Building resilience in New Clark City

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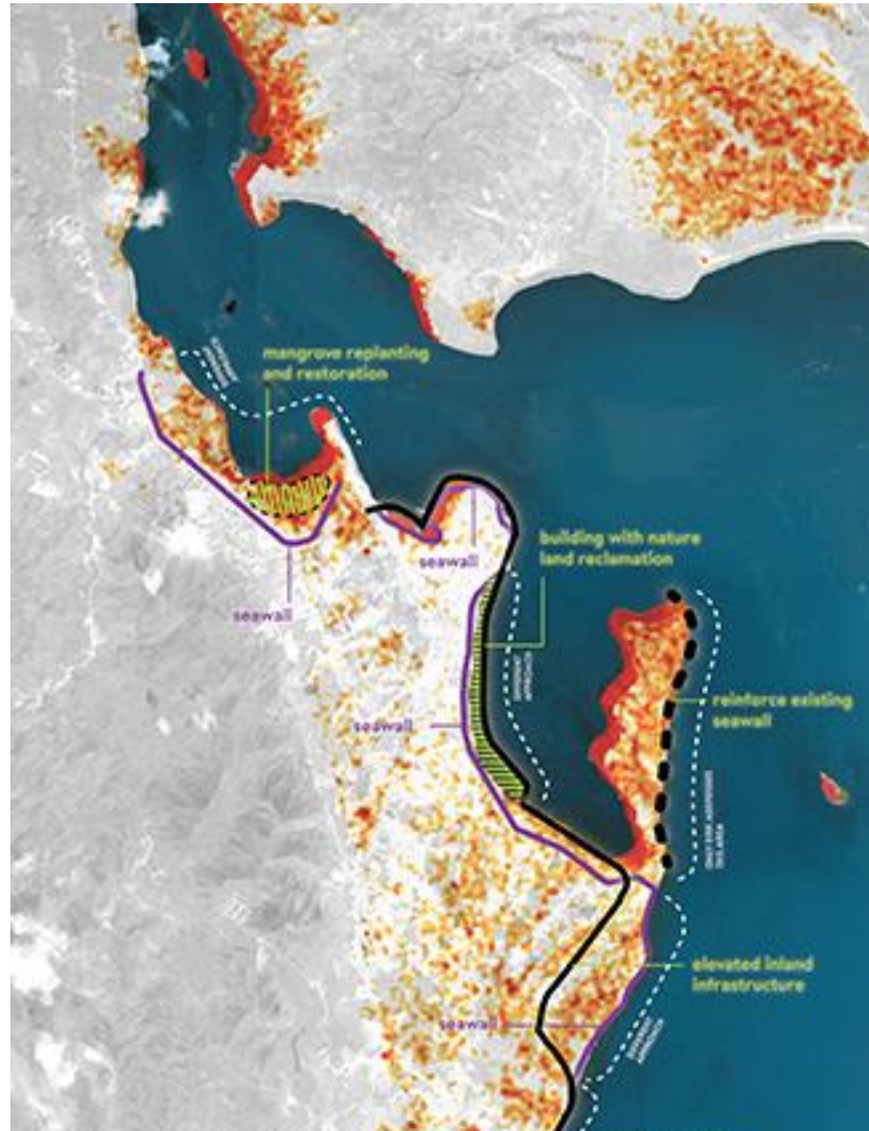
PennDesign

one architecture


PROPOSED - PERSPECTIVE FROM HOUSTON ST. ARRIVAL


mangrove replanting
and restoration
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building with nature
land reclamation
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reinforce existing
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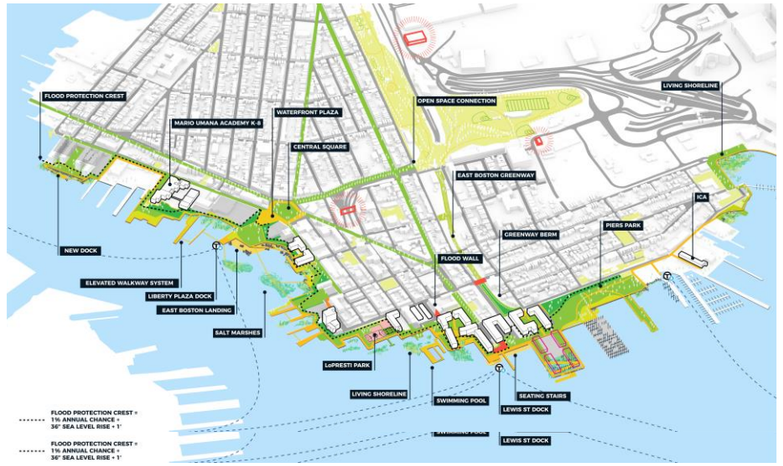
elevated inland
infrastructure
seawall


FLOOD PROTECTION CREST
MARIO UMANA ACADEMY K-8
WATERFRONT PLAZA
CENTRAL SQUARE
OPEN SPACE CONNECTION
LIVING SHORELINE
EAST BOSTON GREENWAY
ICA
PIERS PARK
GREENWAY BERM
FLOOD WALL
NEW DOCK
ELEVATED WALKWAY SYSTEM
LIBERTY PLAZA DOCK
EAST BOSTON LANDING
SALT MARSHES
LoPRESTI PARK
LIVING SHORELINE
SWIMMING POOL
SEATING STAIRS
LEWIS ST DOCK
LEWIS ST DOCK
FLOOD PROTECTION CREST = 1% ANNUAL CHANCE + 36" SEA LEVEL RISE + 1'
FLOOD PROTECTION CREST = 1% ANNUAL CHANCE + 36" SEA LEVEL RISE + 1'

What is Urban Resilience?

Urban Resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.

CHRONIC STRESSES

Stresses weaken the fabric of a city on a daily or cyclical basis.

Examples include:

- high unemployment
- overtaxed or inefficient public transportation system
- endemic violence
- chronic food and water shortages.

ACUTE SHOCKS

Acute shocks are sudden, sharp events that threaten a city.

Examples include:

- earthquakes
- floods
- disease outbreaks
- terrorist attacks

ENHANCING URBAN CLIMATE CHANGE RESILIENCE

7 Qualities of Urban Climate Change Resilience

1. **Reflective**
   Learn from experience, adapt to unpredictability
2. **Robust**
   Well-conceived, constructed, and managed; anticipate failure.
3. **Redundant**
   Spare capacity to accommodate disruption
4. **Flexible**
   Evolve and adapt to changing circumstances
5. **Resourceful**
   Readily available, multiple ways to deal with shocks and stresses
6. **Inclusive**
   Broad consultation and engagement of communities
7. **Integrated**
   Integration and alignment between city systems

Figure 2: Seven Entry Points

Source: Building Resilient Cities: 7 Entry Points for Urban Climate Change Resilience (video), produced by the Urban Climate Change Resilience Trust Fund, October 2016.

“resilient infrastructure is different from resilience infrastructure”


NEW
CLARK CITY
BCDA
Bases Conversion and
Development Authority

WHY OF INTEREST TO ADB?

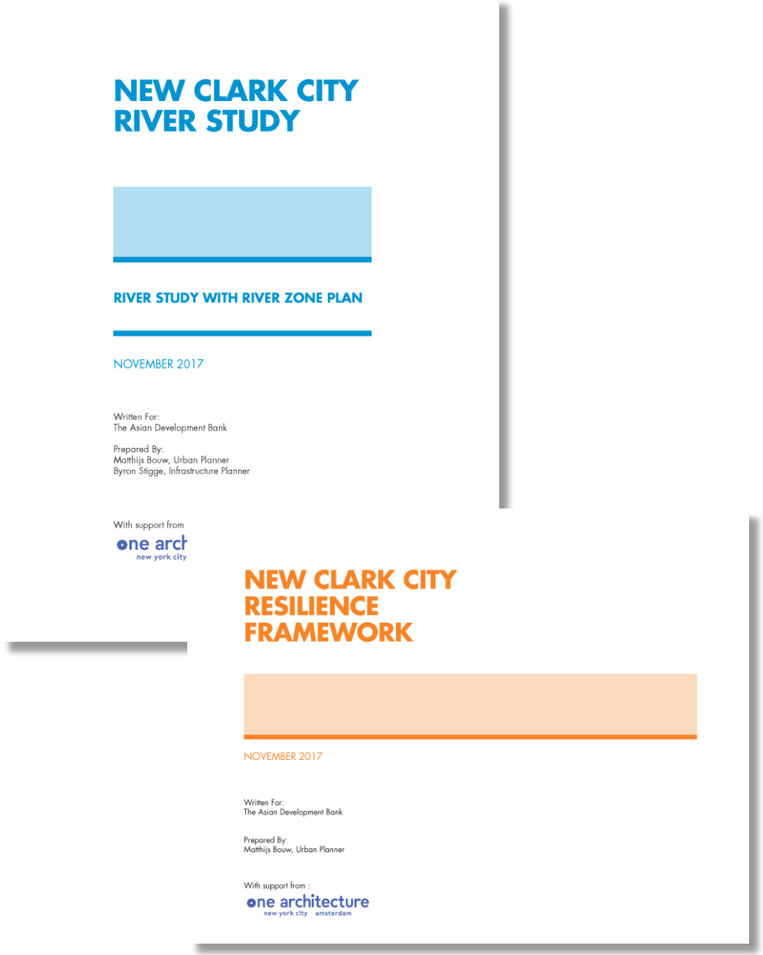
- Collaboration of URF and OPPP

- OPPP: risk reduction and - management critical for transaction advice
- A city that is not resilient is not a good investment

- URF: mainstream resilience and climate change awareness into ADB
- Combine strategy with opportunities for pilot/prototypes/examples

MASTERPLAN REVIEW PROCESS

- Review of Masterplan (through workshops and design research), *leads to*
- Masterplan Addendum, *leads to*
- River Study, *leads to*
- Resilience Framework, *leads to*
- Design Guidelines and Program Management



NCC MASTER PLAN REVIEW ADDENDUM

Climate Risk and Adaptation

Issues

- Unclear use of climate data
- Homogeneous design criteria

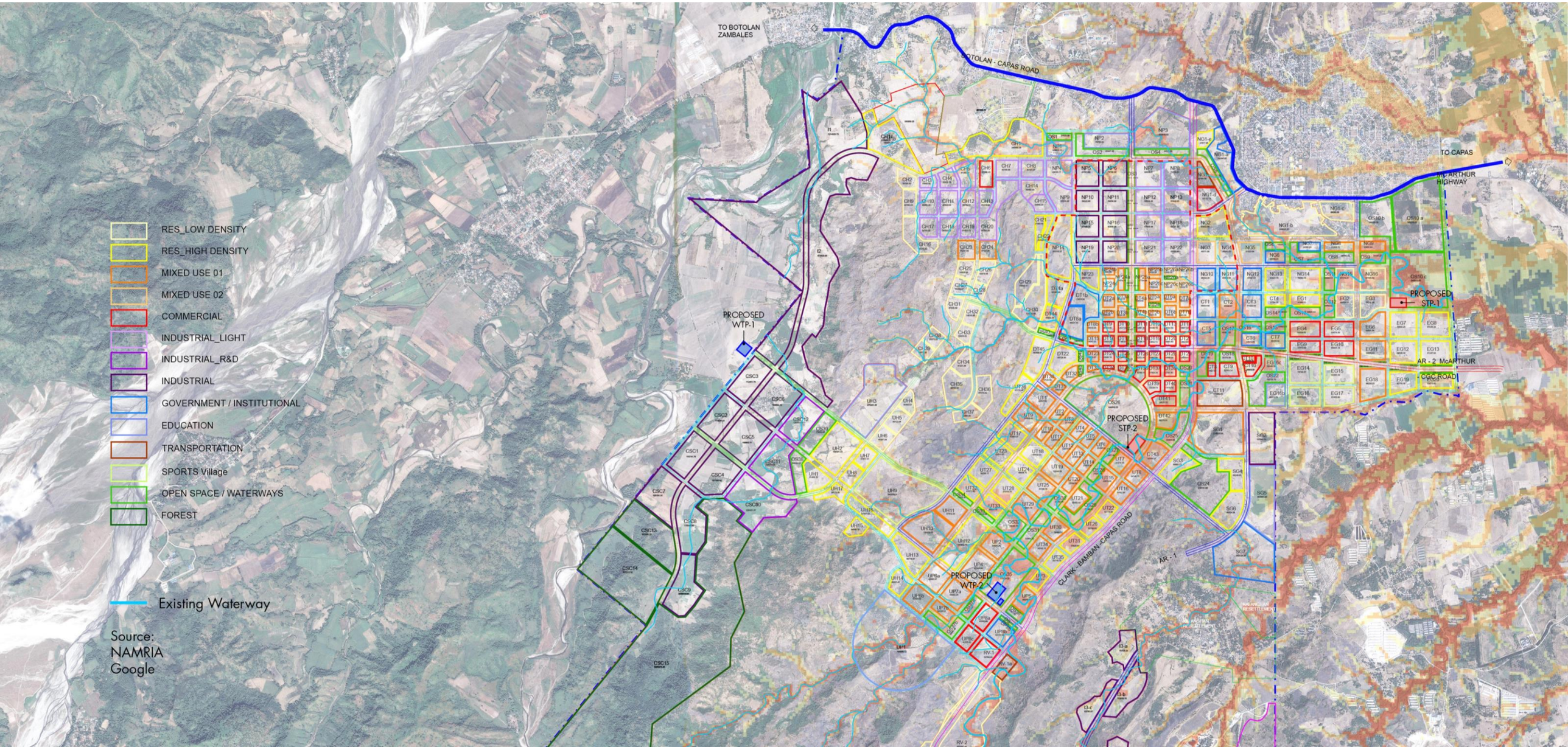
Suggestions

- Use the latest data regarding rainfall and temperature projections
- Use data consistently
- Design for the 2050 projections (high range emission scenario)
- Explore the use of different design criteria in different situations

Return Period	Flow Rate Q (m^3/s)	Depth d (m)
100 (Final Report)	423	2.5
100 (UNESCO)	517	2.9
500 (UNESCO)	704	3.6
1000 (UNESCO)	807	4.1

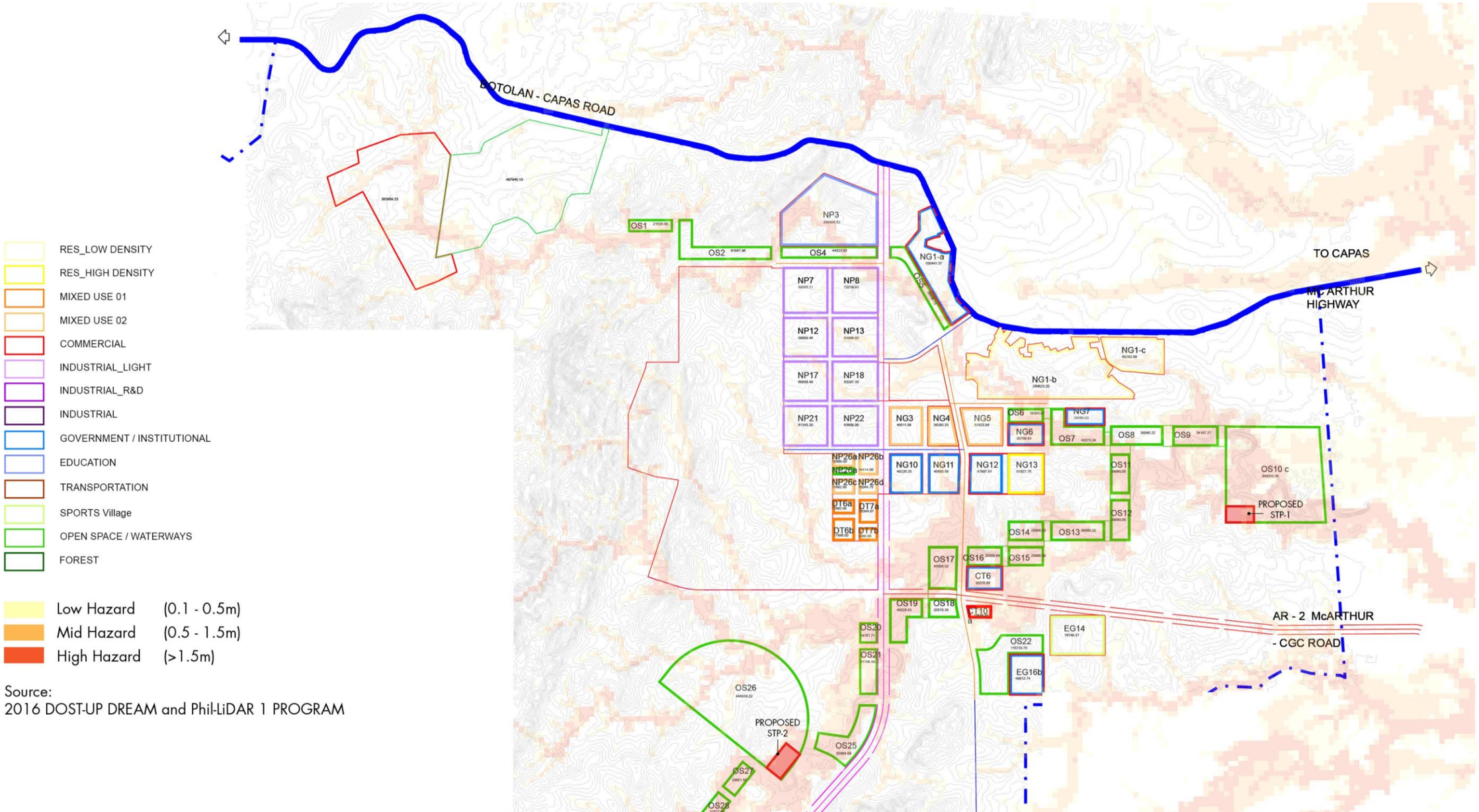
NCC MASTER PLAN

Land Use Plan (May 19)



NCC MASTER PLAN

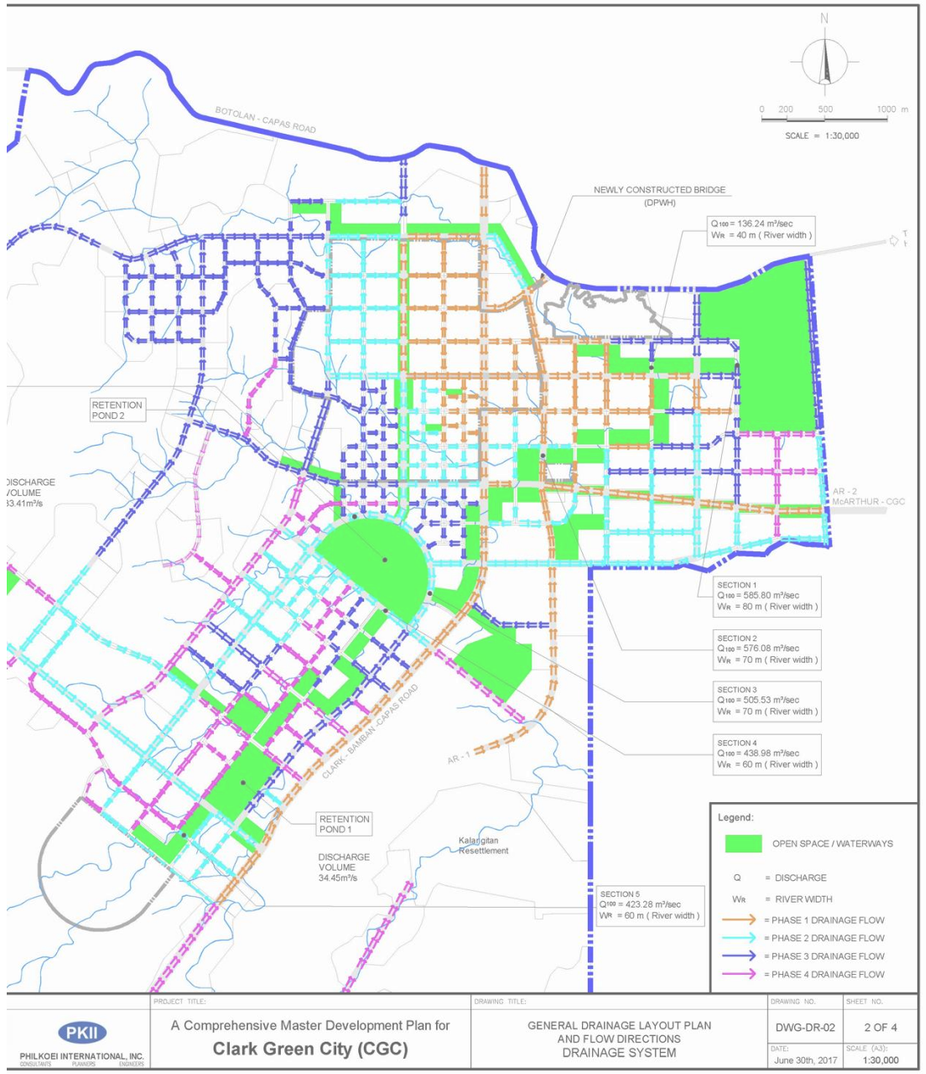
Phase 1 Land Use Plan (May 19)



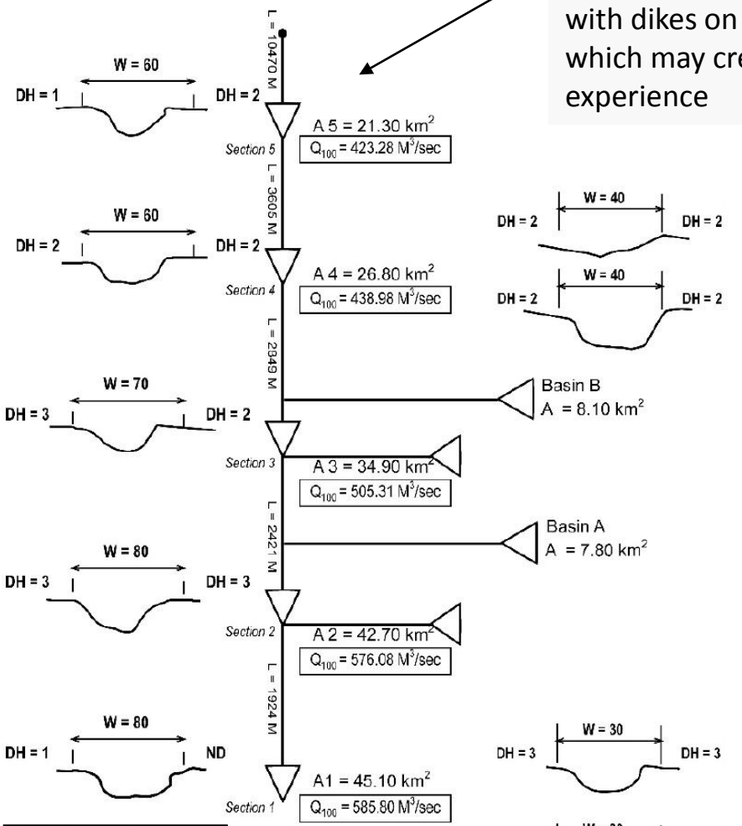
Source:
2016 DOST-UP DREAM and Phil-LiDAR 1 PROGRAM

NCC MASTER PLAN

Current Channel Design



Currently, the river sections are imagined as channels with dikes on the sides, which may create a wall-like experience



Hda. Luisita, Tarlac
Rainfall Intensity Duration Frequency Data (RIDF)

Condition:
100 Year Return Period
n = 0.03

DH = Minimum Dike Height
ND = No Dike
W = Distance Dike to Dike

RESILIENCE: KEY QUESTIONS

- Are the design guidelines sufficient from the perspective of business continuity and the protection of economic value?
- Can we think about the river/floodplain so that it becomes a social and economical asset for Clark Green City, and save cost in the process?
- Can we link a open space strategy to a community resilience strategy?

Bishan Ang Mo Kio Park (Before Restoration)

Bishan Ang Mo Kio Park (After Restoration)

NEW CLARK CITY RIVER STUDY

RIVER STUDY WITH RIVER ZONE PLAN

NOVEMBER 2017

Written For:
The Asian Development Bank

Prepared By:
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Byron Stigge, Infrastructure Planner

With support from :

one architecture
new york city amsterdam

level
Infrastructure

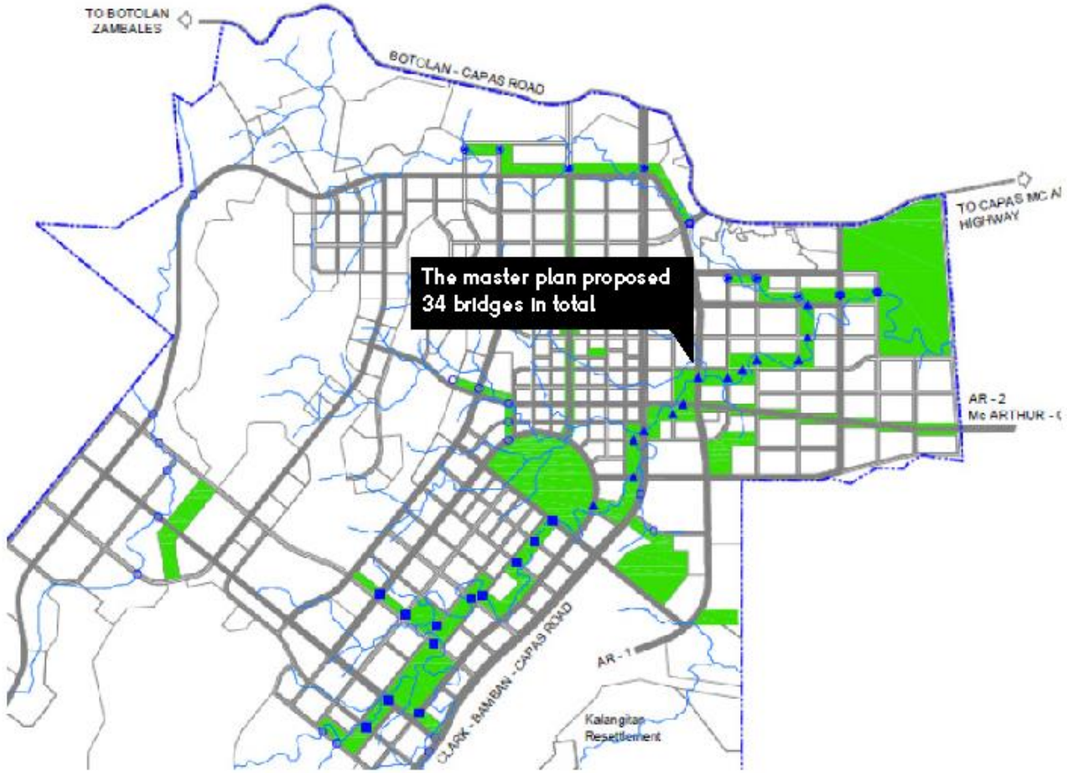


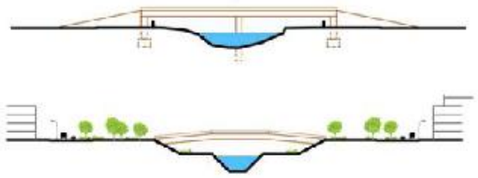
Figure 6. Location of the 34 bridges proposed in the Master Plan, spanning from 40m to 80m.

2.3 Few benefits

As set out in the master plan, most of the "green zone" area is utilized by the hardened river channel, which leaves minimal opportunity for multi-benefit open space throughout the city. An implication of this design and engineering approach, limits the use of the master plan's "green zone" as open space during dry weather.

In addition, the full river system as proposed in the master plan is unlikely to function within the larger ecological systems in the region due to amount of disturbance required to construct the river as proposed.

Putting dikes along the channel would require a higher and longer bridge, incurring higher costs and larger footprints



A thoughtfully designed section can yield benefits such as smaller footprint, and better public spaces

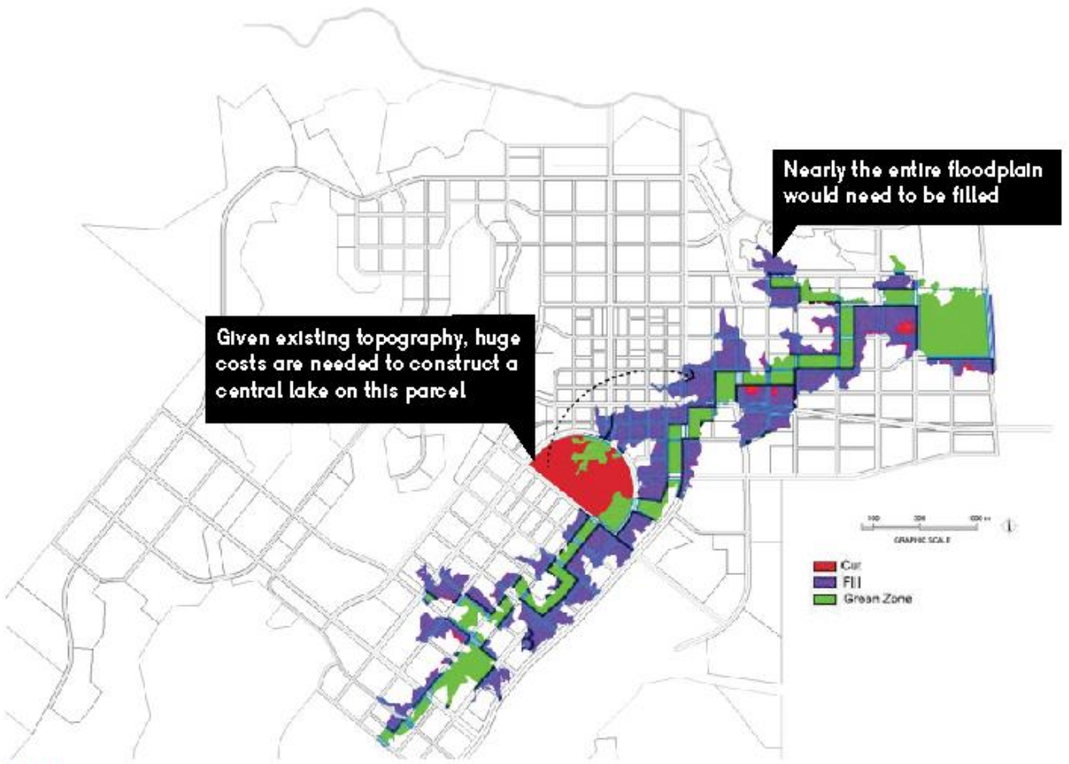


Figure 7. Master plan grading implications.

2.4 Costly infrastructure, dedicated maintenance required

Siting of key infrastructure, such as bridges and landings, is a critical component of the development process and has cascading implications for sub-development schedules and costs. Infrastructure has direct impact on the city's urban character and public spaces. Carefully designed infrastructure should integrate necessary protection strategies and livable urban experience.

Given the master plan's gridded road network, approximately 34 bridges are proposed across the main river stem. This amount of infrastructure is costly and requires detailed, dedicated maintenance schedules and strategies.

Crossings should be designed such that smaller footprints are required and integration with open space produces better public space. Reducing the number of vehicular crossings would reduce costs.

2.4.1 Earthwork and grading

Considering the existing topographic variation across the city, huge costs are needed to construct on the floodplain and the central lake parcel.

03
LEARNING FROM OTHER PLACES

3.1 Houston: Buffalo Bayou

Houston, Texas, USA
Completed 2006
SWA
9.3 ha, 2 km

The result of a public-private partnership to revive downtown Houston's urban waterfront, Buffalo Bayou is one of the largest investments made in a public park in Houston. Previously, the site housed overhead freeways, utilities, steep slopes, and limited access.

The then overlooked site was transformed into a 915-meter continuous corridor, providing an additional 20 acres of park space in Houston's core. The river was brought back to its natural form with gentle sloping banks and native landscaping. Today, the waterway is not only a recreational space for the residents, but also home to various animal species. Buffalo Bayou has animated the city with new commercial, cultural, and civic vitality.

Figure 8. Buffalo Bayou scale comparison.

Figure 9. Buffalo Bayou normal and flood condition after Hurricane Harvey, 25-29 August 2017.

Figure 10. Buffalo Bayou offers both pedestrian and bike trails along the water's edge.

image (above) http://nypost.com/2017/06/27/dramatic-before-and-after-photos-show-surreal-flooding-in-texas/, (below) http://www.landezine.com/wp-content/uploads/2015/06/Buffalo-Bayou-Promenade-by-SWA-02-Tom-Fox.jpg

3.2 Singapore: Bishan-Ang Mo Kio Park

Singapore, Singapore
Completed 2012
Ramboll Studio Dreiseitl
3 km

The Kallang River–Bishan Park project is a vision for Singapore as global city to promote blue-green infrastructure. As a part of the Active, Beautiful, Clean Waters (ABC Waters) Programme, the project integrates water supply and flood management in a form of public space, enhancing relationship between people and nature.

Through the edge of the park, the original 2.7 km concrete channel of the site was altered into a naturalized river, forming new urban river park. Today there are three playgrounds, a restaurant and a new vista point constructed using the recycled walls of the old concrete channel completing the park.

Figure 14. Bishan Park scale comparison.

Figure 15. From concrete channel to naturalized river.

Figure 16. Today Bishan Park is one of the most popular parks in the heartland of Singapore.

image (above) https://www.asla.org/2016awards/images/169669/BishanPark_4.jpg, https://www.asla.org/2016awards/images/169669/BishanPark_15.jpg (below) http://www.landezine.com/wp-content/uploads/2012/06/bishan-park-by-atelier-dreiseitl-landscape-architecture-01.jpg

3.4 Pasig City, Manila: Ortigas Greenways

Manila, Pasig City, Philippine
Under Construction
PGAA Creative Design, ADB
apx 2 km

The rapid urbanization in Asia Pacific today has culminated into a transit system crisis. Non-vehicular transit such as walking is often neglected in terms of policy and investments. Organized by the Asian Development Bank (ADB), the Ortigas Greenways aims to enhance pedestrian safety and facility to start the effective loop of reducing traffic congestion, improve air quality and reduce greenhouse gas emission. Located in the heart of Manila, the project is one of the biggest pedestrian revitalization in the metro area.

The project demonstrates how development patterns that are too compact and not adaptive can lead to higher costs later.

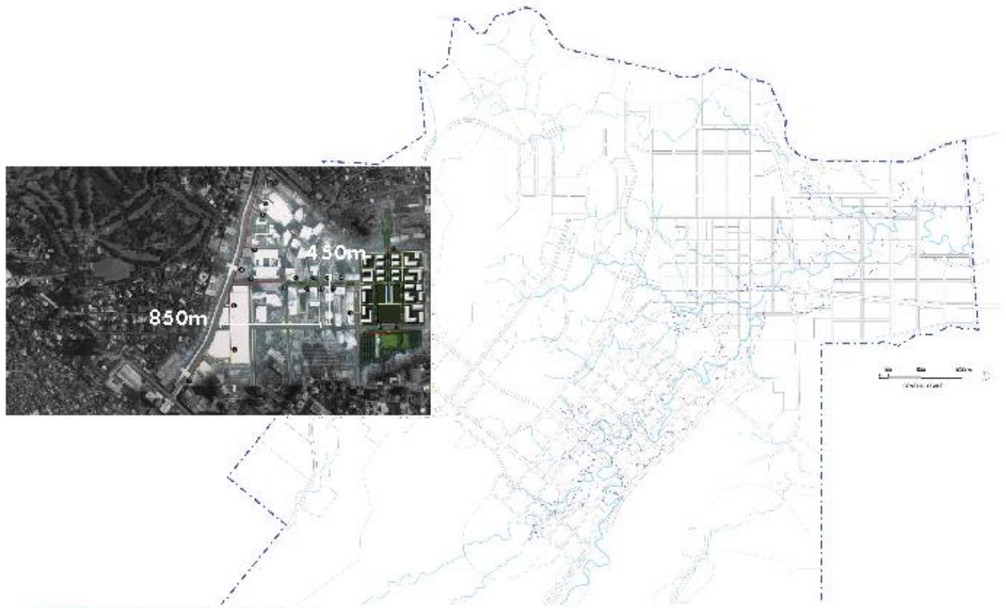


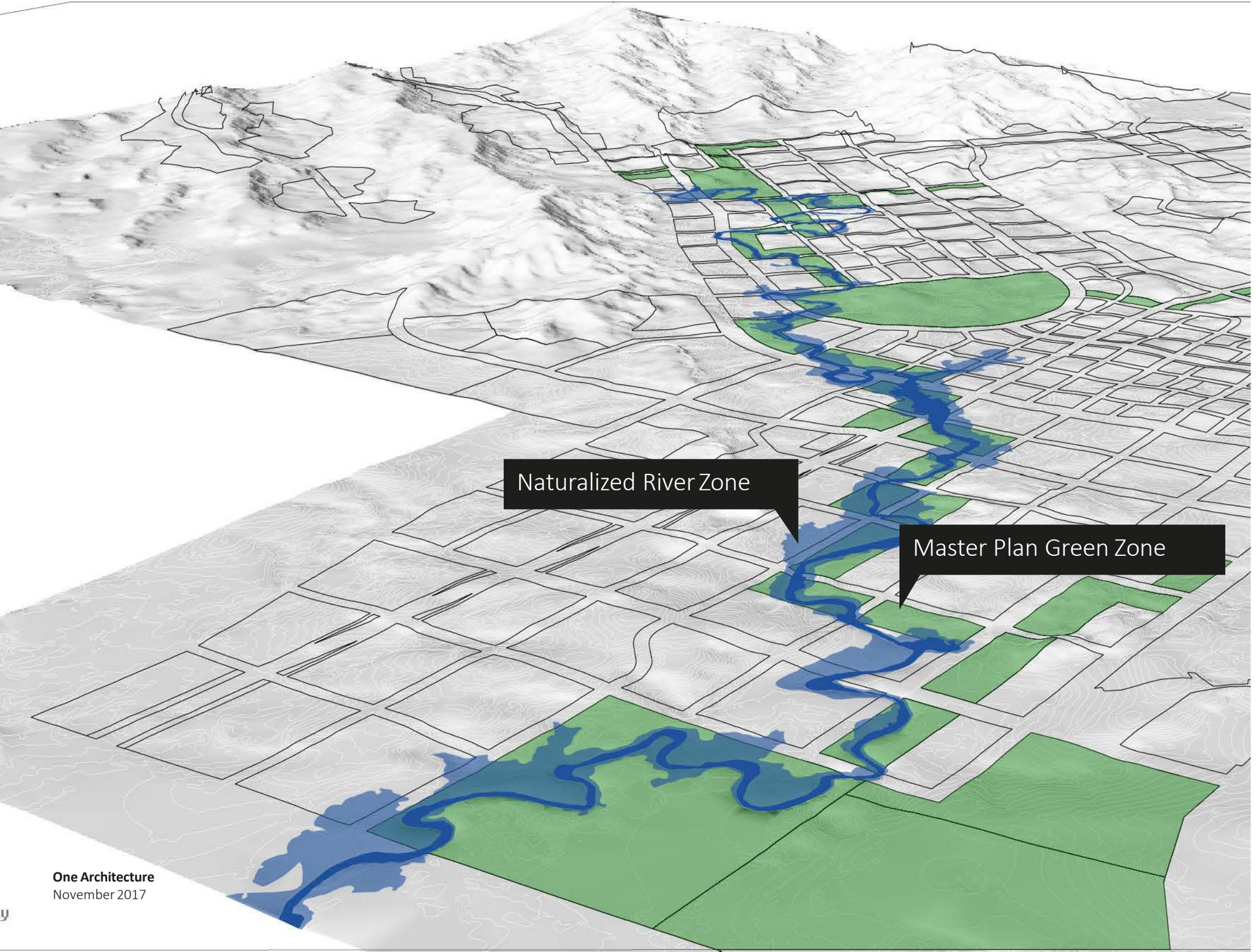
Figure 23. Ortigas Greenways scale comparison.

NCC RIVER STUDY
03. Learning from Other Places

Figure 24. Existing walkway today around downtown Ortigas area and construction in progress for the Ortigas Greenways Project.

Figure 25. Constructed walkway in Ortigas.

Image (above) http://withinorthe.net/wp-content/uploads/2015/12/walkway-manila-philippines.jpg, https://flic.kr/p/V3MQwM, (below) http://withinorthe.net/wp-content/uploads/2011/12/pedestrian-walkway-ortigas-manila-philippines.jpg

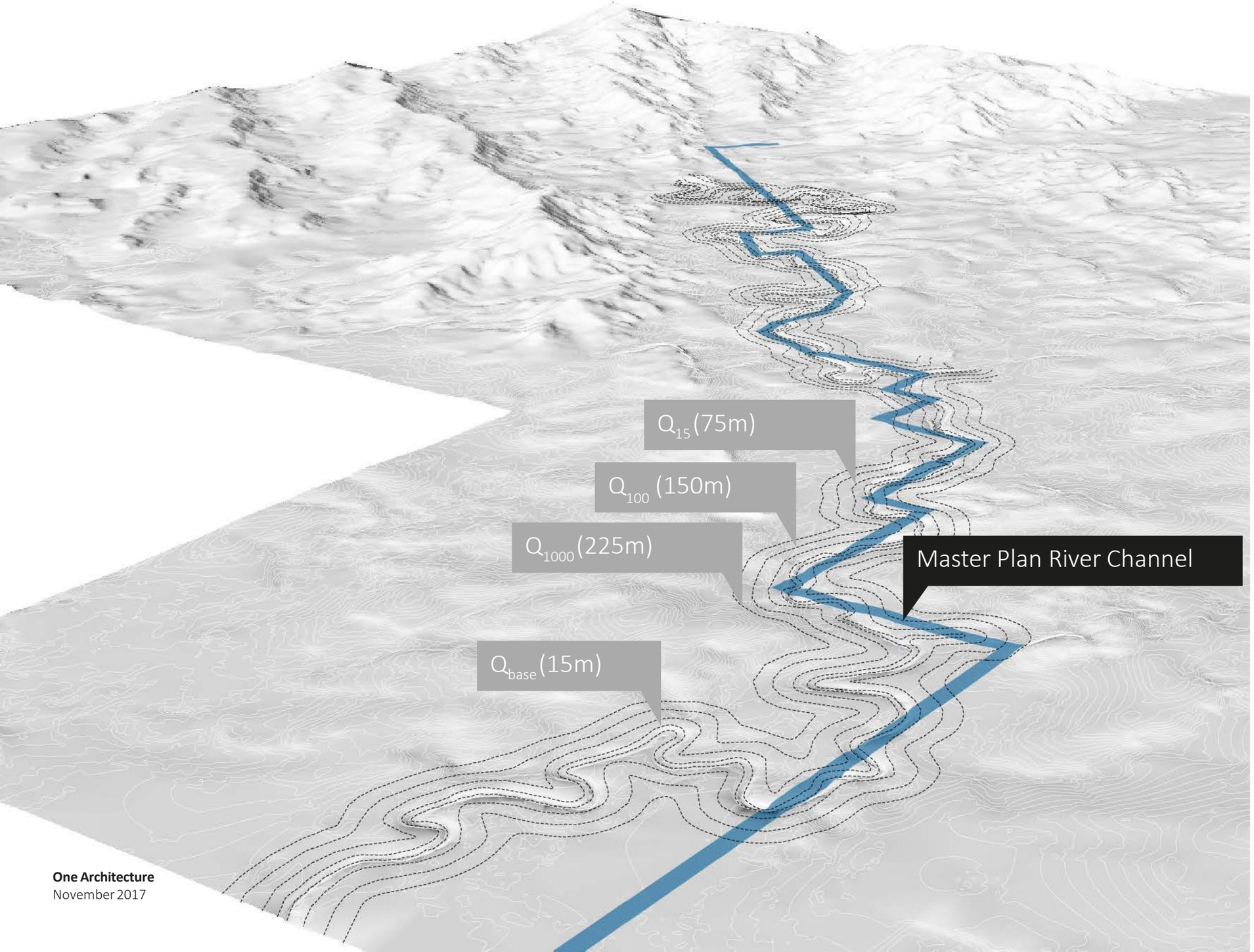


Conceptual Master Plan

Dated August 2017

View looking south

The rigid formality of the conceptual master plan is often in opposition to the natural terrain. As originally conceived, these moments of discordance would require extensive engineering and re-grading to resolve. While this issue is apparent across the site, the most stark conflicts occur between the existing river and the proposed green zone.

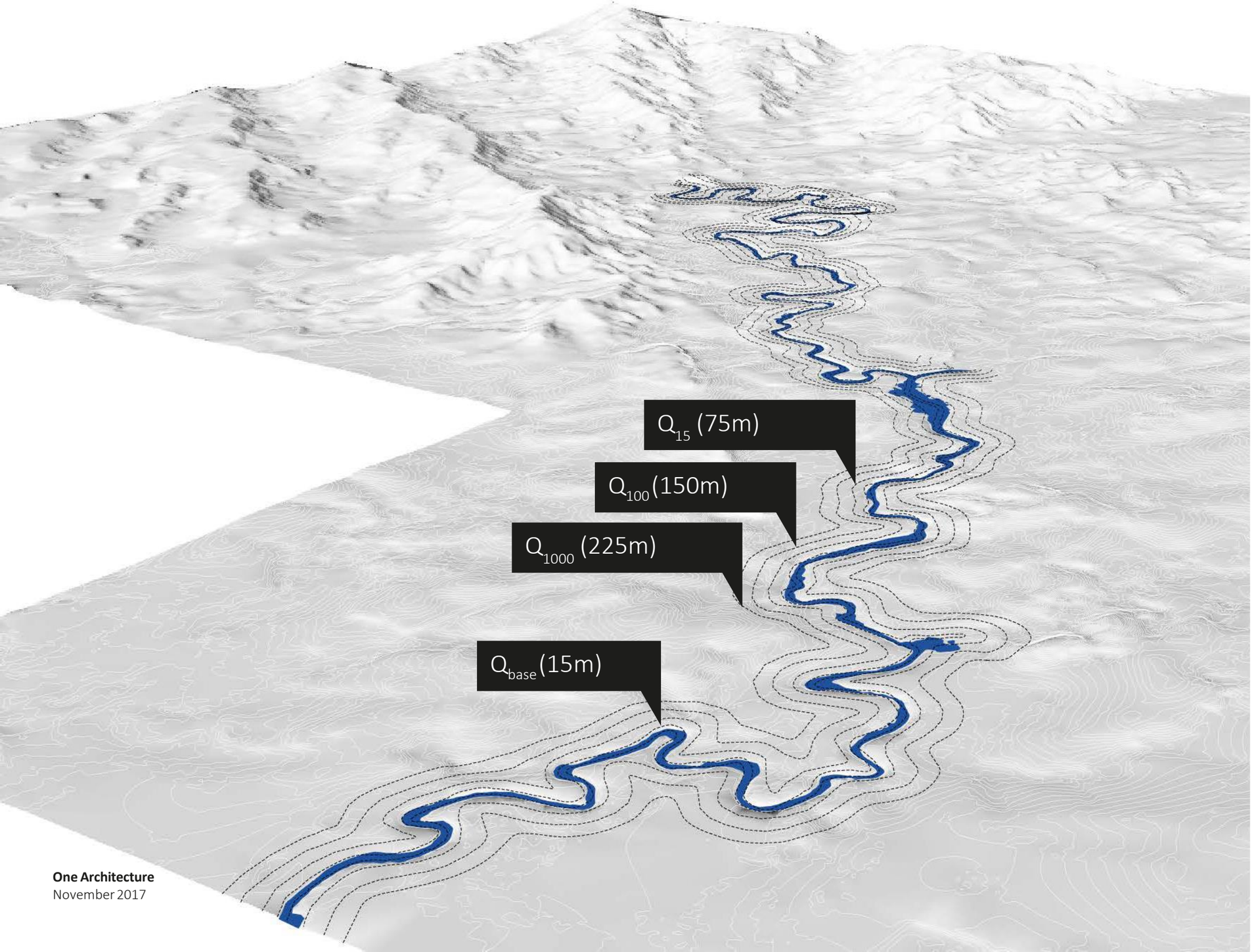


Master Plan River Channel

An engineered approach

The channeliz ed river in the Master Plan does not respond to the natural topography or established river flow conditions. It proposes a series of engineered 90-degree turns, requiring extensive concrete infrastructure, an approach at odds with modern water management practice.

A standard, professional water-focused engineering approach would instead use regular off-sets from the natural waterway to build capacity in the channel. Limited re-grading and dredging would occur within these offsets only, and concrete canals could be avoided.

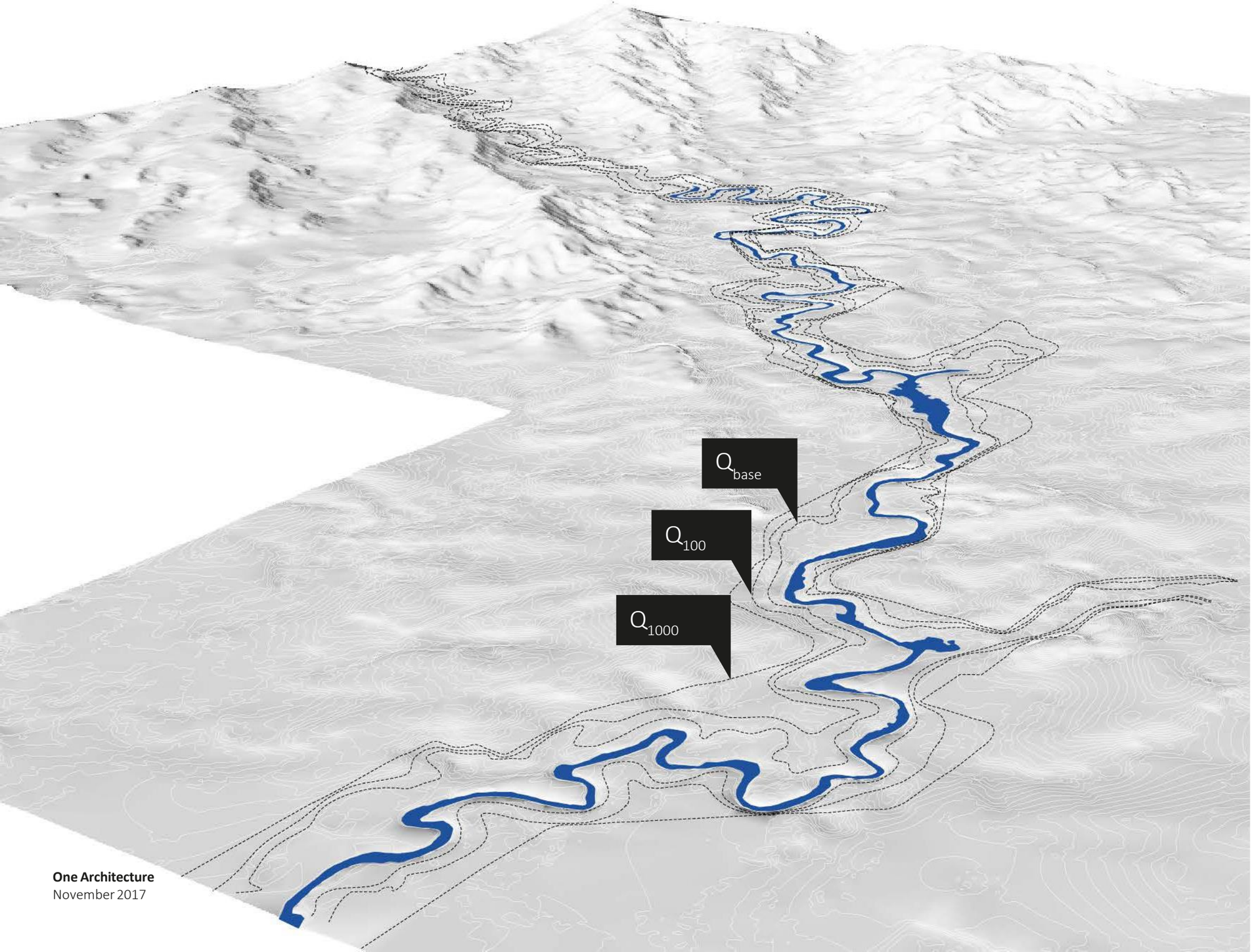


Adapted Channel Widths

An event-based approach

Q_{base}	base river channel	15m
Q_{15}	15-year flood	75m
Q_{100}	100-year flood	150m
Q_{1000}	1000-year flood	225m

A standard, professional water-focused engineering approach would instead use regular off-sets from the natural waterway to build capacity in the channel. Limited re-grading and dredging would occur within these offsets only, and concrete canals could be avoided.



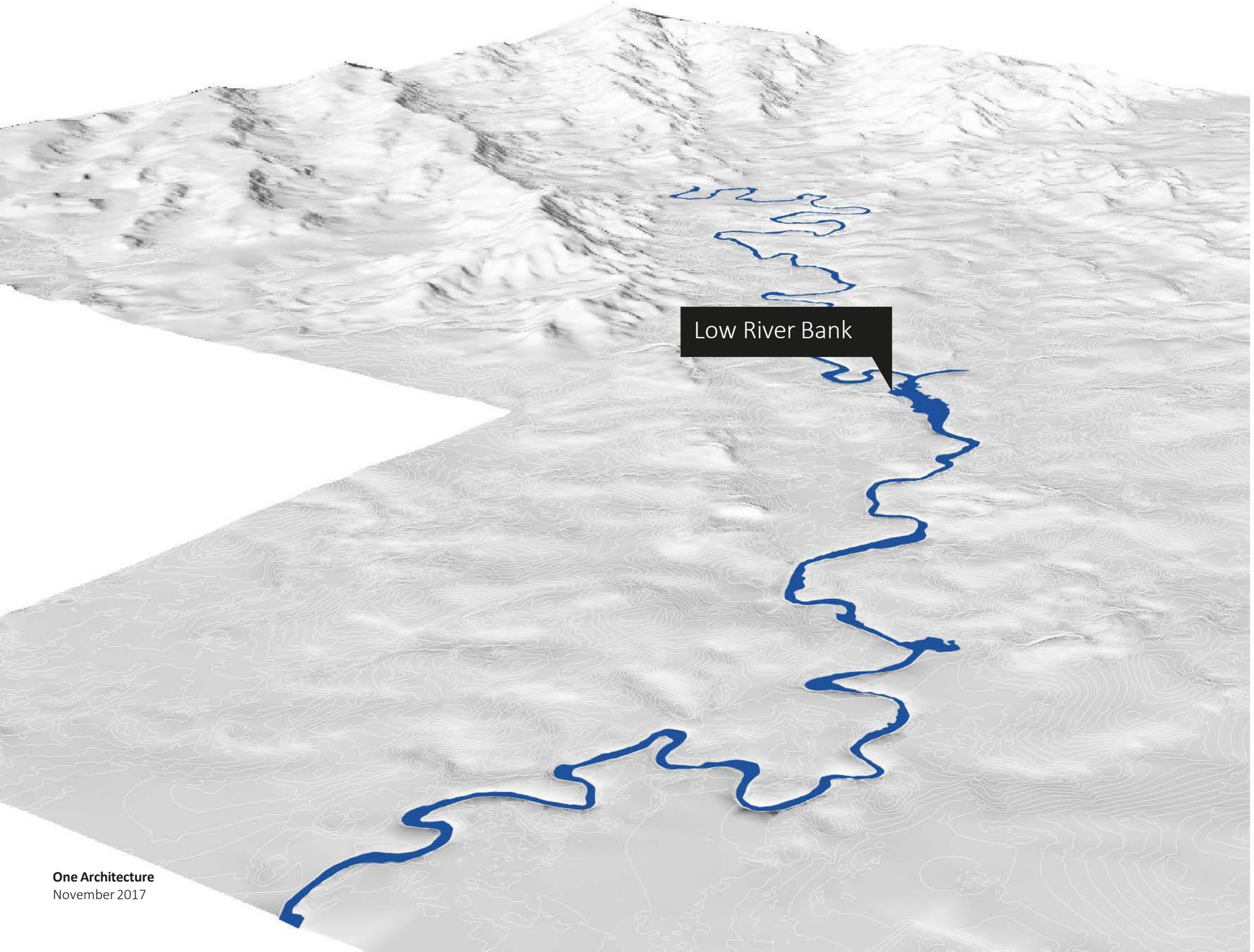
Refined Channel Widths

A design approach

Taking the engineering offsets as a guideline and starting point, the design can be further refined according to the existing natural topography.

The revised channel widths and river zone are based on a more holistic and resilient approach to the river that incorporates both the natural topography and an event-based engineering.

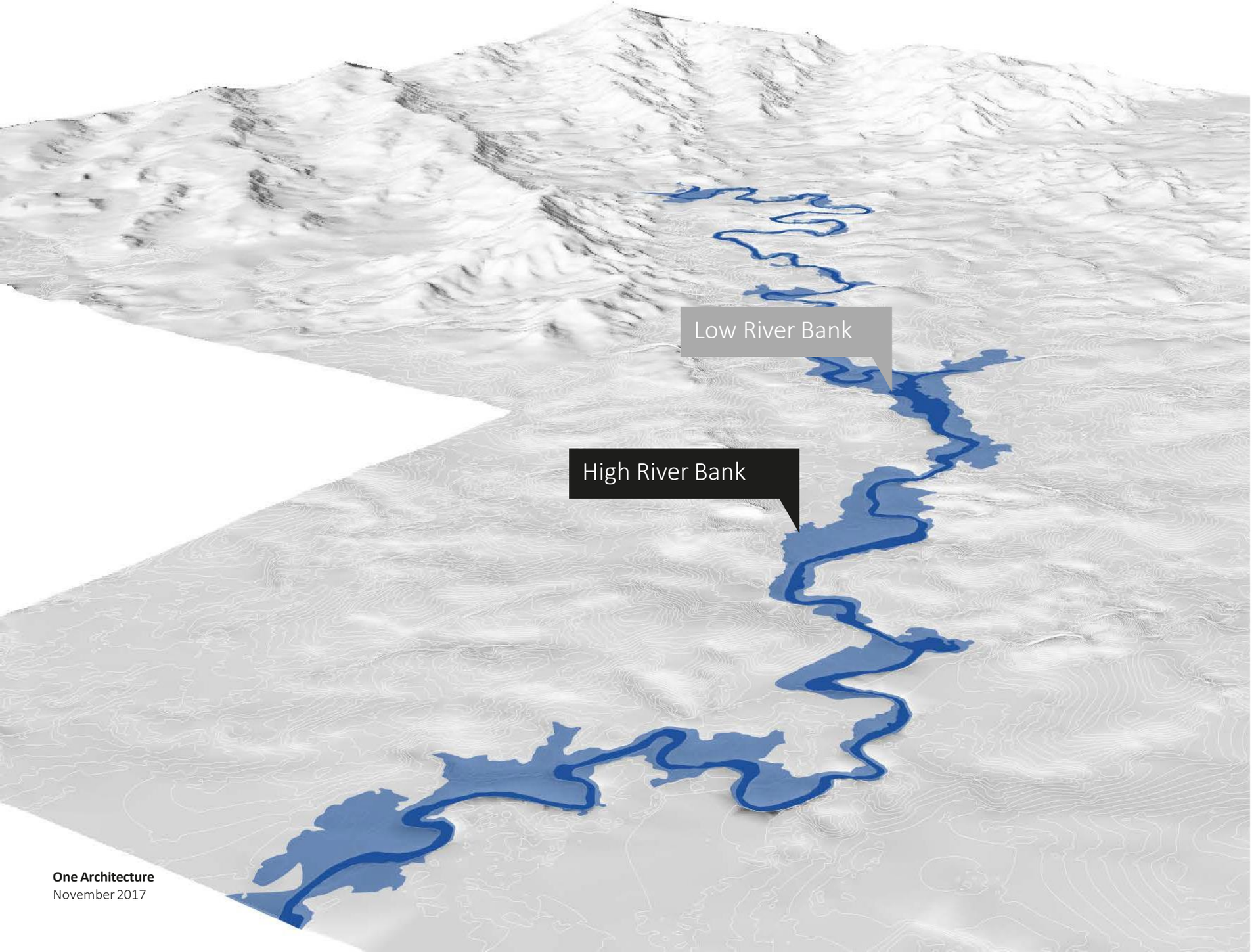
This strategy better aligns ecologic value and urban functions, while respecting the current development process and associated real estate investments.



Natural Topography

"Low river bank"

The natural low river bank marks the river condition during base conditions.

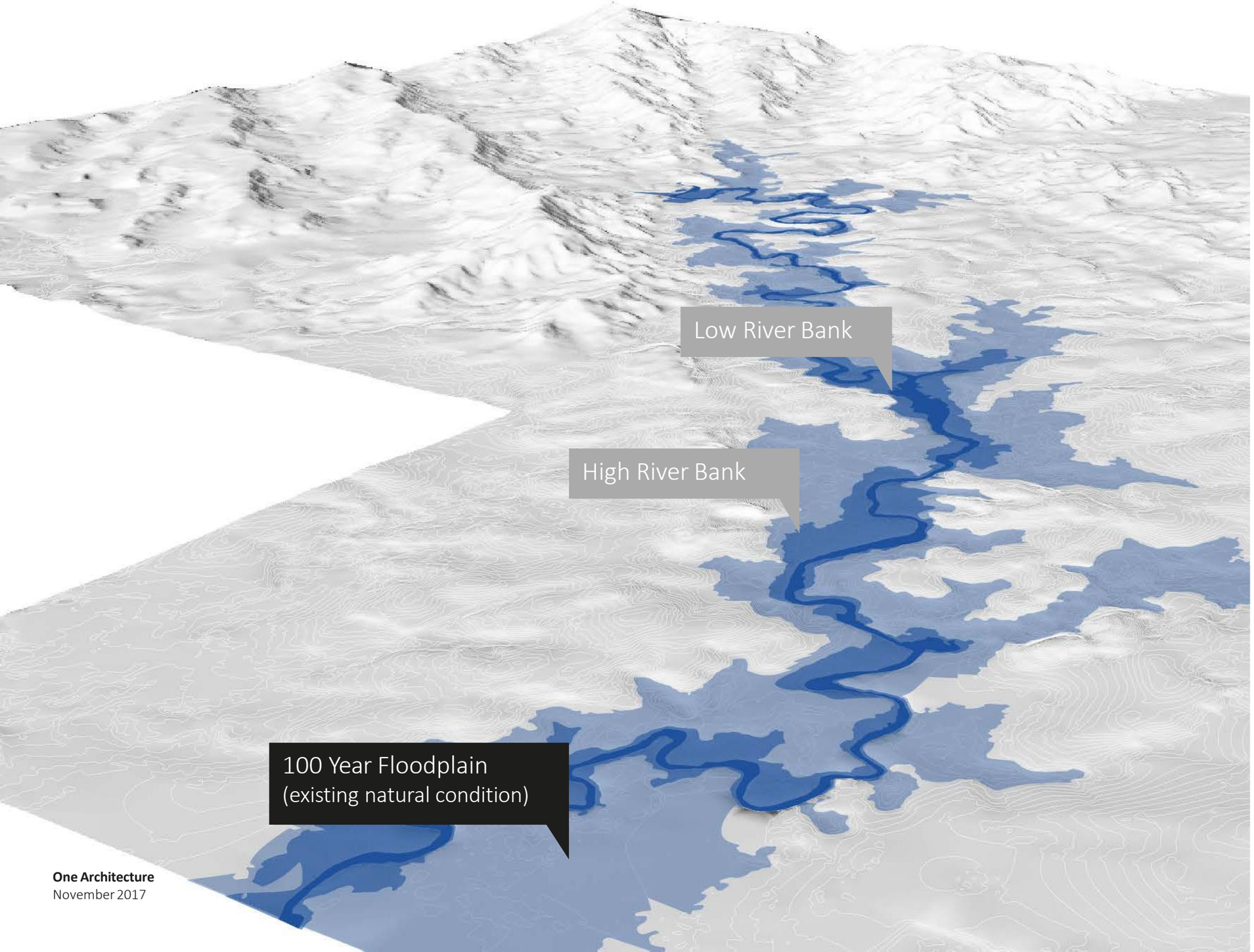


Natural Topography

"High river bank"

The natural low river bank marks the river condition during base conditions.

The natural high river bank shows the frequently flooded zone during wet season.



Natural Topography

Natural Floodplain

The natural low river bank marks the river condition during base conditions.

The natural high river bank shows the frequently flooded zone during wet season.

The natural 100 year floodplain is the area estimated to have a 1% chance of flooding in any given year.

It is critical that development is avoided as much as possible in this zone. If development does occur, proper protection must be offered.

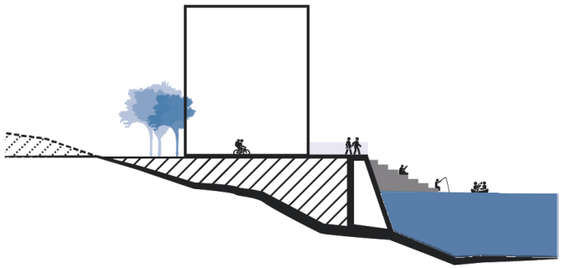
Proposed Edge Toolkit

An urban edge

The proposed urban edge uses engineered options, such as bulkheads with raised promenades, to protect the land adjacent to the river zone from flooding, while also providing urban functions and amenities.

Its urban functions are predominantly used for recreation, also supporting commercial and residential areas through promenades, playgrounds, amphitheaters, and seating.

Urban Edge

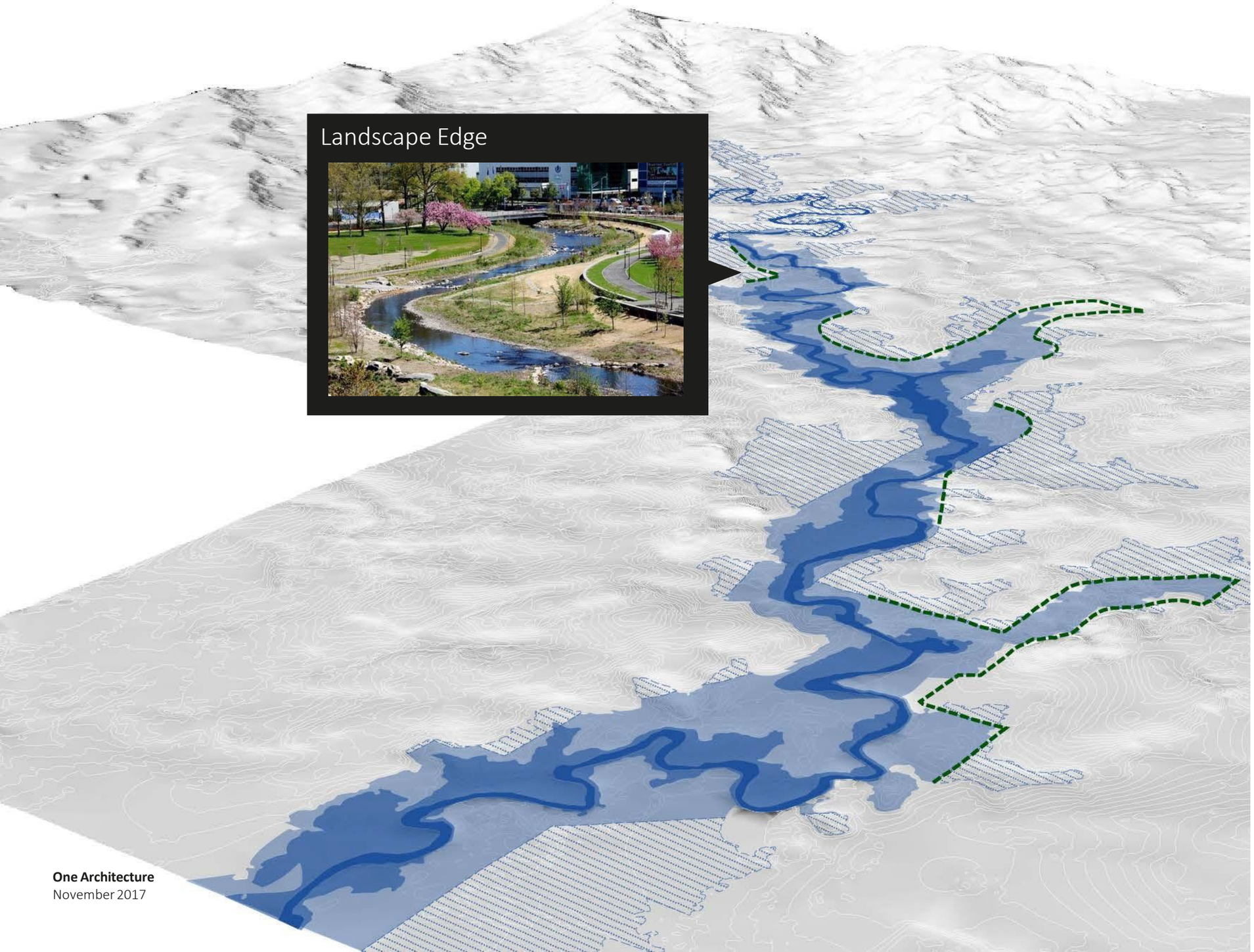


Proposed Edge Toolkit

A landscape edge

The proposed landscape edge creates a gradual slope of green landscape from the urban fabric to the river zone, aiding in stabilizing the river bank, leaving a more natural ecologic condition.

The urban functions may include recreational areas such as sports fields, temporary event venues, walking trails, and bike routes.



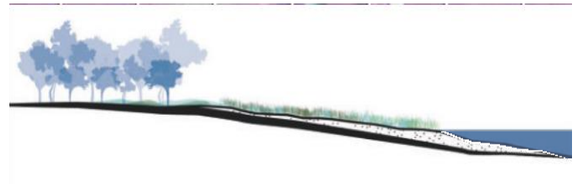
Proposed Edge Toolkit

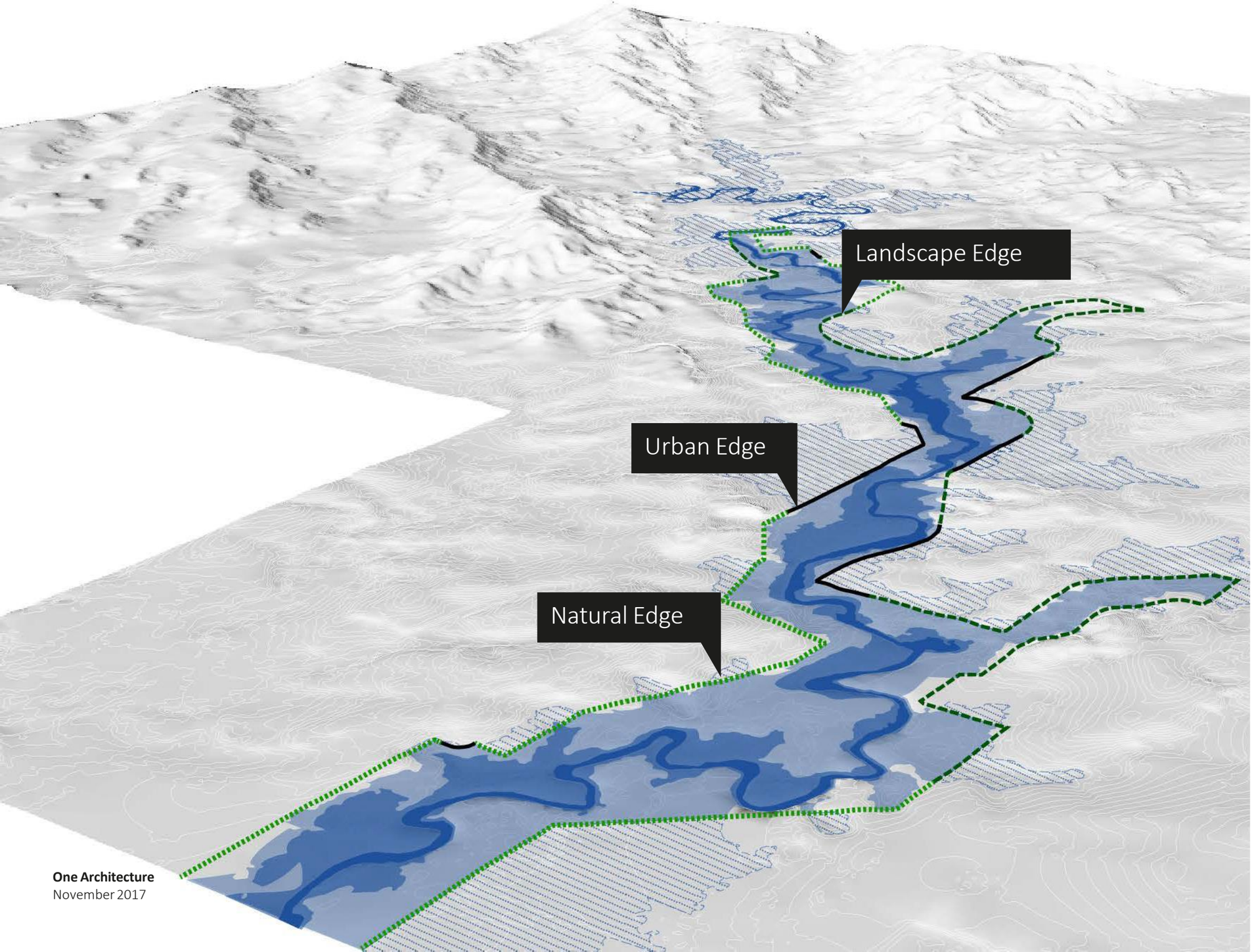
A naturalized edge

The proposed natural edge is a “soft” edge that acts as a natural buffer between the floodplain and urban area. This edge receives little hard engineering.

Urban functions may include a nature preserve, wetland, and some recreational areas, such as park facilities and boardwalks.

Natural Edge





Edge Toolkit Typology

All conditions

The three edge types form the proposed river zone. The different edges offer multiple benefits, such as increased protection from various levels of riverine flooding, preserved ecosystem services, and many sustainable urban benefits. These designed edges create areas with diverse activities where residents and visitors can interact with the river, ultimately, enhancing urban life and real estate assets as well.

Proposed Waterway

Hybridizing Natural & Engineered

In coordination with the edge treatments, the water channel itself can be lightly refined to ensure adequate capacity.

...

Two check dams are proposed along the river zone to control flow and flooding.

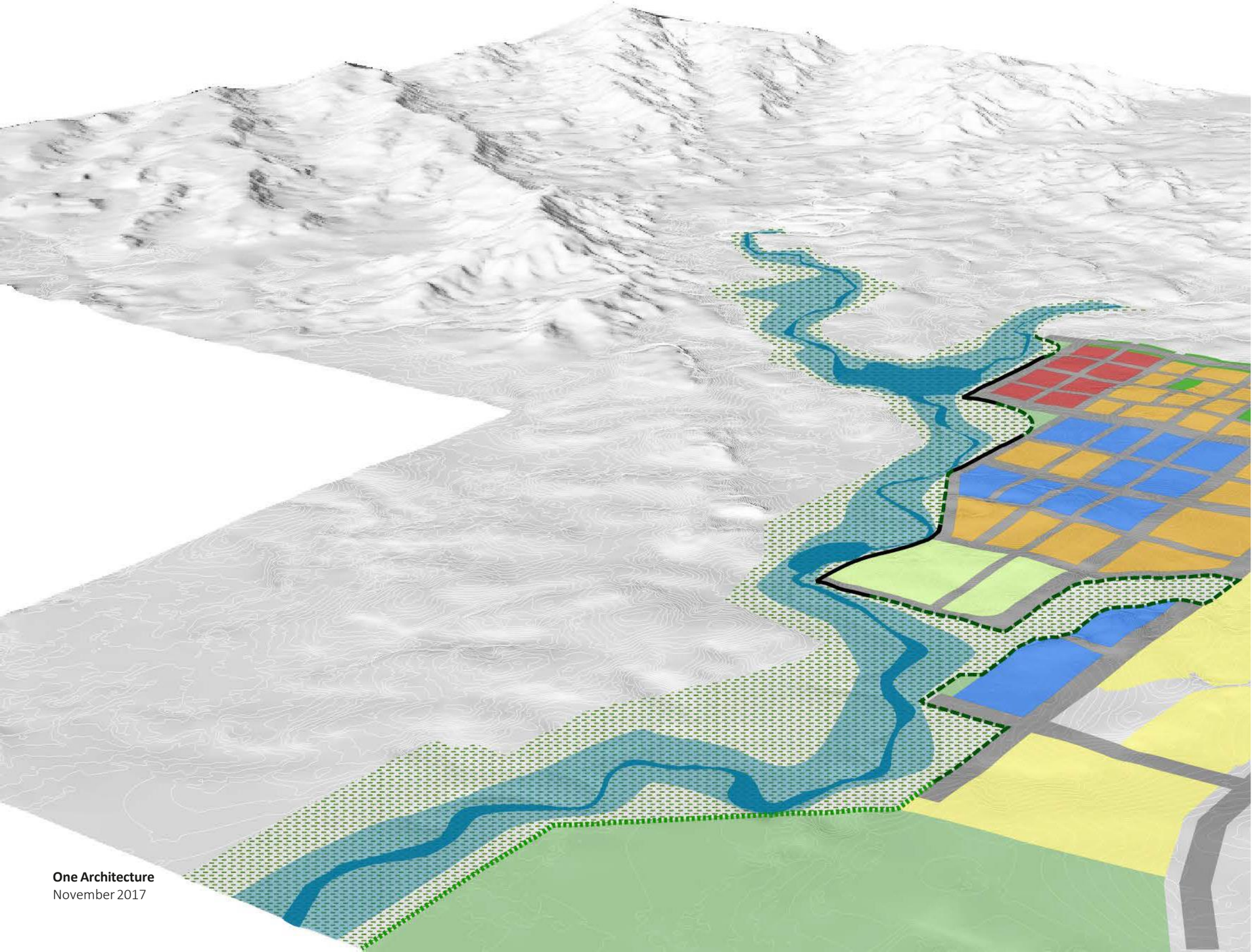
Check Dam 1
- spillway elevation at El. +69.0m
- permanent lake volume ~30,000m3

Check Dam 2
- spillway elevation at El. +66.0m
- permanent lake volume~130,000m3
- dam elevation at +69.0m
- wet weather retention volume = ~825,000m3

Proposed Plan

Connecting a green infrastructure network

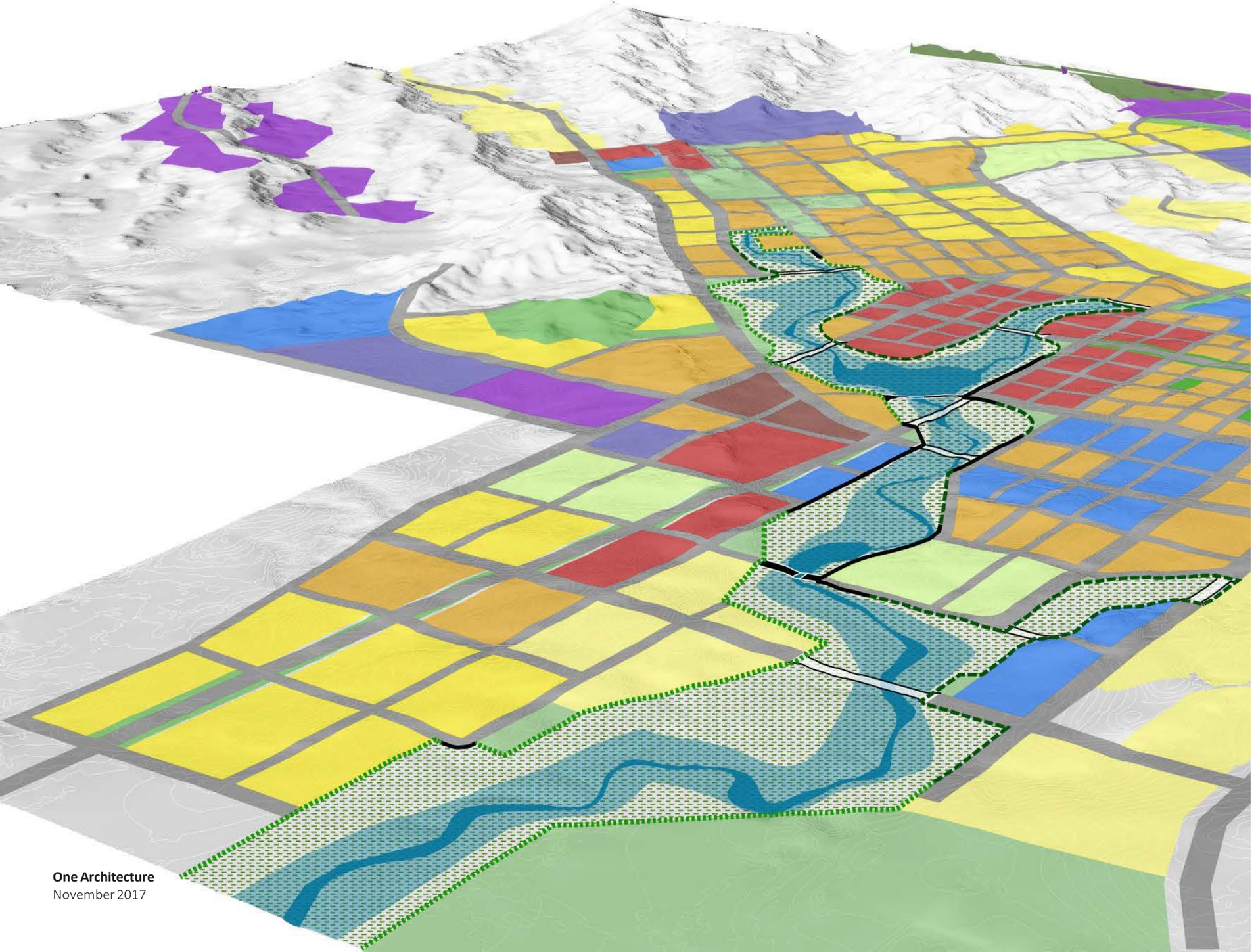
The river zone acts as the city's signature open space connecting to other smaller green infrastructure through boulevards and parks, forming a holistic green network.



Proposed Plan Phase 1

Developing on the north side of the river

In order to achieve a successful development anchored by a signature river zone, smart phasing and cost efficiencies become critical. Phase 1 development should prioritize the north side of the river, including civic institutions, public green space, commercial, and mixed use areas.

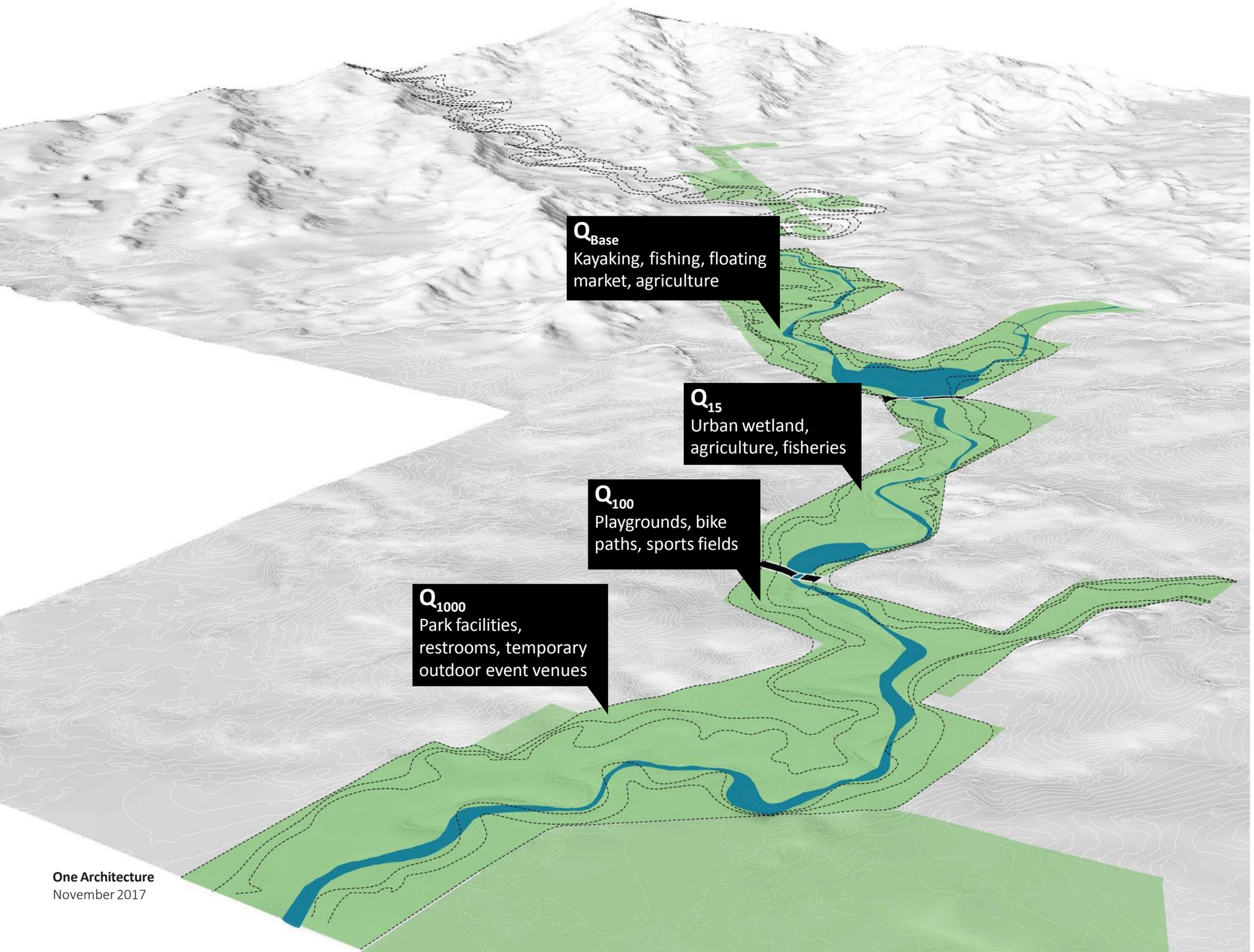


Proposed River Zone Plan

A smart, sustainable, disaster-resilient city...

Further development of the plan will be completed after the phase 1 development.

The proposed river zone plan is a combination of flood resilient design and dynamic open space network connections, resulting in an enhanced urban experience for residents and visitors. The extensive cost-savings achieved by working with nature (instead of against it) can be re-invested in social and civic amenities.



Urban Functions in the River Zone

Programming the River Zone

Development of the River Zone creates an opportunity to better align urban and ecosystem services for New Clark City through strategic programming. Seasonal programming, as well as, dry and wet weather conditions offer different opportunities for various users to interact with the river.

Flow Condition	Dry Weather Programming
Dry Weather Q_{base}	Kayaking, fishing, floating market
Wet Weather Q_{15}	Urban wetland, fisheries, agriculture
Wet Weather Q_{100}	Playground, bike path, sports field
Wet Weather Q_{1000}	Park facilities (elevated boardwalks), restrooms

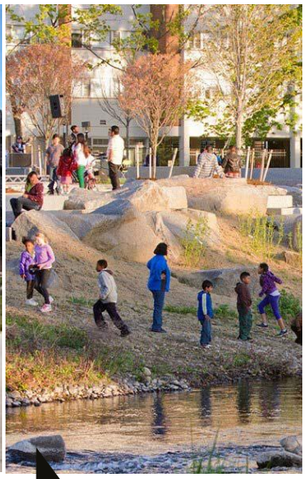
Dry Season

Flow Conditions

Seasonal programming, as well as, dry and wet weather conditions offer different opportunities for various users to interact with the river.

During the dry season, with more of the River Zone exposed, programming can range from active uses such as bike races and group exercise classes, to leisure activities such as picnics and outdoor learning experiences.

Active recreation like bike paths or training routes



Young school kids enjoying class outdoors

Wet Season

Flow Conditions

Seasonal programming, as well as, dry and wet weather conditions offer different opportunities for various users to interact with the river.

The wet season for this region, spans from June to October. It is anticipated that conditions such as Q100 levels, will be more frequent at this site. Programming during these conditions can include fishing and water sport activities, as well as support ecosytem services like wetlands.

Group kayaking and canoing

Quiet fishing spots and other leisure areas

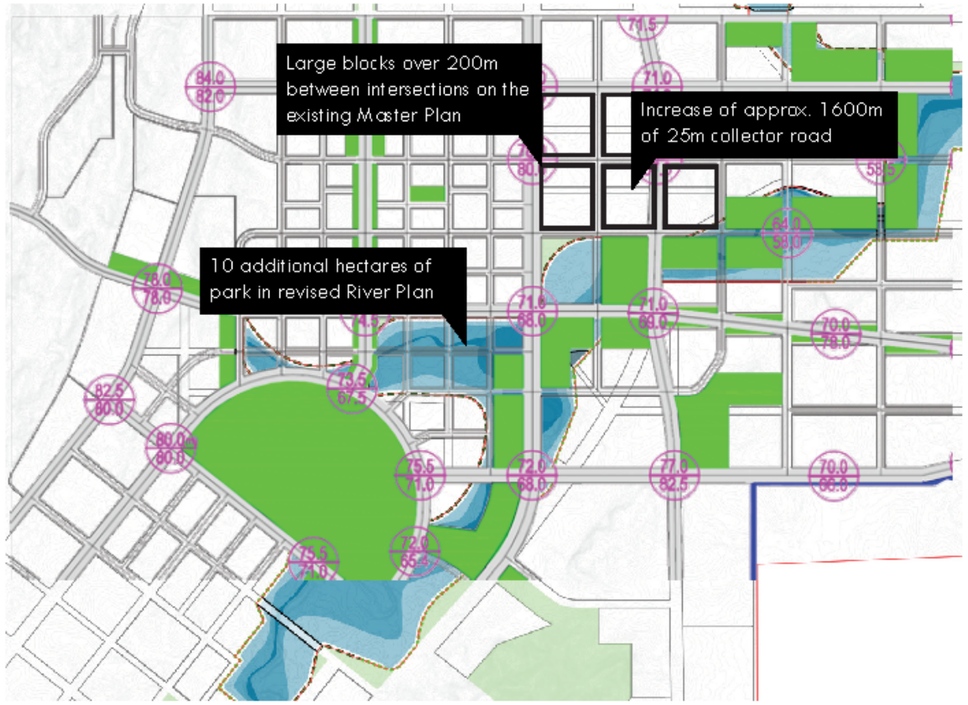


Figure 40. Increase of collector road and river zone.

Cost Increase 1: Additional roads to reduce block size

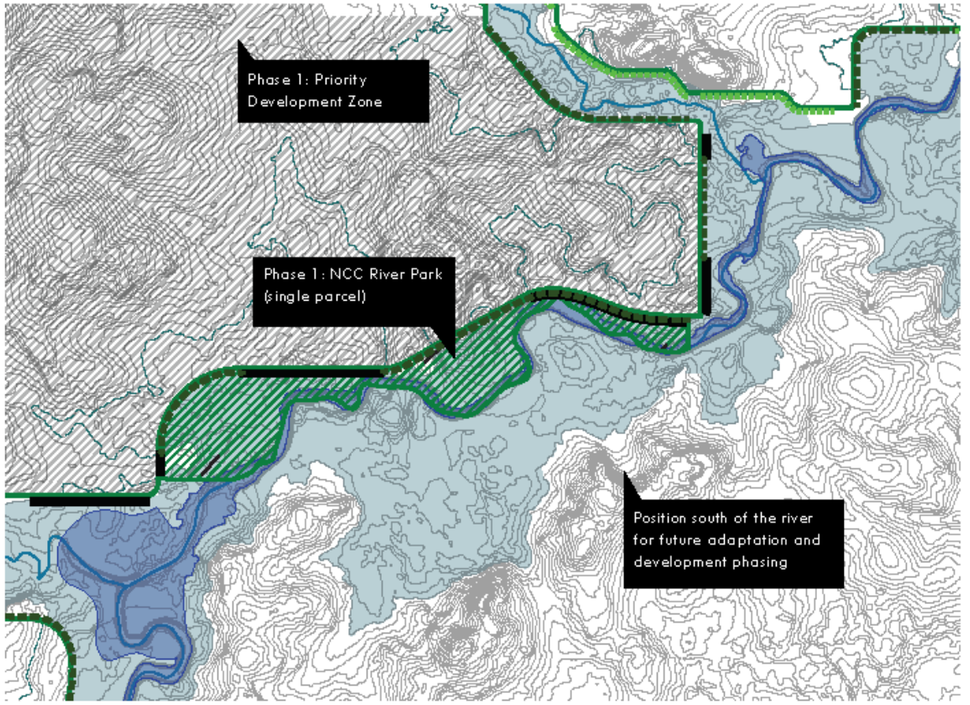
25m collector roads estimated at $489/m
Increase road length of 1,600m
1,600m *$489/m = $782,000

Estimated Cost Increase of ~$1M

Cost Increase 2: Expanded river zone to build

Park development was not estimated in MP
Increase in park area 1,600m
Estimate of $500,000/ha to design and build active urban park land
10ha *$500,000/ha = $5,000,000

Estimated Cost Increase of ~$5M



Action	Reduction / Increase	Order of Magnitude	Value (USD)	Value (PHP)
Reduced Bridges	↓	$$$$$	$30,000,000	1,540,000,000
Relocated AR2 Bridge	↓	$$	$2,000,000	102,800,000
Reduced Grading Cut/Fill	↓	$$$	$15,000,000	771,300,000
River to Remain in Channel	↓	$$	$3,000,000	154,200,000
Additional Roads	↑	$	$1,000,000	51,000,000
Expanded River Zone	↑	$$	$5,000,000	257,100,000
Lanscaping and Planting	↑	$	-	-
Architectural Features	↑	$$	-	-
		Total Reductions	$50,000,000	2,568,300,000
		Total Increase	$5,000,000	308,100,000

River Park

Urban Edge

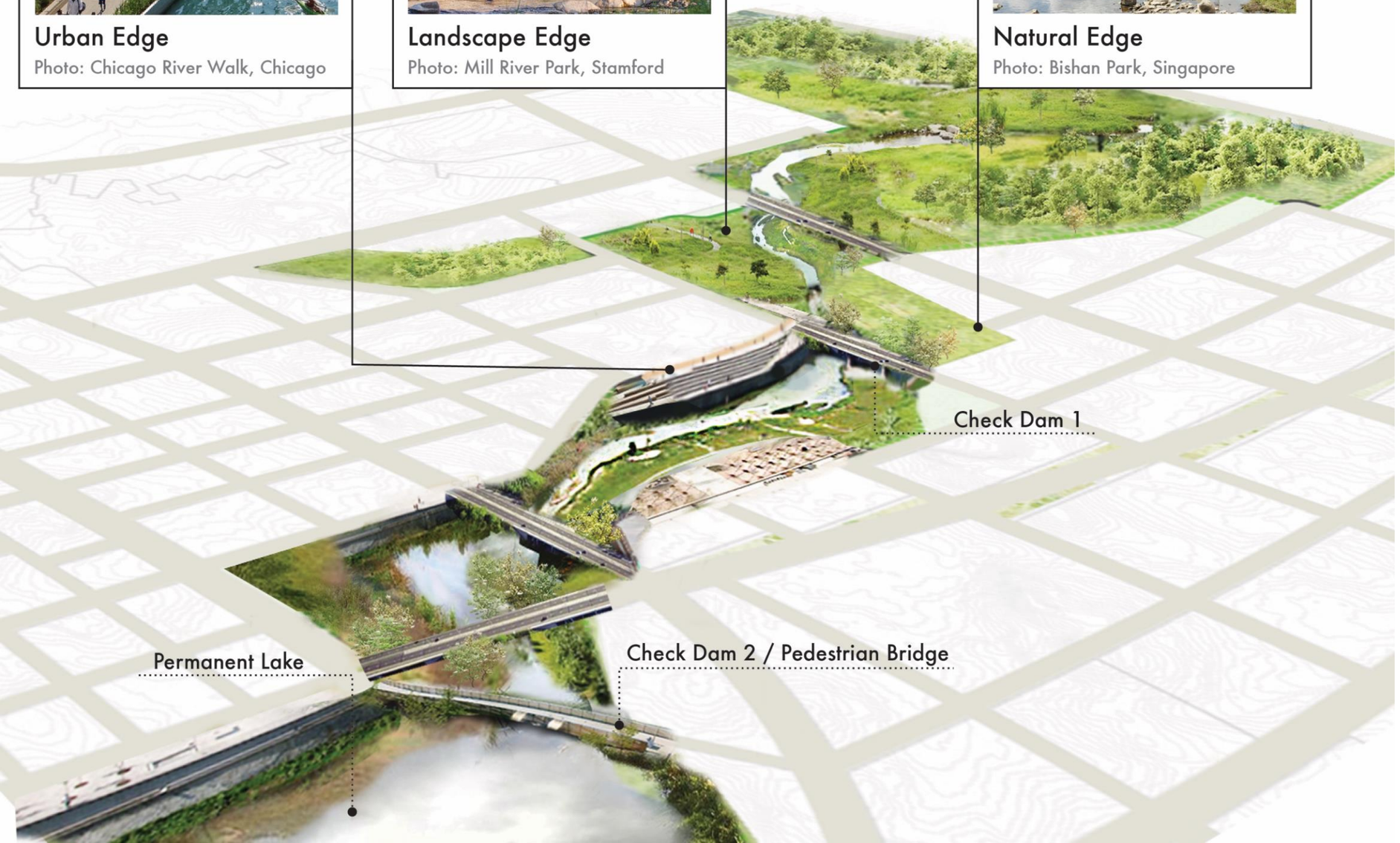
Photo: Chicago River Walk, Chicago

Landscape Edge

Photo: Mill River Park, Stamford

Natural Edge

Photo: Bishan Park, Singapore



- Unique selling point in relation to Manila market
- Ecosystem benefits
- Community benefits
- Cost benefits
- More adaptive

From River Study to Resilience Framework

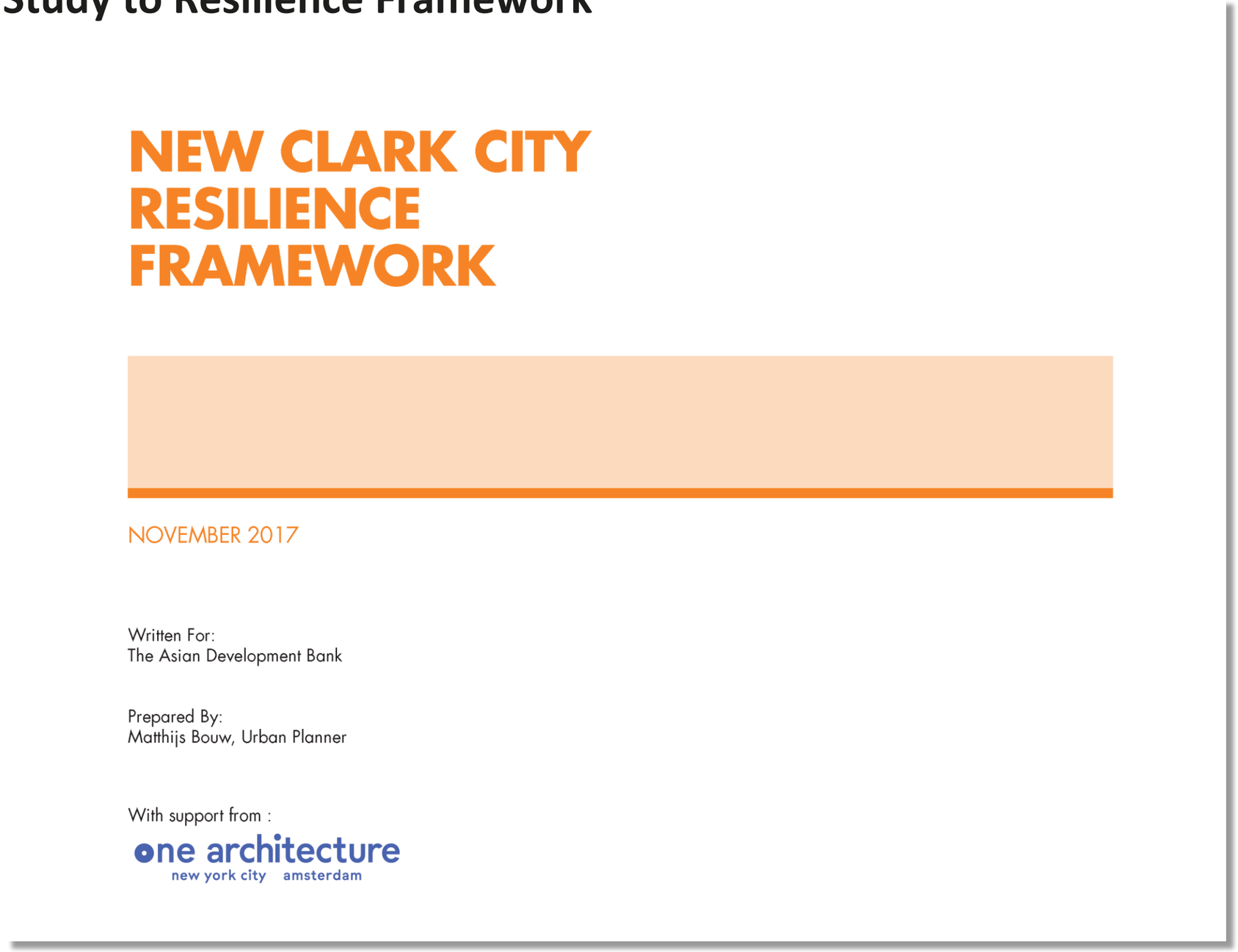


TABLE OF CONTENT_

PART I

APPROACH

PART II

EXPOSURE AND VULNERABILITY

PART III

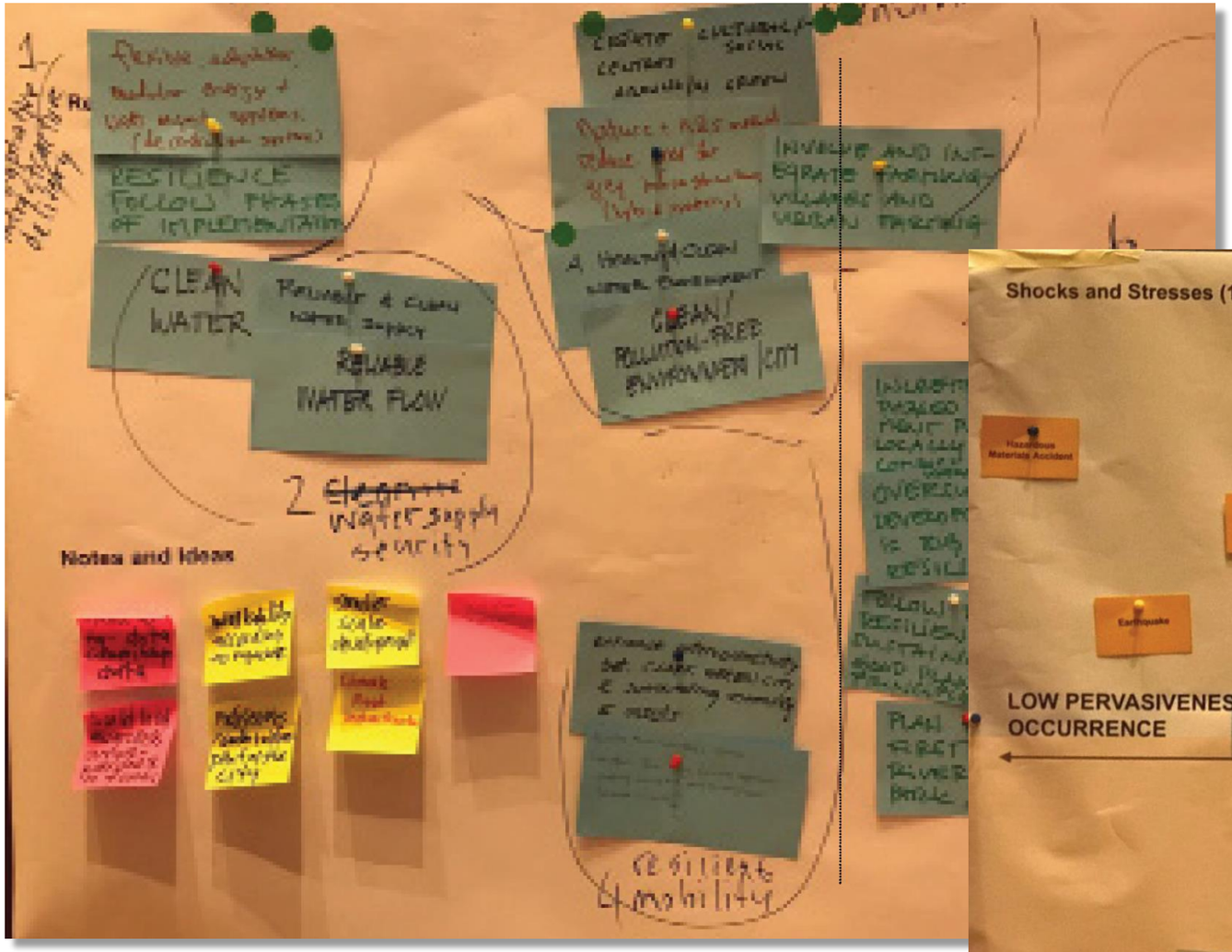
HIGH-LEVEL GUIDELINES

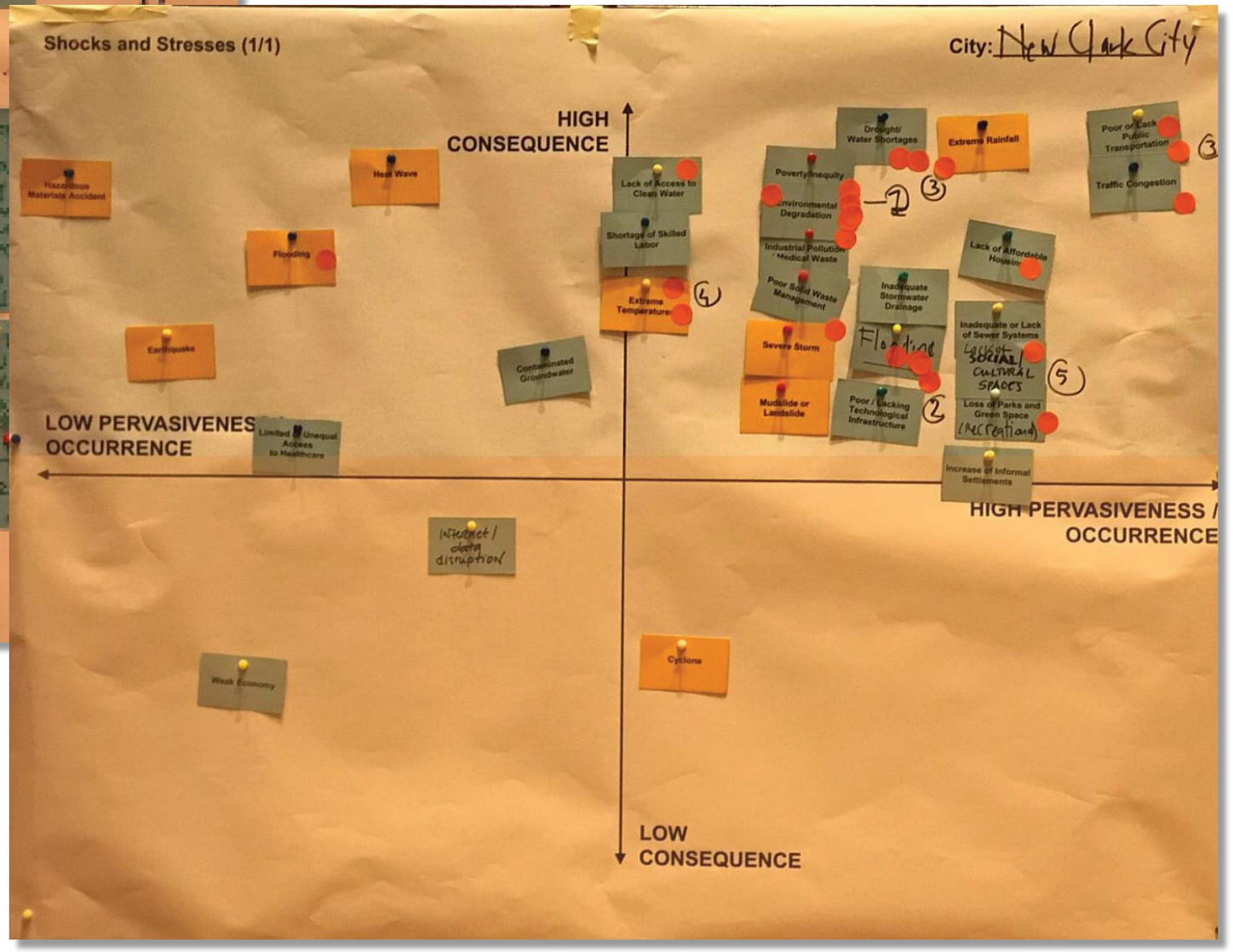
PART IV

VALUE AND BENEFITS

URBAN RESILIENCE

This chapter describes the concept of urban resilience as it is developed worldwide.


CLEAN WATER
RELIABLE WATER FLOW
RESILIENCE FOCUS PHASES OF IMPLEMENTATION
CLEAN/ POLLUTION-FREE ENVIRONMENT/CITY
2 WATER SUPPLY SECURITY
Notes and Ideas
RESILIENT HABITABILITY


Shocks and Stresses (1/1)
City: New York City
HIGH CONSEQUENCE
LOW CONSEQUENCE
LOW PERVASIVENESS / OCCURRENCE
HIGH PERVASIVENESS / OCCURRENCE
Hazardous Materials Accident
Heat Wave
Flooding
Earthquake
Contaminated Groundwater
Limited / Unequal Access to Healthcare
Internet / data disruption
Weak Economy
Cyclone
Lack of Access to Clean Water
Shortage of Skilled Labor
Extreme Temperature
Drought/ Water Shortages
Extreme Rainfall
Poor or Lack Public Transportation
Traffic Congestion
Poverty/Inequity
Environmental Degradation
Industrial Pollution
Medical Waste
Poor Solid Waste Management
Severe Storm
Mudslide or Landslide
Inadequate Stormwater Drainage
Flooding
Lack of Affordable Housing
Inadequate or Lack of Sewer Systems
Lack of SOCIAL/ CULTURAL SPACES
Loss of Parks and Green Space (Recreation)
Poor / Lacking Technological Infrastructure
Increase of Informal Settlements

THE RESILIENCE APPROACH

2.1 Principles of resilience

The organization 100 Resilient Cities has articulated 7 key principles.: reflective, resourceful, inclusive, integrated, robust, redundant and flexible.

2.1.1 Building capacity in NCC

In an early set of workshops with BCDA amd their consultants, these 7 principles have been considered in relation to the masterplan development. For each of the 7 principles, a set of key points for NCC have been articulated.

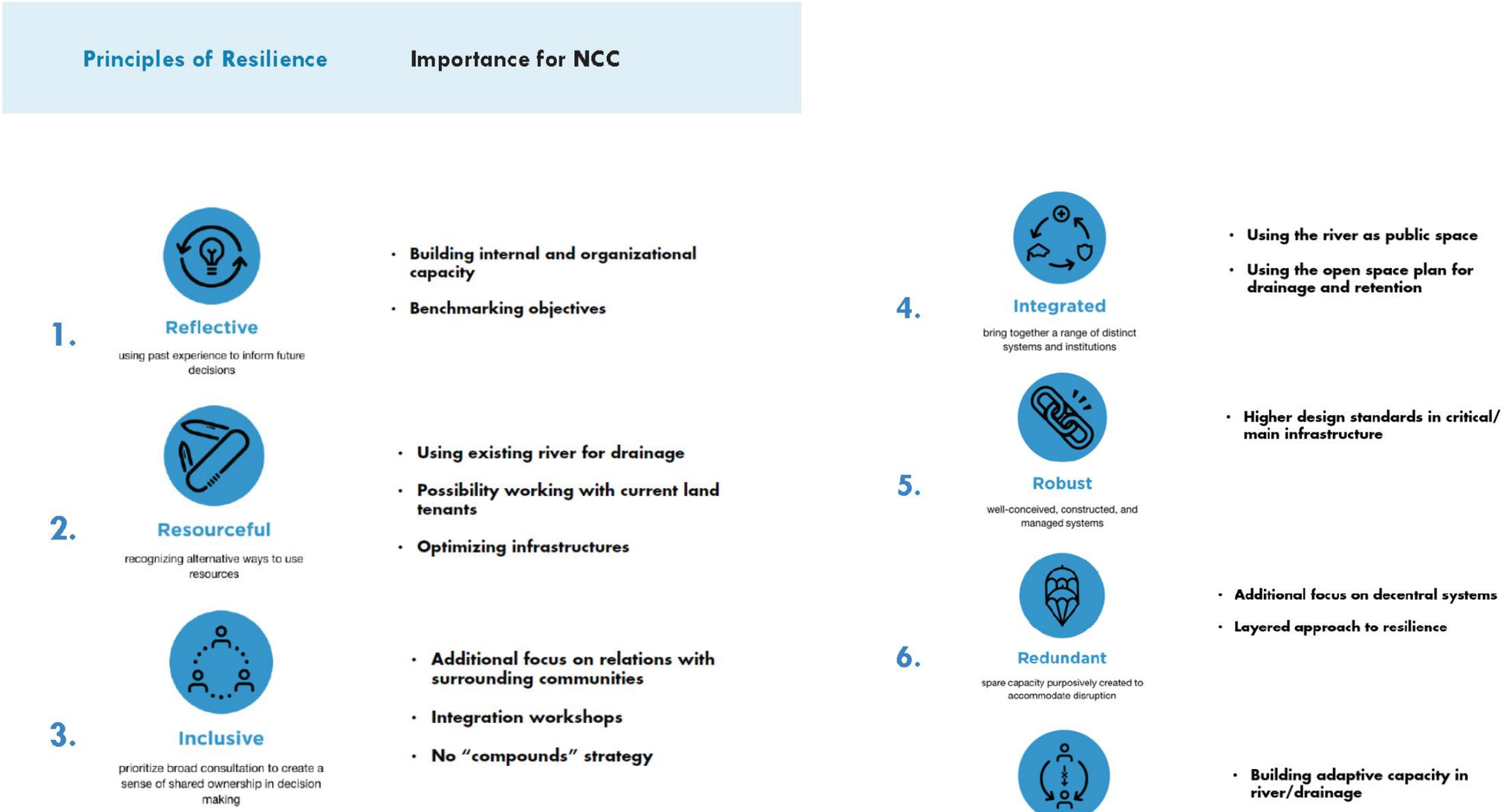


Figure 2. Key datum established have horizontal (planar) and vertical implications for design.

2.2 Nature-based systems

For building a "..disaster resilient, smart, green city," it is aitical that the approach institute the use of nature-based systems as a hallmark of planning and implementation.

Using nature-based systems is:
- Cheaper and more cost effective
- More adaptive
- Able to provide additonal ecosystem services
- Environmentally friendly and sustainable

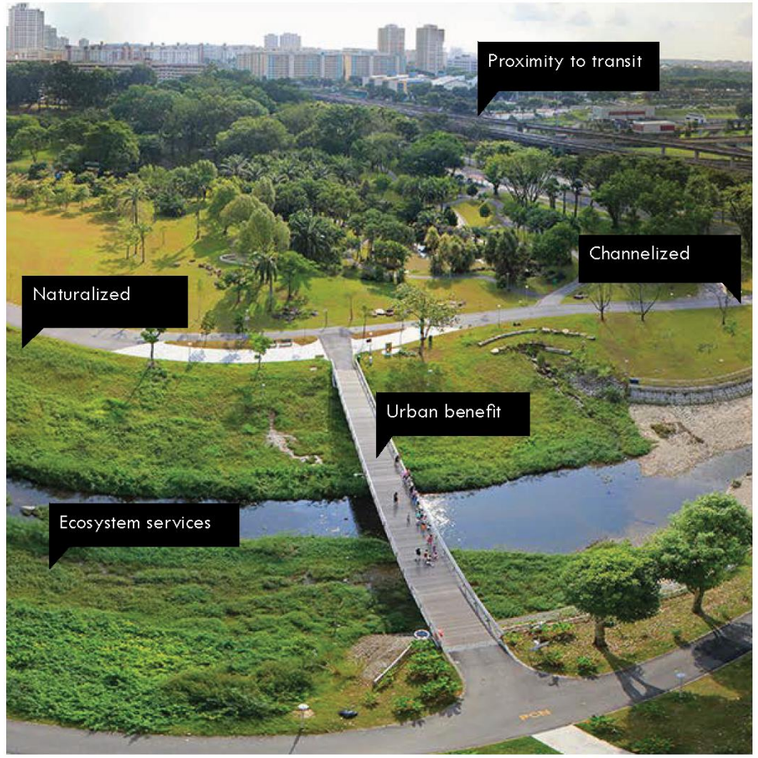


Figure 3. Performance indicators.

CITY
Large-scale planning systems and mechanisms

DISTRICT
Local features that interact with many facilities

FACILITY
Parcel or structure-level aspects and qualities

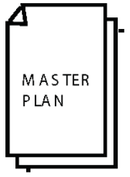


Figure 4. Resilience at every scale.

2.3 Scales of resilience

Resilience interacts at all scales. A multi-scalar approach is necessary for the development of New Clark City.

In this framework, program suggestions and high-level guidelines have been articulated on three scales:

City

District

Facility

SHOCKS AND STRESSES

Resilience theory makes a distinction between shocks and stresses. Shocks are low frequency, high impact events such as earthquakes and typhoons. Stresses are chronic. In this chapter, the most predictable shocks are described. Stresses are much less evident for a new development, but will need to be vigilantly monitored.

SHOCKS Acute impacts

The Philippines is one of the most disater prone countries in the world. In NCC, possible shocks include seismic events such as earthquakes and volcanic eruptions, as well climate change related events, such as flooding, typhoons and heatwaves.

STRESSES Chronic impacts

Also conceived of as urban challenges, stresses include governance issues related to cooperation, weak building codes, lack of funding, land use conflicts as it pertains to rapid growth or development in the floodplain. Additonal stresses that should be monitored are traffic related stress, environmental and economic stresses for the local community.

3.1 Climate change

Climate change impacts in the New Clark City region of the Philippines include both increased annual rainfall and increased severity of wet weather events.

Cluster I
extreme heat events,
sea level rise

Cluster II
extreme heat, extreme rainfall, disturbed water budgets, sea le
seismic events, v
eruption, landsl

Cluster X
extreme heat events,

Cluster III
heat events,
disturbed water bu
sea level rise

Cluster IV
extreme heat even
sea level rise

Cluster XI
sea level rise

Cluster XI
sea level rise

Cluster VI
sea level rise

3.2 Flooding

In cases and around the world, floods are the most costly common disaster.

Figure 6. Implications of severe flooding.

	Observed Baseline (1971 - 2000)mm				Change in 2020 (2000 - 2035)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 3								
Auroroa	615.7	546.4	768.7	1151.1	-0.3	-17.1	6.7	5.8
Bataan	71.7	368.7	1326.2	872.6	2.7	-5.2	9.4	-0.4
Bulacan	212.4	288.9	1041.4	842.1	4.2	-23.0	12.8	-2.9
Nueva Ecija	155.2	316.5	995.0	745.0	7.5	-13.8	10.1	1.6
Pampanga	120.8	320.6	1030.4	785.2	16.3	-18.8	4.4	-5.1
Tarlac	434	265.4	1193.5	644.3	26.0	-13.7	-1.6	-9.6
Zambales	40.9	368.0	1793.9	872.0	34.2	-4.5	13.3	-1.6

Figure 5. Seasonal rainfall projections for Tarlac (New Clark City) in 2020, medium-range emission scenario.

Season	Observed Baseline (1971 - 2000) mm	Projected Rainfall in 2020 (2006 - 2035)mm
DJF Dec/Jan/Feb	43.4	54.7
MAM Mar/Apr/May	265.4	229.0
JJA Jun/Jul/Aug	1,193.4	1,174.4
SON Sept/Oct/Nov	644.3	582.4

Figure 7. Seasonal rainfall projections for Tarlac (New Clark City) in 2020, medium-range emission scenario.

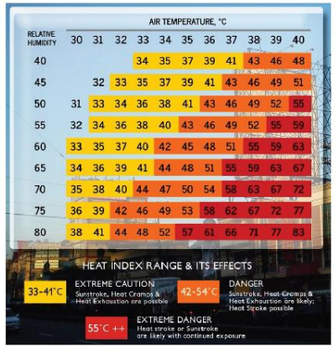
3.3 Heat

Heat can impact cities, agriculture and individuals. Of all climate change related disasters, extreme heat is the most deadly.

Figure 11. Implications of extreme heat, drought.

Provinces	Stations	No. of Days w/ Tmax >35 °C			No. of Dry Days		
		OBS (1971 - 2000)	2020	2050	OBS	2020	2050
Aurora	Baler	397	819	2008	1295	6176	6161
Nueva Ecija	Cabanatuan	1293	3271	4796	8113	6117	6202
Pampanga	Clark	335	1855	3108	889	5701	5754
Zambales	Iba	259	573	1573	8034	6500	6325

Figure 10. Frequency of extreme heat days.



data, chart http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Asia&ThisCode=PHL
Climate Change in the Philippines Report, 2011 (cited above) http://dilg.gov.ph/PDF_File/reports_resources/DILG-Resources-2012130-2ef223f591.pdf

3.4 Seismic events

The Philippines sits within the Pacific ring of fire, whic is an expansive are with many faults on the coast of the Pacific Ocean.

In addition to earthquake tremors, risks include volcanic eruptions and the resulting ash.

Figure 13. Implications of seism

Seismic
East Zamb
Iba Fractu
Philippine Fault Zone
West Valley Fault
Manila

Figure 12. Fault model parame

data, chart http://sdwebx.world
Climate Change in the Philippines

3.5 Landslides

Landslides can have seismic causes or can be the result of heavy rainfall. Slope stability can be reduced by long-term impacts from rain and changes in the vegetation.

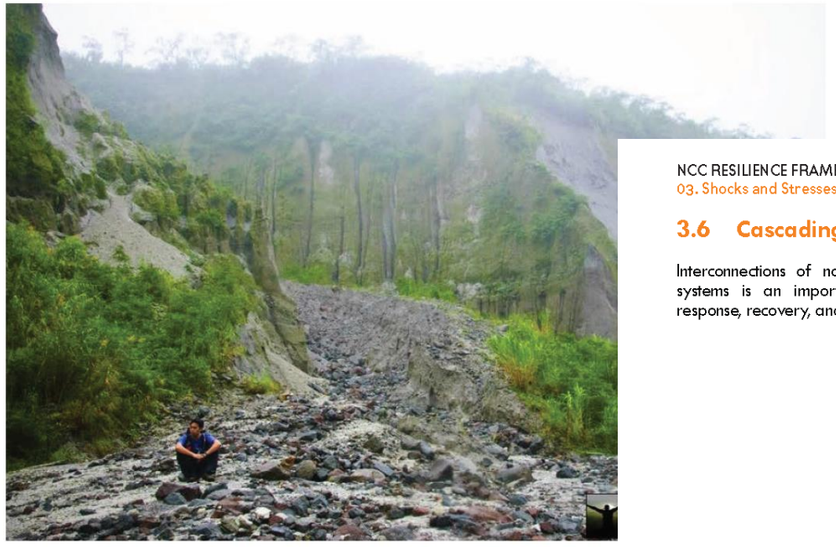


Figure 15. Landslide due to typhoon at Mt Pinatubo.

Landslide Source (triggers that influence slope stability)			
Ground shaking (geologic disturbance) from earthquake or volcanic eruption; steep land failures	Short duration, high-intensity rainfall events; sudden downpours and flash flooding	Moderate duration, intense typhoon rainfall events	Long cum of n pre-
Seismic	Precipitation		

Figure 14. Landslide susceptibility for New Clark City. Vol III 5-32.

image http://pathways-2-resilience.org/ebook/part-i-pathways-to-resilience/

3.6 Cascading impacts

Interconnections of natural and man-made systems is an important consideration for response, recovery, and long-term planning.

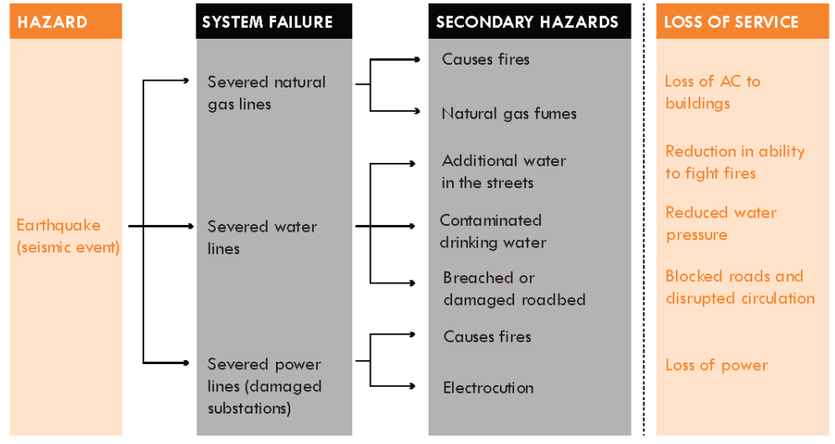


Figure 16. Key datum established have horizontal (planar) and vertical implications for design.

photo (right) Iwan Baan. New York Magazine.

SYSTEMS

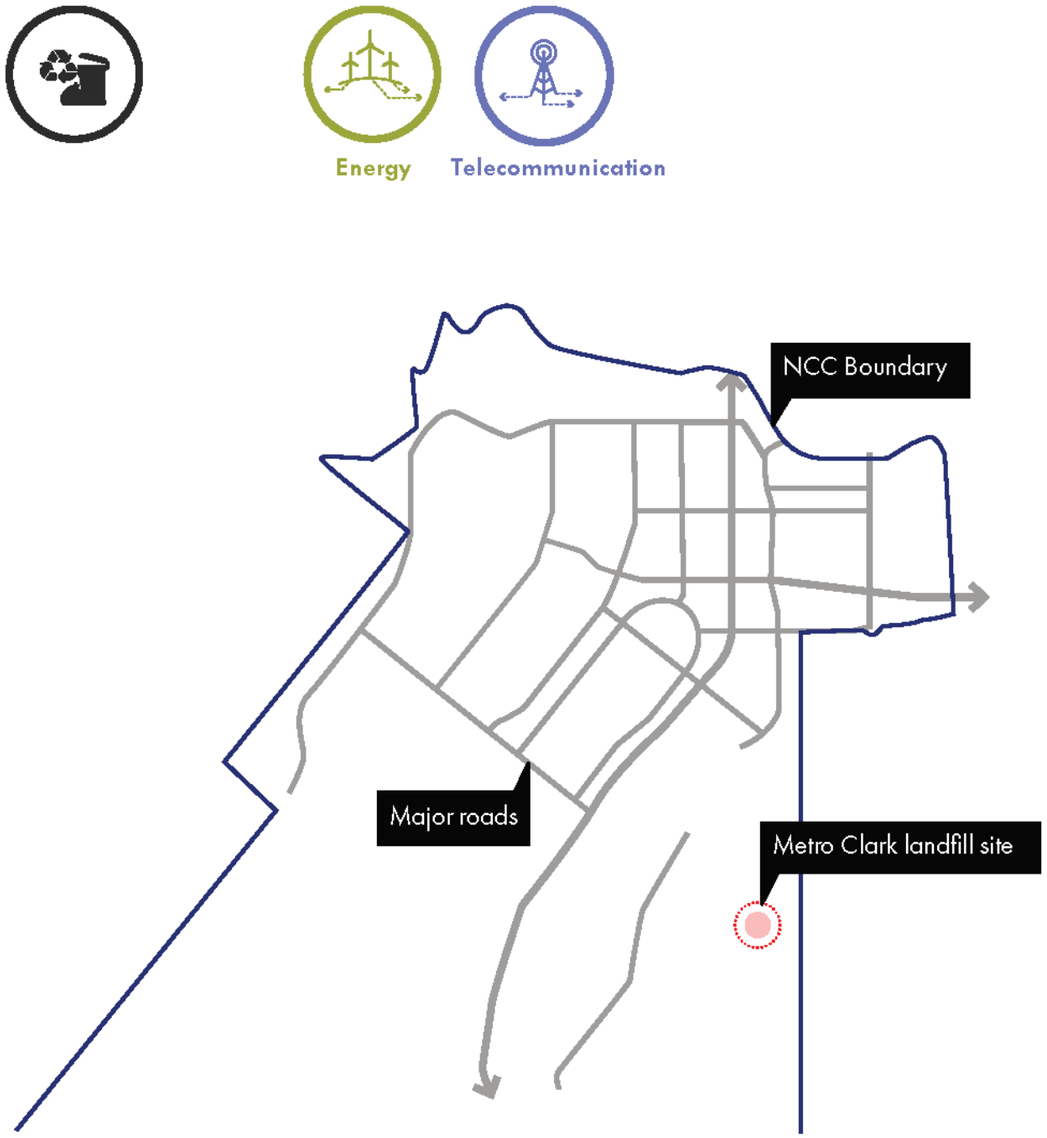
In this chapter, the NCC masterplan is described by system. For each system, the exposure and vulnerability of the system is articulated on a high-level. In addition, since systems are often interlinked (both in terms of cascading impacts and in multiple benefits), the linkages between the different systems are visualized.

WASTE

Waste management often requires the largest budget of the city[1]. The waste disposal in New Clark City will be processed in the Metro Clark Landfill site. Waste management shall be monitored and managed, including the disposal method of the waste and treatment method for the hazardous waste. The solid waste strategy should also accommodate the application of mandatory garbage segregation, recycling program on the resource and the disposal location.

EXPOSURE & VULNERABILITY

Effective waste management is vital as within new city that experience increasing population and higher economic development, the solid waste generation rates will rise exponentially. If not well-managed, the system can cause additional strain on the city with surging cost and environmental impact. During the time of climate disaster, good waste management will be very helpful to dispose or transfer excessive construction debris.



Waste | Water Supply | Open Space

STORMWATER & DRAINAGE

There are four different phases in the wastewater treatment in the sewage system. However, the wastewater will be treated within the source before the treated water will flow to the existing system. Micro system is recommended that every facility in the city

WATER SUPPLY

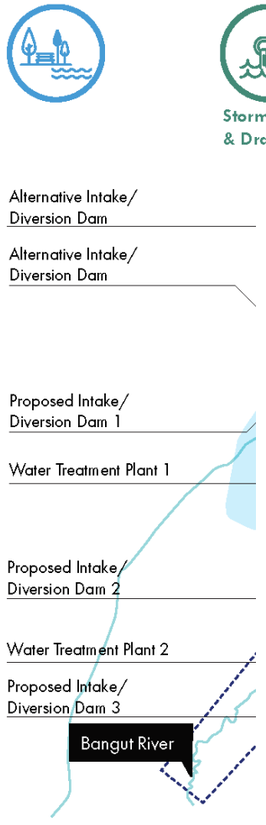
The water system of New Clark City including water treatment plants, several alternative intake / diversion dam and deepwell where area is suitable. Rainwater will be utilized for fire protection and industrial use. In terms of the sewage system of rainwater, according to Revised National Plumbing Code of the Philippines, the pipeline shoud not be used as soil, waste or vent pipe.

EXPOSURE & VULNERABILITY

Preserving the quantity and quality of water system in the city will require flexible and highly distributed system. By focusing to not only watershed source but also catch basin for rainwater, bluebelts, and green infrastructure will enhance the system's resilience. Catch basin will be useful to retain the rainwater. Bluebelts treats stormwater using existing water bodies, vegetation and natural elements to filter impurities. Meanwhile green infrastructure complements the bluebelts, managing run-offs and clean the water.

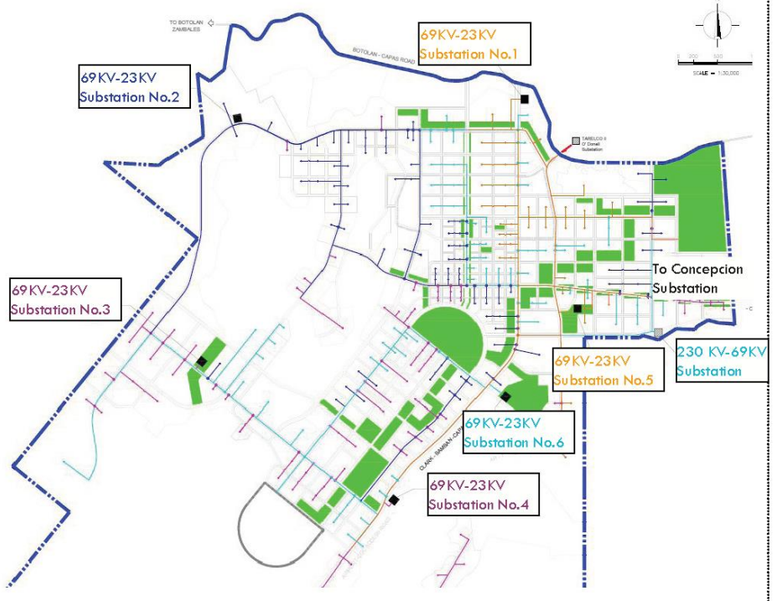
LEGEND

- CGC Boundary
- Rivers / Waterways
- Transmission Lines
- Water Treatment Plant
- Intake / Dam
- General Area for DeepWell Sites



Stormwater & Drainage | Energy | Open Space

Waste | Water Supply | Telecommunication



ENERGY

New Clark City aims for an energy system which accommodate smart system to reduce consumption within different scale. On the larger scale, there will be centralized supply for Liquified Petroleum Gas (LPG). Decentralize energy available within district level will acquire solar energy for daytime, which can be utilized for electric supply and mass transit system. Micro-grid for the smallest scale will adjust to the LEED guidelines such as the requirement for smart home and energy-efficient building using renewable and environment-friendly sources.

EXPOSURE & VULNERABILITY

Decentralized smart system provides cheaper, more reliable energy accessible to the people. Today, the application is very feasible as there are many options, including coupling electricity sector for district cooling on high density area: through water pump when the demand is high and renewable energy when it is low demand. Upon the disaster prevention, acquiring the well-distributed system also means higher resiliency for the city.

Waste | Stormwater & Drainage | Ciivc

TRANSPORTATION

Transportation network as a spine of the city needs to be well integrated both with the existing access and conform with the site's topography. The master plan shows varieties of street hierarchy in regional, provincial and

CIVIC

Strong and resilient social system highly related with the zoning of the city. New Clark City intends to display safety, social dynamism and multi-cultural relations. The residential areas are located within the higher land to avoid future flooding to ensure safety of the society. Meanwhile to activate city dynamics, the proximity between residential with public facilities open the possibility to create a vibrant environment on both daytime and nighttime. On the higher level, civic institutions, community organization and well-integrated neighborhood planning will firmly support the entire social system.

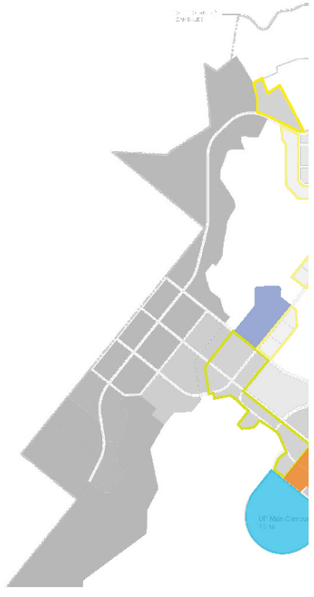
EXPOSURE & VULNERABILITY

Investing on housing and planning quality can lead to more resilient neighborhood. Excellent construction method for the housing reduces the risk of damage. Meanwhile planning such as placemaking within the neighborhood will enhance the community activities and open the possibility of the multi-used space in the emergency time, for instance as evacuation point. Investing in social systems through community organizations and civic institutions is beneficial to extend the reach of disaster response and increase the speed of recovery.

LEGEND

- Government/Institutional
- Education
- Mixed Use 01
- Mixed Use 02
- Residential

Transportation | Telecommunication | Open Space



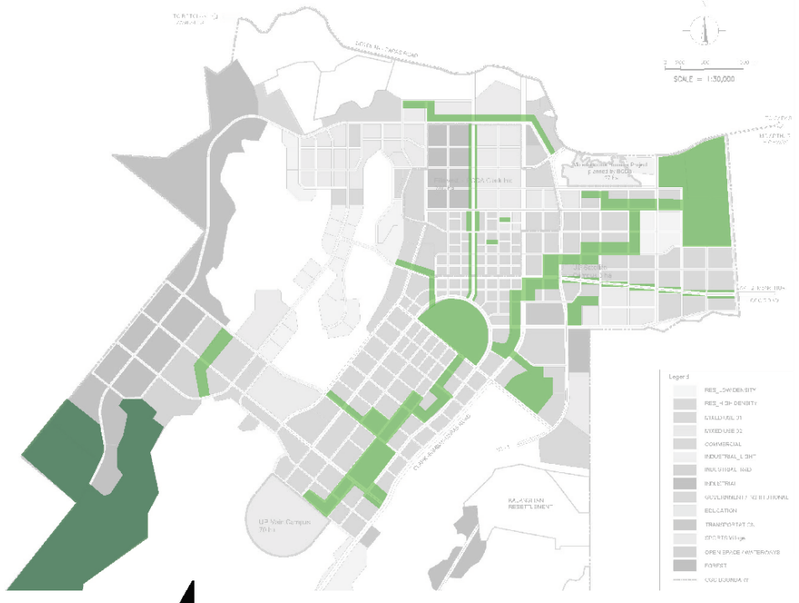
Transportation | Civic

OPEN SPACE

Public spaces are key to transform communities and social systems. Cities struggle with a lot of issues daily, from unemployment, political concern to climate change which often alleviate the social bond between neighbors. Public spaces that centered on people and activity helps increase sense of belonging to the city, reduce stresses and promote health. New Clark City has an advantage with river inside the city which could be transformed as an urban river, open possibility of new public spaces and integrate it with nature. The city has also aim to facilitate public space with descent illumination to increase safety and activity during the night.

EXPOSURE & VULNERABILITY

Beside enhancing stronger community tie and promoting healthy life, public spaces also have a crucial role to ensure safety. Public spaces attract more people to the street, increase 'eyes on the street', people's awareness to their surrounding and thus can lower criminal rate. As a prevention to hazard, public spaces could feature catchment basin that allow water run-offs to be retained or as evacuation point during earthquake and volcano eruption.



LEGEND

- Open Space ("Green Zone")
- Forest

GUIDELINES METHODOLOGY

In the following chapters, key aspects for building resilience are described on three scales: city, district and facility. These descriptions are high-level and are intended to serve as input for both the program management strategy and the development of design guidelines.

In order to facilitate the latter, key takeaways from the descriptions are summarized in orange in the outer column of the pages and, when possible, linked to specific sections of the guidelines.

GUIDELINES SECTIONS:

SECTION 1
Master Plan: Design Goals

SECTION 2
Master Plan: Zones

SECTION 3
Green and Open Space Plan
(including River Zone Plan)

SECTION 4
Transport and Circulation Plan

SECTION 5
Smart Infratructure Plan

SECTION 6
Utilities Plan

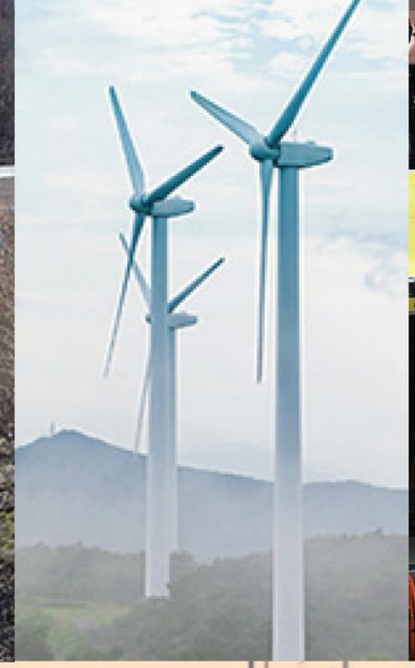
SECTION 7
Disaster Resilience Plan

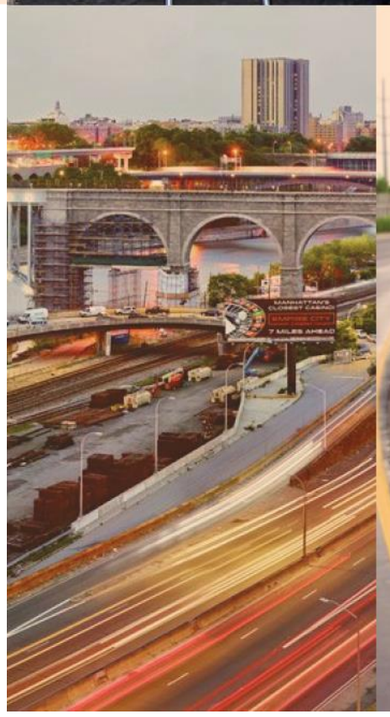
SECTION 8 Architecture
(including lighting, signage, and art)

SECTION 9 Landscape Architecture
(including landmarks, vistas, corridors)

CITY GUIDELINES

On the ‘city’ level, this resilience framework focuses on four aspects. First, it makes a suggestion for mainstreaming resilience in the program management of NCC. Second, it establishes the need for better data and clear metrics for resilience. Third, it articulates a number of necessary amends to the current masterplan, specifically by the introduction of nature-based development and an ecosystem perspective on the new city. Fourth, it adresses the issue that NCC’s resilience also depends on aspects outside of NCC’s perimeter.



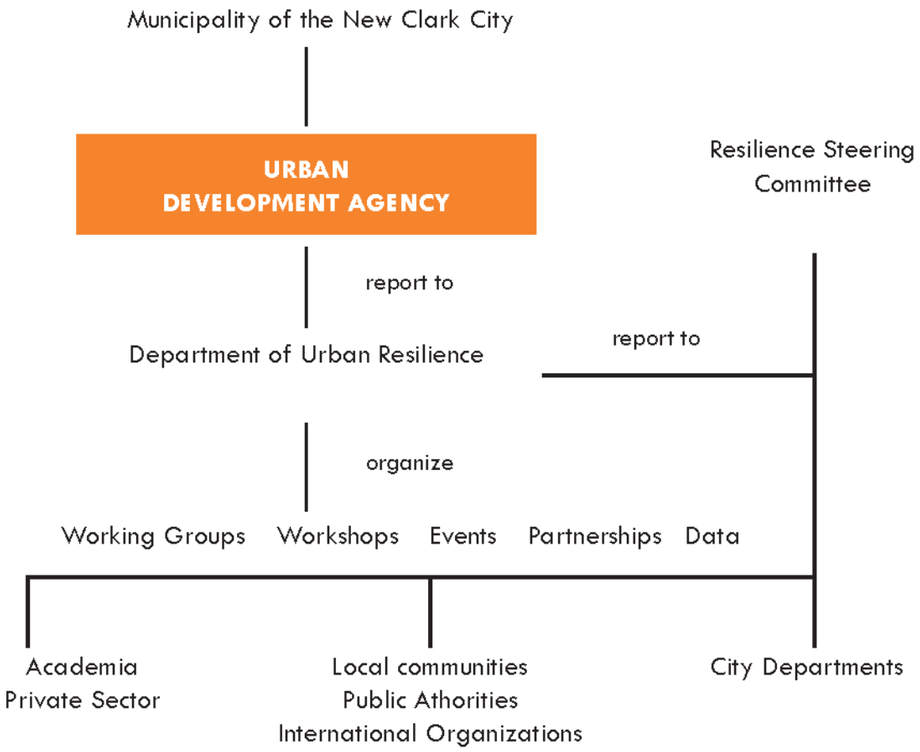


SECTION 7
Disaster Resilience Plan

Governance and Inclusion

ACTION 1 Include as many key stakeholders as possible at various points throughout the development process.

ACTION 2 Establish resilience as a key component of urban management



Establish a resilience governance structure with the proper legal and jurisdictional capacities to have impact. Task them with the role of reviewing tender documents and enforcing and monitoring development projects to ensure proposed resilience goals and objectives are met.

Ensure that resilience is embedded in the development of the New Clark City, from tender documents to facility operations.

Resilience committee that enforces, updates, refines and monitors guidelines.

SECTIONS 4-6
Transport Plan, Smart Infrastructure Plan, Utilities Plan

Critical Infrastructure

ACTION 3 Protect critical infrastructrure at a higher standard level than other infrastructure to ensure continued operation. Consider the role of road network as it relates to initiating services post-event.

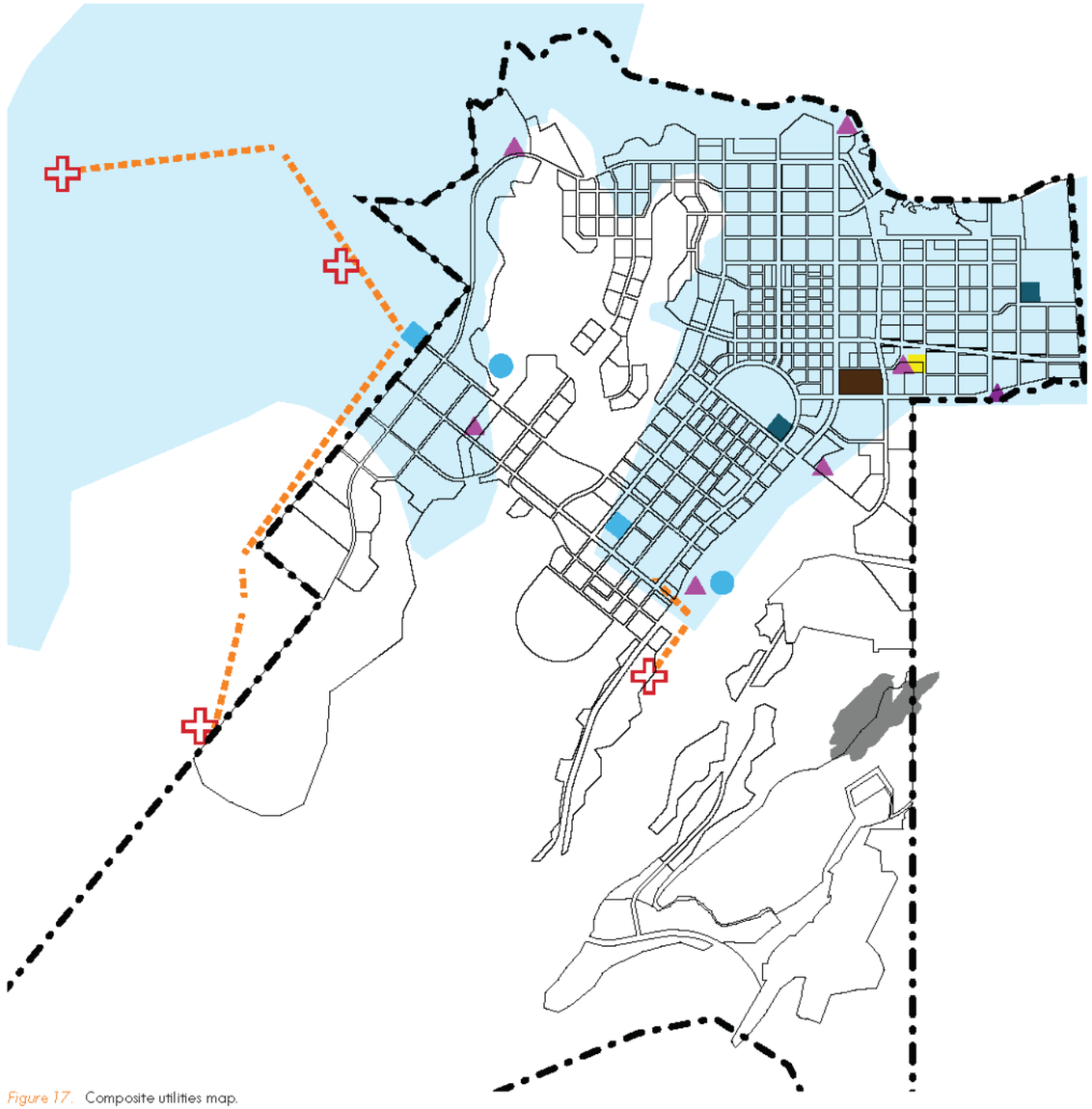


Figure 17. Composite utilities map.

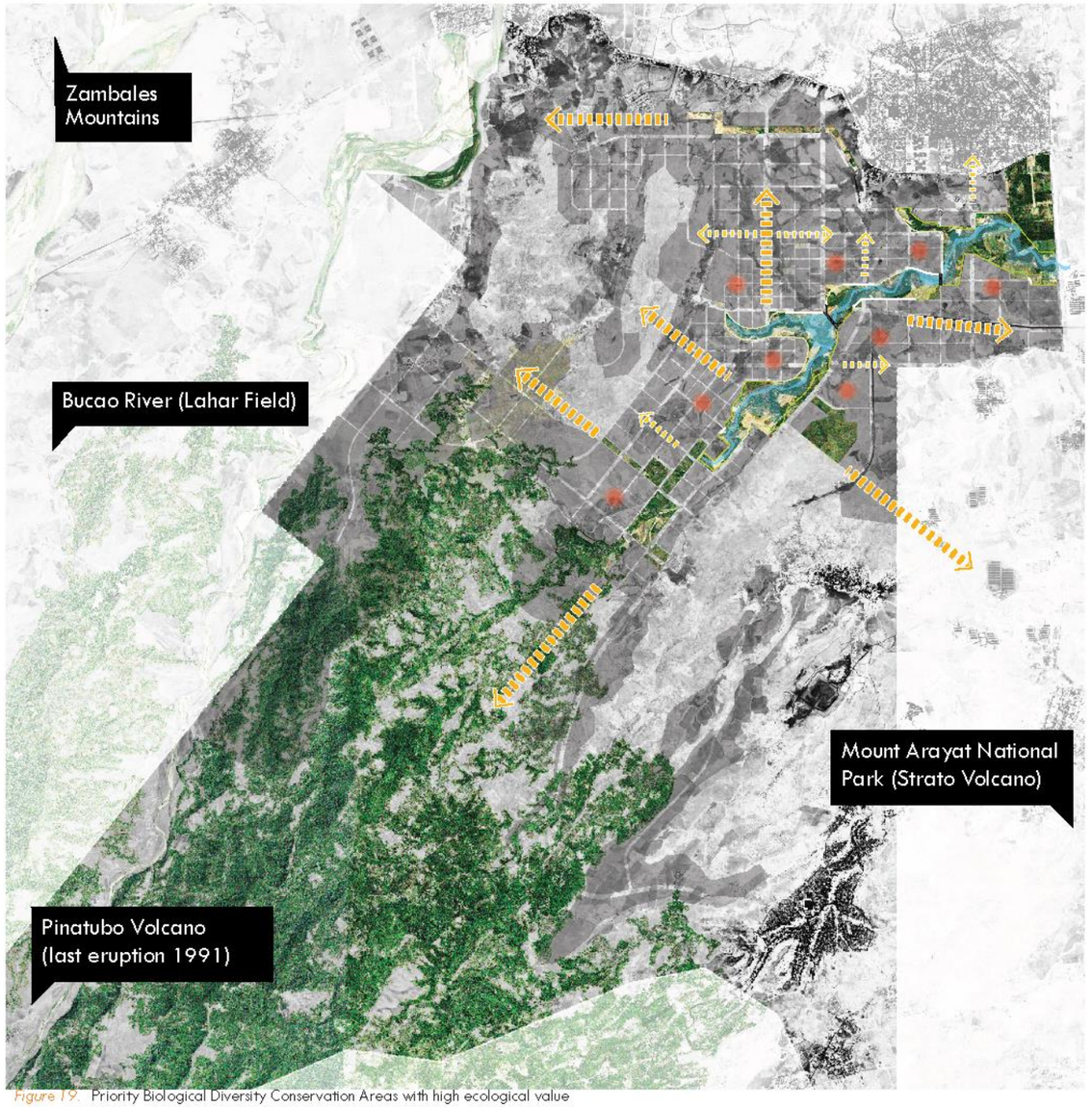


Figure 19. Priority Biological Diversity Conservation Areas with high ecological value

SECTIONS 2-3
Master Plan Zones, Green and Open Space Plan

ACTION 5 Link new development to River Zone and larger ecosystems by green infrastructure corridors that provide co-benefits.

DISTRICT GUIDELINES

The district level is critical for building resilience because it provides the linkages between the top-down plans and the individual facilities.

It is at this scale that the benefits of an integrated resilience strategy can become most manifest. At the district scale, the open spaces meet the community, and decentral, often nature-based, infrastructure creates community benefits.

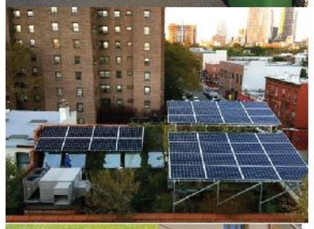
photo http://pelicanbomb.com/art-review/2017/a-new-vision-for-water-building-the-gentilly-resilience-district

Waste

Solid waste mangment
Sustainability (landfill diversion)

Opportunity: Recyling, Composting

Energy



Energy generation
Storage and back-up (redundancy)
Renewables (solar, wind, biomass)

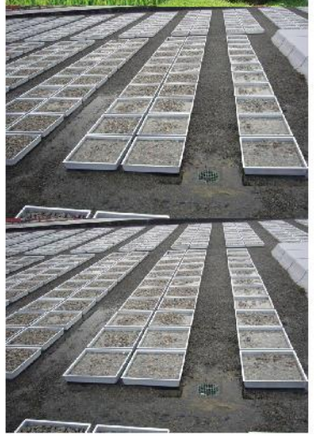
Opportunity: Micro-grid

Water Treatment

Treatment and supply

Opportunity: Water Harvesting (storage), aquifer/groundwater recharge, Graywater systems

Drainage



Water management and storwater drainage

Opportunity: bioswales, blue roofs, green infrastructure

Transportation

Safe and accessible transit

Opportunity: bike infrastructure, shuttle bus services (mini-bus, Google bus), electric vehicles (AVs?) and other modes

Figure 2.5. Examples of decentral infrastructure

SECTIONS 5-6
Smart Infrastructure Plan, Utilities Plan

Decentralized infrastructure

ACTION 1 Implement recycling and composting programs

ACTION 2 Encourage renewable energy generation through policy and land use related incentives

ACTION 3 Develop a district network for micro-grids for storage and back-up systems

ACTION 4 Incentivize water harvesting (storage), groundwater recharge, graywater

ACTION 5 Establish local stormwater management guidelines for urban drainage such that the overall drainage system is minimally impacted during large rain events

ACTION 6 Invest in multi-modal transit opportunity to diversify options

The use of decentral infrastructure should be encouraged. Decentral infrastructure is more adaptive, 'smart' and builds redundancy. The use of decentral infrastructures also reduces upfront infrastructure costs, which will allow for more flexible phasing and better use of most current technologies.

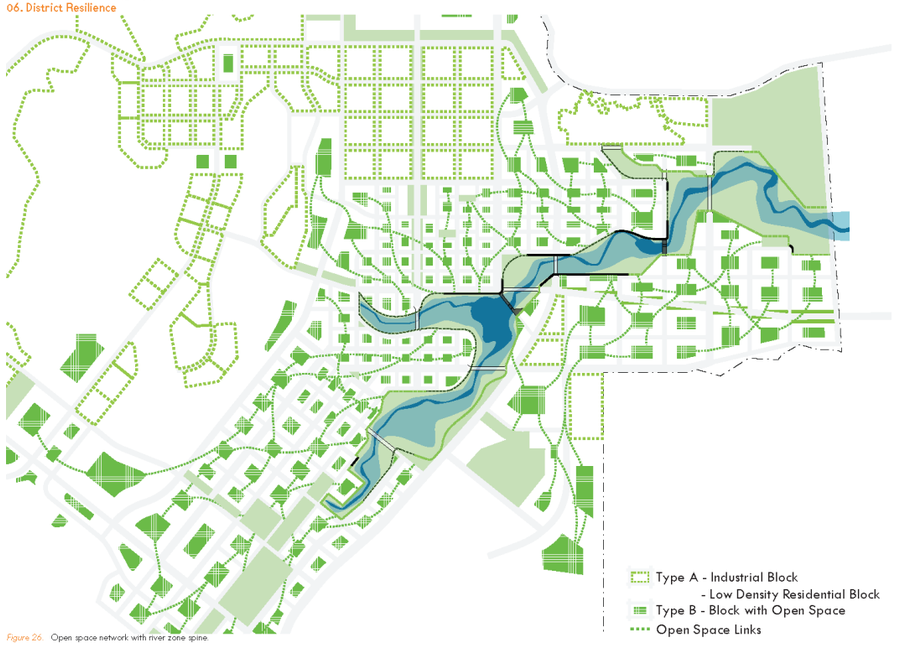
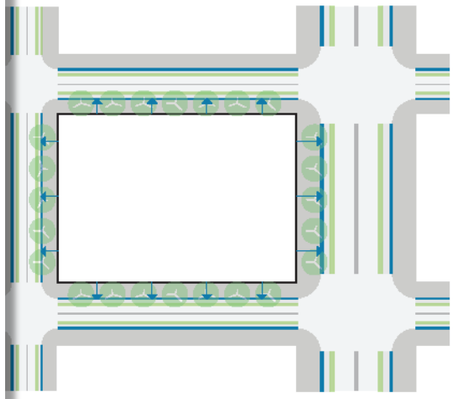
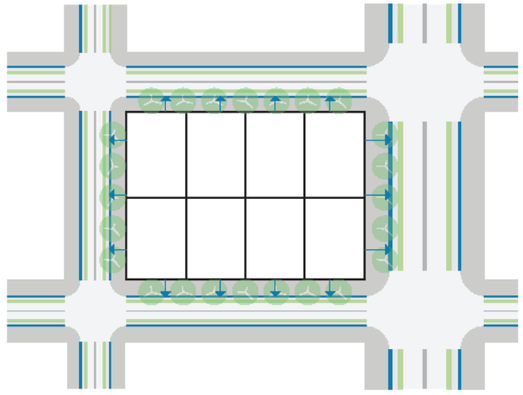


Figure 26. Open space network with river zone spine.

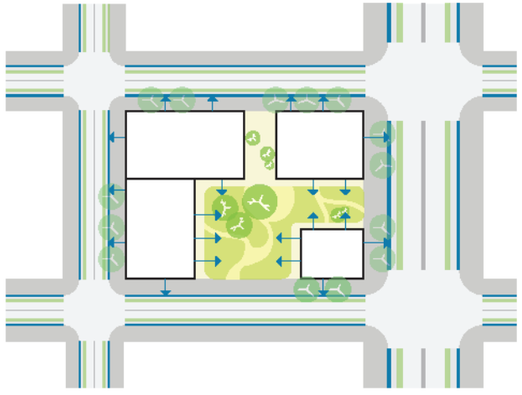
Type A
Industrial Block



Type A
Low Density Residential Block



Type B
Block with Open Space



SECTIONS 3-9

Green and Open Space Plan, Transport Plan, Smart Infrastructure Plan, Utilities Plan, Architecture Plan and Landscape Architecture Plan

Open space network

ACTION 1 Establish a clear hierarchy in transit development and financing: pedestrian, bikes, public transit, bus, AV's, cars

ACTION 2 Create green infrastructure links on a block level. In Type A blocks, these links should take place in the public ROW. In Type B blocks, a focus should be on interior open space.

ACTION 3 Anchor social-, civic-, and critical infrastructure to various types of open space and green infrastructure

Open spaces and green infrastructure provide a multitude of services. They allow for a transportation plan that promotes walking and biking over other forms of traffic. It provides possibilities for local water harvesting, retention and drainage. It reduces the urban heat effects and promotes health. And it provides a meeting and recreational spoce for the local community.

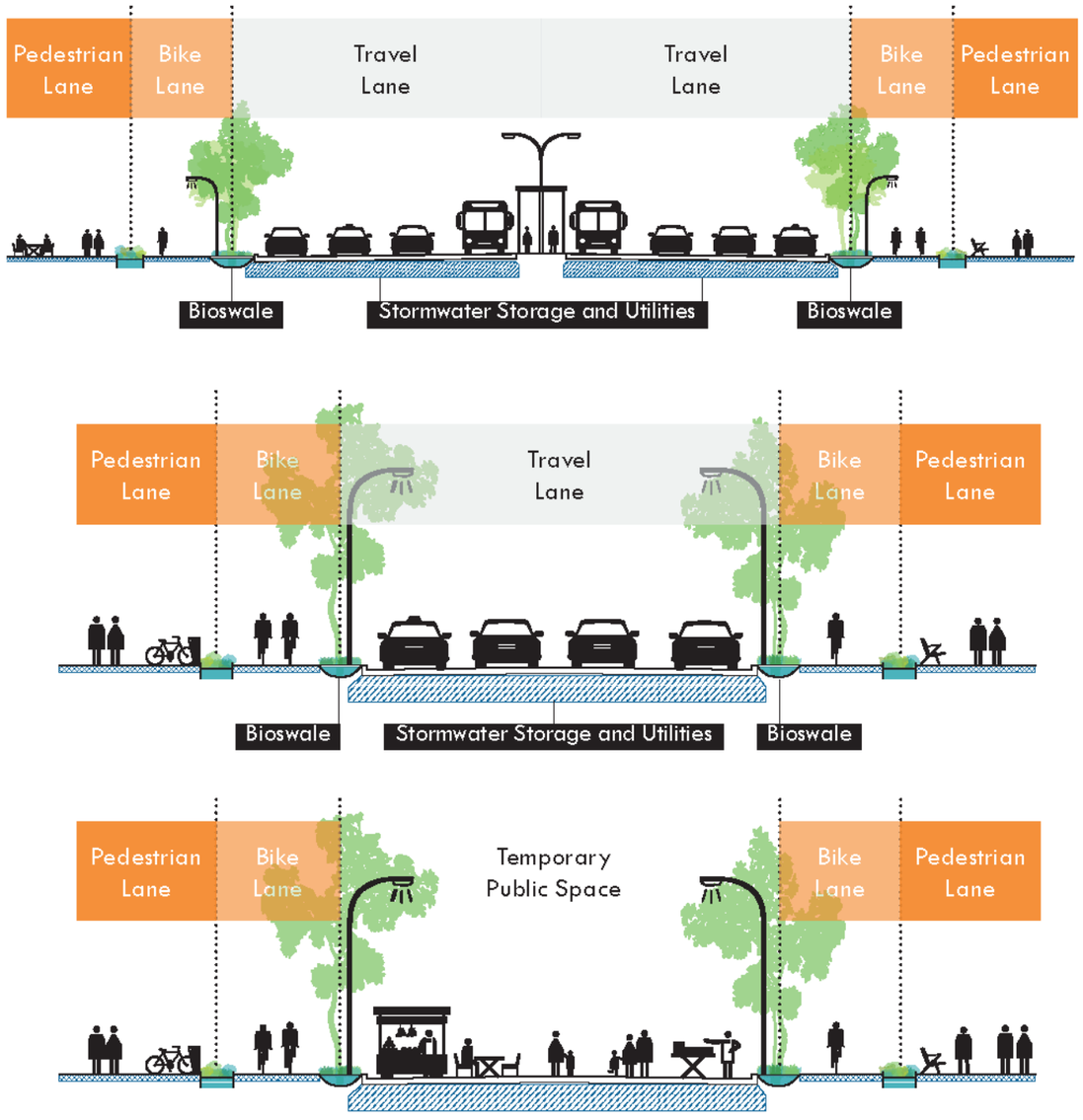
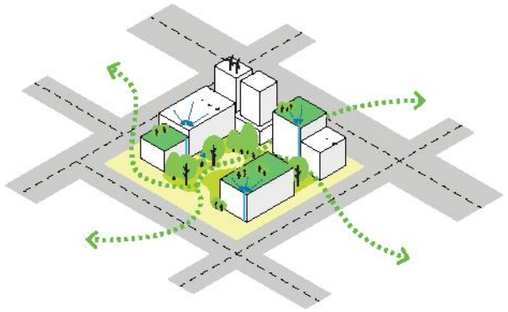


Figure 27. Road sections show the integration of green infrastructure and the intended hierarchy of traffic

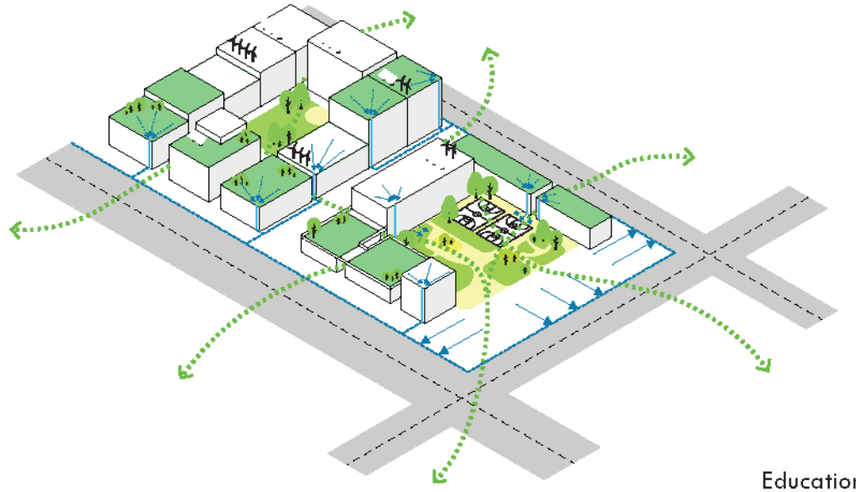
Transit Hierarchy

- First Priority
- Second Priority
- Third Priority



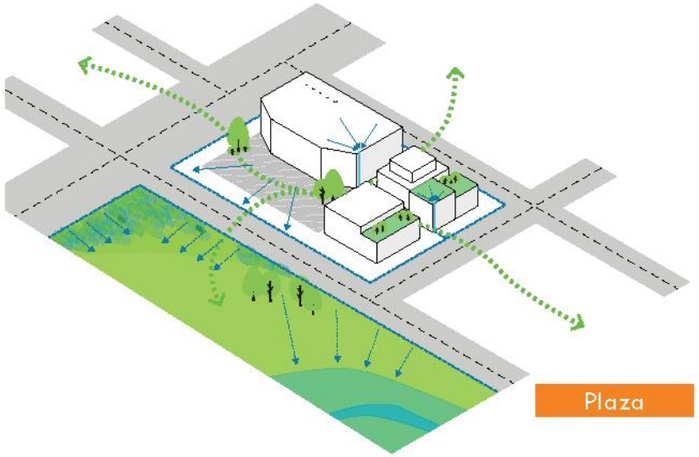
Green Space

Mixed Use
Commercial
Residential



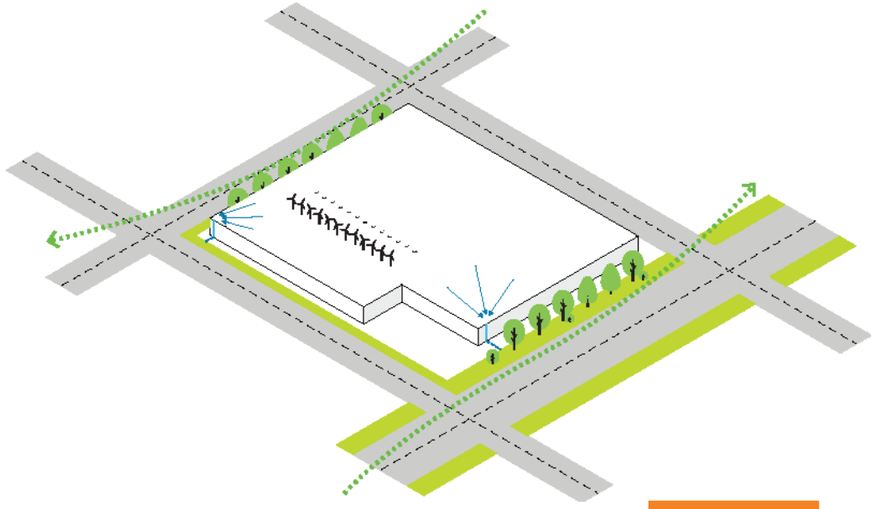
Sports Field

Education
Mixed Use
Sports



Plaza

Institution
Commercial
Education



Sidewalk

Industrial

FACILITY GUIDELINES

At a facility level, resilience focuses mostly on disaster risk reduction guidelines and on response and recovery plans.

SECTION 8
Architecture

Design and construction for Disaster Risk Reduction

ACTION 1 Monitor floodpaths every 5 years as development progresses

ACTION 2 Establish design parameters to mitigate impact from flooding for buildings in the 10 year floodzone

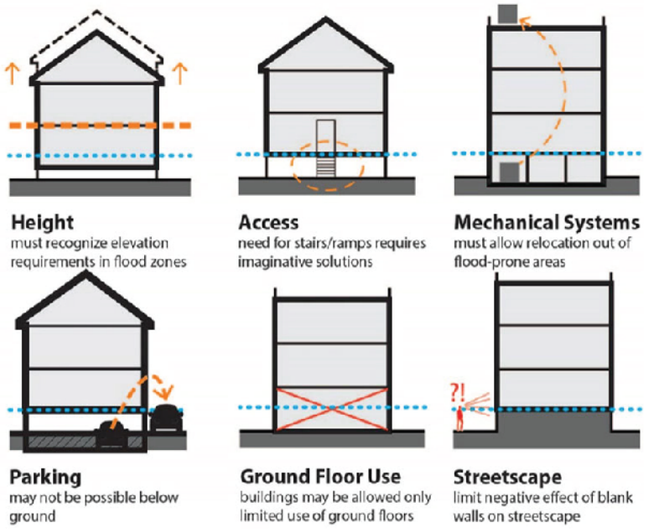
ACTION 3 Establish design parameters to mitigate impact from seismic events. At the minimum, every building should be able to withstand a magnitude 8 earthquake and be able to bear 1 m. of ash.

As development in NCC progresses, the floodpaths and floodplains will change. It is important to monitor these frequently in order to have up-to-date risk data and to be able to adapt accordingly.

Key flood parameters include elevating finished first floor heights, establishing access to buildings at grade, moving mechanical systems on roofs or higher floors, and locating structures outside of the floodplain.

Seismic considerations revolve around shake-resistant materials such as steel or wood, and construction options which include mechanical systems to dissipate the kinetic energy of seimic waves.

Floodproofing Buildings



Seismic-Resistant Structures

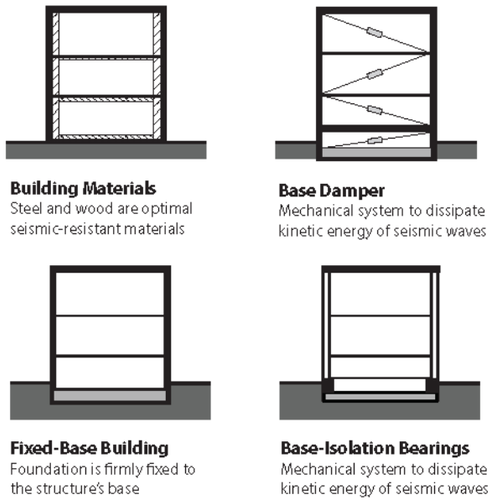


image (chart) "Building Regulation for Resilience: Managing Risk for Safer Cities." 2015. The World Bank and The Global Facilities for Disaster Risk Reduction. 24.

Figure 29. Key datum established have horizontal (planar) and vertical implications for design.

SECTION 7
Disaster Resilience Plan

Disaster response and recovery plans

ACTION 2 Each public facility, and each facility over 5.000 m2, should develop a disaster response and recovery plan.

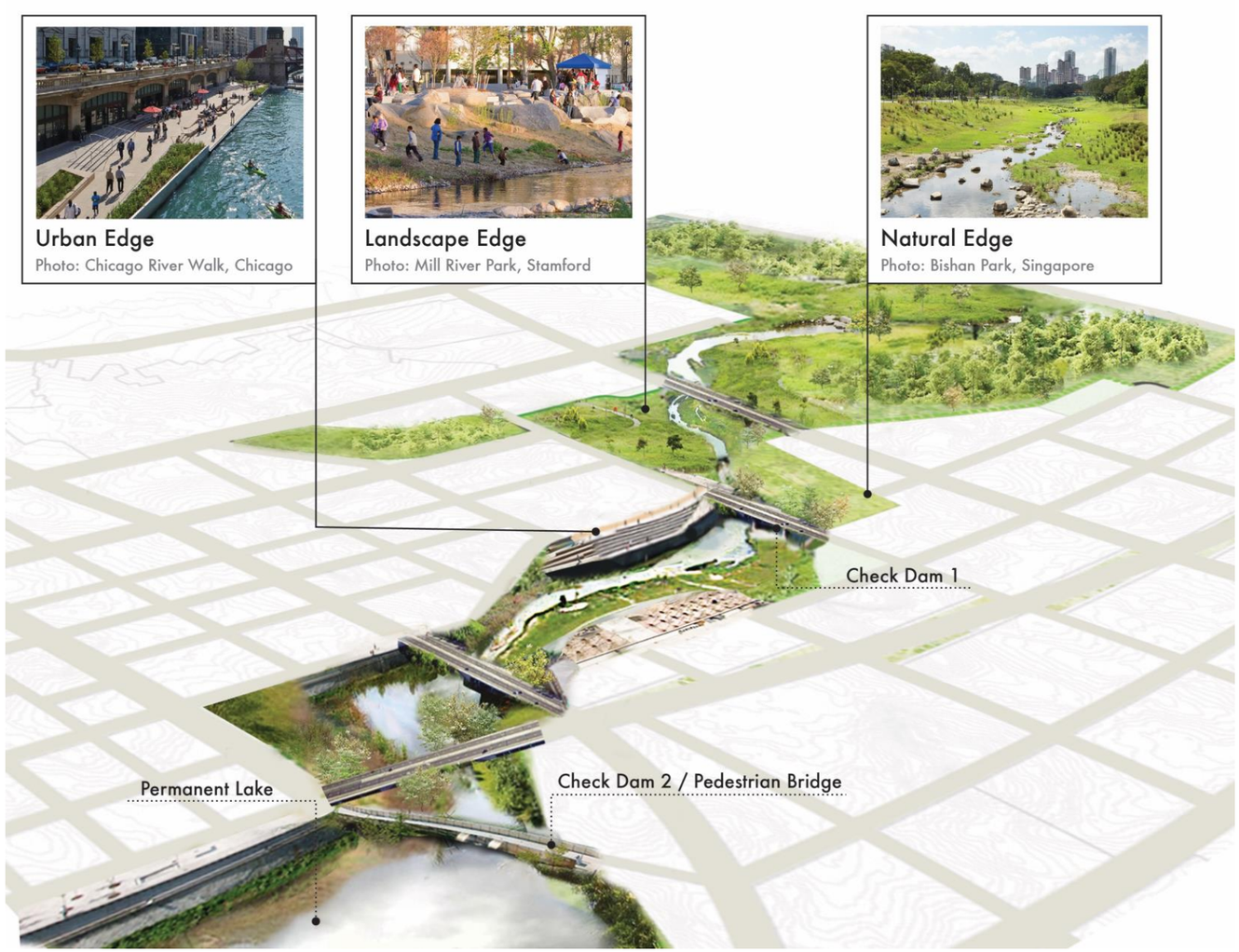
ACTION 3 Develop a process for monitoring and evaluating plans, schedule training, and initiate drills

Leverage captial budgets and emergency funding to address mitigative facility maintenance as well as immediate repairs. Develop clear communication trees and organizational charts that identify chain of commands and necessary entities and agencies.

Conduct regular trainings to enforce planning components.

Institute monitoring and evaluation strategies that align with other key regional assets.

RESILIENCE DIVIDEND



+

Using process of Design Standard Guidelines, Program Management + Transaction Advisory to develop and build real examples of integrated resilience in New Clark City as an inspiration for both urban development in the Philippines and for ADB's agency to implement change

design is...

public

principled

iterative

risky

communicative

an action

a holistic understanding

a way of thinking

vision

a framework

a local initiative

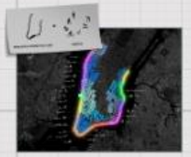
a social process

more than an object

a shared language

integrative

not a science



participatory

THANK YOU

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