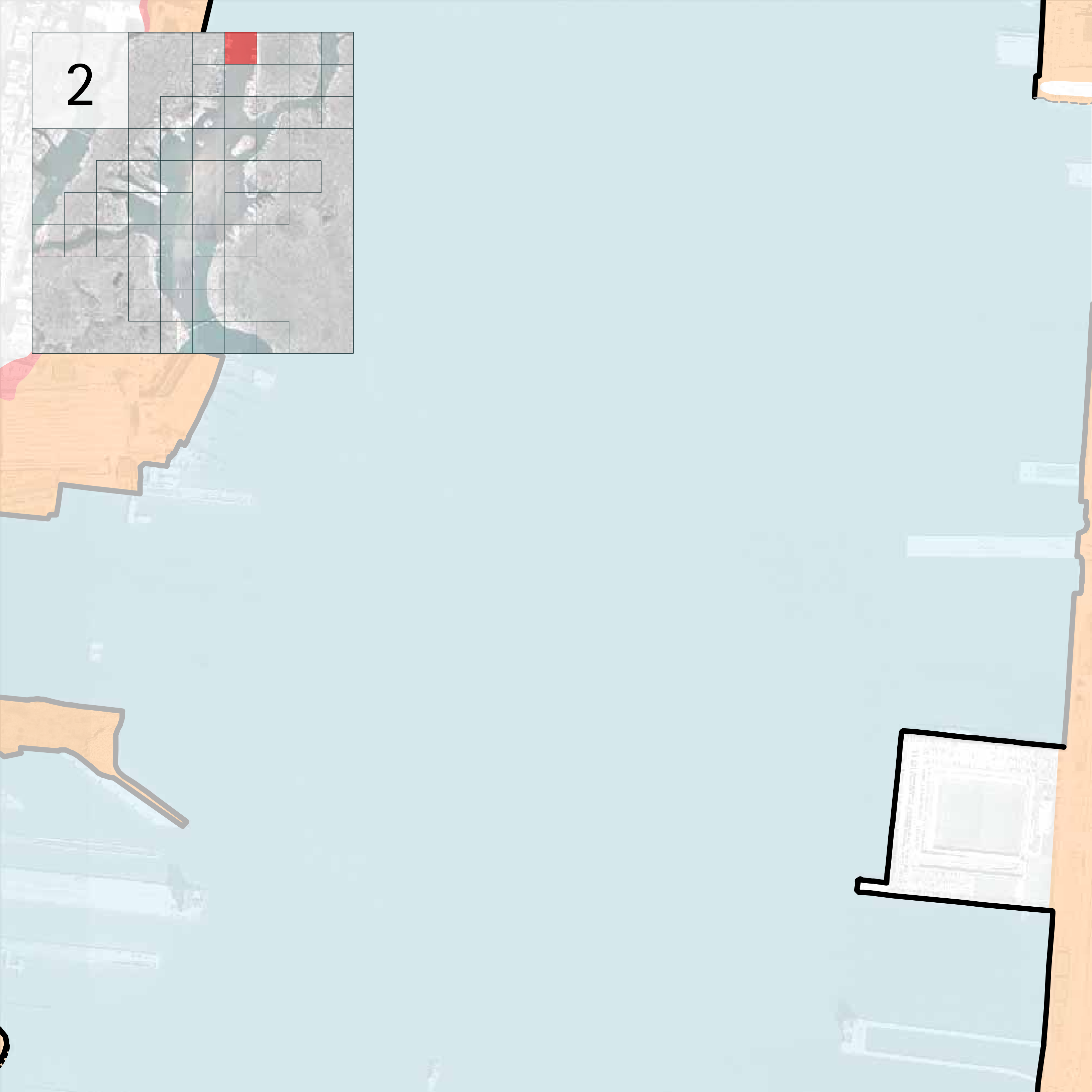
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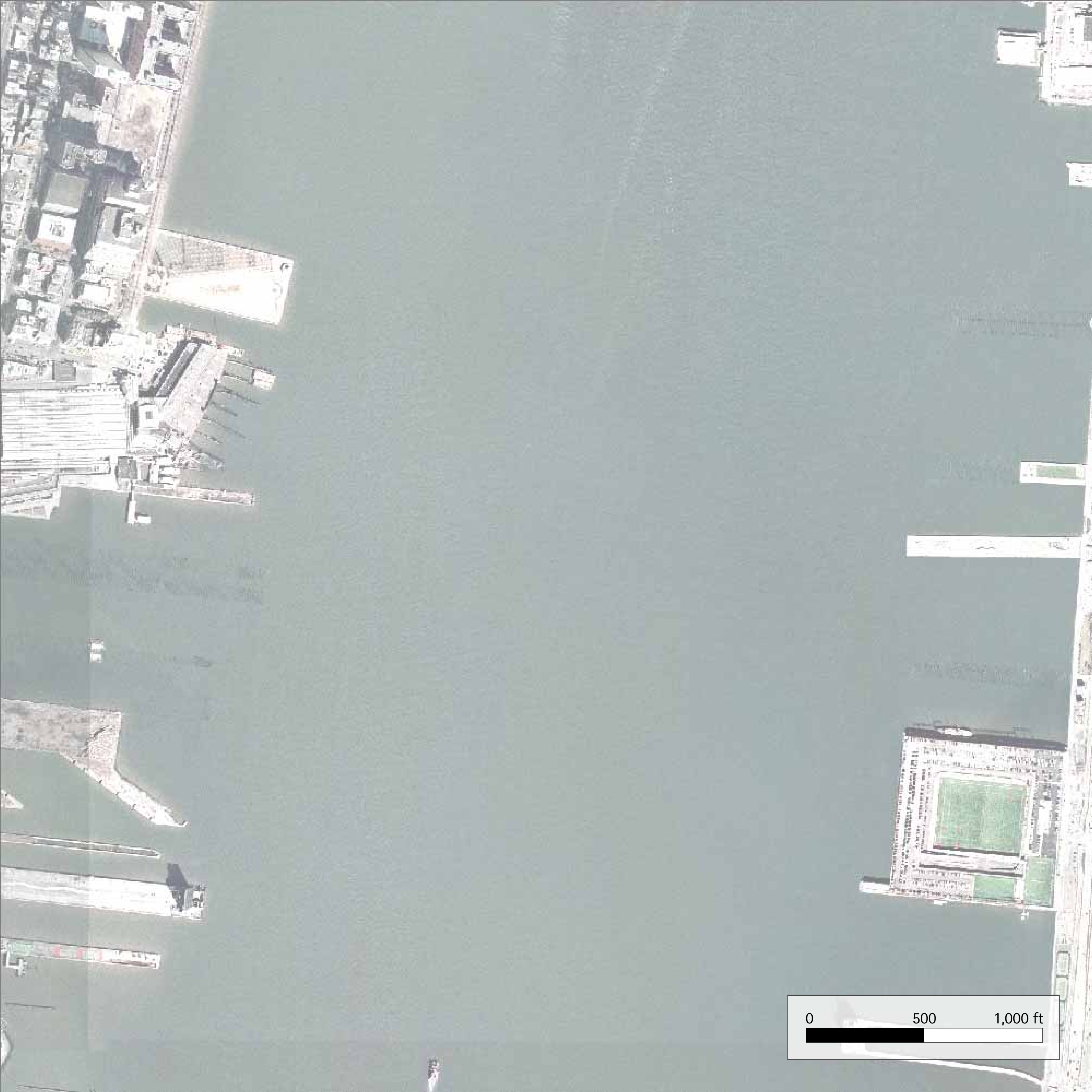

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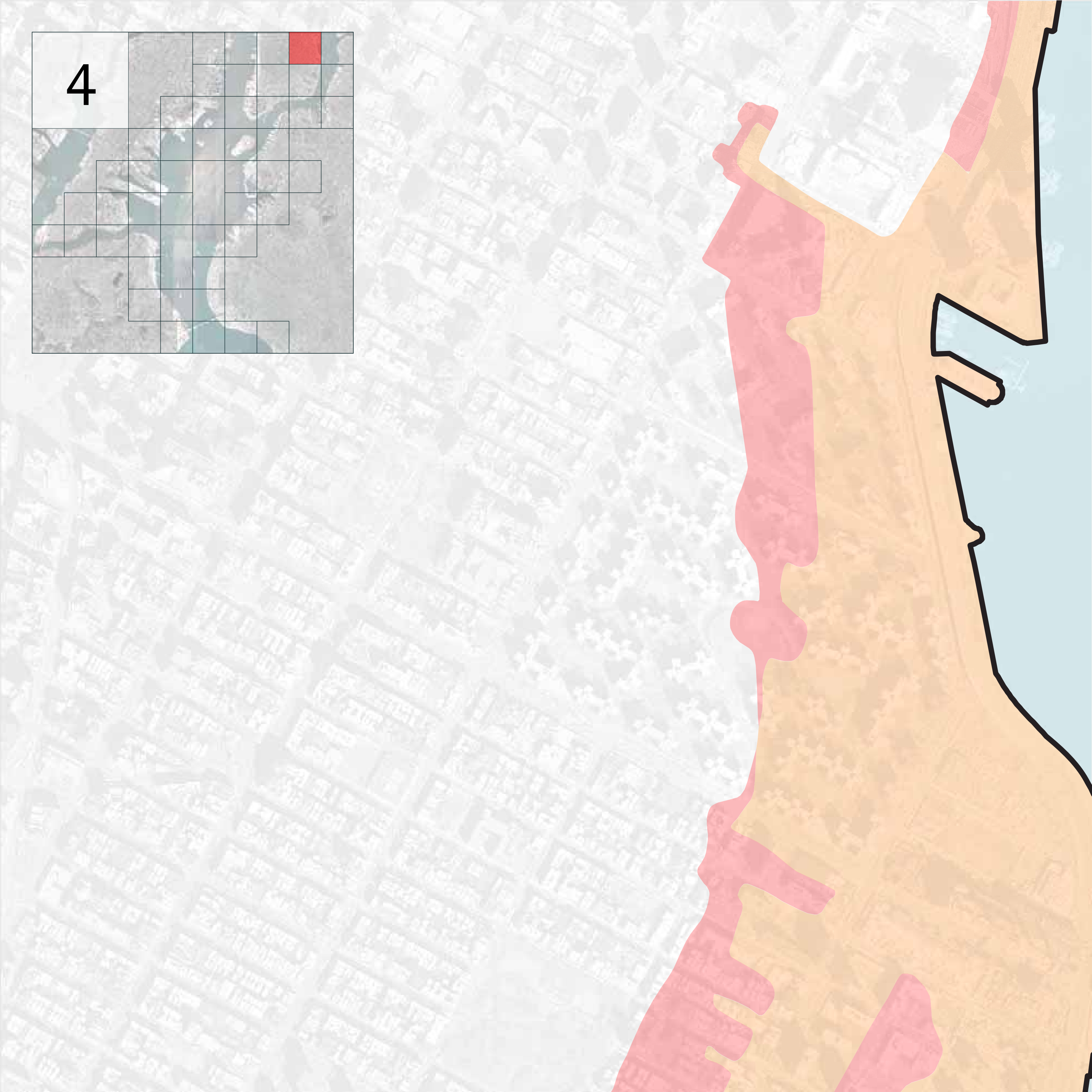
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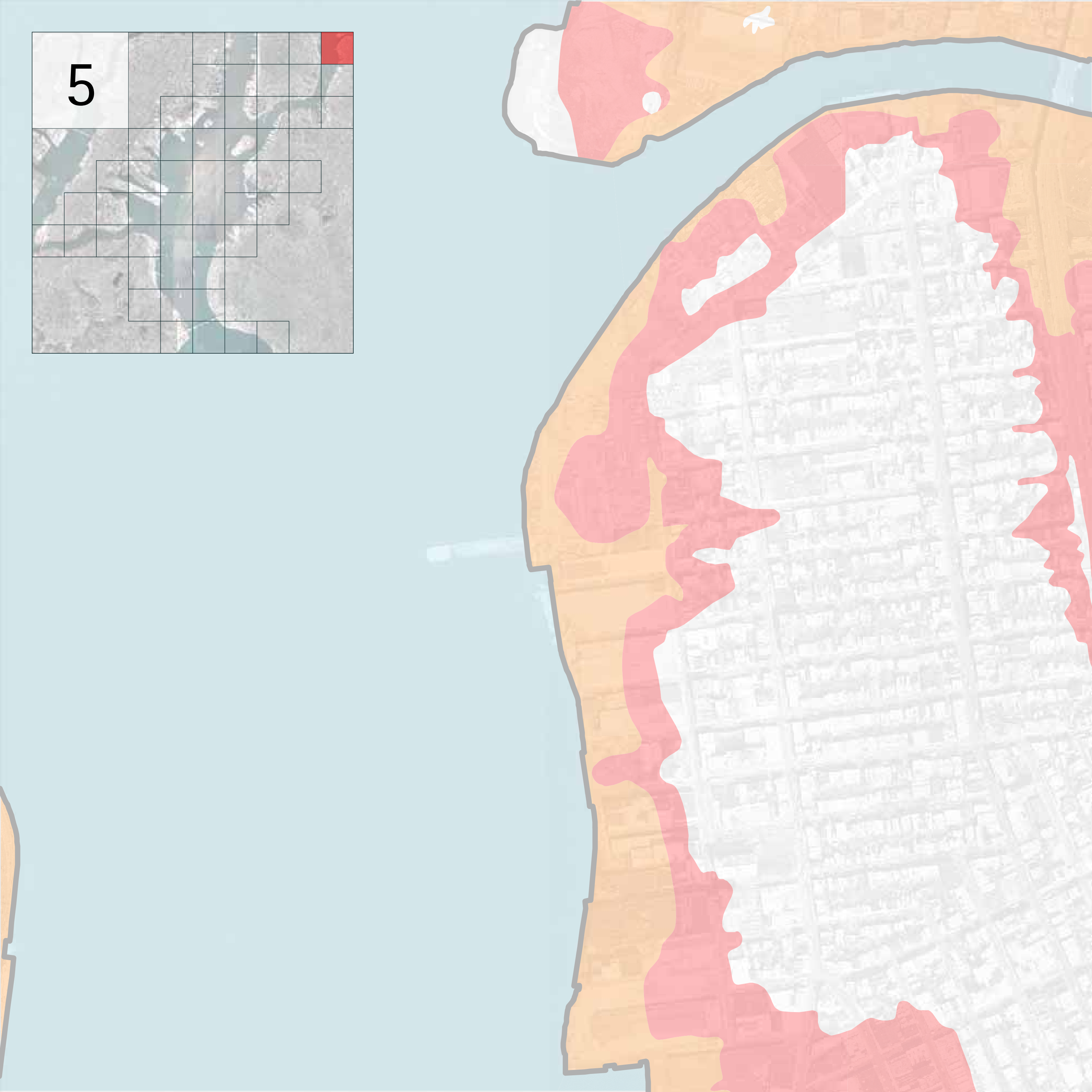
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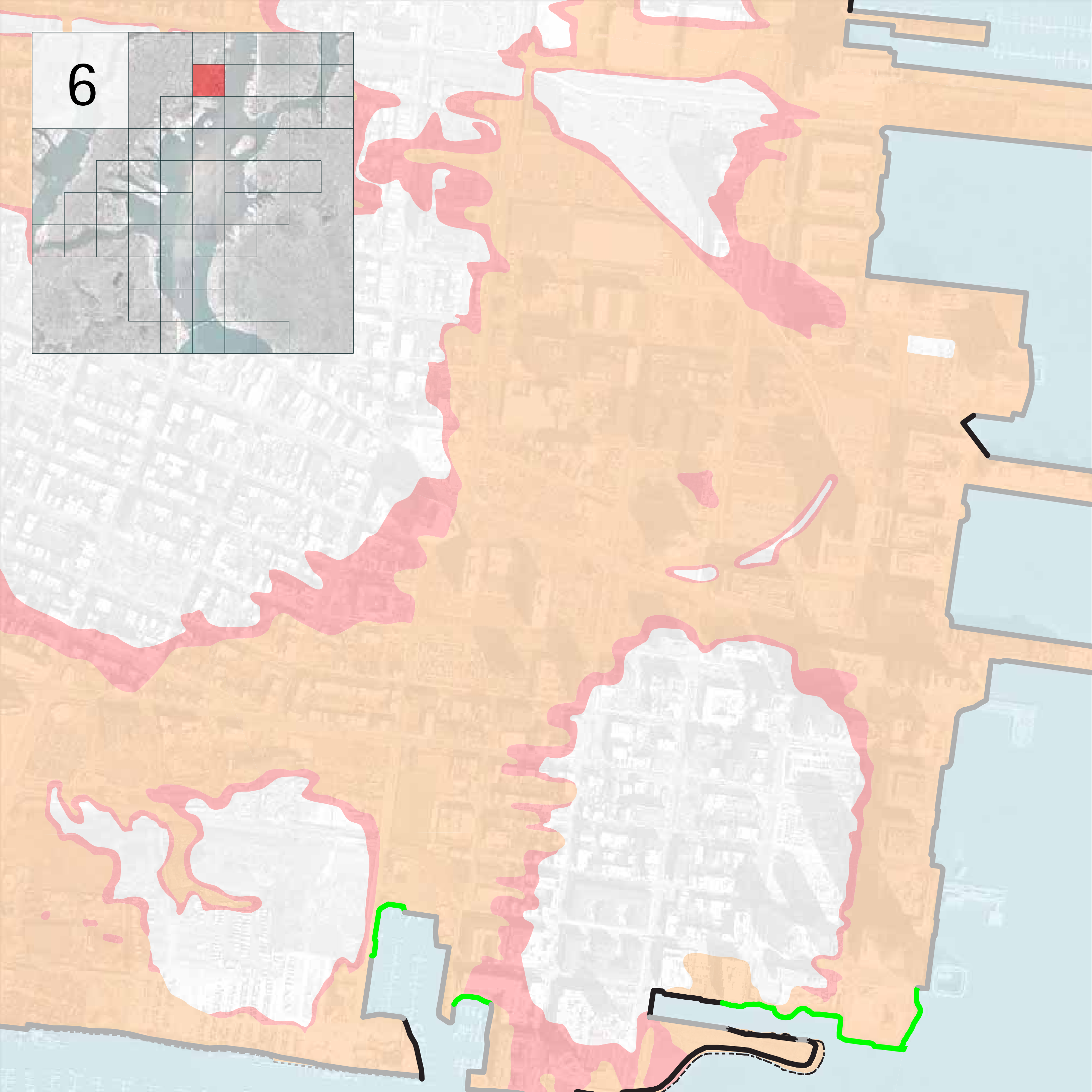
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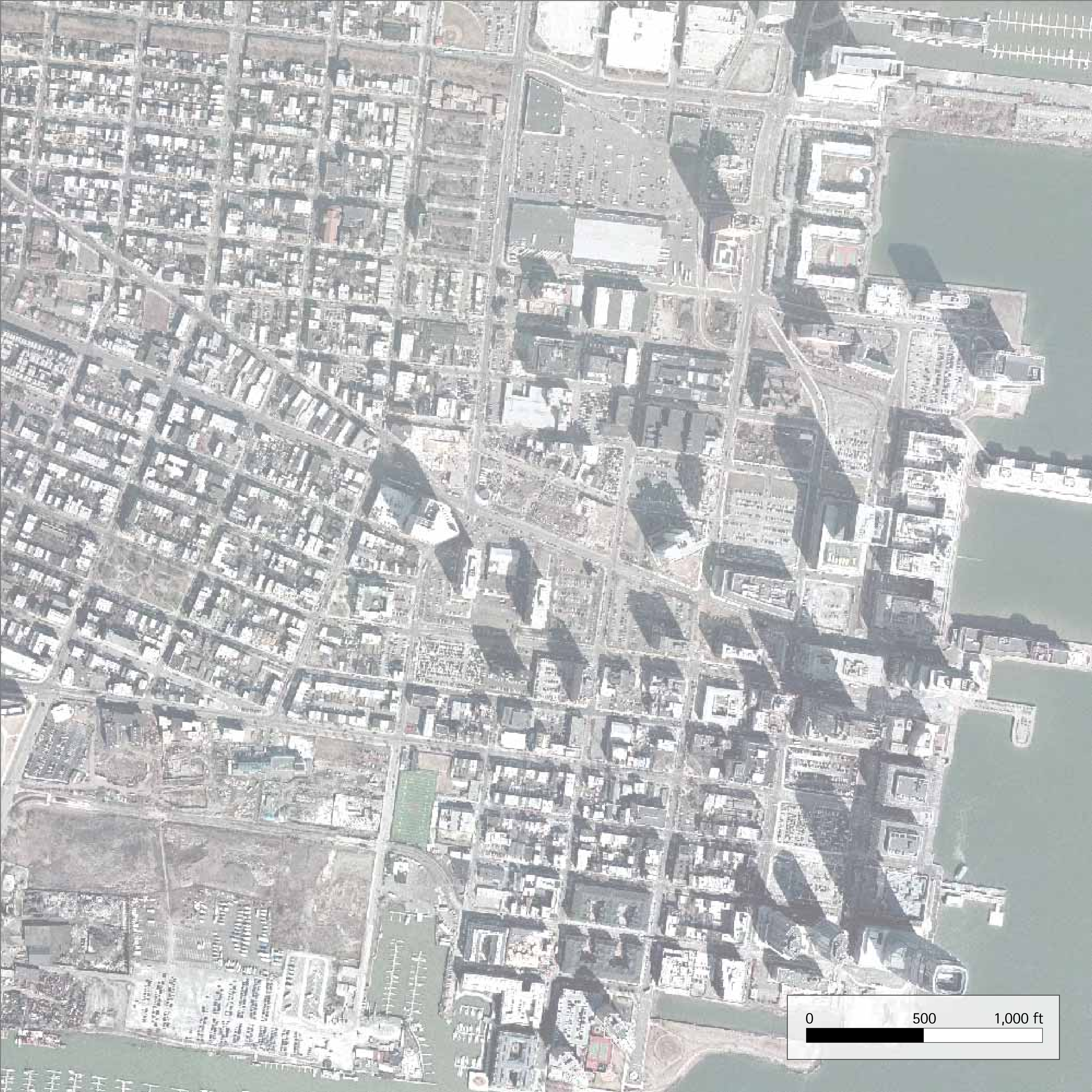
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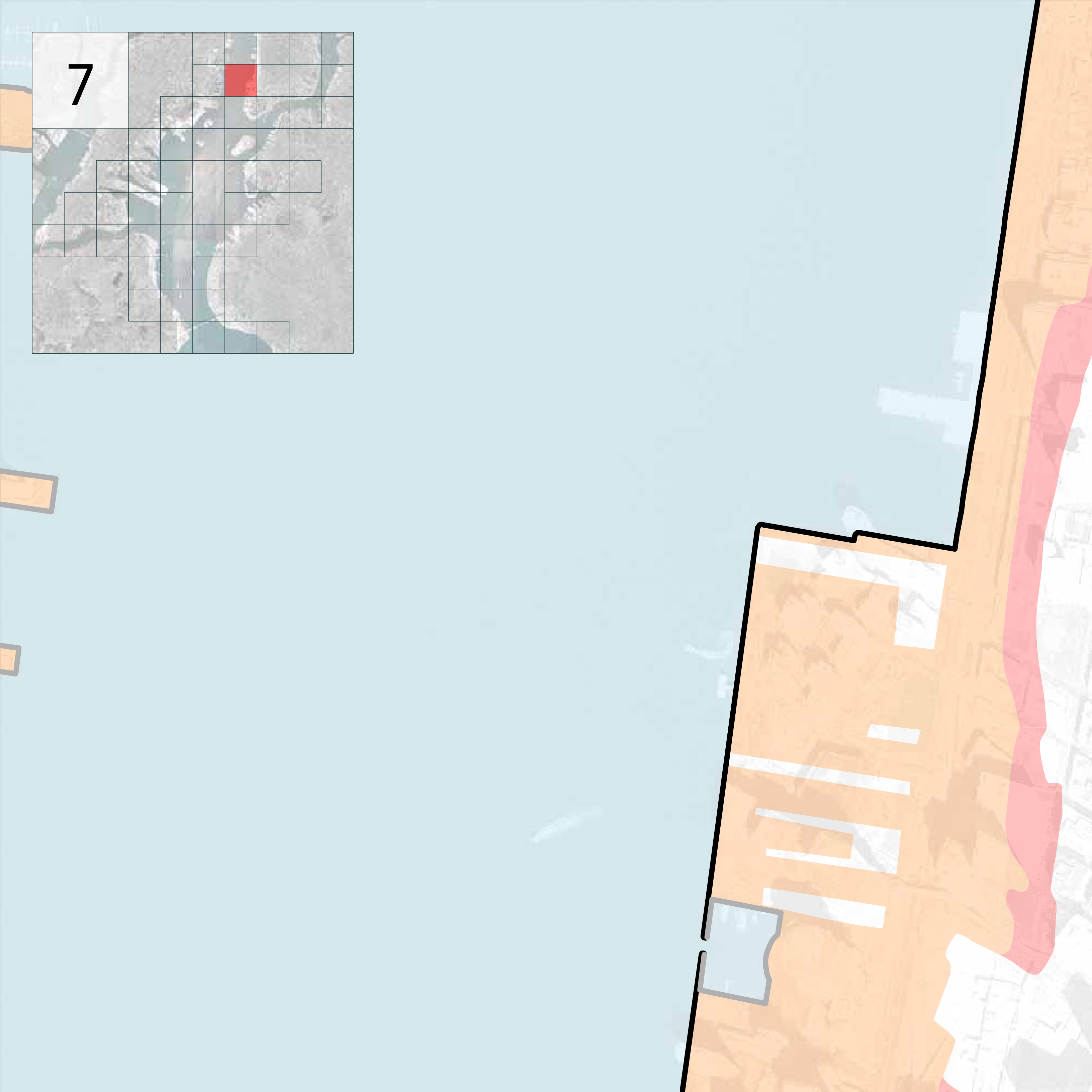
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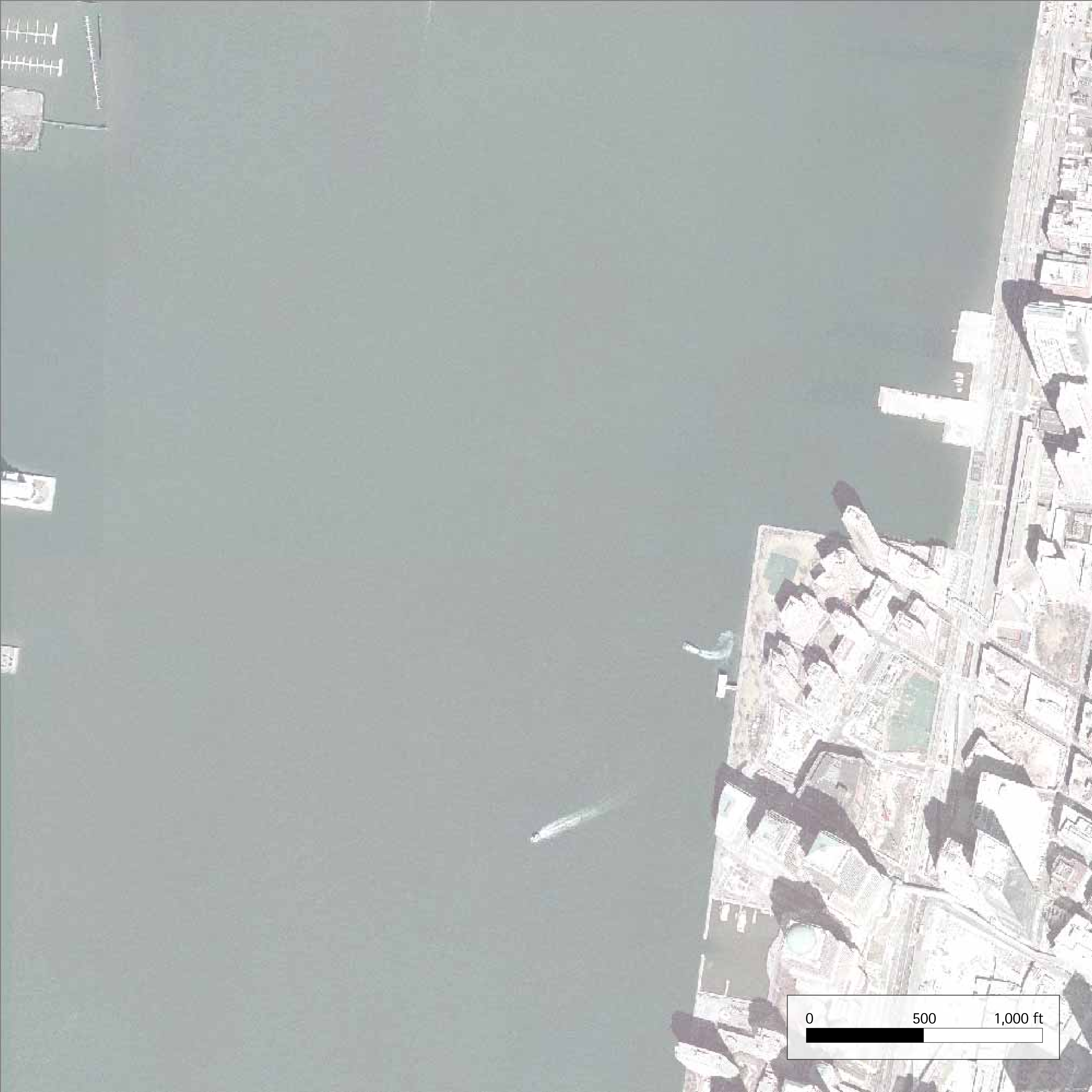
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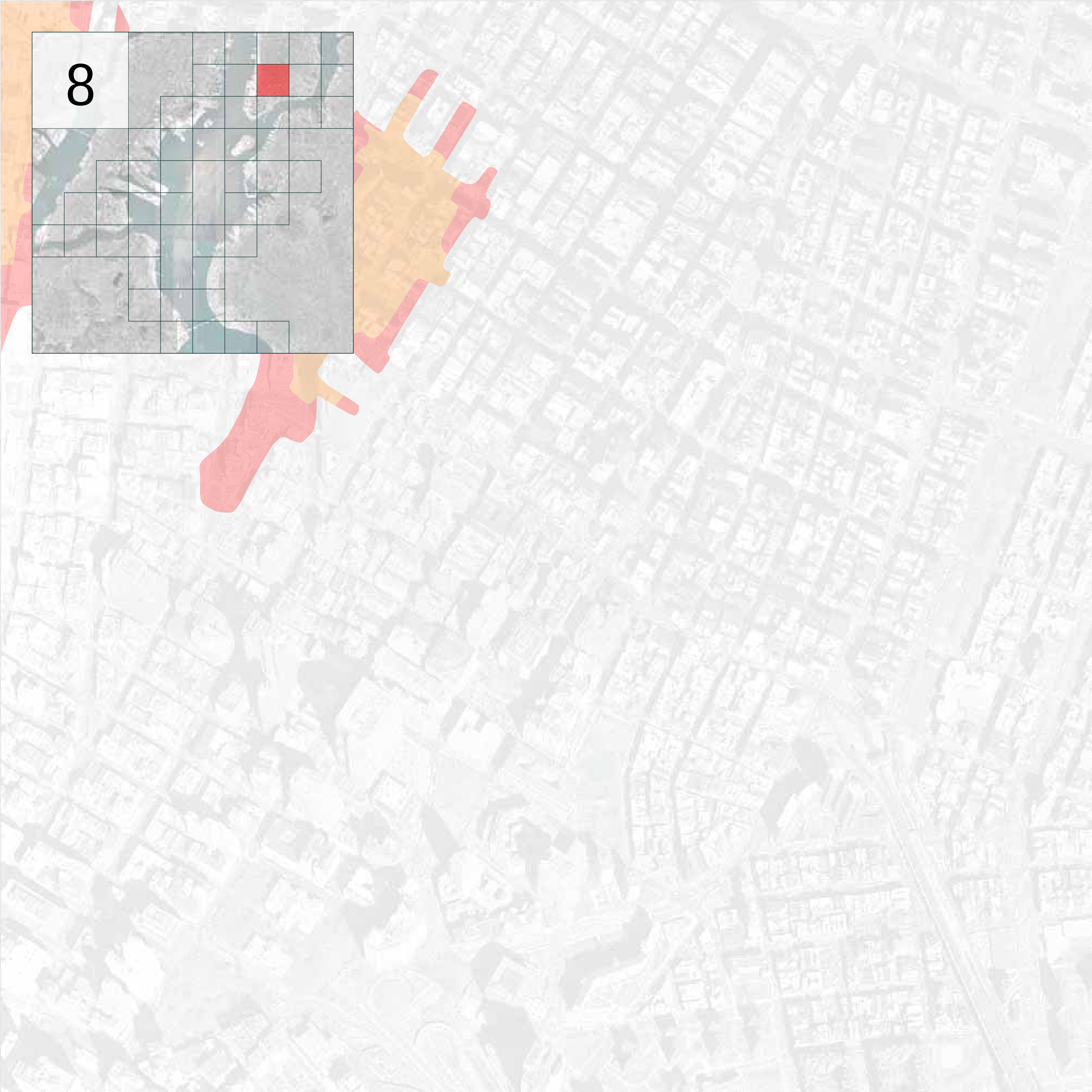
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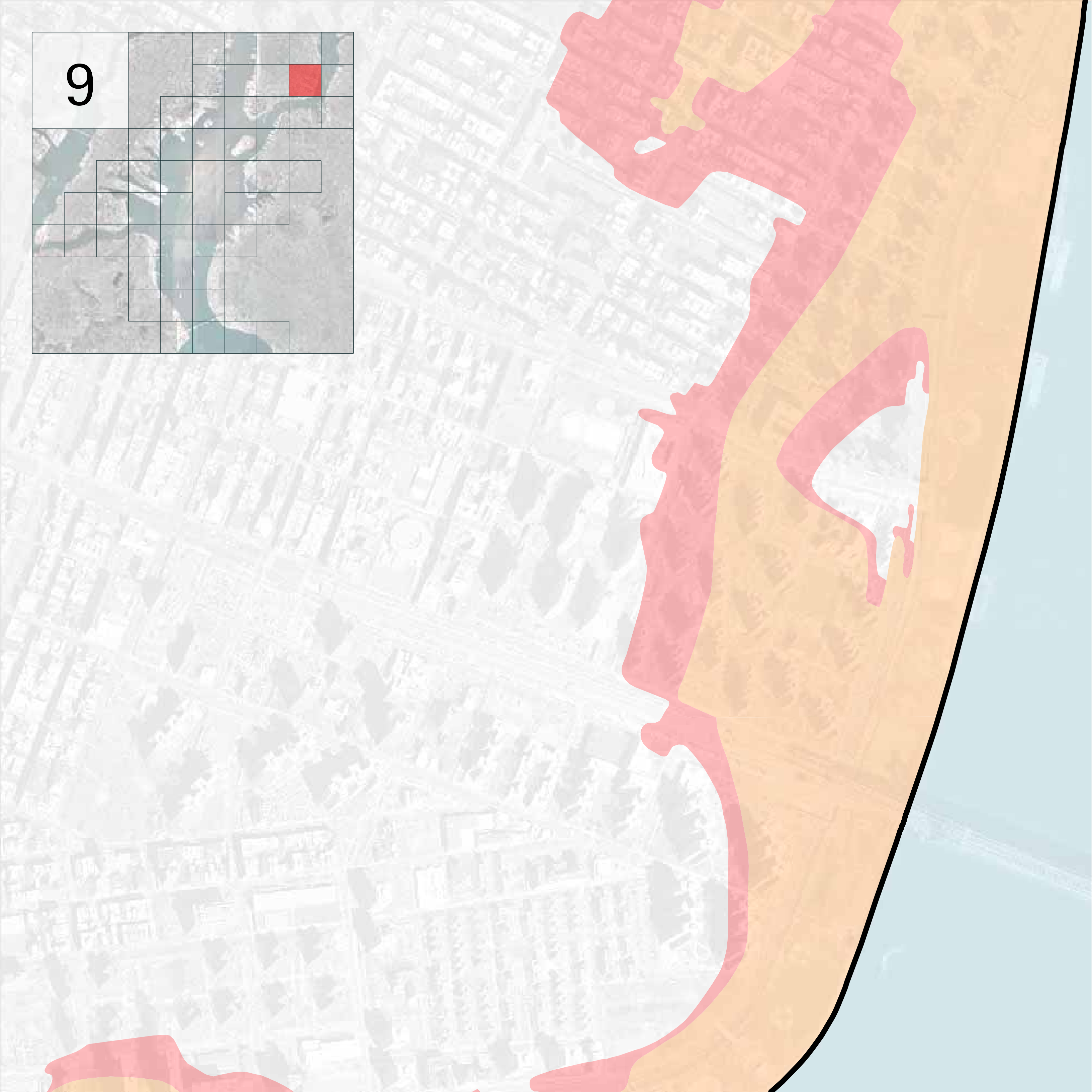
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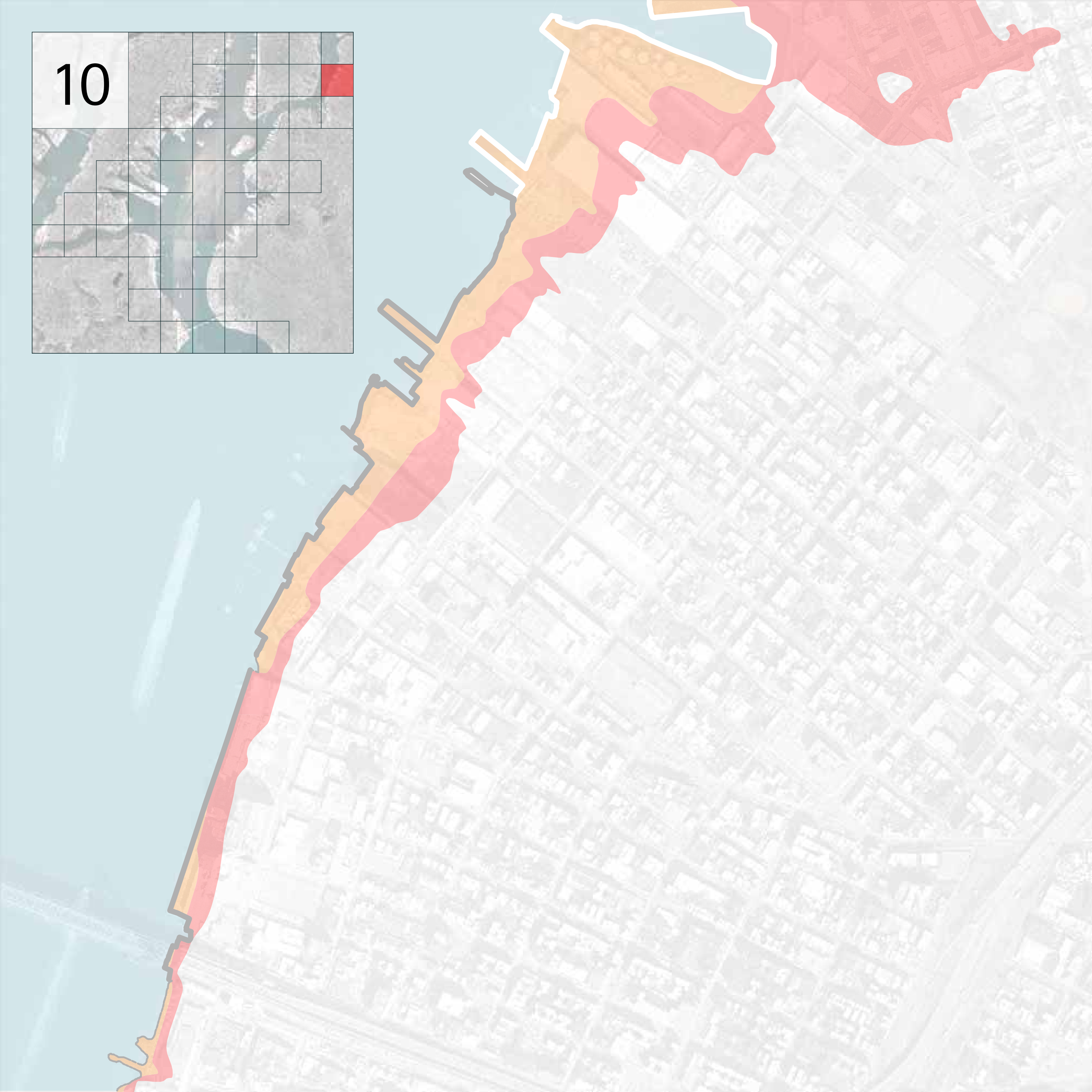
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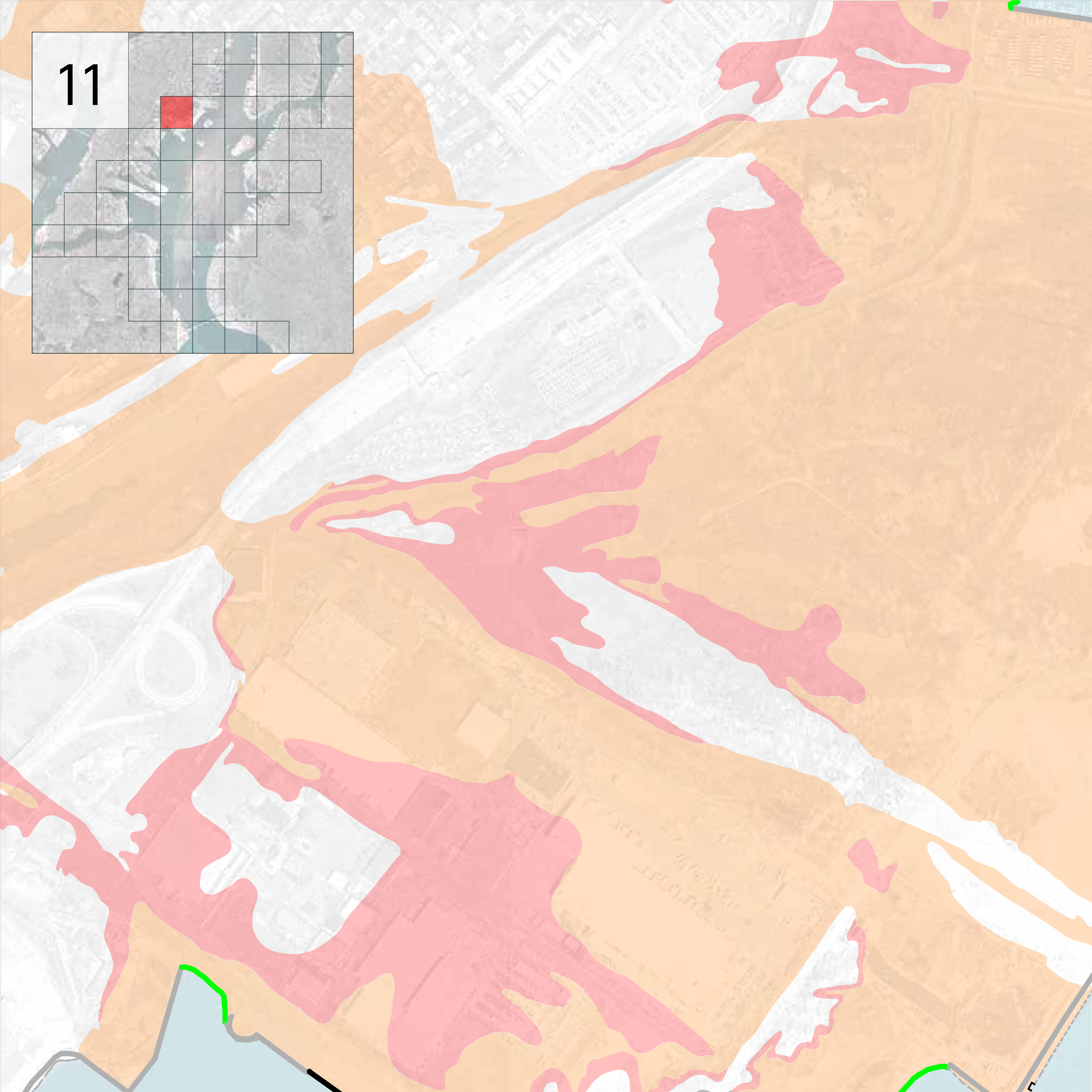
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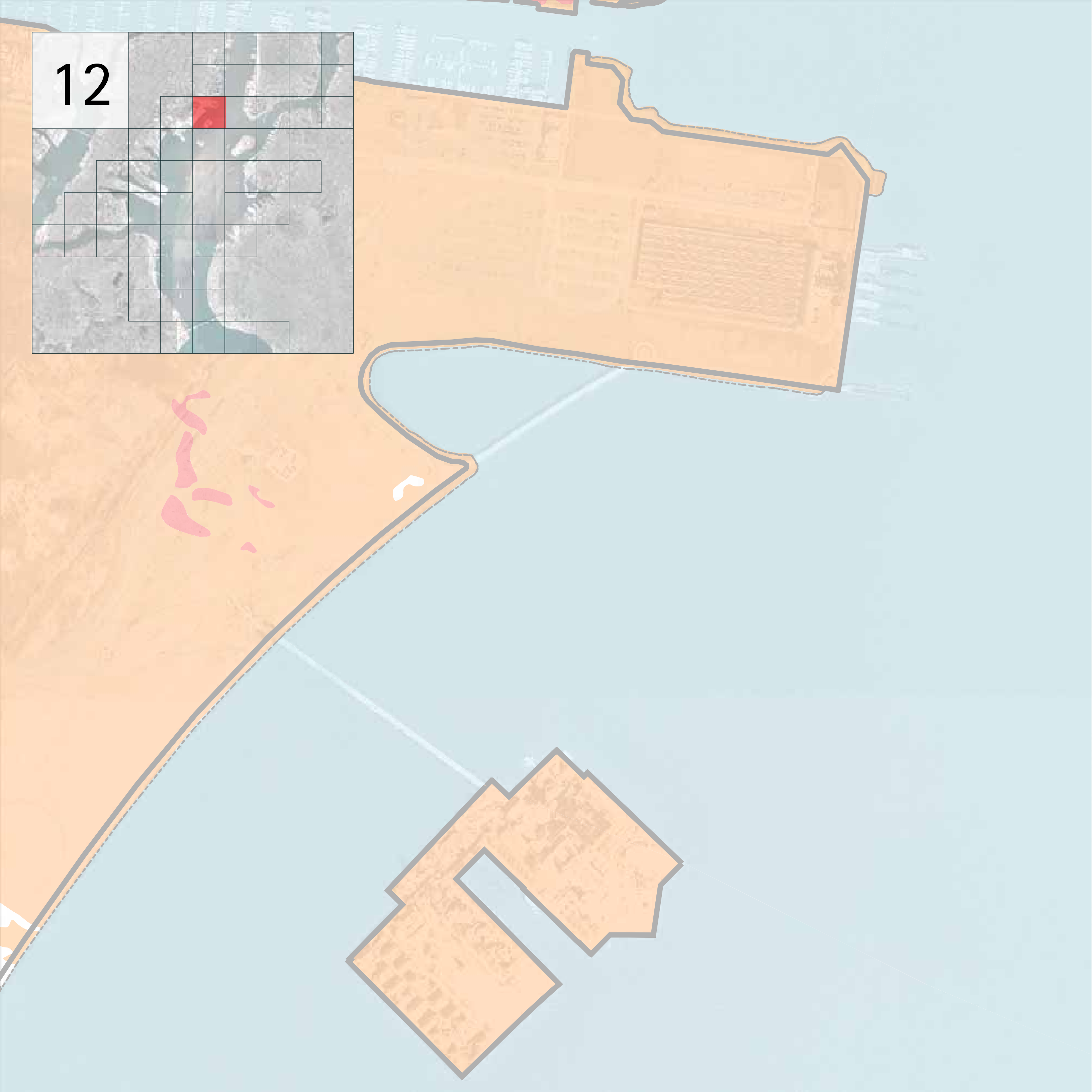
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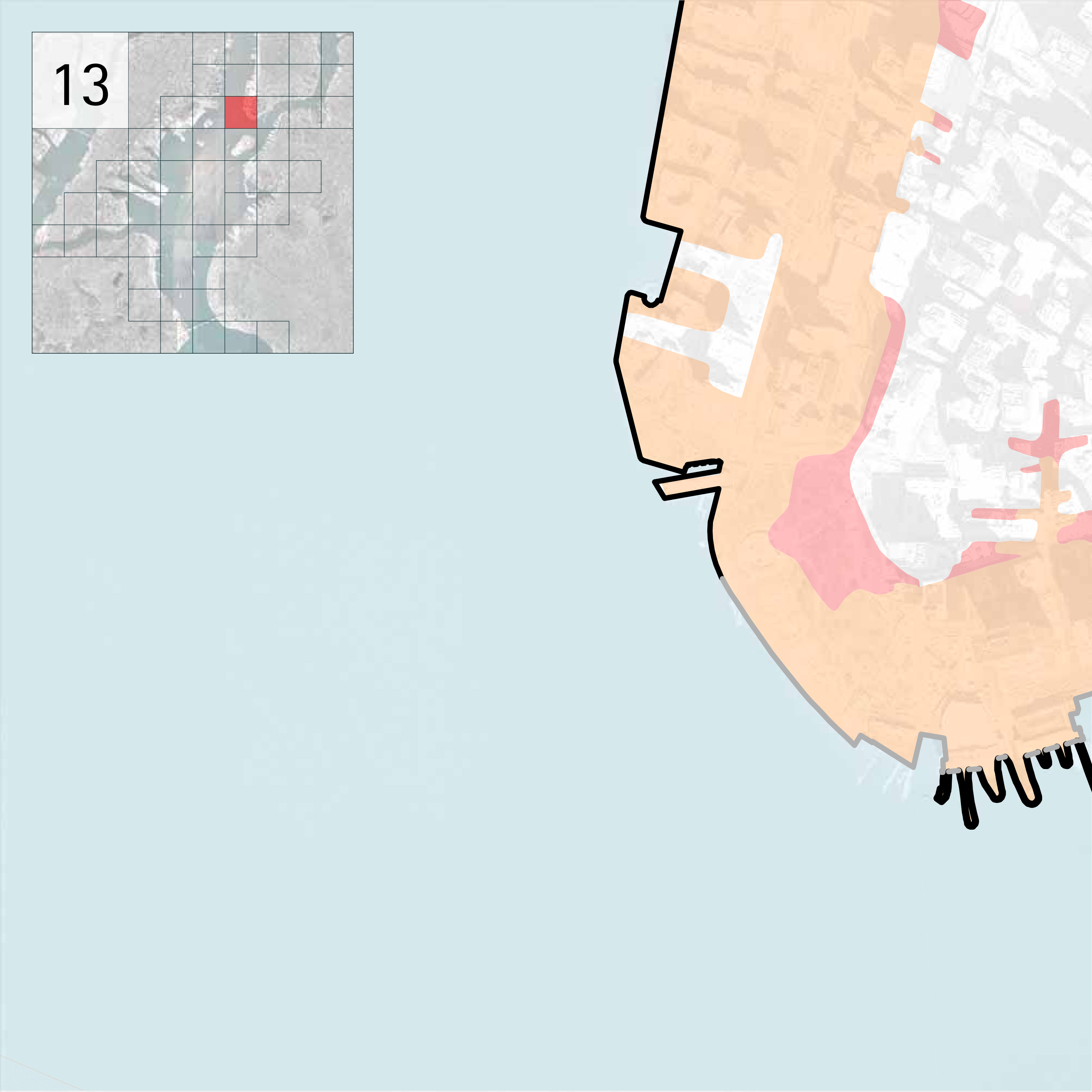
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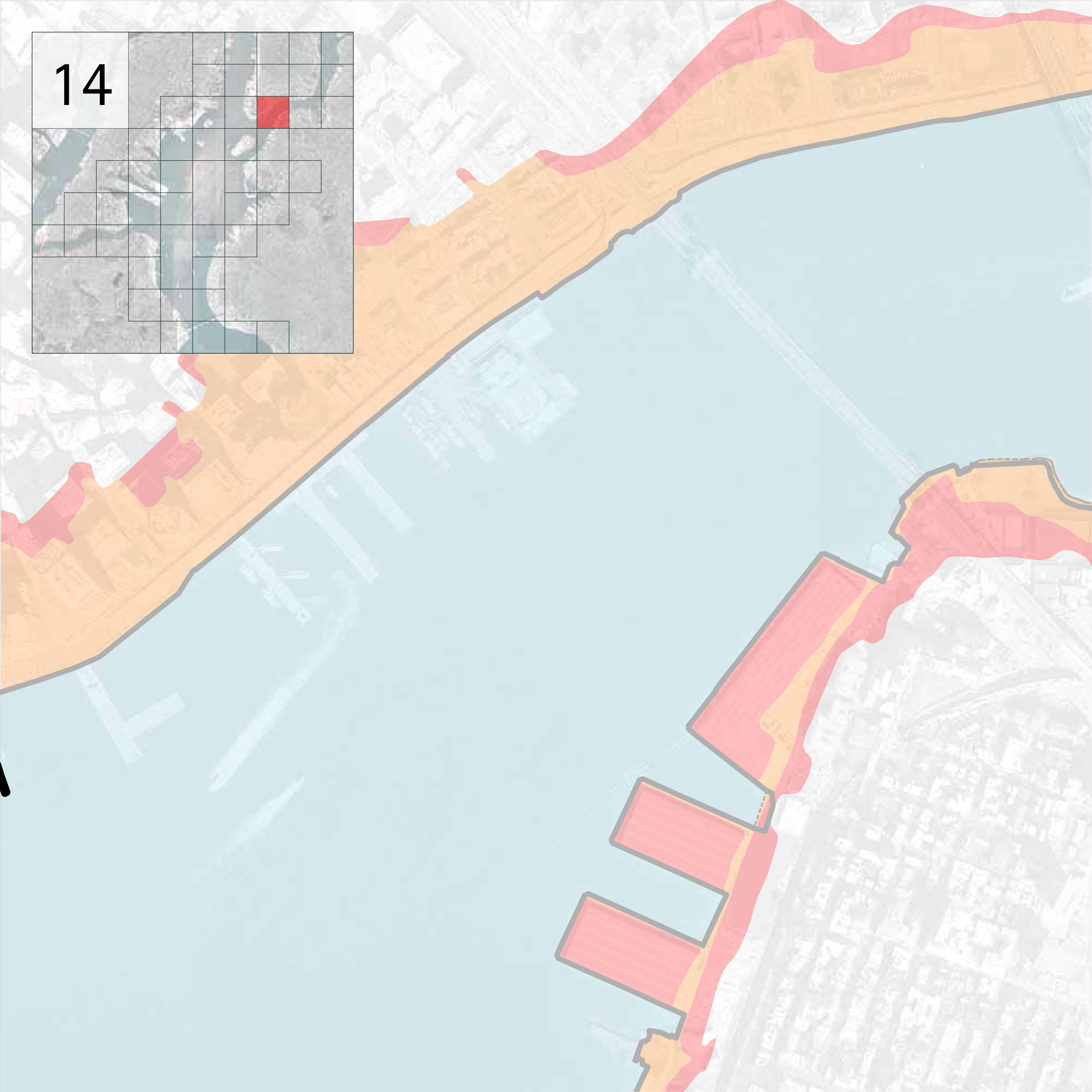
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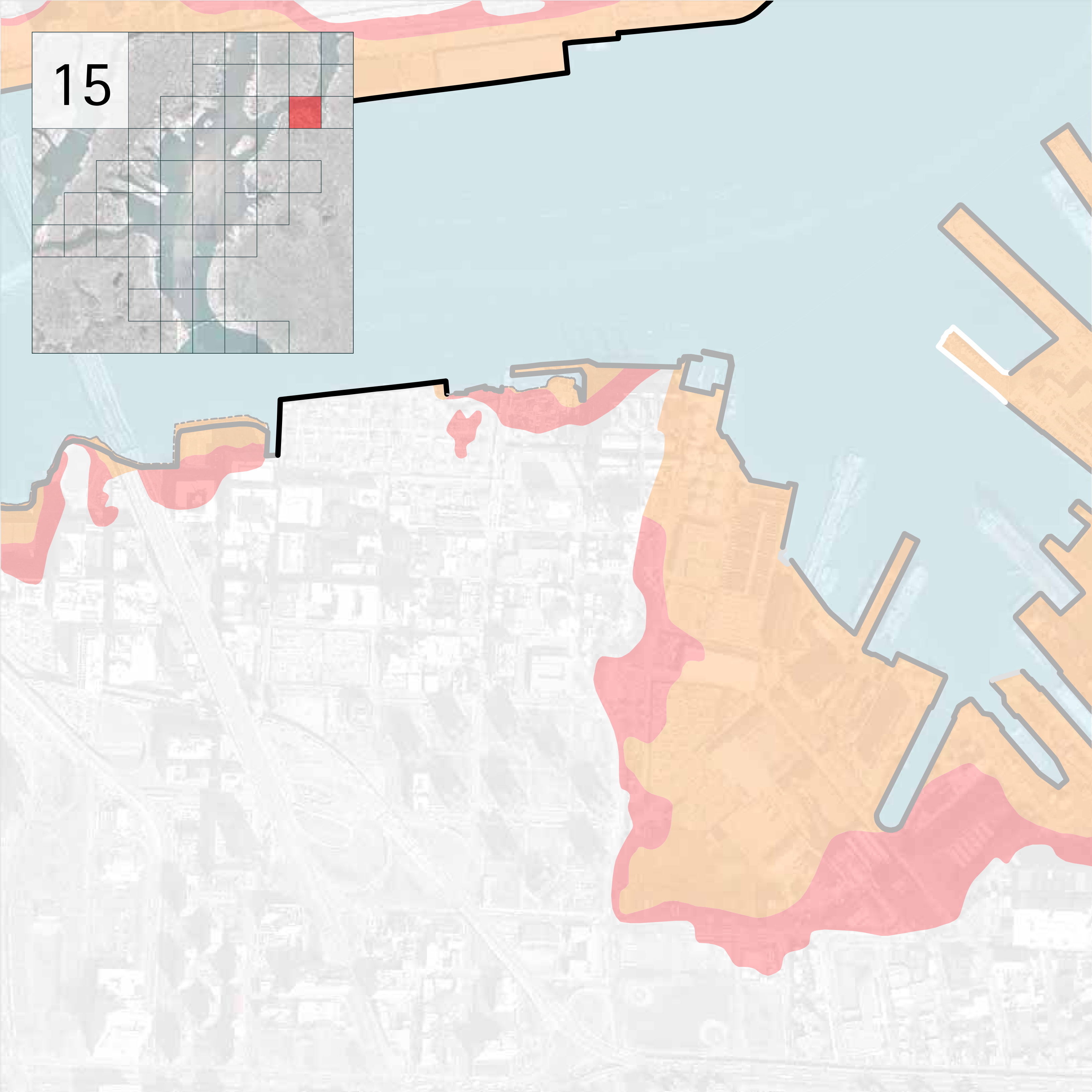
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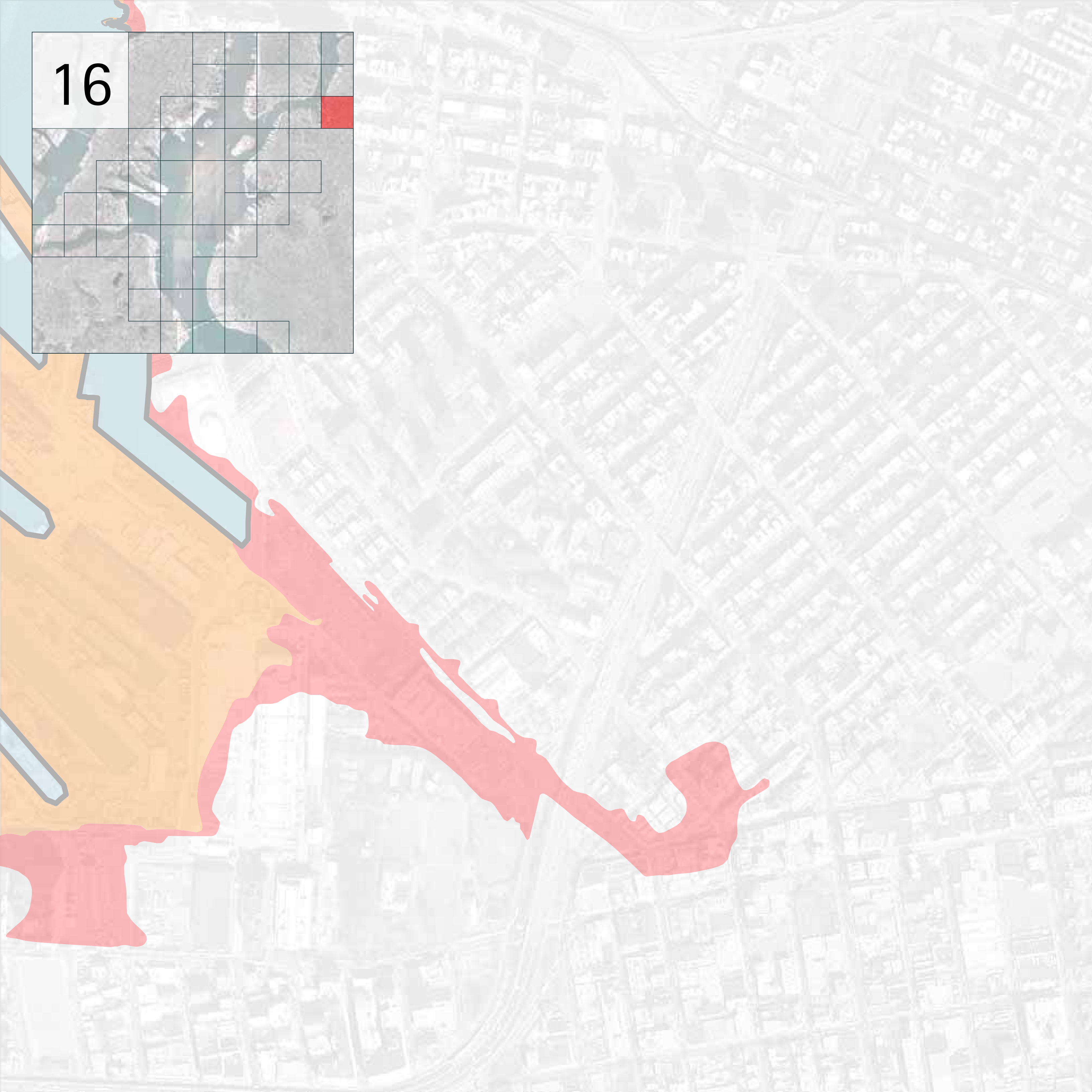
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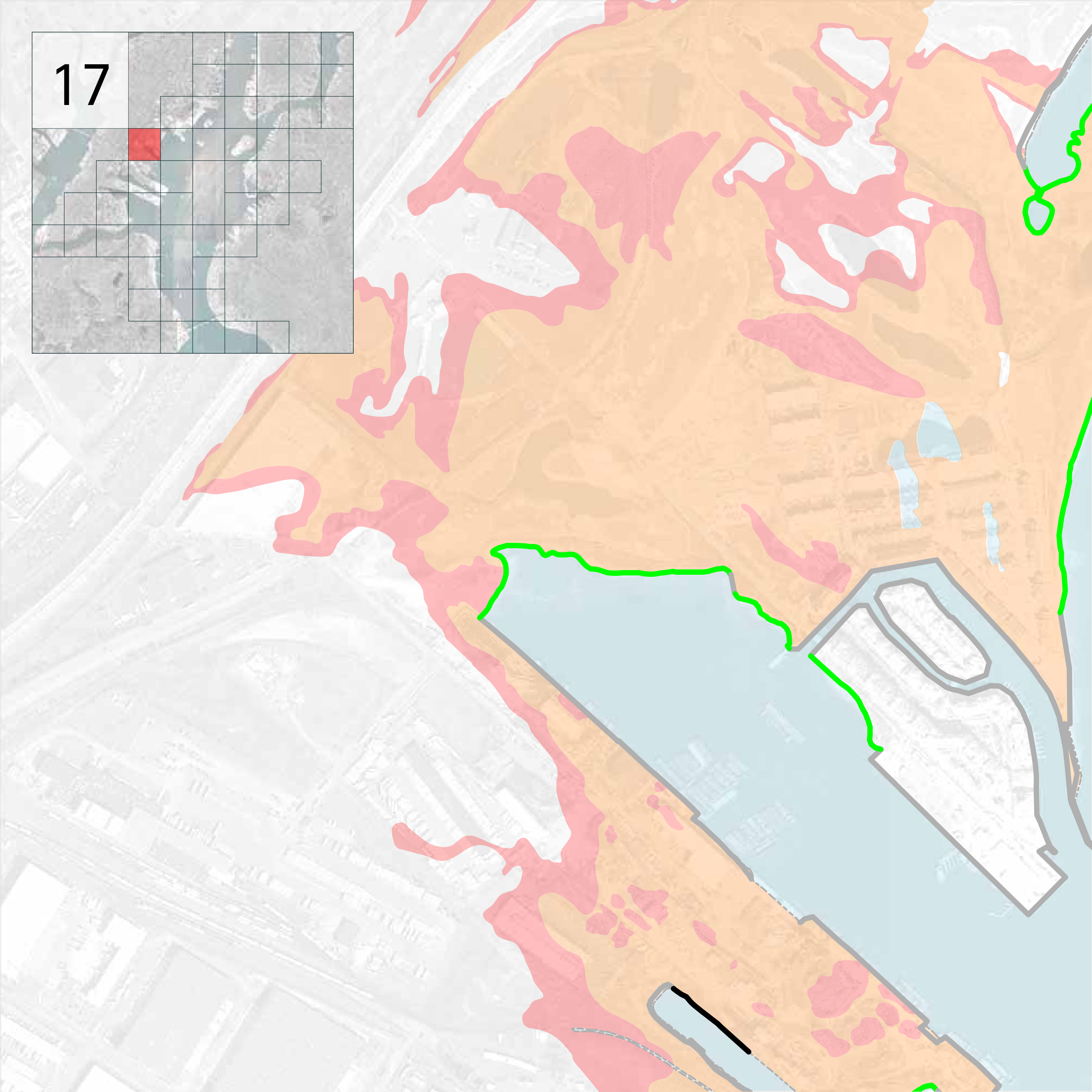
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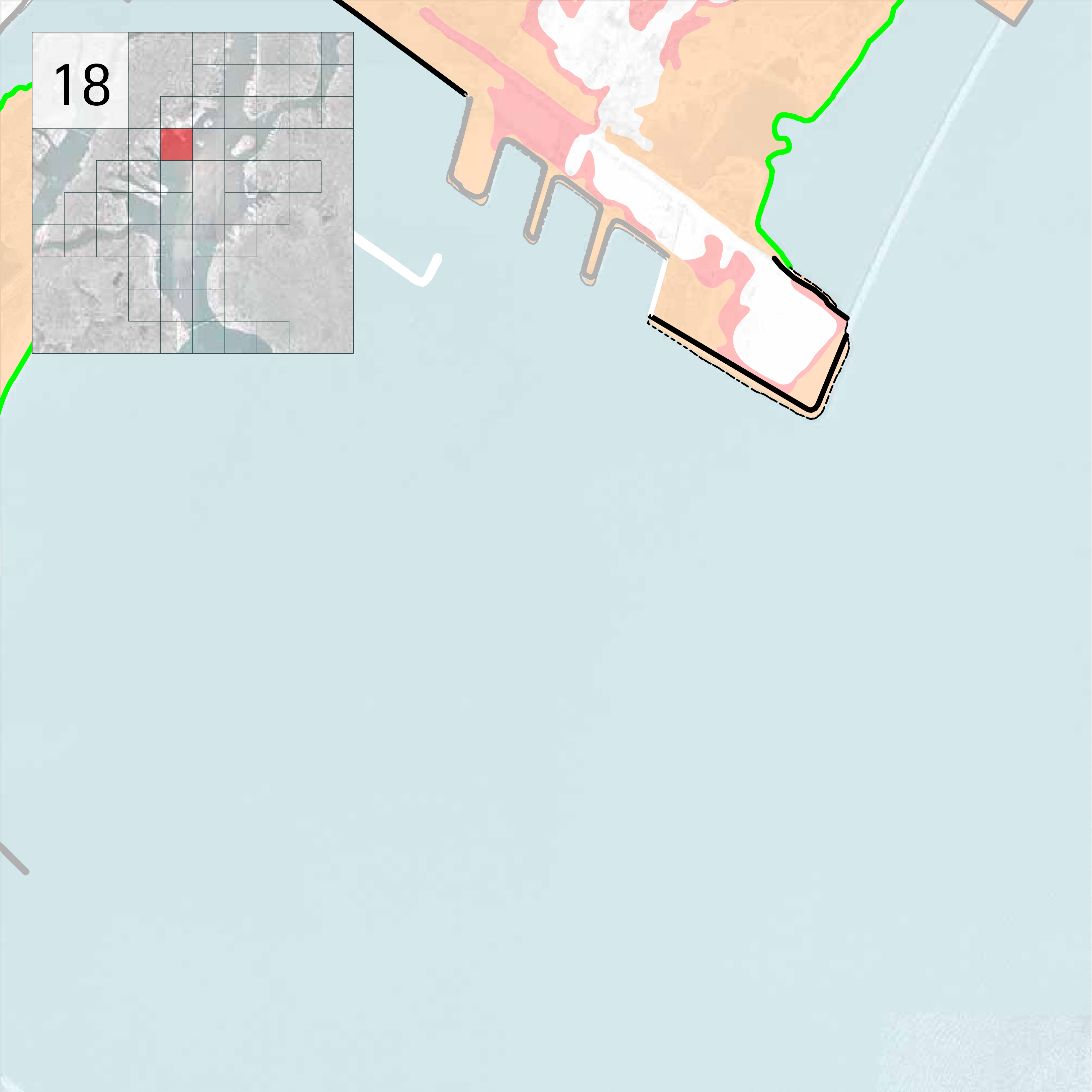
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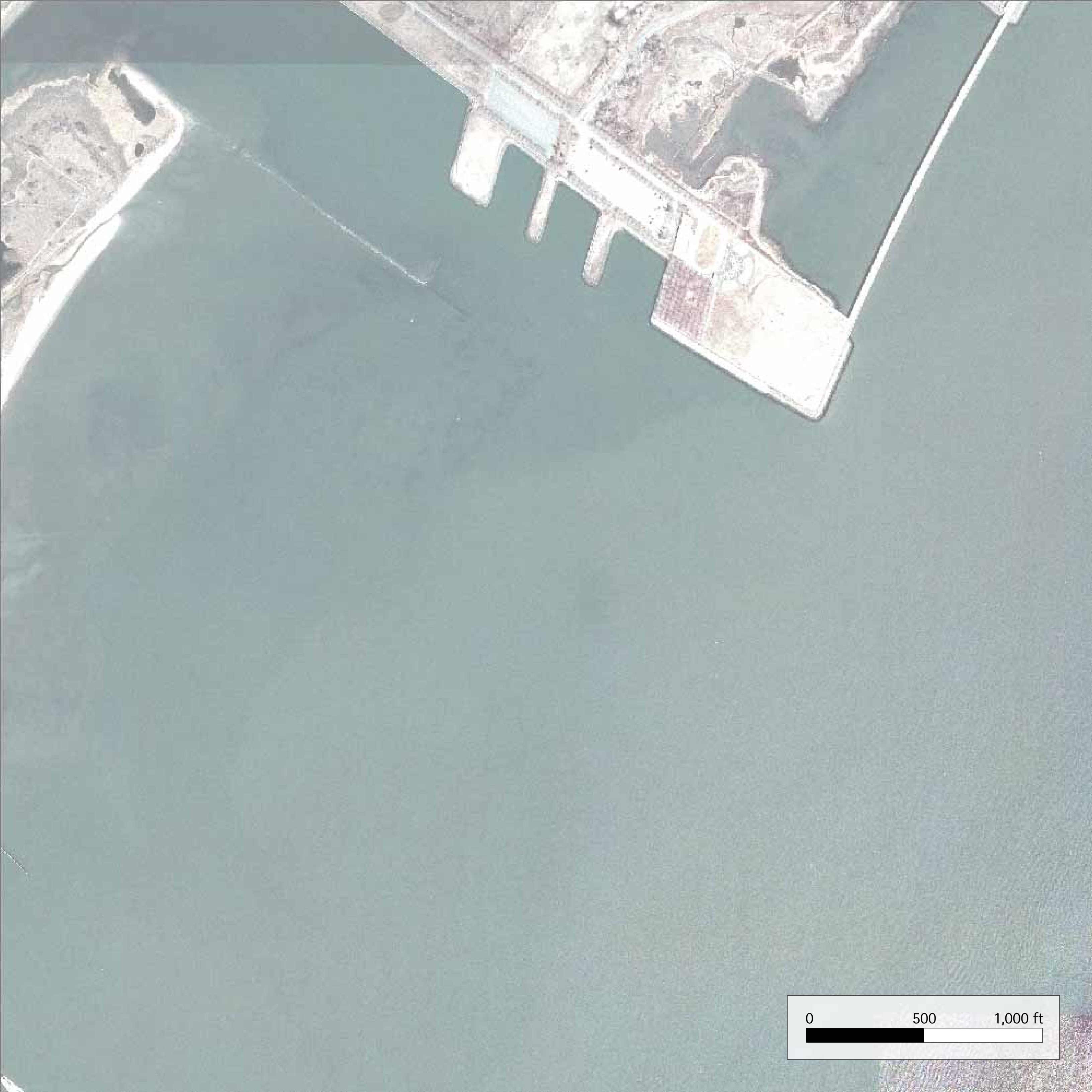

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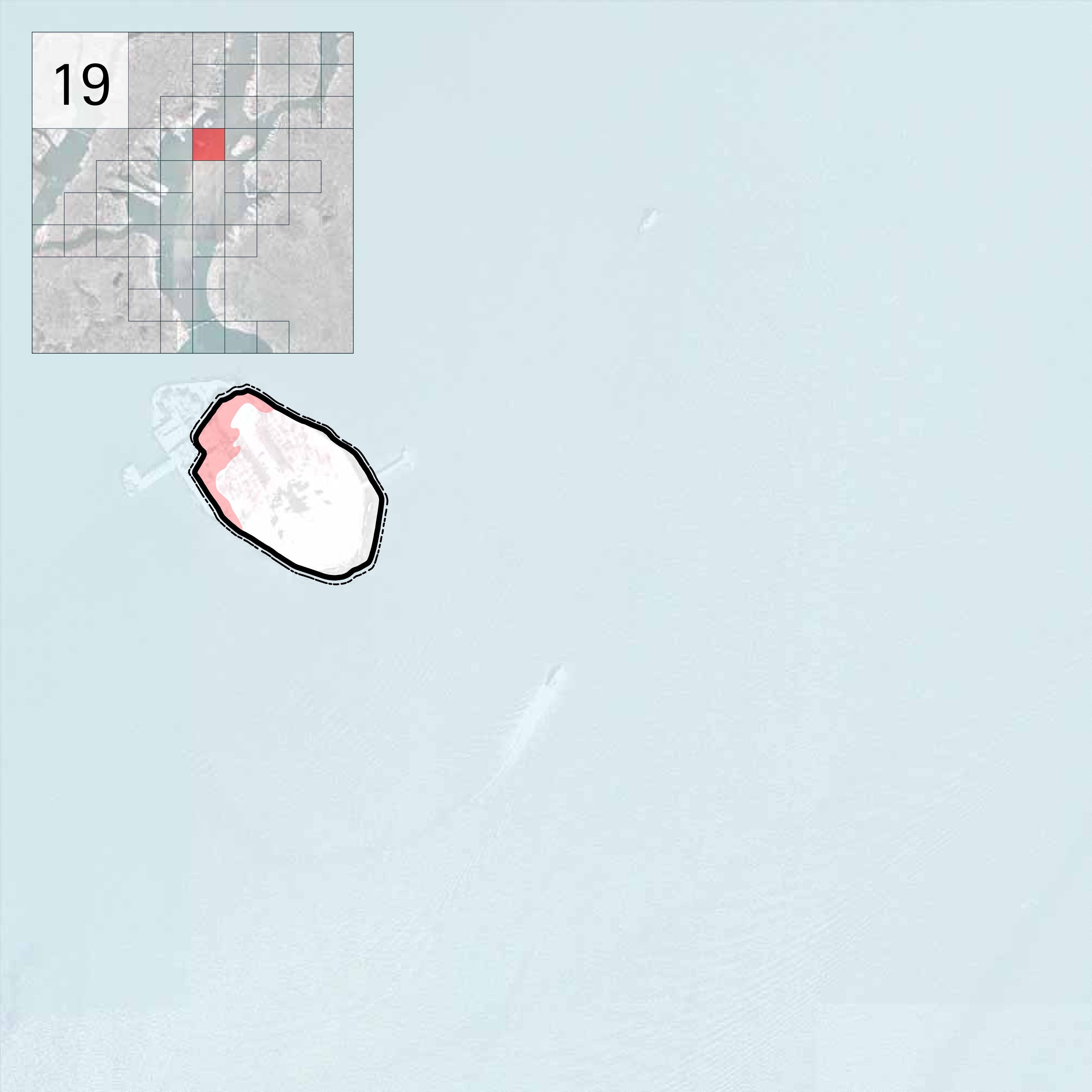
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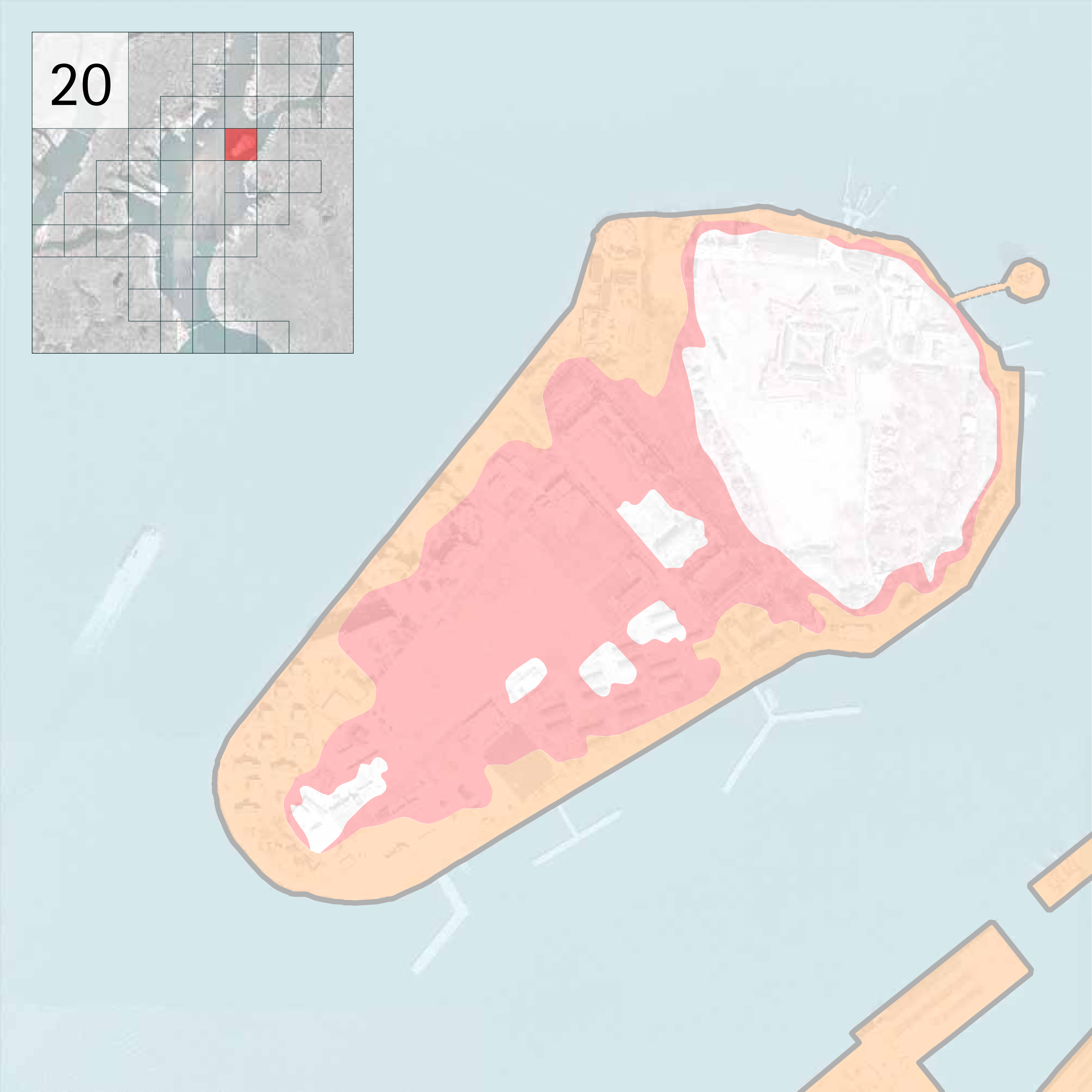
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