COASTAL RESILIENCE SCORECARD

Waterfront Alliance and ARISE-US

WATERFRONT ALLIANCE

arise
PRIVATE SECTOR ALLIANCE FOR DISASTER RESILIENT SOCIETIES

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INTRODUCTION

Global Context

As of 2018, nearly 2 billion people live within 50km of a coastline, and some 1 billion within 10km[i]. Researchers estimate that over 410 million people will be at risk from rising sea levels by 2100[ii]. How oceans will rise is not a given due to uncertainty in modeling longer-term periods, however it is evident that coastlines in the immediate through medium-terms will be impacted by higher frequency, higher impact events if the planet remains committed to global warming. Human-induced climate change, driven by excess greenhouse gas (GHG) emission contribution to Earth's carbon budget, will also put 20% of global domestic product (GDP) at risk by 2100 via coastal flooding alone[iii]. Exposure and vulnerability to disruption, damage, and loss in **coastal settings**[1] is expected to increase due to faster, more frequent and intense **acute coastal disasters** as well as dynamic natural and human-induced **chronic coastal stress conditions** which require robust, continuous monitoring, evaluation, and operational response.

Structures may be built on land that is suitable at the time of construction, but the relationship between the structures (i.e., built environment), land and water's edge (i.e., natural environments) can change over time for a multitude of reasons. Meanwhile, expanding or densifying urbanization in and around **coastal zones** signifies that more people and more economic activity are effectively moving into harm's way. Unsurprisingly, with the effects of climate change already being felt by many coastal nations, states, and cities, the subject of **coastal resilience** is attracting significant attention from not only coastal and waterfront communities and residents, but also businesses, financial institutions, governments, intergovernmental, and non-governmental organizations. Due to the complexity of the considerations involved, acting upon **climate change mitigation** (i.e., halting and reversing sources of anthropogenic emissions) and **climate change adaptation** (i.e., channeling adversity into everyday design and implementation) simultaneously from the point of view of key stakeholders is overwhelming. To de-densify the complexity while meetings the needs comprehensively, **coastal disaster risk reduction** tools are required to enable swift, efficient and financially effective development of **coastal resilience** tactics and strategies.

For the Coastal City Context: Scorecard as the Start of a Partnership

The critical challenge ahead for coastal cities is to identify, assess, design, fund and implement tactics and strategies that build up to **coastal resilience** as a desired outcome or state in their particular contexts and fit-for-purpose. The **Coastal Resilience Scorecard**

[1] The Scorecard uses and repeats various working terms (**bolded in blue throughout document**) that require elaboration in advance as they will be used and repeated throughout the ten chapters of the Scorecard and its affiliated material (see Appendix A for Glossary).

(or "the Scorecard") was designed to be an early, adaptive and catalytic enablement tool for responsible teams within city boundaries (however defined) to access technical expertise and encyclopedic knowledge sets in a single platform dedicated to **coastal disaster risk reduction**.

Cities were particularly targeted as the first-generation user group given their natural role of intermediating between bottom-up (i.e., physical implementation on ground-level), top-down (i.e., design, governance and policy), and cross-stakeholder (i.e., communities, businesses) resilience initiatives. We use the term "city" as a shorthand to refer to any level of entity from informal settlement up through global mega city in size and scale. The Scorecard's completion lays the foundation for development of a future **Coastal Resilience Toolkit**, effectively Phase 2 for the **Coastal Resilience Partnership**, which will showcase local and regionalized planning and implementation resources (i.e., coastal resilience products & services) that enable cities to turn insights from the scorecard into feasible, measurable and defensible action.

The Scorecard's Intended Use

City professionals and key stakeholders are encouraged to utilize this Scorecard to evaluate composite 'readiness levels' for the prevention, response and recovery periods of **coastal disasters** and **chronic coastal stress conditions**. The self-scoring outputs will serve as an input to developing viable coastal city resilience plans for the immediate and longer terms. As cities evaluate their readiness levels against the considerations laid out in the Scorecard, they will identify both strengths and weaknesses in planning & implementation, in policy and finance prioritization, and in education and awareness.

Framework & Standards Alignment

The Scorecard is based on the UNDRR's **Ten Essentials for Making Cities Resilient** (see Figure 1 on next page), developed to accelerate implementation of the **Sendai Framework for Disaster Risk Reduction** (2015–2030) at a local level. There is a set of questions native to each Essential, however cross-cutting themes and references make themselves evident throughout the document. The Essentials serve as chapter headings for the Scorecard, guiding users directly to the key areas of **coastal disaster risk reduction** and **coastal resilience** capacity-building. It is the breadth of the Ten Essentials that makes the Scorecard unique - while there are other instruments focused on coastal risk reduction, to date none, so far as we know, offers the breadth of coverage that the Scorecard provides for the extreme nature of **coastal disaster risk reduction**.

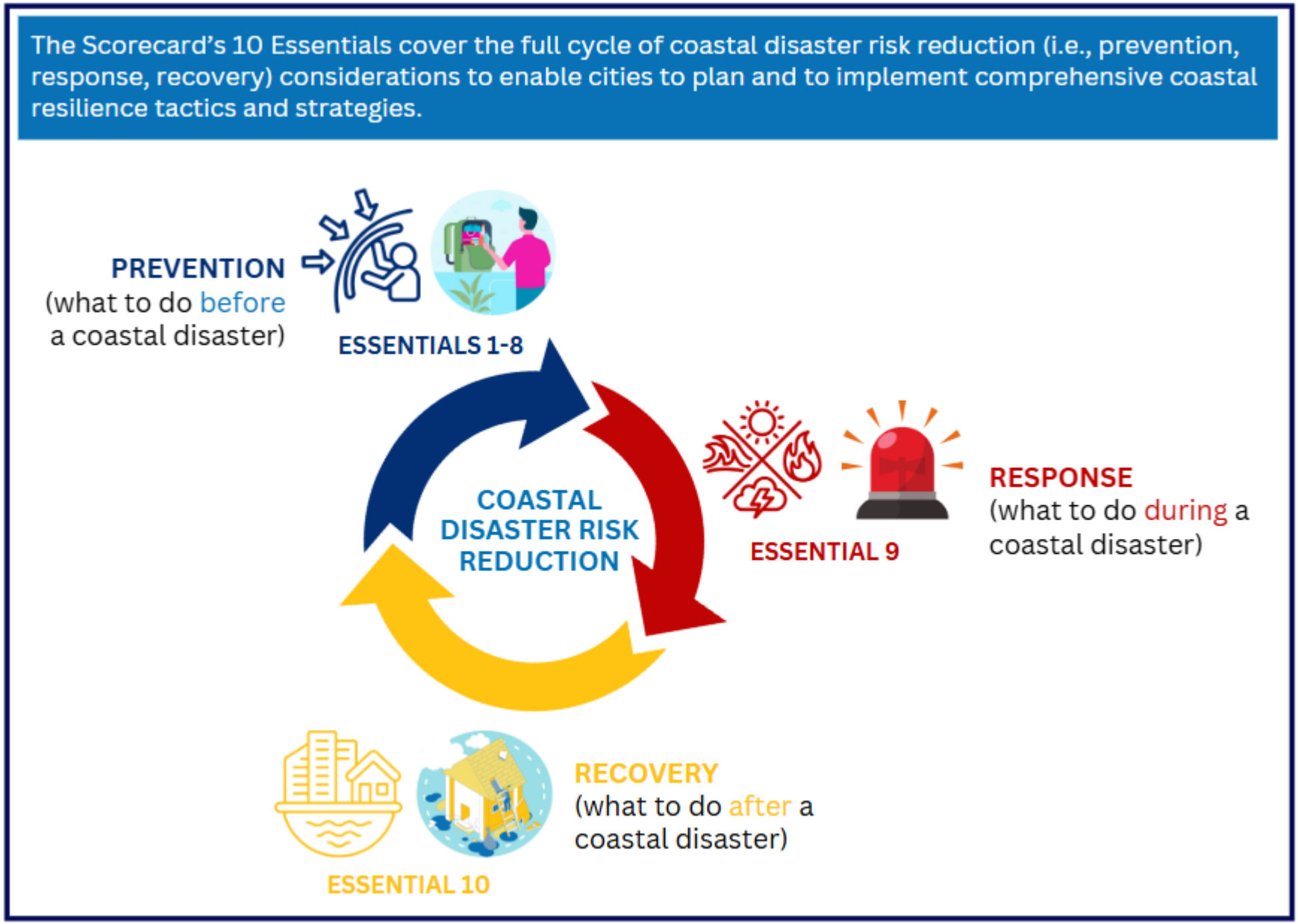
To support implementation in users' local contexts, each Essential is further amplified using relevant credits from the **Waterfront Edge Design Guidelines Version 3.0** (**WEDG®**) standard created and stewarded by **Waterfront Alliance, Inc.** By combining the globally comprehensive remit and structure of the Ten Essentials with the site-specific, design-oriented guidance of WEDG, the

Scorecard becomes a practical and holistic tool for assessing **coastal disaster risk reduction** and directly informing resilient coastal and waterfront planning and implementation.

The **Prevention Period** for **coastal disaster risk reduction** is naturally emphasized in Essentials 1-8 including a focus on Governance (Essential 1, Essential 3) since maximum **resilience dividends** realize *before* events occur. The **Response Period** is the key time for ensuring that human health and safety escalate to top priority during a coastal emergency while the **Recovery Period** emphasizes how to rebuild in the post-disaster aftermath by advancing enablement environments for success.

Figure 1: Ten Essentials for Making Cities Resilient by 2030[iv]

Figure 2: The Periods of Coastal Disaster Risk Reduction (Cycle)



Coastal Disaster Risk & Resilience

Any event or condition consisting of a **coastal hazard** combining with exposures and vulnerabilities to cause major damage or disruption to people, natural and physical assets and economic activity is referred to in the Scorecard as a **coastal disaster**. **Coastal Disaster Risk**, like other kinds of risk, refers to the potential for events to have adverse consequences such as loss of life or injury, disruption, damage or loss of social, economic, and/or natural capital in **coastal settings**.

Coastal Disaster is used throughout the Scorecard to refer to an **acute coastal disaster** (i.e., event such as a tropical cyclone) and/or a **chronic coastal stress condition** (i.e., severe land subsidence in a **coastal setting**). The broad definition refers to the impact manifestation of **coastal disaster risk** – whether acute or chronic. An acute event has the benefit of being more precise to measure in time while a chronic condition challenges users to evaluate slower-moving catastrophes with less precision. The Scorecard, by design, narrows in on extreme **coastal hazards** that stress understanding, capabilities and ultimately assets – natural or human-built – so that **coastal disaster risk profiles** can be improved with resilience design and implementation interventions.

Coastal Disaster Risk Reduction starts with risk identification and assessment before plans to develop **Coastal Resilience** can be formed. As such, the physical determinants of **coastal disaster risk** are required data points – **coastal hazards**, **coastal exposures**, and **coastal vulnerabilities** – for measurement using quantitative methods such as scenario tools and models that determine baseline and target **coastal disaster risk & resilience profiles** (see Essential 2). The Scorecard presents **coastal disaster risks** as those that can be quantified and qualified by models applying the IPCC's determinants of physical climate risk[v]:

Coastal Hazard

- Hazard refers to potential human-induced or naturally occurring elements that can cause harm in a **coastal setting**. Hazards are drivers of risk – not risks themselves. The Scorecard primarily categorizes **coastal hazards** into geohazards, hydrological, and meteorological to simplify understanding for city end users

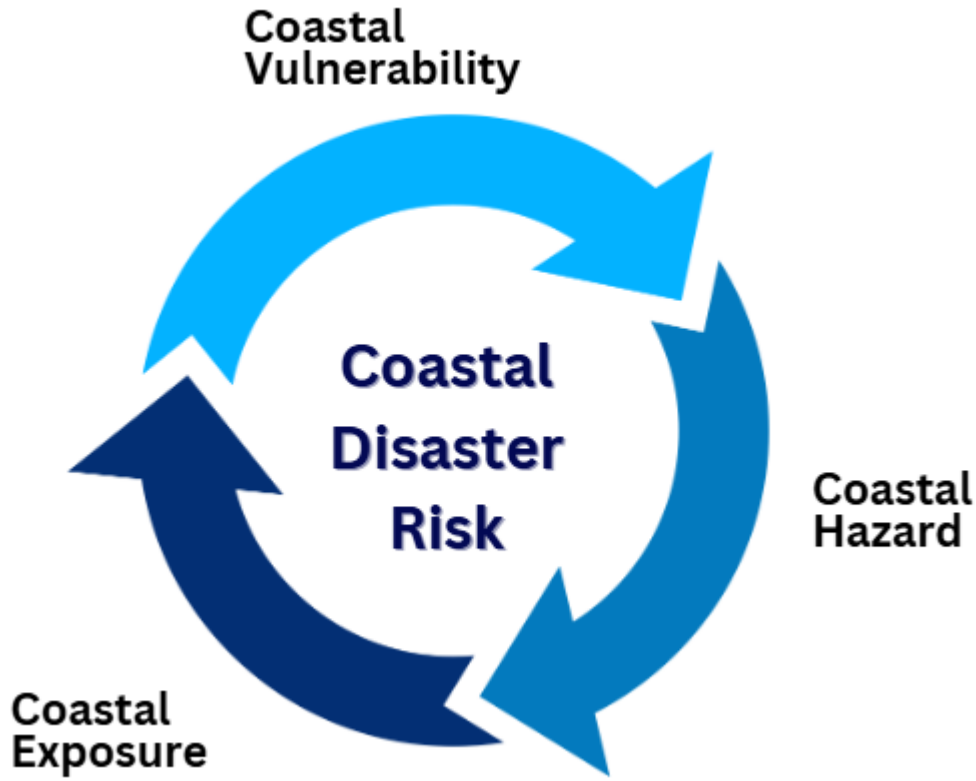
Coastal Exposure

- Exposure refers to what lies in harm's way – including people, buildings, infrastructure, and natural assets/ecosystems

Coastal Vulnerability

- Vulnerability is best defined as the likelihood that a hazard will cause harm, as well as how well structures and systems can cope, recover and adapt based upon extenuating factors such as material composition and physical location

Figure 3: The Interplay of Coastal Disaster Risk Determinants (adapted from IPCC)



Coastal Disaster Risk is the composite of measurable uncertainty that may arise when these three elements interact analytically to quantify and qualify baseline and target state **coastal disaster risk profiles**. With these determinants in mind, the most significant and universal **coastal hazards**, **coastal exposures** and **coastal vulnerabilities** examined in producing the Scorecard are comprehensively displayed in Appendix B.

The Scorecard's lead authors exhaustively reviewed **coastal hazards** in particular – both human-induced or naturally occurring – to summarize and provide the most universal ones that coastal cities will face irrespective of geography (see Appendix C for Universal Coastal Hazards). The Scorecard assesses the extent of a city's knowledge of hazards and exposures; and the strengths and weaknesses of the city's preparations (mitigation, adaptation) to reduce vulnerability.

Coastal Resilience

The Scorecard's definition of **coastal resilience** is adapted from the IPCC definition of resilience[vi]: "the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure".

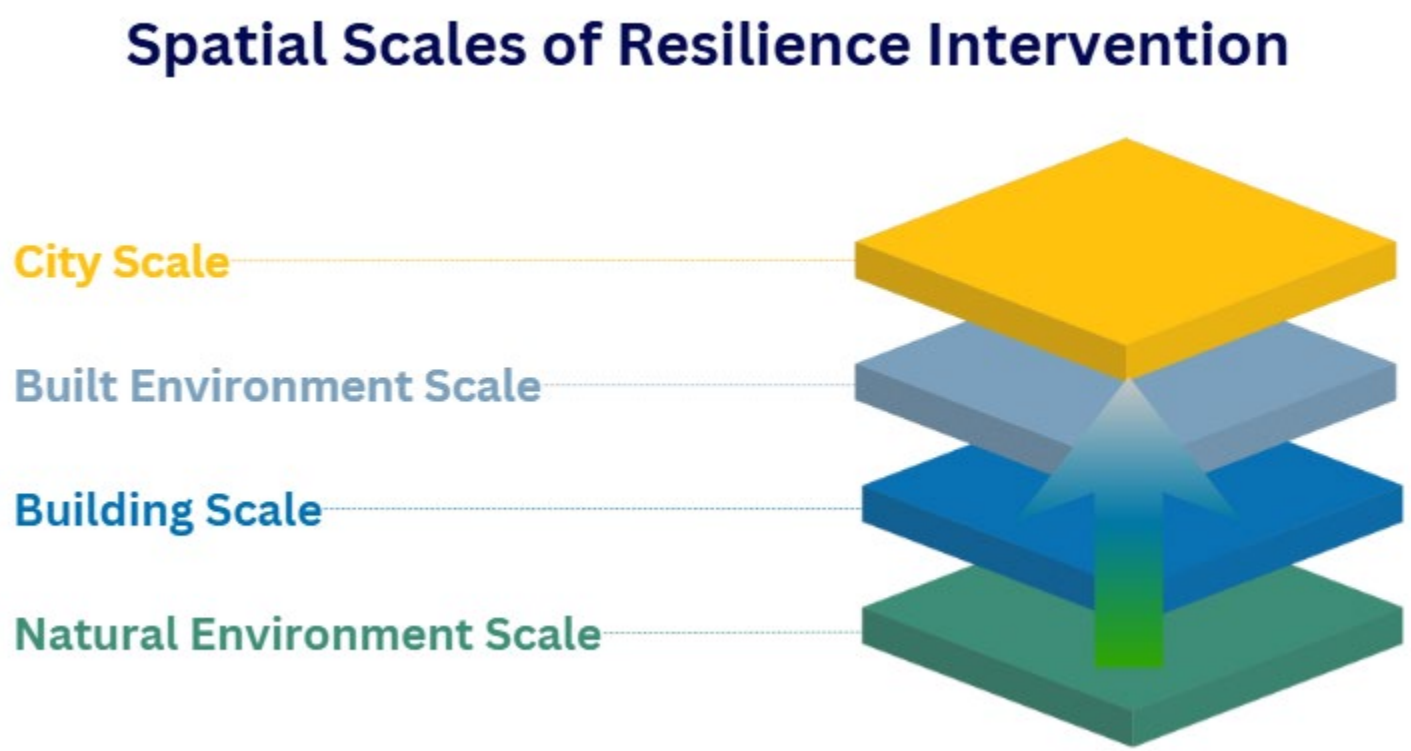
Achieving **coastal resilience** is a "system-of-systems" change mission with an emphasis on the ocean, weather, people, economies, nature and coastal physical assets. Building **coastal resilience** in a city requires intervening in multiple natural, physical, socio-economic, governmental, political, and cultural systems, and managing the relationships between these systems.

The Scorecard's definition does not imply simply returning to the status quo after a **coastal disaster** merely to some viable equilibrium. Adaptation to climate change and urbanization means that many aspects of coastal living may need to be modified: in this sense, resilience is more about "bouncing forward" than just "bouncing back". It's a future-proofing transition not unlike the changing role for hydrocarbons in city primary and secondary energy supplies.

The most foundational part of **coastal resilience** is physical location and natural geography. As used in this Scorecard, **coastal zone** refers to the zone immediately interfacing with the sea (or inlets of the sea such as estuaries, harbors and ports). Ecologically, this will include beaches, salt-flats, marshes and tidal areas; it will also include any land or settlements that might be impacted by tidal flooding, storm surge, tsunami, wave action or erosion. A **hinterland coastal zone** is situated behind the **coastal zone** stretching as much as 100 miles (or more) back from the sea itself and reaching into the floodplains/watersheds. This zone may be safe from the above issues but may nevertheless be affected by factors such as high winds and extreme rainfall caused by coastal storms or may be disrupted by the loss of infrastructure closer to the coast such as ports, railway lines or roads. For this reason, both **coastal zone** and **hinterland coastal zones** together are considered **coastal settings** when referenced as such throughout the Scorecard. Users have the option to focus on their areas of highest priority/effectiveness for their city's intervention in resilience-building.

The following pages will visualize the spatial and temporal scales of risk & resilience (i.e., staging for design and implementation interventions) as cities will make challenging choices while they face constraints – social, physical, and financial – to achieve city-scale resilience against **coastal disasters**.

Figure 4: Spatial Scales of Resilience Intervention for Key Stakeholders



The **natural environment scale** provides the foundation for the pre-settlement natural coastal domain conditions developed over epochs. It can be broadened further into the ecological health underpinning the success of built environment assets and include factors such as topology, geology, hydrology, ecology, meteorology, and chemistry, among other disciplines.

The **building scale** layers in asset- and site-specific factors (i.e., design, materials, construction) unique to structures built in **coastal settings**. The **built environment scale**, layers in broader factors such as operations and maintenance of key infrastructure in, around and between key coastal assets and sites.

The **city scale** zooms out the most to expand the built environment scale concept into a network of sites and/or assets within and around the coastal city, and adds layers of governance, engagement and socio-economic context to planning and implementation in service to **coastal resilience**.

Figure 5: Interplay of Coastal Disaster Risks

Coastal disaster risks manifest and interact in both acute and chronic time frames – the **coastal resilience** investments in prevention, response, and recovery must adequately adapt to similar time horizons. Acute events impact chronic conditions and vice versa.

Reducing **coastal disaster risk** requires intervening at different time scales. Some required actions may take decades - bringing a housing stock up to a new code or restoring a mangrove forest, for example, or even moving a city. Some actions, such as improving evacuation routes or building deeper city awareness and concerted neighborhood action, will take less than decades but still rests on the order of years.

As you complete the Scorecard you will find illustrative guidance across the interplay of risks and resilience and benefit from framing your design and implementation to the three periods of **coastal disaster risk reduction**.

Sustainable Blue Economy

The genesis of the **Coastal Resilience Partnership** and its Phase 1 Scorecard was a roundtable workshop that took place on March 13th, 2024 as part of the third Aspen Ideas Climate Festival in Miami Beach and moderated by Waterfront Alliance. It became readily apparent that coastal adaptation & resilience remained a heavily under-invested area of climate action. Shortly after, ARISE US approached Waterfront Alliance to create a city-level scorecard following up on the success of various scorecards such as the Wildfire Disaster Risk Reduction Scorecard released in 2023.

In parallel to the core development of Phase 1 of the partnership (i.e., making the Scorecard), the lead author team has participated in various conferences globally to showcase the Scorecard concept including Economist Impact Regional Ocean Summit in Dead Sea, Jordan (May 2024), UNFCCC COP 29 Resilience Hub in Baku, Azerbaijan (November 2024), Disasters Expo USA in Miami (March 2025), Economist Impact World Ocean Summit in Tokyo (March 2025), Third United Nations Ocean Conference in Nice, France (June 2025) including the Ocean Rise & Coastal Resilience Summit, and lastly the global release event happening at the World Ocean Council's Sustainable Ocean Summit alongside the Tomorrow Blue Economy Expo in Barcelona (November 2025).

The Role for Large Ocean States

Much focus on sustainable blue economy finance and implementation to date has rightly been on small island developing states (SIDS), which are now being referred to as large ocean states. Coastal cities and communities in large ocean states live with the ocean and water's edge in more advanced and time-tested ways than their counterparts in highly developed coastal cities. One goal of the Scorecard's Phase 2 will be to transfer socio-cultural and indigenous techniques to the nature-based restoration of **coastal conditions** that support human life in developed economies. The urgency of impending extreme sea level rise and the existential threat it poses to large ocean states has heavily guided the peer review process of the Scorecard to make it more relevant and useful for audiences outside of the United States.

Call to Action!

Self-scoring is not the end point, rather the beginning of a journey to reduce the likelihood and impact of acute **coastal disaster** events and **chronic coastal stress conditions**. That journey will take some years. The Scorecard will aid you with encyclopedic knowledge to set your spatial and temporal priorities and best determine tactical and strategic interventions that will sequentially and incrementally build up to **coastal resilience**. Since no-one can know when the next disaster will befall a coastal city, the time to start work, if you have not already done so, is now!

We wish you every success in developing meaningful, tangible and sustainable **coastal resilience** planning and implementation!

LEAD AUTHORS & KEY PARTNER INSTITUTIONS

ARISE US

Dr. Peter Williams (Coastal Resilience Partnership Co-Lead)

ARISE-US is the US network of ARISE[2], established by the United Nations Office of Disaster Risk Reduction (UNDRR) to build public-private collaboration in disaster resilience. We are a 100% pro bono organization operating in 30 countries worldwide, with some 450 corporate members. ARISE-US has played a key role in developing the Disaster Resilience Scorecard for Cities (Scorecard or City Scorecard) in collaboration with UNDRR, now used by over 800 cities worldwide (including many in the US). It is the basis on which this Coastal Resilience Scorecard is modeled, as well as several other scorecards such as the Wildfire Disaster Risk Reduction Scorecard, action guides, and so on that will form the basis of the toolkit referred to earlier.

Waterfront Alliance, Inc.

Mr. Eugene Karl Montoya A. (Coastal Resilience Partnership Co-Lead)

Waterfront Alliance was incubated by the Municipal Arts Society of New York (MAS) following the tragic events of the September 11th, 2001 terrorist attacks in New York City. This human-induced disaster created a large loss of life because the waterfronts were not operable for evacuation. Waterfront Alliance became an independent stand-alone entity in 2007 when a group of leading activists, businesses, foundations, and civic organizations came together with the goal of making the New York and New Jersey harbor a shared, resilient, and accessible resource for all. Since its founding, the Alliance has grown to encompass more than 1,100 organizations working together to bring about real change to the region's waterways and 700 miles of shoreline, and the greater nation at large. Waterfront Alliance created the Waterfront Excellence Design Guidelines (WEDG)® which are featured throughout.

Fugro USA Marine, Inc.

Dr. Cheryl Hapke (Coastal Resilience Expert)

Fugro is the world's leading Geo-data specialist. Through integrated mapping, modelling, and monitoring, we unlock intelligence from data to mitigate risks of assets and resources, both built and natural. Our solutions support sustainable infrastructure, climate

[2] See https://www.ariseglobalnetwork.org, and https://www.arise-us.org/

change adaptation, and inland water management as part of our climate and nature strategy. We have offices in 57 countries and employ approximately 11,000 staff worldwide. By utilizing our fleet of specialized equipment and cutting-edge digital solutions, we provide a vital contribution to building a safe and livable world, which is the purpose of our company.

Global Development College

Professor Dr. Jeremy Novak (Small Island Developing States Expert)

Global Development College is an internationally accredited research and higher education institution. Global Development College specialises in providing high-quality academic and commercial research, as well as tailored training and development for individuals, communities, governments, and businesses. The areas of specialty include resilience, hazard mitigation, crisis and disaster management, UN Sustainable Development Goals (SDGs), UNDRR MRC 2030, crisis and disaster management, engineering, infrastructure and asset management, business, and project management. Global Development College has been a contributing committee member of scorecards such as the Coastal Resilience Scorecard and the Lead organization for the **Small Island Developing State (SIDS) Resilience Scorecard Addendum** and the Public Health Resilience Addendum. Other scorecards that Global Development College has been involved in include those related to gender, health, and food security, which strengthen government and community resilience worldwide."

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We would also like to thank our key contributors and global peer reviewers above. Without their critical and invaluable support, perspectives, ideation, technical content, editing, infographics, and dedication to the subject matter, the Scorecard would not be ready for cities across the globe to immediately utilize for self-identifying and self-assessing their readiness levels for coastal disaster risk reduction and coastal resilience.

ESSENTIAL 1: ORGANIZE FOR DISASTER RESILIENCE

The E1 chapter begins the Scorecard's focus on the **Prevention Period** and primarily addresses a coastal city's governance approach to **coastal disaster risk reduction** and **coastal resilience** planning. All parties ("stakeholders") must be represented, active in organizational efforts, and engaged in the transparency, resourcing, and decision-making of public and private interests in service to **coastal resilience** plans, an objective every coastal city should aspire to develop, adequately resource, update, and maintain.

For Essential #1's development, the following WEDG® V3.0 credits provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 0.3 (Develop and Implement a Plan for Equitable Stakeholder Engagement)**
- **WEDG® Credit 1.4 (Establish an Emergency Preparedness and Response Plan)**

***** See the end of Essential 1 chapter for WEDG® credit descriptions and select design strategies for coastal resilience planning and implementation.

#	Question	Guidance
1.1	**Governance**	
1.1.1	To what extent have cities actively included and engaged key stakeholders on the topic of **coastal resilience** for the development of **coastal disaster risk reduction** and resilience plans?	Any city is a complex entity in itself and will have a web of complex governance structure and dynamics. The city should invite all key stakeholder groups to participate in an approach and methodology for ensuring long-term **coastal resilience**. Disaster risk reduction (DRR) professionals must prioritize inclusive engagement in all DRR activities, ensuring that all stakeholders share equitable opportunities to participate and "own" the process and outcomes. It is essential to recognize that city resilience professionals are unlikely to have access to all stakeholders on day one. For this reason, the city should consider incremental but meaningful approaches to developing multi-stakeholder access. Cities need to engage with the widest possible selection of stakeholders accepting that it may not be possible to engage them all immediately. Effective governance requires active engagement from all stakeholders in development, planning, and implementation efforts. Governance structures should promote participation through clearly defined roles and responsibility, manageable meetings, and regular updates, optimized to different stakeholder needs. Meetings to discuss governance, planning, and **coastal disaster risk reduction** should be accessible, well-documented, and facilitate meaningful co-investment in action. Cities need to ensure consistent inclusion across all participating stakeholders.

#	Question	Guidance
		Stakeholder groups who have an interest or role (or both) in **coastal disaster risk reduction** may include (but are not limited to) the categories and examples below, which must be localized. **Residents/Citizens** • Homeowners & renters (individuals, companies) • Informal and unincorporated settlements (as applicable) • City groups (religious, social, and neighborhood organizations) • Affinity groups (anthropological, ethnic, indigenous, cultural, linguistic, health, environmental) • Advocacy groups (alliances, coalitions, non-governmental organizations) **Commerce & Industry** • Enterprise entities (small businesses through multinational corporations) • Enterprise leadership, heads of sustainability/engineering/property management, risk management, city affairs and others (as applicable) • Chambers of commerce; industrial membership organizations **Critical Infrastructure & Utilities** • Utilities (heating, cooling, power, water, sanitation, communications) • Critical services facilities (hospitals, emergency shelters, emergency food distribution) • Flood management (districts, flood zone managers) • Other key infrastructure services - roads/transportation **Government** • Local (city and/or county) departments including emergency management, planning, fire, engineering, parks and recreation, environment, public works, finance and taxation) • Adjacent cities, especially if infrastructure, facilities and equipment are shared, or if there is a strong economic relationship • State/regional/provincial (legislators, finance, fire services, water, environment, public health) • National/federal entities where applicable (for example, in USA this would include FEMA, NOAA including coastal zone managers, USDA, EPA, BLM, Forest Service, USACE, US Coast Guard, etc.) **Emergency & Public Health** • First responders (police, fire, emergency medical services) • Public health (hospitals, clinics, health agencies) **Land & Resource Management** • Agriculture & conservation (farmers, landowners, land trusts) • Education & research (schools, universities, conservation districts)

#	Question	Guidance
		Advocacy Organizations • Alliances & NGOs (coalitions, advocacy groups) • Environmental groups **Validation**[3] • Evidence of meaningful engagement such as meetings, public referenda, consultations, benchmarking, action-oriented workshops, and focus groups, etc. • Notable absence of groups or key individuals choosing not to participate • Establishing a governance framework that defines inclusion, roles, meeting frequency, and decision-making processes and integrates diverse inputs • Availability of meeting records/minutes and clear documentation of decisions made • Providing regular updates and ensuring accessibility of public information • Ensuring participation of all stakeholders with targeted outreach to underrepresented groups
1.1.2	To what extent is there a single point of resource and communication coordination (i.e., a person or an office) for **coastal disaster risk reduction** and **coastal resilience** planning and implementation?	Ideally, there exists a single body that coordinates *all* stakeholders including local communities and businesses. In reality, there may well be separate bodies where separate government agencies are involved (public health is one common example), or where private utilities manage their own activities. In such cases the key is then the connectedness of these different bodies and their propensity and/or incentives to collaborate. Cities need to create a single overall point of coordination of all resource activities, able to work across and between organizational boundaries. **Validation** • Program office or similar, with clearly defined responsibilities for all stakeholders and buy-in from them. May be in emergency management office (EMO), or waterfront management district, or other. • If there are multiple coordinating bodies – proof that they share assumptions, communications, data and other resources with each other.
1.2	**Strategy**	
1.2.1	To what extent is there a comprehensive strategy for **coastal disaster risk reduction** or **coastal resilience**?	A comprehensive **coastal disaster risk reduction** strategy must go beyond a single tool – it requires governance, risk & resilience assessments, stable funding & financial planning, civic engagement, emergency preparedness, and long-term city-wide efforts.

[3] **Validation** is used throughout the Scorecard to capture tangible and measurable examples that prove that a coastal disaster risk reduction consideration has been addressed. It is impossible to state all possible validation criteria and other criteria beyond those stated may apply in any given instance.

#	Question	Guidance
		The Ten Essentials framework can be combined into a single city-specific strategy document wherein each Essential (i.e., Chapter) is compositional and representative of the prevention, response and recovery dimensions of **coastal disaster risk reduction**. • **Governance & Policy** (E1, E4): Clear roles, regulations, enforcement, and land-use policies • **Risk & Resilience Assessment** (E2): Identifying vulnerabilities at different spatial scales (property, neighborhood, landscape) • **Financial Capacity** (E3): Sustainable funding sources, incentives, and innovative financing • **Natural & Built Environment** (E5): Protecting natural buffers • **Institutional Capacity** (E6) • **Social & Cultural Capacity** (E7) • **Civic Engagement** (E7): Inclusive participation, education, and stakeholder buy-in • **Infrastructural Capacity** (E8): hardening and/or duplicating physical infrastructure • **Response Capacity** (E9): Access to critical response resources, coordination responsibilities, and readiness for human health and safety considerations • **Recovery Capacity** (E10): Post-event economic and social rebuilding, long-term mitigation measures Cities need to create a comprehensive strategy for **coastal disaster risk reduction** in service to **coastal resilience**. **Validation** • Evidence of a documented **coastal disaster risk reduction strategy** that incorporates elements of the 10 Essentials, supplemented by local policies and cultural contexts, funding mechanisms, and long-term adaptation plans
1.2.2	To what extent is the **coastal disaster risk reduction** and/or **coastal resilience** strategy enhanced with metrics and targets to address weaknesses and define progress, and to what extent are those targets and metrics governed (i.e., updated at relevant and material intervals)?	Targets and metrics should be set within the **coastal disaster risk reduction** strategy for: • Budgets and timelines of intervention • Measurable resilience indicators (as appropriate to city context) • Fitness for purpose • Lack of adverse environmental impact (E5) • Progress under all Ten Essentials in this Scorecard Cities need to frame a defined scope, strategies, targets and metrics, along with schedules and budgets to be considered credible. **Validation** • Evidence of governance process for setting and updating metrics and targets; periodic report of progress to internal and/or external stakeholders as appropriate to local city setting

#	Question	Guidance
1.2.3	To what extent are key stakeholders' **coastal resilience plans** in this city consistent with each other and with the overall city-wide strategy?	Misalignment between stakeholders' plans for **coastal resilience** can lead to conflicting assumptions, inefficient resource allocation, and weakened response capacity. Without coherence, critical systems may fail to function effectively when needed most. To ensure effective action, stakeholders must align their plans in key areas, including: • Risk & Resilience Assessment (interplay between nature, probability, extent, timing) • Rating and Ranking of **Climate Change Mitigation** & **Climate Change Adaptation** plans • Assumptions about stakeholder intentions, capabilities, and responsibilities • Evacuation Logistics (routes, shelters, emergency food, energy and water systems) • Response Coordination (capacity for handling multi-hazard scenarios simultaneously) • Avoiding Conflicts or Duplication of Efforts Cities need to undertake side-by-side comparisons of plans to confirm compatibility, and stakeholders need to share plans with each other. Data Sharing (E6), shared drills and practices (E8 and E9) and active alignment of post-event recovery (E10) will help in this regard. **Validation** • Side-by-side reading and comparison of plans, demonstrating absence of inconsistencies in terms of readiness for **coastal disaster risks**
1.2.4	To what extent are **coastal disaster risks** separately considered in new policymaking?	It is essential to consider material **coastal disaster risks** in new policymaking, just as the operational and financial risks would routinely be considered. Cities need to ensure that **coastal disaster risk** issues and impacts are considered in all categories of policymaking not only in disaster risk-specific policies. **Validation** • Evidence of city meeting minutes and standing orders demonstrating that **coastal disaster risks** are routinely considered in developing new policies
1.2.5	To what extent are all existing city-level policies aligned with **coastal disaster risk reduction**?	Cities should review existing policies with the goal of **coastal disaster risk reduction**. Cities need to review existing policies for any provisions that reduce, or prevent the improvement of, resilience to **coastal disaster risks**, and change these as applicable. **Validation** • Evidence of the required review and adjustment of policies that serve either to increase **coastal resilience** in some way or enhance **coastal disaster risk reduction**

Develop and Implement a Plan for Equitable Stakeholder Engagement (WEDG® Credit 0.3)

Description

When organizing for coastal resilience, a city should engage stakeholders in the vision, design, and implementation periods of coastal resilience planning to create a welcome and equitable coastline for all. Coastal cities need to recognize the needs, priorities and concerns of a diverse set of city residents and other stakeholders.

Design Strategies

- Establish a **stakeholder engagement plan** from the beginning that enables city residents and other stakeholders to participate in the visioning process, multiple stages of the design process, and all the way through implementation.

For more details, see the **WEDG® Version 3.0 Manual**, pages 23-27.

Establish an Emergency Preparedness and Response Plan (WEDG® Credit 1.4)

Description

Clear communication and outreach about coastal hazard risks can increase human safety during and after emergencies. Projects should create an emergency preparedness plan for human safety prior to an extreme weather event, particularly considering the most vulnerable communities, such as those with impaired mobility, overburdened communities, or environmental justice communities.

Design Strategies

- Establish an **emergency network** of on-site team leaders, as well as applicable local, city, state, and federal entities.
- Create an **education and outreach strategy** about the risks before, during, and after an extreme event. For example, identify and communicate about your hurricane or tsunami evacuation zone, nearby shelters and resources, and process for monitoring evacuation order. Consider relevant language barriers.
- **Conduct annual training** of employees, managers, and residents to present flood risk avoidance information and provide informational brochures or newsletters.

For more details, see the **WEDG® Version 3.0 Manual**, pages 54-55.

ESSENTIAL 2: IDENTIFY, UNDERSTAND USE CURRENT AND FUTURE RISK SCENARIOS

The E2 chapter focuses on the **Prevention Period** and primarily addresses the completeness and adequacy of a city's understanding of **coastal disaster risks** framed by spatial and temporal considerations used in scenario tools/models.

Spatial Scales of Resilience Intervention

- The **natural environment scale** where Scorecard users can and should utilize scenario tools to quantify and qualify current and future plausible states of foundational natural asset systems in and around **coastal zones** (e.g., land, mangroves, coral, seagrass, salt marsh, etc.)
- The **building scale** where Scorecard users can and should utilize scenario tools study physical structures (standalone, attached) in and around **coastal zones**. The natural environment layer must be retained in all scenarios to ensure foundational relevance.
- The **built environment scale** where Scorecard users can and should utilize scenario tools to quantify and qualify current and future plausible states of collective performance broader than **building scale** such as infrastructure, transportation networks, public spaces, etc. The natural environment layer must be retained in all scenarios to ensure foundational relevance.
- The **city scale** where Scorecard users can and should utilize scenario tools to quantify and qualify current and future plausible states of natural, built and socioeconomic system performance interaction. The natural environment layer must be retained in all scenarios to ensure foundational relevance.

Temporal Scales for Resilience Intervention

- Functionally, acute time scales are immediate and very near-term or short-term time periods. Understanding the drivers and impacts of disasters pre-event will support response and recovery capabilities assessments for resilience against single or multi-hazard scenarios.
- Likewise, chronic time scales extend into medium and longer-term periods that potentially overtake conventional city and key stakeholder planning. As such, chronic **coastal disaster risks** and dynamic **chronic coastal stress conditions** will be challenges to model but are essential in relaying how resilience investment (i.e., **prevention period**) translate into value enhancement

For Essential #2, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Appendix A (Initial Assessments)**
- **WEDG® Credit 1.1 (Avoid or Reduce Flood Risk from the Waterbody)**
- **WEDG® Credit 1.2 (Reduce Pluvial Flooding and Stormwater Discharge)**

***** See the final section of Essential 2 chapter for WEDG® credit description and select design strategies for coastal resilience planning and implementation.

Coastal Disaster Risk Assessments and **Coastal Resilience** Plans should be integrated within a city's overall disaster risk reduction plan and/or sustainability plan Users are encouraged to reference the **Physical Determinants of Coastal Disaster Risk & Resilience** table (see Appendix B) and the **Universal Coastal Hazards** table (see Appendix C) to ensure comprehensive identification, classification and inclusion of **coastal hazards** relevant to their coastal city setting.

<table>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td>2.1</td><td colspan="2">Natural Environment Scale</td></tr>
<tr><td>2.1.1</td><td>To what extent has the city adequately mapped the coastal natural environment with respect to coastal hazard variability?</td><td>To adapt to and mitigate coastal disaster risks, it is essential to understand key factors driving the natural coastal conditions that could exacerbate (or mitigate) the physical determinants of coastal disaster risks (hazards, exposure, vulnerability).

For example:

<table>
<tr><th>May exacerbate coastal hazard</th><th>May mitigate coastal hazard (see also E5)</th></tr>
<tr><td>Topography
• Low elevation
• Decaying seawalls
• Poor drainage
• Coastal areas that are prone to failing and/or eroding
• Narrow inlets (may amplify storm surge or tsunamis)
Bathymetry
• Shallow, low slope shelf (amplifies waves).
• Lack of or low relief offshore sandbars
• Lack of natural or human-made reefs or breakwaters or other wave mitigation
Coastal Typology
• Narrow beaches
• Adjacency to rivers which may increase flooding, water accumulation
• Lack of dune system
• Compromised mangrove fringes (cleared or cropped canopy), narrow fringing marshland
Land Cover (natural and built)
• Overdeveloped coastal system(s)
• Inadequate storm water management systems
• Development too close to water body
• Diminished vegetation cover
• High ratio of impervious to permeable surfaces</td><td>Topography
• (Absence of exacerbating factors)
• Height above sea level.
Bathymetry
• Steep nearshore zone
• Multi-bar system
• Natural or human-made reefs or breakwaters
• High-resolution bathymetric data for predictive models
Coastal Typology
• Wide beaches and dunes
• Well vegetated dune system
• Wide fringing marshland or mangrove forest
Land Cover
• Natural coastal system with no impediments to coastal processes
• Coastal development set far back from the water body
• Extensive vegetation cover
• Low ratio of impervious to permeable surfaces
Weather
• (Absence of exacerbating factors)</td></tr>
</table>
</td></tr>
</table>

#	Question	Guidance
		Weather • Location in or near hurricane or storm zone • Long periods of drought impacting strength of dykes **Factors that increase or reduce exposure and vulnerability** • It will be seen that some of these factors are relatively dynamic (especially human activities). The disaster risk assessment therefore ideally would not be a "once every five years" exercise - it needs updating annually, to account for changes. • It is also important to continue to project the assessment into the future, as climate change continues to impact and as urban boundaries expand in and around the **coastal zone**. Define and update most severe and most probable incidents and associated mitigation actions. **Validation** • Evidence of complete mapping of natural coastal environment to identify hazards, exposures, and vulnerabilities in and around the **coastal zone** • Some public data sources are included in the footnote below[4].
2.1.2	To what extent is the impact of local topography and seabed bathymetry on the city's **coastal disaster risk profile** understood and/or mitigated? Under what conditions?	Topographic features can either increase or decrease the risk of **coastal disasters**. For example, higher-elevation cities are at lower risk because water flows to lower areas. Seabed bathymetry (the shape of the sea floor) closer to the coast can also increase wave and tsunami impacts. Cities need to understand the impact that their local topography and bathymetry may have on their **coastal disaster risk profile**. **Validation** • Evidence of complete assessment of topographic and bathymetric risk for the city's in-scope **coastal zone**
2.1.3	To what extent are the impact of vegetation presence and trends, and reefs, on the city's **coastal disaster risk profile** understood? (See also E5)	It is well-documented that vegetation, such as mangroves and marshes, can significantly attenuate storm surge and even tropical storm winds in select cases. Well-vegetated dunes are more resistant to erosion, and well-vegetated coastal slopes are less prone to coastal landslides. Coral or other reefs may also offer protection from extreme wave action. Cities need a complete understanding of the impact of vegetation presence and trends and reefs as critical natural assets in and around their in-scope **coastal zones**. **Validation** • Evidence of a complete mapping of vegetation and reefs to identify and assess protective value in and around the city's in-scope **coastal zone**

[4] World Meteorological Organization (WMO) Climate Data NOAA National Centers for Coastal Ocean Science (NCCOS) World Bank Climate Change Knowledge Portal

#	Question	Guidance
		• Evidence of integrating vegetation and reef data into **coastal disaster risk** assessments and resilience planning; keep in mind that dynamic data sets will force adaptive thinking for using scenarios to inform planning
2.1.4	To what extent does the city's **coastal disaster risk** assessments include compound flooding?	Sometimes, especially in the event of heavy rain associated with a coastal storm, there may be riverine flooding compounded by excessive rainfall which adds to surge flooding, exacerbating **coastal disasters**. Cities need to ensure that their risk analysis includes the possibility of compound flooding in their emergency response planning (E9) if there are rivers or streams in or around the **coastal zone**. **Validation** • Inclusion of compound flooding in risk analysis
2.1.5	To what extent does the city understand how fluctuations in surface water levels both acutely and chronically impact **natural coastal conditions** (i.e., storm surge, sea level rise, tides)?	Surface water (rivers, lakes and surrounding wetlands) and water bodies in the **coastal zone** (oceans, estuaries, large lakes) fluctuate based on storm characteristics, tidal stage and local sea level rise. These features can act as natural buffers, but their protective function may be compromised by erosion, changes in sediment transport, or loss of nature. Cities need to understand the level of protection or risk associated with fluctuations offered by surface water features. This understanding is crucial, particularly when protection from features they may have relied upon has decreased due to weather or vegetation issues, thereby increasing their risk. **Validation** • Presence of complete assessment of surface water levels/local water bodies fluctuations as part of the 5-mile (8km) "perimeter of understanding" within the coastal zone, and around and within the city boundary, updated seasonally • Identification of areas where natural buffers have weakened, or protective features have been lost for **coastal resilience** purposes
2.1.6	To what extent is there retained knowledge and documentation of **natural coastal conditions** and natural **coastal disaster** history in the area?	Understanding past **coastal disasters** is crucial for assessing future risks. While some areas have historically been more prone to flooding and other **coastal hazards**, changing climate conditions, land use, and coastal erosion mean that historical patterns may not fully predict future risks[5]. Certain broad areas have historically proven more prone to flooding and other **coastal hazards** than others. Is the city in a high-risk area?

[5] In one example, in clearing the aftermath of the Tohoku earthquake and tsunami in Japan in 2011, ancient stones, such as that in the village of Aneyoshi, were found warning future generations not to build below a certain level due to the risk revealed by past tsunamis.

#	Question	Guidance
		• Cities facing open exposure to water bodies (oceans, estuaries, large lakes) are at the frontline of experiencing **coastal hazards**. However, inland areas adjacent to the **coastal zone** which have rarely, if ever, have flooded historically may unexpectedly experience flooding in large-scale events • Coastal landslides and cliff erosion are extremely episodic and areas that have not historically experienced these hazards may be exposed at a future point; history is not always telling of future risks in these areas **Validation** • Identification of areas where natural buffers have weakened or protective features have been lost • Proof of complete **coastal disaster** history for the **coastal zone** at a minimum
2.2	**Building & Built Environment Scales**	
2.2.1	To what extent does the city understand the impact of building patterns and densities on its **coastal disaster risk profile?**	On one hand, more densely packed buildings and row-homes increase exposure: they are more prone to being caught up in a single **coastal disaster** incident (for example being blown over onto one another). On the other hand, however, if building density means less open land, it may in some ways reduce hazard (for example flooding) in the first place. **Validation** • Building patterns are mapped and annotated for **coastal hazard** and exposure implications
2.2.2	To what extent has the city identified structures or sites that might become dangerous in the event of a **coastal disaster**?	Facilities such as warehouses that contain dangerous chemicals, or holding pond dams, may be vulnerable to causing additional danger if damaged in a **coastal disaster**. Cities need to know where these facilities are and plan accordingly. In addition, buildings with prolonged exposure to salt water may have been weakened by that exposure, undermining the structural integrity of subsurface foundations, and may require structural fatigue assessments. **Validation** • Undertake pre-development or re-development vulnerability assessments to understand how a structure or site will be impacted by present and future storms + sea level rise • All especially hazardous facilities are identified and the asset owners have been engaged with an agenda to evaluate prevention and response measures
2.2.3	To what extent does the prevailing style of landscaping on public spaces increase or reduce the city's **coastal disaster risk profile**?	Landscaping choices on public land can significantly influence **coastal disaster risk**, particularly through wind and flood mitigation. Properly maintained vegetation can serve as a natural buffer and improve drainage to mitigate flooding. Conversely, poorly planned landscaping can exacerbate risks. Cities need to be sure that they have reduced the risk that may be inherent in their public and commercial landscaping. Governments need to encourage the adoption of such practices.

#	Question	Guidance
		Validation • % of large open areas such as parks, highway medians, commercial landscaping and the like deploying flood and wind resistant landscaping
2.2.4	To what extent is the street layout of the city, and the layout of the roads leading to and from it, conducive to rapid evacuation in the event of an **acute coaster disaster**?	Cities with single evacuation routes, or those with narrow streets intended for evacuation routes, are known to have experienced loss of life from fast-moving floods that might not otherwise have occurred. Cities need to understand constraints on their ability to evacuate and plan for these, including exposure of evacuation route(s) to themselves being cut off by **coastal hazards** such as flooding, wind damage or landslides. **Validation** • Presence of more than a single evacuation route • Analysis of carrying capacity of designated evacuation route(s)
2.2.5	To what extent is **coastal disaster risk** mitigated in the city by compliance with effective building codes or standards attuned to the risks that may be faced? (See also E4)	Effective building codes, standards and land use zoning, when enforced, can significantly reduce vulnerability to **coastal disaster** disruption, damage, and loss. Cities need to identify the **coastal hazard** mitigation standards (as embodied in building codes and land use zoning) to which they aspire that all buildings and assets should (increasingly, over time) comply, and they need to monitor compliance levels. **Validation** • Identification of standards • % of properties compliant with the designated standards • Mapping of compliant and non-compliant properties (rely on self-reports or aerial photos to avoid privacy concerns), identifying "hot spots"
2.2.6	To what extent does the city understand how the construction materials used within its boundaries affect its **coastal disaster risk profile?** (See also E4)	Some building materials are more liable to damage than others in **coastal disasters**. For example, wood structures are particularly vulnerable to hurricanes and storm surges due to their susceptibility to water damage. At the same time, asphalt or concrete shingles on roofs can be easily torn off by high winds. Conversely, materials like reinforced concrete, steel framing, and impact-resistant glass offer greater durability. The structural integrity of buildings tend to weaken over time when exposed to multiple extreme weather events. **Validation** • % of buildings inventoried for construction type and annotated for specific **coastal disaster risk** factors
2.3	**City Scale (incl. Socioeconomic Perspective)**	

#	Question	Guidance
2.3.1	To what extent is the population of the city at risk of permanent or semi-permanent displacement due to **vulnerability** to acute and/or chronic **coastal disasters**?	The answer to this question may depend on answers to other questions throughout the scorecard. Therefore, you may wish to complete this assessment and the next one last. Keep in mind that permanent or semi-permanent displacement may arise even if the city rapidly clears immediate damage and starts to rebuild. New Orleans, Louisiana, USA, is an example of where permanent population loss occurred after an **acute coastal disaster**. (Insurance can offset population losses by making it easier to rebuild – see E3). **Validation** • Evidence of a population impact study, considering risk factors, land use, insurance levels and readiness indicators laid out in this scorecard
2.3.2	To what extent is the economy of the city at risk of permanent or semi-permanent economic impairment or adverse socioeconomic impacts from a **coastal disaster**? (Business continuity and structural damage insurance can offset total vulnerability – see E3).	Coastal cities reliant on tourism, fisheries and shipping are especially exposed to disasters like floods and storm surges. Damage to ports, infrastructure and ecosystems can halt economic activity and threaten jobs. Additional investments in **coastal disaster risk reduction** protects these vital sectors, ensuring economic resilience and reducing long-term recovery costs. The impact on a city's economy can be measured in terms of GDP, employment, or if composed wholly of small businesses, a simple count of businesses. Keep in mind that permanent or at least long-term damage to the city's economy may still result even if the city rapidly clears immediate damage and starts to rebuild. The answer to this question may depend on the answers to other questions throughout the scorecard. Therefore, you may wish to complete this assessment last. Cities need to compile estimates of economic risk as part of building the case for investing in **coastal resilience**. This can be validated through sector-specific GDP data, employment, figures and past disaster impact reports. Combined with climate risk modeling and stakeholder input, these tools help to justify risk reduction measures. **Validation** • Evidence of reasoned estimate of economic risk, considering risk factors, land use and readiness indicators laid out in this scorecard • Evidence of reasoned estimate of economic impact averted by current and planned readiness levels for **coastal disasters**

#	Question	Guidance
2.3.3	To what extent are features in the social fabric of city that may influence **coastal vulnerability** understood?	In order to enable effective financial planning (E3), land use planning (E4 and E5), data, data sharing and skills needs (E6), city mobilization (E7), infrastructure investment (E8), emergency panning (E9) and post event response planning (E10), it is recommended that risks be assembled into scenarios. Ideally there will be a minimum of two – a "moderate" case and a catastrophic, worst case. They should address hazard, exposure and vulnerability; and they should be updated regularly. In addition, scenarios should consider multi-hazard potential (for example, storm surge and fluvial flooding, combined with landslide), along with disaster consequences such as human health impacts. Cities should attempt to assemble coastal disaster scenarios. It may help to seek scientific, engineering and other professional input when assembling these. **Validation** • Presence of at least the two scenarios just described, updated in the last 12 months • Presence of multi-hazard scenarios • Evidence that the scenarios are being used for planning.
2.4	**Scenario Design & Tool Use**	
2.4.1	To what extent has the city assembled all known **coastal hazards**, **exposures** and **vulnerabilities** into specific scenarios to help to assess the adequacy of proposed interventions to prevent and/or mitigate **coastal disasters**?	In order to enable effective financial planning (E3) land use planning (E4 and E5), data, data sharing and skills needs (E6), city mobilization (E7), infrastructure investment (E8), emergency planning (E9) and post event response planning (E10), it is recommended that risks be assembled into scenarios for **coastal disaster risk assessments**. Ideally there will be a minimum of two – a "moderate" case and a catastrophic, worst case. They should address hazards, exposure and vulnerability, and they should be updated regularly to ensure ongoing effectiveness. The most probable and most severe incidents should be defined and distributed as baseline conditions in order to develop **coastal resilience plans**. Cities should assemble **coastal disaster scenarios**. It may help to seek scientific and other professional input when assembling these. **Validation** • Evidence of at least the two scenarios described above, updated at least once every 12 months • Evidence that the scenarios are being used for city planning across relevant time scales – short, medium, and long
2.4.2	To what extent do **coastal disaster scenarios** also include multi-hazard considerations?	**Coastal disasters**, though catastrophic enough, need not occur in isolation from other, coinciding hazards (e.g. pandemic + wildfires). Cities' scenarios should address multi-hazard situations, such as flooding combined with a landslide. They should also include hazards that are not specific to **coastal disasters** such as a tsunami coinciding with an on-shore wildfire, or a major coastal flood combined with a pandemic. **Validation** • Use of multi-hazard scenarios as described above for **coastal resilience** purposes

#	Question	Guidance
2.4.3	To what extent are **coastal disaster scenarios** considering human health in addition to economic and physical disruption, damage, and loss?	Flooding and hurricanes can provide pathways for infectious diseases to bloom by displacing water, leaving pools of standing water as areas dry out, and creating favorable conditions for reproduction and proliferation of disease-transmitting insects. **Validation** • Evidence that health scenarios or variables are included in **coastal disaster** risk assessments and resilience plans (i.e., scenario tools for **coastal resilience** purposes)

WEDG® Appendix A provides methods for completing site-level baseline assessments. It contains suggested methods and levels of analysis to support baseline analysis of site context. It is neither exhaustive, comprehensive, or directly applicable to city-wide assessment.

Design Strategies

- For the purposes of resilience, within Appendix A, communities should focus on:
  - City and Historical Context
  - City Profile
  - Discharge Rate
  - Emergency Preparedness
  - Extreme Temperatures
  - Heat Island Vulnerability
  - Ice
  - Offshore Depth
  - Precipitation
  - Risk and Vulnerability to Extreme Events and Sea Level Rise
  - Slope and Shoreline Shape
  - Snow and Ice Melt
  - Stability, Soils, Propwash, Sediment Transport, and Marine Asset Condition
  - Stormwater Infrastructure
  - Tidal Range
  - Transportation Access

For more details, see the **WEDG® Version 3.0 Manual**, pages 20-22.

Avoid or Reduce Flood Risk from the Waterbody (WEDG® Credit 1.1)

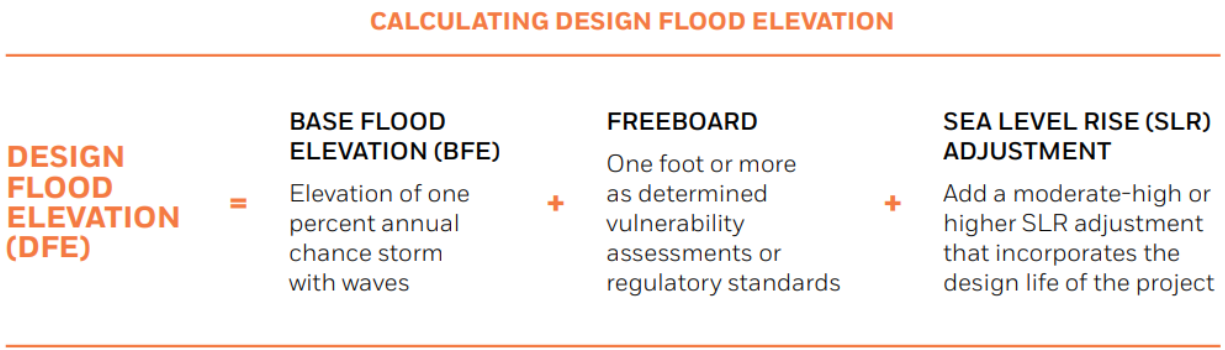
Description

When designing and using current and future risk scenario tools for coastal resilience, a city should seek to reduce human health and safety risks and potential damage to site structures from coastal, lacustrine, and riverine flooding threats. Coastal resilience plans should develop the risk strategies that protect cities against applicable flooding types: storm surge, fluvial, tidal/nuisance, waves, and flooding caused by shoreline erosion, as well as compound flooding which is when multiple drivers of flooding occur simultaneously, amplifying the effects of floodwaters and potential damage.

Design Strategies

- **Increase sites' Design Flood Elevation** (**DFE**), the minimum elevation to which a structure must be elevated or floodproofed for flood protection. The elevation should be based on a specific design storm (e.g., the 1% annual chance flood event) with added elevation to accommodate sea-level rise and additional freeboard (additional height for safety)
- **Setbacks** or simply moving away from the water, offers the highest level of structural protection and risk reduction
- **Dry Floodproofing** ensures that structures are effectively sealed to prevent floodwater intrusion and fortified to accommodate the pressures that floodwaters can put on a structure. Wet Floodproofing is a design in which the building is designed to allow floodwaters to enter a structure safely, without causing serious damage or compromising structural integrity
- **Landscape protections** and nature-based features such as wetlands, armoring, and berms can provide effective protection against flood threats while also providing ecological benefits
- **Floodplains** may have been heavily modified in urban centers. Reconnecting floodplains to waterbodies can reduce flooding across large scales by facilitating natural movement of water. Floodable spaces, such as parks designed to take on flood waters, can provide storage for floodwaters that reduces regional flooding, particularly in riverine environments
- **Increase the durability and future adaptability of structures** to enable more rapid repairs and the ability to reduce costs of future adaptation projects; critical infrastructure redundancy and elevation should be considered for all sites

For more details, see the **WEDG® Version 3.0 Manual**, pages 33-44.



Reduce Pluvial Flooding and Stormwater Discharge (WEDG® Credit 1.2)

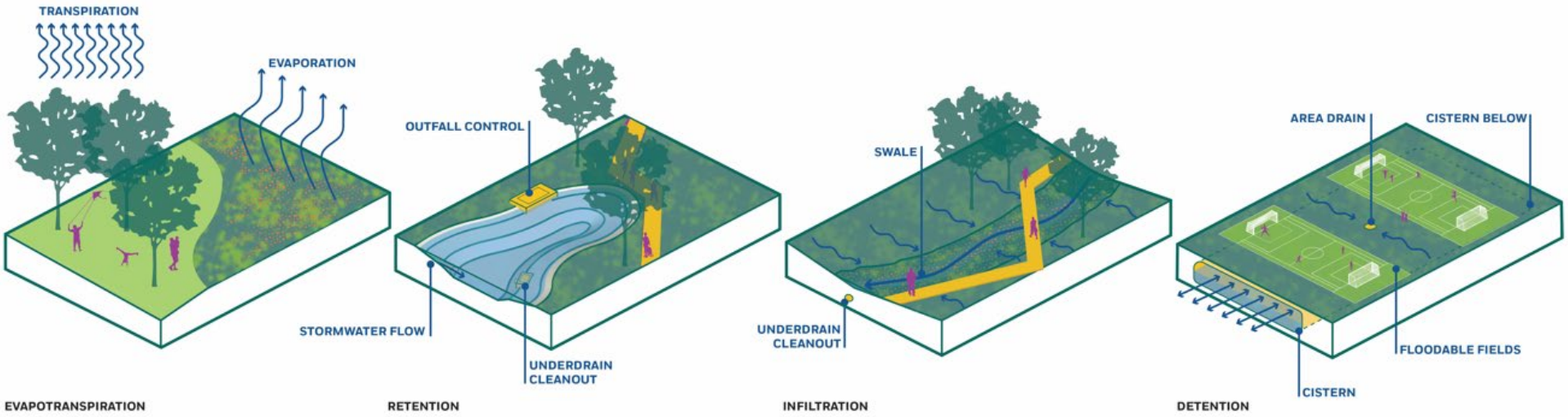
Description

When defining/ identifying, understanding and using current and future risk scenario for coastal resilience, seek to reduce the risk of pluvial flooding and the overall volume of stormwater discharge whenever feasible.

Design Strategies

- Define strategies to manage anticipated point source and non-point source stormwater
- Retain, infiltrate, evapo-transpire, reuse, divert, store or detain stormwater to manage precipitation to the maximum event feasible
- Utilize Green infrastructure for stormwater management as well as reducing urban heat, improving aesthetic value and supporting biodiversity habitat. Examples: bioswales and rain gardens with native plant species, rainwater harvesting, green roofs, permeable pavements, planter boxes, vegetated filter strips, wetlands, and trees.
- Design for storm events, in in particular the capture and active management of stormwater will vary depending on local conditions, policies and regulations, technical feasibility, environmental considerations, and the type of stormwater infrastructure that local municipalities use
- Reduce unmanaged stormwater and reduce peak flows and adjusted designs to accommodate climate projects and coastal risk profiles; grey infrastructure can also achieve desired stormwater goals alongside green and blue infrastructure

For more details, see the **WEDG® Version 3.0 Manual**, pages 45-50.



ESSENTIAL 3: STRENGTHEN FINANCIAL CAPACITY FOR RESILIENCE

The E3 chapter focuses on the **Prevention Period** and primarily addresses the financial architecture of a city's **coastal resilience** universe – understanding of sources, quality and stability of funds, provision of tax and grant incentives, identification of monetizable co-benefits/**resilience dividends** to incentivize the business case for **coastal disaster risk reduction**, capital budgeting and the securing of specific resilience funding. **Coastal resilience** funding should allocate to both capital expenditures and operating expenses to pursue sustainable profitability. (Note: Insurance support may be extremely limited in some regions)

For Essential #3, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 2.3 (Support Industrial Water-Dependent Uses)**
- **WEDG® Credit 2.7 (Create Maritime or Environmental Employment Opportunities)**
- **WEDG® Credit 2.10 (Support Diverse and Sustainable Maritime Activity)**

***** See the final section of Essential 3 chapter for WEDG® credit description and select design strategies for coastal resilience planning and implementation.

#	Question	Guidance
3.1	**Funding Mechanisms (Public, Private, Blended)**	
3.1.1	To what extent has the city researched and explored possible funding sources for the long-term work required to reduce **coastal disaster risk** and increase **coastal resilience**?	**Coastal resilience** enhancement requires consistent multi-year actions that utilize both capital reserves and annual operating funds. Many cities lack a comprehensive understanding of potential **coastal resilience** funding sources, resulting in missed opportunities for financing necessary improvements. Financing methods and sources may include, but are not restricted to: • Public Funding: federal, state and local government grants (including matching grants), development financial institutions, international aid organizations • Special city assessments to address acute needs • Debt Capital & Investment instruments[6]: green, climate, social, sustainability, and resilience bonds, municipal bonds, green and blue bonds and tax increment funding (TIF) programs • Private Sector & Philanthropy: foundations, NGOs, corporate funding (e.g., insurers, large companies), public-private partnerships • Innovative & alternative models: Leasing, crowdfunding, development fees, blended finance

[6] For further resources on issuing sustainable debt capital (bonds/loans) for blue purposes, see the recently-released Ocean Investment Protocol framework and focus on the blue bond project categories when engaging with city treasury officials to raise capital for coastal resilience interventions at any scale

#	Question	Guidance
		• Targeted Government Collaboration: cost-sharing by and between public and private sector organization including Agency funding for **coastal resilience**-related projects (e.g., a transportation agency funding a bridge that enhances evacuation routes) • Tax-based Approaches: surcharges, special resilience taxes • **Resilience dividends**: capturing "co-benefits" from proactive resilience investments (see below) **Validation** • Proof of a review of financial reserves and other financial sources purposed towards **coastal disaster risk reduction** and **coastal resilience** purposes
3.1.2	To what extent are there adequate financial investments into critical resilient infrastructure such as flood barriers and drainage networks at a city scale for **coastal resilience**?	As climate risks intensify, many coastal cities face a growing gap between the need for resilient infrastructure—such as flood barriers, elevated roads, and drainage systems—and the financial resources available to implement them. Large-scale investments are required to upgrade or replace outdated systems, yet limited municipal budgets, competing priorities, and fragmented funding sources often stall progress. Without dedicated and scalable financing mechanisms, cities remain exposed to costly and recurring flood damage. Cities need to secure funding for creating resilient infrastructure, or hardening assets already in place, beginning with an assessment of the funding gap. Public expenditure reviews, climate finance tracking, and input from financial institutions can also highlight shortfalls and support strategic planning for future capital mobilization. **Validation** • Proof of resilient infrastructure assessments, cost estimates for greenfield and brownfield interventions, and direct investments into resilient coastal infrastructure assets
3.1.3	To what extent have **resilience dividends** been pursued to reduce the cost of, or enhance the value achieved from, **coastal disaster risk reduction** strategies?	**Resilience dividends**, often called co-benefits, arise in two ways and should be considered across all city projects: • Inbound dividends refer to investments for non-resilience reasons in the city that generate additional resilience benefits. For example, upgrades to a seawall or stormwater management system for operational purposes may also make the city more resistant to **coastal hazards**. Inbound dividends tend to reduce the funding needs of **coastal disaster risk** management • Outbound dividends occur when investments in **coastal resilience** provide additional, non-resilience benefits. For example, creating natural dune systems might also enable recreational and tourism opportunities, increasing the return on investment of **coastal disaster risk** management measures; and mangroves enhance **coastal resilience** while also supporting fisheries, as they provide vital breeding grounds and habitats for marine life. Outbound dividends tend to improve the business case for resilience investing and enable more funding **Validation** Coastal cities should explore **resilience dividends** as part of their funding strategies. While dividends are unlikely to meet all funding or business case needs, they can make a significant contribution. • Identification of inbound and outbound dividends for **coastal resilience** purposes

#	Question	Guidance
3.2	**Funding & Financing Plans**	
3.2.1	To what extent does the city have an integrated financial plan for the work required to reduce its **coastal disaster risk** and enhance **coastal resilience**?	Combined funding must be adequate for **coastal resilience** needs and deployed "as if" there were a single source and a single plan. If there are separate subsidiary plans (e.g., transportation, coastal zoning, or sustainability plans), these need to be coordinated, complete, and mutually consistent. **Validation** • Evidence of an integrated financial plan that aligns funding sources with specific **coastal resilience** objectives ensuring coordination of all efforts to address **coastal disaster risk reduction** needs • Evidence that plans will persist – even if changed or updated – through electoral cycles
3.2.2	To what extent does the city have a coherent capital expenditure plan, and to what extent are funds purposed and secured for **coastal resilience**?	Capital funding may be required for long-term **coastal resilience** projects, such as seawalls, wetland restoration, flood defenses, or other engineering projects. Funding strategies may include "design-build-operate" and/or design-build contracts, leasing, or other financing models aligned with **coastal resilience** goals. If funds are sourced from multiple stakeholders, their deployment must be coordinated, consistent with the financial plan, and protected from being diverted to non-resilience uses (sometimes referred to as "ring-fencing"). **Validation** • Evidence of an integrated, ringfenced capital plan that meets the city's **coastal disaster risk reduction** needs; should include integrated and comprehensive information from all stakeholders to effectively address the risks and protect funds from being allocated away
3.2.3	To what extent does the city have a coherent operating expense strategy for **coastal resilience**?	Capital investment usually also requires follow-on operating expense funding, whether in the form of debt servicing (interest) or for day-to-day operations, and upkeep and maintenance. Other resilience items (for example, rain gardens, vegetation management water storage features or city awareness activities) will be funded from operating expense from the outset but recur annually. If operating expense is met from a general fund, there needs to be a method of "ring fencing" that money so that it is not diverted to uses which do not reduce **coastal disaster risk**. As explained above, if that funding is coming from multiple sources there needs to be coherence and clarity about where the funds are allocated. If other stakeholders (e.g., energy utilities) are responsible for some of that spending then they need to be lobbied to ensure that they are financially planning to fulfil their roles also. **Validation** • Evidence of an integrated, ringfenced operating plan that meets the city's **coastal disaster risk reduction** needs

#	Question	Guidance
3.2.4	To what extent does the city have access to contingency funds to deal with a **coastal disaster**?	Coastal cities must develop integrated financial plans that not only align funding sources with specific resilience objectives but also include dedicated contingency funds (e.g., financial reserves, line-of-credit, financing) for responding to **coastal disasters**. Ensuring access to flexible reserves is essential for addressing immediate recovery needs and long-term adaptation efforts. Cities need to ensure that they will have access to sufficient contingency funds to deal with the aftermath of **coastal disaster risks** identified in Essential 2. **Validation** • Evidence of a plan for contingency funds adequate to deal with potential needs post-event
3.3	**Insurance, De-Risking & Financial Innovation**	
3.3.1	To what extent is insurance availability and affordability considered in the event of a **coastal disaster** the city? Is it understood what is covered by insurance? What protection gaps remain?	Insurance is a valuable resource for protecting assets and revenues in both public and private sectors, but there may be protection gaps - defined as the difference between insured and uninsured losses. The ability of individual property owners to repair or rebuild their homes (and those homes they may be renting) is a critical determinant of the probability of long-term city recovery from a **coastal disaster**. If residents or companies cannot afford to repair or rebuild, the city will suffer economically and socially. In most cities this will require adequate flood and wind insurance, either provided by the private sector or underwritten by a state or national government. Both public and private sector organizations should have a basic insurance coverage plan. The insurance market in some countries is beginning to develop approaches to insurance that reduce coverage costs based on adaptation and/or mitigation work carried out. Many city residents may underestimate the costs of rebuilding and replacing their possessions. They may also wrongly assume that their health insurance will cover disaster-related health issues. Cities need to: • Understand the level of insurance cover for their residential properties. • Understand government funds that might be available and the remaining gap • Persuade and/or help the uninsured and under-insured to get the cover they need. If data is not available on flood, wind, or hurricane coverage levels, surveys, or working with local insurance brokers to assess total insurance market penetration may help. Persuasion should be part of city engagement activity (E7) and all government-to-individual communications; help may be through targeted help for individuals, or neighborhood and landscape-scale action to mitigate risk in advance. **Validation** • % of homes with confirmed adequate insurance cover for loss of/repairs to premises in the worst case scenario in E2

#	Question	Guidance
		• % of residents with life insurance, for example such that youth who lose one or both parents in an event are able to survive and recover • % of residents with health insurance • Assistance for the financially vulnerable who cannot otherwise afford insurance • Delivery of city messaging on domestic insurance options • Availability of resilience-based premium discounts or incentives
3.3.2	To what extent is residential property insurance for **coastal disaster risks** accessible and affordable for property owners in the city?	Insurance affordability is a critical component of **coastal resilience**, ensuring that property owners can maintain financial health against acute and chronic **coastal disasters**. Rising premiums, exclusions for specific risks, and high deductibles can leave homeowners financially vulnerable, even if coverage is technically available. Cities with limited access may face long-term economic instability and lower recovery capacity. Cities need to: • Assess whether insurance options cover a meaningful portion of **coastal hazard**-related damages • Work with insurers and policymakers to explore mitigation measures that could stabilize or guarantee insurance coverage and costs • Ensure city awareness of available coverage options and financial assistance programs **Validation** • Evidence of local/state insurance assistance programs to improve coverage and affordability
3.3.3	To what extent are insurers maintaining or withdrawing property insurance coverage in the city due to the increasing exposure to **coastal disaster risks** (if applicable to region)?	As **coastal disaster risks** increase, insurers may reassess their market exposure, leading to reduced coverage, policy non-renewals, or full geo-based withdrawals. These shifts can leave homeowners without viable insurance options or force them into unsustainable, high-cost policies. States may need to offer "back-up" insurance options if private sector withdrawal is too severe. Understanding insurance availability trends and communicating with insurers helps cities anticipate gaps and explore strategies to stabilize coverage options. Cities need to: • Monitor changes in the number of active insurers in the region • Identify coverage trends and areas where policy non-renewals or cancellations are increasing • Establish contingency plans for homeowners losing private coverage **Validation** • Evidence of a tracking system for insurer participation and market withdrawals • Availability of alternative insurance programs (e.g., state-backed insurance pools)

#	Question	Guidance
		• Documentation of city-level engagement with insurers on **coastal disaster risk reduction** strategies
3.3.4	To what extent do city residents have access to affordable automobile insurance that covers them for coastal-related vehicle risks (if applicable to region)?	In many countries (including the US), vehicles damaged by **coastal hazards** such as storm surge, flooding, and hurricanes are typically covered under comprehensive auto insurance policies, rather than domestic property insurance. City residents who lose their vehicles to these hazards may face significant disruptions, including an inability to commute to work or access essential services, particularly in rural and island cities, and thus incur major costs. This loss can impact the economic stability and resilience of cities. Cities should ensure that residents are aware of the need for comprehensive automobile insurance coverage, including protection from flood and hurricane-related damages, as part of their resilience planning and outreach efforts (Essential 7). **Validation** • Delivery of automobile insurance needs
3.3.5	To what extent do city residents have excess coverage insurance for other **coastal disaster**-related costs (if applicable to region)?	Losses from **coastal disasters** may extend beyond direct property damage and include additional financial burdens such as temporary displacement costs, loss of property use, damage to boats and marine assets, or loss of income from business disruptions. These gaps in coverage can impose significant economic challenges for affected cities. Coastal cities should educate their residents on the importance of comprehensive insurance coverage that includes protection against additional losses. **Validation** • Delivery of excess coverage insurance needs
3.3.6	To what extent is business insurance adequate in the city for **coastal disaster risks** (if applicable to region)?	The ability of coastal businesses to repair or rebuild after hurricanes, storm surges, or flooding, and to survive the loss of cash flow (business interruption/continuity losses) while doing so, is crucial to the long-term recovery of cities. If businesses cannot restart, the local economy will suffer: for example, it took over a decade for the economy of New Orleans to fully stabilize after Hurricane Katrina in 2005. Insurance for property, stock loss and business continuity losses can make the difference between going out of business and survival. This is especially true for small businesses that may have limited cashflow and limited resources to pay for re-stocking or purchasing new premises or equipment. As with residential insurance, adequate coastal risk insurance for businesses may need to come from the private sector or be supported through state, national, international government and blended finance programs. In some regions, the insurance market is evolving to offer coverage incentives for businesses that invest in **coastal disaster risk reduction** measures such as floodproofing, elevating buildings, or reinforcing structures against wind damage. It may also be possible to cover cashflow losses with parametric insurance that usually pays out more rapidly than conventional insurance, albeit with a higher uninsured portion based on sizing and scoping of contracts.

#	Question	Guidance
		Insurance cover will need to be sized to offset the likely increase in costs after a **coastal disaster**. Cities need to: • Assess the level of **coastal hazard** insurance coverage available for businesses' stock losses, property or asset damage and business continuity • Educate business owners on what insurance coverage they may need, including business interruption insurance • Assist uninsured and underinsured businesses in exploring and obtaining appropriate coverage If data on coastal business insurance coverage is lacking, surveys or collaboration with local insurance brokers can help assess market penetration. Encouraging businesses to obtain adequate coverage should be a key part of city engagement activity (Essential 7), including outreach through Chambers of Commerce, business networks, and municipal planning efforts. **Validation** • Delivery of city and business-level insurance needs • Assistance for smaller businesses that would not otherwise afford insurance • % of businesses with adequate insurance cover for loss of/repairs to premises and loss of business in the worst case scenario in E2 • % of local GDP protected
3.3.7	To what extent is commercial insurance adequate to cover losses related to privately owned coastal assets such as tourism, fisheries & agriculture, real estate and timberlands (if applicable to region)?	As a subset of business insurance needs, coastal landowners, farmers, and fisheries must ensure that their assets—such as crops, fisheries, and timber—are insured against **coastal disaster risks**. Insurance gaps in these sectors can result in substantial economic losses and prolonged disruptions to local economies. Examples of these losses include: • Saltwater intrusion into aquifers and freshwater irrigation systems can devastate agricultural production as well as water utility infrastructure before geohazards arise from shifting hydrology • Hurricane-induced destruction of timber resources, such as the massive losses in Florida's Panhandle after Hurricane Michael, from strong wind. Cities need to: • Assess the availability and affordability of insurance for coastal and maritime industries such as farming, fisheries, tourism, real estate, and forestry • Provide education and outreach to landowners, farmers, and fishery operators on risk exposure and appropriate insurance coverage • Work with insurers and policymakers to expand or adapt insurance products to better reflect risks **Validation** • Demonstrated adequacy of farming, fisheries, and forestry insurance to cover likely **coastal disaster risks**

#	Question	Guidance
3.3.8	To what extent are the city's insurance coverage and other financial means adequate to cover public buildings (i.e., courthouses, offices, utilities, facilities, infrastructure) against **coastal disaster risks** (if applicable to region)?	In many coastal cities, critical infrastructure such as water, energy, and transportation systems may be self-insured or covered by government-backed programs. However, where such coverage does not apply, cities must rely on private insurance to protect against flooding, storm surge, wind damage, and loss of service from their own assets. For example, after hurricanes, cities may need alternative water and power sources if primary infrastructure is damaged. Cities need to: • Confirm that they can withstand potential losses from **coastal hazards** where self-insuring (see Essential 8 for infrastructure costs) • Ensure they fully understand the terms and limitations of government-backed insurance programs • Identify and fill coverage gaps with private insurance, including loss of use coverage for essential facilities and services **Validation** • Demonstrated adequacy of the city's insurance and financial coverage for critical assets and facilities in service to **coastal resilience**
3.3.9	To what extent is the city's insurance coverage adequate to cover liabilities arising from **coastal disasters** (if applicable to region)?	If a coastal city is found liable for failures in mitigation, planning, or response to disasters such as storm surges, flooding, or infrastructure failures, it may face significant financial liabilities. This applies even when other aspects of disaster preparedness are well-executed. This possibility needs to be planned for, to mitigate the risk of a potentially crippling financial burden. Cities need to: • Ensure they have adequate liability insurance to cover potential legal and financial risks associated with **coastal disasters** such as flooding, storm damage, or infrastructure failures • Plan for long-term financial resilience by evaluating the scope of potential liabilities and securing appropriate insurance coverage • Collaborate with legal and risk management experts to identify vulnerabilities and implement preventative risk-reduction measures **Validation** • Demonstrated presence of liability insurance proportional to the city's risk exposure
3.3.10	To what extent has the city investigated alternatives to traditional insurance such as innovative products and evaluated ways to reduce traditional insurance costs for **coastal disaster risks**?	Parametric insurance has been used for crop, earthquake, and hurricane coverage and could be applied to **coastal disaster events**, such as storm surge, flooding, and hurricane-related damages. Some insurers have begun exploring parametric models for **coastal resilience**, such as faster payouts tied to measurable storm intensity thresholds, which could provide immediate financial relief for impacted cities. Cities need to:

#	Question	Guidance
		• Explore alternative insurance mechanisms, such as parametric insurance, catastrophe & resilience bonds including municipal debt offerings, and public-private partnership co-investment funds • Assess whether **coastal disaster** financing programs (e.g., low-interest loans, federal reimbursement mechanisms) could supplement or reduce reliance on traditional insurance • Advocate for policy changes to enable broader access to innovative insurance solutions **Validation** • Demonstrated exploration of alternative financial protection mechanisms beyond traditional insurance
3.3.11	To what extent does the city have adequate municipal debt insurance supporting its capital raising goals for **coastal disaster risk reduction** and **coastal resilience**?	Increasingly, disaster prone cities are finding that bond insurance is hard to obtain, meaning that their ability to issue bonds to deal with post-event reconstruction costs may be problematic. Cities need to understand their likely bond insurance position before a major event and confirm that cover will remain adequate for their needs - or alternatively, devise other recovery fund strategies. **Validation** • Evidence of credible bond insurance, whether or not bonds are part of the **coastal disaster risk reduction** financing strategy – they will need to be in place before they can be purposes to **coastal resilience**
3.4	**Financial Incentives**	
3.4.1	To what extent has the city created financial incentives to help homeowners reduce their vulnerability and exposure to **coastal disaster risks**?	Incentives for **coastal disaster risk reduction** can come from multiple sources including, as examples: • Free resilience advice on floodproofing, wind mitigation, and elevation strategies • Discounts at local hardware stores for storm shutters, flood barriers, and reinforced roofing materials • Tax credits and rebates for home elevation, seawall improvements, rain gardens, permeable landscaping or other adaptation actions • City-provided discounts on services such as home inspections and storm preparedness programs • Tax incentive funding • Expedited (and discounted) permitting and inspections for home resilience improvements • Matching grants or direct funding for property hardening measures • Low-interest or no-interest loans for home retrofitting projects • Property tax reductions for homeowners who implement flood and wind resistance upgrades • Organized crowdfunding **Validation** • Evidence of compelling incentives for homeowners (and renters) to harden properties against acute and chronic **coastal disaster risks**; incentives should partner between state and local governments, financial institutions and private organizations

#	Question	Guidance
3.4.2	To what extent has the city created financial incentives for businesses (particularly small-to-medium enterprises) to reduce vulnerability and exposure to **coastal disaster risks**?	Financial incentives play a crucial role in helping businesses, especially small-to-medium enterprises (SMEs), invest in measures that reduce their exposure to **coastal disaster risks**. Without support, SMEs may struggle to implement necessary adaptations, leaving them more vulnerable to disruptions from acute and chronic coastal events and stresses. Incentives can come from multiple sources including, as examples: • Discounts on city-provided resilience services such as risk and resilience assessments, business continuity planning or adaptation planning • Guaranteed contracts with local governments for businesses that meet resilience standards (where legally permissible) • Expedited and discounted permitting & inspections for climate adaptation projects • Matching grants or direct funding for storm-resistant improvements • Low-interest loans for businesses investing in climate resilience • Tax incentives for businesses that implement risk reduction measures **Validation** • Evidence of compelling incentives for businesses to harden infrastructure assets and properties
3.4.3	To what extent has the city created financial incentives to non-governmental organizations (NGOs) and city groups to help reduce vulnerability and exposure to **coastal disaster risks**?	The potential for NGOs and city organizations to support **coastal disaster risk reduction** and emergency response is significant. For example: • Churches and neighborhood organizations can assist with city engagement (E7) and also, in some cases, with food provisioning after a coastal emergency; environmental groups can support coastal restoration efforts • Schools and universities can lead citizen science programs that monitor sea level rise, shoreline erosion, and evolving flooding patterns to make key data more available and usable • Recreational groups (e.g., fishing, diving, or boating clubs) can log reports of coastal degradation or hazards affecting shorelines and marine ecosystems • Organizations supporting disadvantaged cities can help deliver **coastal disaster risk** preparedness education and early warning systems • Sustainability groups can promote climate-adaptive agriculture and coastal land use practices that mitigate risks from rising seas and extreme weather Cities need to create ways to "help these groups help the city" in **coastal disaster risk reduction**, with grants, cost recovery, publicity and so on. **Validation** • Evidence of active non-governmental organization (NGO) support in **coastal disaster risk reduction** with city incentives enabling some proportion of their planned activity

#	Question	Guidance
3.4.4	To what extent does the city regulate adverse financial incentives that work against **coastal disaster risk reduction**?	Just as the city should encourage, by whatever means, **coastal disaster risk reduction**, it should avoid providing incentives for individuals, businesses, and activities that will increase **coastal disaster risk** or create moral hazard, where financial incentives lead to riskier short-, medium- and long-term adverse outcomes. Activities and perverse incentives that increase **coastal disaster risk** might include using funds to enable: • Subsidizing development in high-risk flood zones • Providing incentives for rebuilding in repetitive loss areas rather than promoting orderly relocation and/or retreat • Failing to require climate-resilient or green infrastructure as a condition for new developments • Offering tax breaks or insurance subsidies for high-risk coastal properties without mitigation requirements where property owners assume they will be bailed out • Encouraging shoreline hardening techniques (e.g., bulkheads, seawalls) that may increase coastal erosion and long-term vulnerability rather than benefitting from sustainable nature-based methods (see Essential 8) Cities need to review their policies and incentives to ensure they do not deliberately or accidentally encourage behavior that undermines **coastal resilience**, in particular with critical infrastructure. **Validation** • Evidence of such a review and absence of adverse incentives • Evidence of policies discouraging repetitive-loss development in high risk coastal areas • Incentive programs tied to resilience-building measures including **Resilience Dividends**

Support Industrial Water-Dependent Uses (WEDG® Credit 2.3)

Description

When strengthening financial capacity for coastal resilience, a city should support water-dependent uses such as commercial shipping to promote associated economic, coastal recreational uses, military and coastal protection assets while providing economic, environmental and public health benefits. Water-dependent industrial uses can revitalize waterways and provide economic and social benefits. Coastal resilience and resilience is both a capital investment priority as well as operation funding responsibility.

Design Strategies

- Loading and shipping raw materials or large components that are difficult to transfer on land such as cement or offshore wind structures, uses requiring large amounts of water for processing and cooling such as hydroelectric power plants, shipping operations that replace truck or air freight with barges or ships, as well as light industry operations such as fisheries, offshore wind maintenance, or tug operations.

For more details, see the **WEDG® Version 3.0 Manual**, pages 66-67.

Create Maritime or Environmental Employment Opportunities (WEDG® Credit 2.7)

Description

When strengthening financial capacity for coastal resilience, a city should provide employment opportunities and vocational training in maritime or environmental fields to support the local sustainable blue economy.

Design Strategies

Supporting maritime or environmental jobs as well as education and skills development can be important aspects of a vibrant coastal city and support environmental justice goals. Job and applicant quality can be strengthened through partnerships with local workforce development organizations; high schools, technical or vocational schools, colleges, and other educational providers. Additionally, partnerships with local work placement programs can help employers reduce costs, seek quality candidates, and preferentially direct outreach and job provision to local residents, low-income applicants, and historically underserved cities. Apprenticeship programs offer another pathway that couples on-the-job training with sustainable, long-term positions where specialized experience is required.

For more details, see the **WEDG® Version 3.0 Manual**, pages 74-75.

Support Diverse and Sustainable Maritime Activity (WEDG® Credit 2.10)

Description

When strengthening financial capacity for coastal resilience, a city should promote low-impact, safe design for critical coastal domains that accommodates a diverse range of vessels, facilitates educational programming and supports sustainable blue economy activities.

Design Strategies

- Floating Docks, Pier Renewals, Mooring Fields

For more details, see the **WEDG® Version 3.0 Manual**, pages 82-85.

ESSENTIAL 4: PURSUE RESILIENT URBAN DEVELOPMENT AND DESIGN

This E4 chapter focuses on the **Prevention Period** and primarily addresses adequacy of the city's land use and building codes with respect to **coastal disaster risk reduction** and **coastal resilience** and enforcement thereof.

For Essential #4, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 1.1 (Avoid or Reduce Flood Risk from the Waterbody)** – (See E2)
- **WEDG® Credit 1.2 (Reduce Pluvial Flooding and Stormwater Discharge) –** (See E2)
- **WEDG® Credit 1.3 (Improve Stormwater Discharge Quality)**
- **WEDG® Credit 1.5 (Reduce Contribution to Urban Heat)**
- **WEDG® Credit 2.6 (Increase Transportation Access to the Waterfront)**
- **WEDG® Credit 2.8 (Increase Waterfront Pathways and Greenway Connectivity)**
- **WEDG® Credit 3.1 (Choose an Appropriate Edge Composition for the Context and Intended Use)**
- **WEDG® Credit 4.1 (Site with Ecological Sensitivity)**

***** See the final section of Essential 4 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
4.1	**Land Use**	
4.1.1	To what extent has coastal land use zoning been defined or considered? (See E2 for summary % of properties and of economy at risk)	Many cities in **coastal hazard** areas were initially laid out with little or under-appreciated consideration of flooding or landslide risk future evolution and as a result find themselves seriously exposed with stationary assets today. Zoning should consider both current **coastal disaster risks** and hazards, as well as potential future, climate-amplified **coastal disaster risks**, such as sea level rise, increasing storm intensity, unstable soil types, and areas expected to become prone to landslides because of coastal erosion. Cities need to acknowledge these **coastal disaster risks**, where present, in their planning and, especially (but not only) for new development or construction. Cities should be open to new ideas about offsetting mitigation practices. These may delay full retreat from the coastline by many years while evaluating the challenging topic of managed retreat in particular geocodes. **Validation** • Land use zoning defined with the **coastal disaster risks** identified in E2 in mind

#	Question	Guidance
4.1.2	To what extent is the city building in areas known to be a natural **coastal watershed**? (See E2 for summary % of properties and of economy at risk)	Cities built into coastal watersheds are known to exacerbate the **coastal disaster risk** profile, essentially because they increase the exposure to additional water-related hazards, or the "attack surface" (i.e., the extent of directly bordering on wild or open land). The higher risk exposure or attack surface allows rainwater, surface runoff, or groundwater to funnel into places where it stands and causes harm. While, once again, mitigation measures may be limited in the short-term, cities need to account for the risk in their planning and use it to drive other offsetting mitigation activities. For example, the California Coastal Commission enforces the California Coastal Act[vii], which includes policies to protect coastal watersheds by regulating development activities and evolving coastal management challenges. In addition to refraining from building on coastal watersheds, cities should consider implementing green infrastructure[viii] solutions like permeable pavements, bioswales, and urban forests to manage stormwater and enhance the natural features of drainage systems. **Validation** • Land use zoning defined to restrict building in watershed drains • % of properties within 0.5 miles of critical watershed areas as a key risk indicator
4.1.3	To what extent are land zoning rules applying **coastal disaster risk reduction** measures enforced?	Lack of enforcement can undermine the effectiveness of **coastal disaster risk reduction** features of land zoning policies or rules and is an issue in many countries and US States. A lack of enforcement and code compliance can exacerbate structural vulnerabilities and public unpreparedness, leading to widespread disruption, damage and loss during and after **coastal disaster events**. Cities must ensure that their **coastal disaster risk** land use zoning is adhered to by local regulators, developers, and authorities, with effective enforcement mechanisms, collaboration, and regular monitoring, to mitigate environmental risks. **Validation** • % of properties of any kind sited contrary to zoning rules since current zones were established • % of properties "grandfathered in" under less stringent zoning rules
4.2	**Building & Construction Standards**	
4.2.1	To what extent do building codes and construction materials mandate flood, wind, and landslide-resistant features in all residential, public, municipal and business constructions?	While each coastal city will have its own building codes the key is to be certain that they maximize protection against of flood, wind and landslide risks, for example (not exhaustive): • Flood-resistant materials (that can endure prolonged water exposure) • Pollutant capture to prevent road runoff and other sources from contaminating drinking water, or marine and freshwater aquatic ecosystems (e.g., filtration strategy for both small and large particulates) • Elevated construction • Hurricane- or cyclone-resistant roofs, windows and doors

#	Question	Guidance
		• Sealed gaps where utilities enter each property • Slope stabilization and retaining walls • For landslides (if included) - slope stabilization techniques, retaining walls, etc. • Rockfall barriers and netting in rockslide-prone areas • Early warning systems Cities need to ensure that their codes for residential and commercial construction embody provisions of this type, and that they are adequate for the city's **coastal resilience** needs. **Validation** • Evidence of codes suitable for advanced flood, wind and geohazard risk mitigation • Flood elevation design and implementation as well as wind-resistant reinforcement • Some U.S. public data sources are included in the footnote below[7]
4.2.2	To what extent do codes mandate that street layouts allow unimpeded ingress and egress from a coastal neighborhood, and provide multiple access/escape routes in the event of a **coastal disaster**? (See also E2)	People have been put at risk in coastal areas as a result of restricted carrying capacity on local roads, or when single access/escape routes became flooded, blocked by debris, or damaged during storms or flooding events. Cities need to account for the risk that road capacities and layouts may pose in their **coastal resilience** planning and develop offsetting mitigation approaches. Building codes for new neighborhoods need to address the issue to avoid the accumulation of risk. **Validation** • % of domestic or commercial properties in the city (or neighborhood within the city) with impeded ingress or egress from an area, or single access/escape routes prone to flooding or storm damage as key risk indicators • Absence of properties that encourage people to congregate (for example, churches, shops, sporting venues, schools) in this situation
4.3	**Physical Asset Resilience Standards**	
4.3.1	To what extent are formal standards for physical asset resilience implemented that may exceed local land use requirements or local building and construction in service to **coastal resilience**?	Adherence to formal standards from international bodies such as BSI, ISO, ASTM, and others may enable higher levels of **coastal disaster risk reduction** than local building codes. For example: BSI 85500:2015: Standard for flood resistant and resilient construction ISO 22301:2019 - Security and resilience ISO 14091:2021 - Guidelines on vulnerability, impacts and risk assessment ASTM E3429: Property Resilience Assessment Methods

[7] **FEMA**: Home Builders' Guide to Coastal Construction, December 2010; **FEMA**: Building Science Resource Library

#	Question	Guidance
		Validation • % of properties conforming to standards in excess of local building codes/minimum requirements – both new builds and retrofits where local protection is enhanced beyond regulations; cities should give consideration to a set frequency of review and a logical certification/re-certification cycle

Improve Stormwater Discharge Quality (WEDG® Credit 1.3)

Description

When pursuing resilient urban development and design for coastal resilience, a city should reduce impacts of stormwater. Stormwater, particularly in urban areas, can acquire particulates, chemicals, litter, excessive nutrients, and other pollutants. Stormwater can accrue heat running over impervious surfaces before discharging into adjacent waterbodies, contributing to pollution of waters.

Design Strategies

- Avoid fertilizing and pesticide/herbicide uses during the wettest periods of any calendar year
- Contain and control storage of petroleum and chemical products
- Align with regional water quality plans
- Where appropriate, the restoration or reintroduction of wetlands can aid in filtration and velocity reduction of stormwater entering the waterbody. If wetland capacity cannot accommodate total maximum daily load requirements, consider approaches that combine natural and engineered systems.
- Use buffers or natural shorelines at the water's edge and between waterbodies and impervious surfaces to infiltrate, filter, and cool stormwater before it enters the waterbody.

Photo: Stormwater Retention and Filtration Basin, **Credit:** Waterfront Alliance

For more details, see the **WEDG® Version 3.0 Manual**, pages 51-53.

Reduce Contribution to Urban Heat (WEDG® Credit 1.5)

Description

When pursuing resilient urban development and design for coastal resilience, a city should reduce contributions to impacts of impervious and heat-absorbing surfaces. In the built environment, the cumulative impact of heat-absorbing materials (e.g., asphalt pavement, roofing material) and local industrial and air-conditioning processes, which increase heat into the air, can drive localized temperatures even higher than regional averages, impacting human health and environment and increasing energy demands. Urban heat is not only an environmental concern but also contributes to environmental injustice.

Design Strategies

- Reduce Impervious Surfaces; utilize permeable surfaces for streets, roads and parking lots as part of storm water management strategy
- Use High-Albedo Materials
- Employ green infrastructure to extent feasible
- Employ the Cooling Effects of Wind
- Increase Shade and Evapotranspiration

For more details, see the **WEDG® Version 3.0 Manual**, pages 56-57.

Increase Transportation Access to the Waterfront (WEDG® Credit 2.6)

Description

When pursuing resilient urban design and development for coastal resilience, a city should improve public access to coastal sites by expanding and encouraging sustainable transportation options, especially waterborne transportation. Increased transportation options provide multiple benefits for city access and evacuation. Subsurface transportation rail systems may not be operable during flooding but may be used for temporary stormwater retention

Design Strategies

- Land-based Transportation
- Waterborne Transportation

For more details, see the **WEDG® Version 3.0 Manual**, pages 72-73.

Increase Waterfront Pathway and Greenway Connectivity (WEDG® Credit 2.8)

Description

When pursuing resilient urban development and design for coastal resilience, a city should increase connectivity of green and blue spaces along the waterfront to promote physical activity, health and well-being and encourage non-motorized transportation options.

Design Strategies

- Pedestrian Pathways
- Biking and Pedestrian Greenways
- Elevated Paths and Boardwalks
- Stabilization and Adaptability

Photo: Greenway, **Credit:** Waterfront Alliance

For more details, see the **WEDG® Version 3.0 Manual**, pages 76-78.

Choose an Appropriate Edge Composition for the Context and Intended Use (WEDG® Credit 3.1)

Description

Ensure the structural integrity and sustainability of the shoreline and near-shore area using a waterfront edge that has the greatest possible positive impact while also managing for erosion, coastal protection, and site use.

Design Strategies

- Assess erosion risks at the site and its primary contributors to understand whether the waterfront must be stabilized.
- Determine what requirements or erosion pressures the future site use may put on the waterfront.
- Reduce the potential for scour (erosion around a structural component like a wall or support wall) from multiple angles.
- Provide functionality for multiple water levels, such as through the use of floating docks.

For more details, see the **WEDG Version 3.0 Manual**, pages 87-89.

Site with Ecological Sensitivity (WEDG® Credit 4.1)

Description:

Prevent adverse ecological impacts and increase resilience to the effects of climate change by establishing proper buffer zones between development and sensitive habitats including the waterfront.

Design Strategies

- Consider the protection of waterfront sites through conservation easements, transfer of development rights, or other preservation methods.
- For projects on undeveloped lands, site structures and modifications away from intact habitats.
- Consider predictions for channel and shoreline migration during the design life of the project.
- Consider buffers away from the water: 200 feet from Mean Higher-High Water for tidal zones, 100 feet from the beach vegetation line, 100 feet from Mean Higher-High Water in estuary zones, and 50 feet from vulnerable ecological features such as dunes or bluffs.

For more details, see the **WEDG Version 3.0 Manual,** pages 99-100.

ESSENTIAL 5: SAFEGUARD NATURAL BUFFERS TO ENHANCE ECOSYSTEMS' PROTECTIVE FUNCTIONS

The E5 chapter focuses on the **Prevention Period** and primarily addresses the protection and enhancement qualities of ecosystem services that serve to reduce **coastal disasters risks** and in aggregate build towards scalable, effective city-wide **coastal resilience**.

For Essential #5, the following WEDG® V3.0 credits can provide additional guidance, illustrative practices and design strategies for application an individual waterfront project:

- **WEDG® Credit 3.1 (Choose an Appropriate Edge Composition for the Context and Intended Use)**
- **WEDG® Credit 3.2 (Maintain or Emulate Natural Shoreline Shape and Slope)**
- **WEDG® Credit 3.4 (Ecologically Enhanced Structural Components)**

- **WEDG® Credit 4.1 (Site with Ecological Sensitivity)**
- **WEDG® Credit 4.2 (Create, Restore, or Maintain Habitats and Ecosystem Services)**
- **WEDG® Credit 4.3 (Preserve and Increase Ecosystem Connectivity)**
- **WEDG® Credit 4.4 (Support Native Habitat Complexity and Biodiversity)**
- **WEDG® Credit 4.5 (Avoid Human Disturbances to Natural Resources)**
- **WEDG® Credit 4.6 (Redevelop and Clean Up Degraded Sites)**
- **WEDG® Credit 4.7 (Practice Sustainable Fill and Soil Management)**
- **WEDG® Credit 4.9 (Reduce Emissions through Carbon Management)**
- **WEDG® Credit 4.10 (Practice Environmentally Responsible Construction)**
- **WEDG® Credit 4.11 (Reduce Water Use)**

***** See the final section of Essential 5 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
5.1	**Coastal Ecosystem Services**	
5.1.1	To what extent does the city identify and assess **coastal ecosystem services** today to provide **coastal disaster risk reduction**?	Ecosystem services (where deliberately encouraged, also called nature-based methods or blue/green infrastructure) can play a critical role in enhancing **coastal resilience** by harnessing or extending ecological features to attenuate wave energy, mitigate flood risks, reduce erosion, reduce storm surge, and improve ecological health, among other benefits. Cities are increasingly deploying such approaches, including:

#	Question	Guidance
		• Living shorelines (marsh creation, mangrove restoration) • Green roofs, greenways and quick-draining/permeable pavements to manage urban stormwater charge, discharge, and runoff • Wetland restoration to absorb excess runoff and act as a natural buffer between natural and built environments Blue-green infrastructure may be used in conjunction with more traditional grey engineered infrastructure - see below). Cities need to understand the potential for ecosystem services to reduce **coastal disaster risk profiles** and plan to integrate these into their **coastal resilience** activities. **Validation** • % total **coastal disaster risk reduction** through use of nature-based methods (if calculable) • % of relevant land area and properties made more flood-resilient in some way through use of nature-based methods • % of large landowners and land area with material nature-based solution plans
5.2	**Coastal Ecosystem Protection**	
5.2.1	To what extent are protective **coastal ecosystem services** an integrated part of the city's nature and biodiversity conservation, restoration and sustainability efforts?	If some part of a city's **coastal disaster risk reduction** positioning is dependent on ecosystem services, then self-evidently it is essential to maintain the health and buffering capacity of those services and protect them from the adverse effects of human activity. For example, poor maintenance of dunes by allowing the dune vegetation to degrade or die-off can make the dunes more susceptible to erosion and overtopping in the event of a storm. Building directly on them will also reduce their effectiveness. It is essential to consider that coastal ecosystem health is dynamic – what may be healthy now may become stressed due to overuse or depletion as well as from climate change – natural and/or human-induced. Cities need to anticipate these impacts and plan for them. This goes beyond capex for new builds and refurbishments but also capital budgeting for planned and estimated maintenance costs associated with coastal ecosystem protection. **Validation** • Evidence of monitoring and management plans to sustain or enhance ecosystem-based disaster protection • For each ecosystem service in the landscape, % assessed as "healthy" or better (e.g., "growing", "flourishing") • The trend over time in this assessment
5.2.2	To what extent are **coastal ecosystem services** identified by stakeholders as having a resilience value also given a financial value?	Valuation of ecosystem services is important to establish the business case (i.e., return on investment - ROI) for protecting and enhancing the city's physical sites and assets. Cities need to understand these values as inputs for ecosystem protection budgets and grant application management.

#	Question	Guidance
	(See also E3 for insight on financing coastal ecosystem services at city or site/asset scales)	Ecosystem services that help with **coastal disaster risk reduction** are capable of being valued, in several ways: • The economic value (GDP), property and lives they help to protect or boost combined with the level of **coastal disaster risk reduction** they bring about • Investment in other forms of protection or asset hardening that they allow to be avoided or reduced "Dividends" or co-benefits beyond coastal flood risk reduction. For example: • Benefit to other species or activities with economic value of their own (e.g. fisheries and aquaculture) • Landscape amenity value, tourism & leisure values • Property values • Decreased coastal erosion due to vegetation holding sand or soils in place **Validation** • Financial valuation of ecosystem services and thus the ROI for defending and enhancing them; natural capital accounting can be used to tabulate the impacts and dependencies ecosystem services have on both financial and real economy applications
5.3	**Balancing Green-Blue-Gray Infrastructure**	
5.3.1	To what extent are **coastal nature-based solutions** (i.e., green and blue) balanced with human-built engineering (i.e., gray)?	Nature-based methods should be considered as one set of strategies, whose use should be maximized, but not to the exclusion of hardened traditional engineering approaches where these may be required. Ideally, they will be used in combination as in hybrid approaches. For example: • Dunes may be restored and replanted but with a more resistant engineered core or one that utilizes biopolymer enhancement, or backed by a concrete seawall • Mangroves may be restored with carefully placed breakwater features to perform wave attenuation for defensive purposes • Reefs may be restored with both natural and artificial approaches Cities need a clear set of policies and plans for considering, and balancing the city's nature-based or "blue/green" methods, with "gray" methods. **Validation** • Evidence of such policies and evidence of their application in implementation

Choose an Appropriate Edge Composition for the Context and Intended Use (WEDG® Credit 3.1)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should ensure the structural integrity and sustainability of the shoreline and near-shore area using a waterfront edge that has the greatest possible positive impact on the environment and city, given the intended use and context.

Design Strategies

- Consider shifts to structural stability (e.g., shear strength of soils) and shape due to increased inundation frequency over time as well as appropriate adaptive management and maintenance strategies; Consider the effects of potential flooding behind structures and analyze impacts to the adjacent structures and shorelines
- Consider width and slope available accounting for land elevation and tidal range, future high tide level, changing lake levels, flood conditions and other water level changes.

Natural assets like mangroves (shown above) can play critical ecosystem services roles and protect coastal communities from disruption, damage and loss. For more details, see the **WEDG® Version 3.0 Manual**, pages 87-90.

Maintain or Emulate Natural Shoreline Shape and Slope (WEDG® Credit 3.2)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should support native biodiversity and reduce the impacts of channelization by maintaining or mimicking local, natural shoreline shape, slope, material and heterogeneity to the extent possible.

Design Strategies

- Identify local areas that demonstrate the likely shape and slope of the shoreline prior to human intervention, which can serve as a natural reference condition for sites within a city's coastal resilience plans. Reference conditions may contain natural or designed living shorelines. Hydrological projections will be needed to understand erosion, flooding, sediment transport, wave regime, current velocity and other impacts.

For more details, see the **WEDG® Version 3.0 Manual**, pages 91-92.

Ecologically Enhance Structural Components (WEDG® Credit 3.4)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should lower the impact and improve the biodiversity of human-made edges by mimicking the structural heterogeneity and materials of the local natural shoreline. If human-made stabilization is needed to support the intended use and context, incorporating complexity and living material into the structures improves the habitat value and reduces the impact of their construction.

Design Strategies

- Use rough, textured, surfaces or varied gradation of rock that create interstitial spaces of varied size and shape, using a material with a pH that fosters attachment or provides refugia for native aquatic organisms. Examples include habitat and reef modules, oyster reefs, form liners, molds, pile casings, and structural enhancements.

For more details, see the **WEDG® Version 3.0 Manual**, pages 95-97.

Before and after photos when ecologically enhanced concrete is deployed. **Credit:** ECOncrete

Site with Ecological Sensitivity (WEDG® Credit 4.1)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should prevent adverse ecological impacts caused by structures to important habitat areas and increase resilience to effects of climate change.

Design Strategies

- Marine, estuarine, riverine, lacustrine, palustrine and other types of natural habitat buffers can be developed
- Consider how habitat buffers protect existing habitat spaces from human impacts, but over time climate change, river channel migration and water-level changes can shift the location of habitats upland, in a phenomenon known as habitat migration or wetland migration.

For more details, see the **WEDG® Version 3.0 Manual**, pages 99-100.

Create, Restore, or Maintain Habitats and Ecosystem Services (WEDG® Credit 4.2)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should foster biodiversity and ecosystem services by creating, restoring, or maintaining habitat space.

Design Strategies

- Maintain intact and significant habitats and ecosystem services
- Create or restore habitat

For more details, see the **WEDG® Version 3.0 Manual**, pages 101-104.

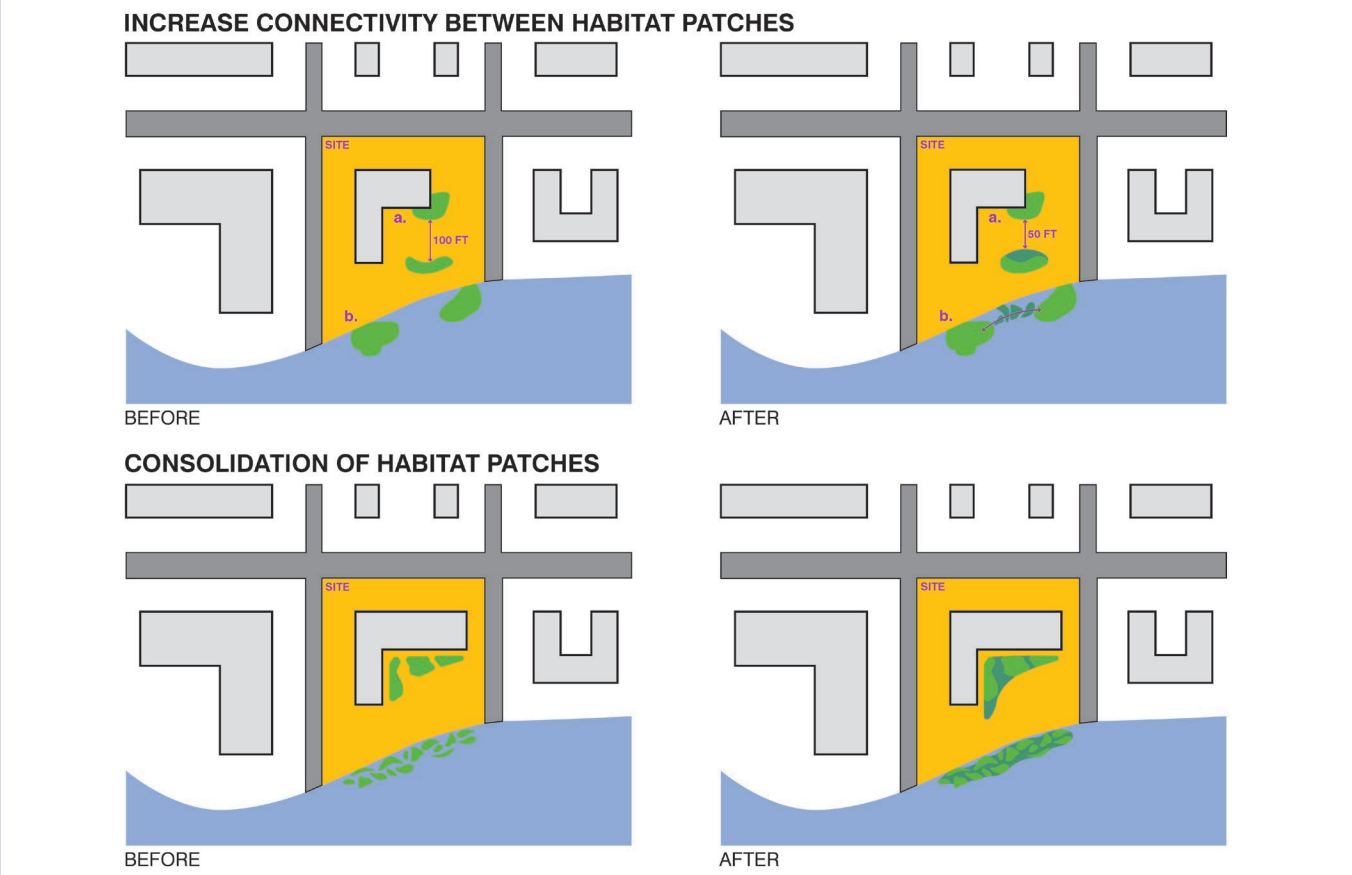
Preserve and Increase Ecosystem Connectivity (WEDG® Credit 4.3)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should increase the diversity of habitats, restore continuity of ecosystems, and reduce fragmentation.

Design Strategies

- **Habitat patch** (i.e., contiguous naturalized areas) creation and maintenance in both upland and in-water settings



For more details, see the **WEDG® Version 3.0 Manual**, pages 105-106.

Support Native Habitat Complexity and Biodiversity (WEDG® Credit 4.4)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should support native, rare and biodiverse ecosystems through planting plans and management.

Design Strategies

- Incorporate the use of locally native and habitat-appropriate plants throughout sites, considering those that are supportive of priority habitats for locally, regionally, or nationally important species where feasible.

For more details, see the **WEDG® Version 3.0 Manual**, pages 107-108.

Avoid Human Disturbance to Natural Resources (WEDG® Credit 4.5)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should avoid disturbance to wildlife due to human activity throughout the life of the project.

Design Strategies

- Avoid Ongoing Disturbance
- Use Sensitive Lighting
- Use Bird-Friendly Building Design

For more details, see the **WEDG® Version 3.0 Manual**, pages 109-110.

Restore and Redevelop industrial and abandoned properties (WEDG® Credit 4.6)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce contamination to the environment.

Design Strategies

- Use environmental assessment results to determine key coastal areas of contamination for remediation
- Remediation approaches range from conventional (such as engineering controls to limit exposure to contaminated soil and pump-and-treat systems for groundwater contamination) to innovative (such as thermally enhanced soil vapor extraction to in-situ chemical oxidation of groundwater contaminants).

For more details, see the **WEDG® Version 3.0 Manual**, pages 111-112.

Practice Sustainable Fill and Soil Management (WEDG® Credit 4.7)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce environmental impacts associated with fill use and management.

Design Strategies

- Reuse Materials On-Site
- Beneficial Reuse of Dredged Material
- Use Locally Sourced Fill Material

For more details, see the **WEDG® Version 3.0 Manual**, pages 113-114.

Employ Mitigation Techniques to Reduce Emissions through Carbon Management (WEDG® Credit 4.9)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce material embodied and operational greenhouse gas (GHG) emissions and remove greenhouse gases through nature-based and/or engineered carbon dioxide removal.

Design Strategies

- Reduce Energy Demand and Increase Efficiency
- Use Materials with Low Life Cycle Carbon
- Incorporate Carbon Sinks and Negative Emissions Design

For more details, see the **WEDG® Version 3.0 Manual**, pages 117-120.

Practice Environmentally Responsible Construction (WEDG® Credit 4.10)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce the environmental impact of construction practices.

Design Strategies

Create a **construction environmental impact reduction plan** to address various strategic elements:

- Reduce in-water construction time and work within approved timeframe, use modular construction, use energy-efficient machinery, protect water bodies from contaminants, minimize environmental harm
- Consider how to mitigate stormwater runoff

For more details, see the **WEDG® Version 3.0 Manual**, pages 121-122.

Reduce Water Use (WEDG® Credit 4.11)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce impact on freshwater resources as well as load to municipal systems and potential for combined sewer outflows.

Design Strategies

- Reduce Outdoor Water Use
- Treat Sewage Using Green Infrastructure
- Reduce Indoor Water Use

For more details, see the **WEDG® Version 3.0 Manual**, pages 123-124.

ESSENTIAL 6: STRENGTHEN INSTITUTIONAL CAPACITY FOR RESILIENCE

The E6 chapter focuses on the **Prevention Period** and primarily addresses two key elements of institutional capacity for **coastal disaster risk reduction** – the availability of skills and the sharing of data on mitigation status, current status and **resilience plans** (see E2 for more information on data sharing). Institutional capacity refers to a key stakeholder's ability to support the city across the five key **disaster risk reduction** areas: understanding, prevention, mitigation, response and recovery. Understanding and mitigation are layered into onto the three previously discussed periods of **coastal disaster risk reduction**. Cities need to be certain that the institutions that support them have the people, resources and capabilities that they need to provide the necessary engagement, advice and technical inputs and outputs to **coastal disaster risk reduction** to enhance **coastal resilience**.

For Essential #6, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 0.4 (Create a Maintenance and Adaptive Management Plan)**
- **WEDG® Credit 4.12 (Engage a Partner to Study or Monitor the Site)**

***** See the final section of Essential 6 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

<table>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td>6.1</td><td colspan="2">Skill Availability</td></tr>
<tr><td>6.1.1</td><td>To what extent does the city have access to the types of skills in the quantity and quality needed to reduce coastal disaster risk and enhance coastal resilience?</td><td>For effective coastal resilience efforts in cities, specific competencies and skills are vital, especially in the context of coastal cities where hazards and risks can be unique and heightened. For example, emergency preparedness and response skills are needed in developing and implementing emergency response plans, including evacuation procedures, first aid, search and rescue operations, and basic disaster medical support.

Skills that a city may need to reduce its coastal disaster risk include, but are not limited to the following table:

<table>
<tr><th>Skill Area</th><th>Expertise</th></tr>
<tr><td>Natural Hazards and Environment</td><td>• Geological and geotechnical
• Oceanographic
• Climate
• Meteorology</td></tr>
</table>
</td></tr>
</table>

#	Question	Guidance		
			• Landscape ecology, biology, botany - especially relating to regenerative techniques • Arboriculture, forestry and landscaping • Climate adaptation	
		Design, Construction, Planning and Engineering	• Civil, mechanical and electrical engineering • Seashore protection and restoration - green/blue and grey infrastructure engineering • City planning, design and layout • Disaster (flood, wind) resistant construction techniques • Building and construction (residential, commercial – new build, mitigation retrofits, etc) • Infrastructure design and operation (roads, energy, water, sanitation and others) • Building code interpretation and analysis	
		Risk and Insurance	• Risk analysis, assessment (property, area-wide) and modeling - hazards, exposures and vulnerabilities • Insurance markets and buying • Risk communication	
		Finance	• Economics and investment appraisal • Valuation of ecosystem services • Budgeting and financial management/accounting • Payment management • Grant applications	
		Health	• Medicine • First aid • Public health and epidemiology • Mental health - stress management and psychological first-aid	
		Emergency Response	• Emergency management • First responders - police, fire etc. • Logistics • Property damage assessments • Event response • Traffic management • Area recovery	
		Governance and Program Management	• Governance and organization structure • Planning, program and project construction and management	

<table>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td></td><td>• Lobbying</td></tr>
<tr><td>City Engagement</td><td>• Local history and cultural history
• City engagement, leadership development and activism
• Languages spoken in the area
• Communications and social media
• Expertise in local industries (e.g., farming and livestock)
• City Emergency Response Teams (CERT) or equivalent</td></tr>
<tr><td>General</td><td>• Data science and analysis
• Communication skills
• Problem-solving and critical thinking
• Collaboration and networking
• Training and capacity building</td></tr>
</table>

Few, if any, cities will have all these skills available immediately. Potential sources for them may include:
• Universities and technical colleges
• Government agencies
• Non-governmental organizations (NGOs), Non-profits
• Consultancies
• Volunteers
• Partnering and sharing with neighboring cities
• Local employers

Validation
• Proof of a full skills needs assessment for coastal resilience purposes
• % of coastal resilience skills needs known to be met</td></tr>
<tr><td>6.1.2</td><td>To what extent does the city have access to relevant coastal disaster risk reduction and coastal resilience skills training and development?</td><td>Some of the skills above require extensive degree-level and professional and/or vocational training in external institutions in addition to perhaps years of practical implementation experience. However, others can be taught on-the-ground, either by local adult training institutions, or internally within the organizations(s) involved - often fairly rapidly. What percentage of the skills above can be taught locally in the city?

Cities should consider which skills they need to acquire through internal or third party training, perhaps delivered in tandem with local universities or technical colleges. They should endeavor to collaborate with local institutions and private sector colleges to create the required classes, if they not already exist.

Validation
• % of "trainable" needs in coastal disaster risk reduction being met through local training or procurement of external training</td></tr>
</table>

#	Question	Guidance
6.2	**Data, Analytics and Technological Resources**	
6.2.1	To what extent does the city have access to the data it needs to reduce its **coastal disaster risk profile** – including understanding, **hazard**, **exposure**, **vulnerability**, and **mitigation** capabilities, etc.? (See also E1 for political and organizational constraints on sharing data)	In addition to data on current and future hazards, exposure and vulnerability (see E2), cities' data needs for **coastal disaster risk reduction** will be extensive. For example, data needs may include: • Future development plans and approvals (see E1 and E4) • Budgets and financial sources (see E3) • Status of code compliance (see E4) and property scale mitigation – hardening (see E6) • Status of landscape-scale mitigation (see E5) • Skills levels (this Essential) • City demographics (see E7) • Status of city engagement efforts (see E7) • Geodatabases of those needing extra help to evacuate (see E7 and E9) • Capacities and capabilities of utility response mechanisms (e.g., backup provisions, service restoration capabilities, etc. – see E8) • Identification, location and ownership of/responsibility for critical assets (infrastructure and other) and dependencies between these (see E8) • Status of those assets (see E8) • Capacities and capabilities of the local health system (see E8 and E9) • Emergency communication and public alerting systems (e.g., methods, devices, coverage data, functionalities, etc.) (see E9) • Capacities and capabilities of first responders and law & order (see E9) • Names, geo-codes/locations and capacities of emergency accommodation (see E9) • Contact and contract details for all those likely to be involved in post-event response (see E10) Data needs to be of sufficient resolution (for example, bathymetric data for predictive models) to enable useful and specific conclusions to be drawn. In particular, Geographic Information System (GIS) software helps cities assess changing **coastal disaster risk profiles** by mapping flood risk from sea level rise, tidal energy changes, and storm surge and their intersectionality with the built environment. It combines elevation, land use, and water data to model impact zones and guide evaluation (e.g., adaptation pricing). Cities need to create an inventory of their data needs, data sources, and owners to meet these needs and agreements on what shall be shared with whom, keeping in mind that some of it may be publicly available on an open-sourced basis. Despite it being open-source, it may still require the build-out of platforms to make it accessible to all key **coastal resilience** stakeholders. **Validation** • Evidence of inventory of information needs, data availability and permitted uses for it • Absence of unmet data needs in **coastal disaster risk reduction** and **coastal resilience**

#	Question	Guidance
		• Some public data sources are included in the footnote below[8]
6.2.2	To what extent is the data that the city requires complete, accurate, current and in a useable and shareable format for **coastal disaster risk reduction** and **coastal resilience**?	Saying that the data is available is one thing - the ability to actually use it may be quite another, due to issues with quality and completeness, or with the compatibility of its format with what the city already has. As well as ascertaining data availability, cities should evaluate the quality and useability of that data, if necessary with assistance from data professionals or analysts from local educational institutions. **Validation** • Inventory of **coastal disaster risk reduction** and **coastal resilience** data needs (see above) is graded for quality and usability • Absence of data quality issues with in-use dat sets for **coastal resilience** purposes
6.2.3	To what extent does the city have access to the computing, data handling and analytics tools needed to extract meaning from, and act on, the data it has for **coastal disaster risk reduction** and **coastal resilience**?	Information tools are likely to include GIS, modelling, analytics, data visualization, and other systems – which cities may buy and operate for themselves or contract with a local university or the private sector. Cities may also elect to create (or share) apps for public consumption of data consumption and alerts. Cities need to identify their data analysis and presentation needs. **Validation** • Evidence that aggregate computing needs for **coastal disaster risk reduction** identified and met as sized and scoped to purpose
6.2.4	To what extent is data on the city shared between key stakeholders in the city ecosystem for the purposes of **coastal disaster risk reduction** and **coastal resilience**?	Data sharing is critical to ensure that all key organizational stakeholders operate from compatible assumptions and have a clear view of what they can expect from one another – sharing needs to be seen as a continuous process (or at a minimum with regular updates) rather than a one-time exercise. In many cases, sharing will come naturally. Unfortunately, there may be legal constraints on sharing some data. Also, not all stakeholders will be willing to share – private utilities are one example of organizations that may be reluctant, and some agencies may also decline. Cities need to share all available data and use all available means to lobby, persuade or compel other stakeholders to do likewise. In the US, there are cases where Freedom of Information Act requests have been required to compel information flow. Key types of **coastal disaster risk reduction** and **coastal resilience** data can include: • Demographic data • Health data • Housing/structural data including primary and secondary modifiers • Economic data • Education levels

[8] World Meteorological Organization (WMO) Climate Data; NOAA National Centers for Coastal Ocean Science (NCCOS); World Bank Climate Change Knowledge Portal

#	Question	Guidance
		• Geographic and environmental data- vegetation, topography, seabed bathymetry, known **coastal zones**, land use, location of buildings and assets • Local knowledge and practices • City assets and resources, and their status • Private sector assets and resources, and their status • Disaster history and experience • Social networks and city organizations • Accessibility and mobility data • Communication preferences and access • Feedback on previous interventions Once assembled, many of these data sets (for example, all those related to the geography, land use and topography of the area) need to be integrated, and inconsistencies resolved, to enable maximum value to be extracted. **Validation** • Access to and absence of instances of refusal to share key **coastal disaster risk reduction** data • Evidence of integrated **coastal resilience** data sets (e.g., hazard, vulnerability, and exposure, asset-level geo-codes/locations) • Visible evidence of data and assumption sharing
6.2.5	To what extent is data (see E2) on **coastal disaster risk** mitigation and reduction made accessible to the public?	Data for the public need to be available and made digestible so that the public can understand extract the key messages and satisfy themselves (or not) as to the level of **coastal disaster risk reduction** underway. This will be a critical aspect of city engagement (see E7). Cities need a plan for making information on **coastal disaster risk** and resilience digestible and releasing it to the public as part of their engagement strategy. They may want to engage a communications specialist for this task. **Validation** • Extent of information quality and quantity in the public domain on **coastal disaster risk reduction** • Public knowledge of, and satisfaction with, data and information available for **coastal disaster risk reduction** and **coastal resilience**
6.3	**Collaboration to Pool Experience and Resources**	
6.3.1	To what extent is there sufficient expert participation to drive well-informed collaboration on **coastal**	Stakeholders working on **coastal disaster risk reduction** need access to subject matter expertise in areas such as engineering, climate science, emergency management, environmental planning, capital planning, asset management and city resilience. If direct access is limited, they should utilize resources from research institutions, government agencies, industry reports, and international frameworks. Coastal

#	Question	Guidance
	disaster risk reduction and **coastal resilience**?	Sustainability and Resilience plans need to be integrated with operational plans. Cities need to take steps to access the expertise they need to deal with the multiple dimensions of **coastal disaster risk reduction** – hazard, vulnerability, and exposure. **Validation** • Diversity of expertise present, covering key disciplines relevant to **coastal disaster risk reduction** and **coastal resilience** • % of meetings with expert attendance and participation • Use of external resources, such as government reports, academic research, or industry guidelines, when direct expert participation is not available • Peer city participation in the development of plans and actions
6.3.2	To what extent has the city boosted its own capacity through connections with neighboring cities on **coastal disaster risk reduction** and **coastal resilience**?	In addition to data sharing, the more general and/or informal experience of others is a powerful capability builder. Collaboration between cities is just as crucial as collaboration within them for effective planning and execution of **coastal disaster risk reduction**, mitigation and emergency response efforts. This includes sharing data, skills and resource but can also extend to protecting shared infrastructure (E8) and ecosystem services (E5); collaborating on drills, agreements for aiding evacuees, and enhancing emergency response capabilities (E9); assisting with rebuilding (E10), and more. Cities need to seek collaboration with their neighbors in the same region. Cities should actively collaborate with nearby municipalities. Working with others who face similar challenges can improve coordination, response strategies, and access to funding. **Validation** • Past evidence that this has happened and measurable frequency of action • Evidence of ongoing collaboration between cities • Disaster mitigation and response strategies informed by the experience of others • Regional mutual help agreements (and capacity to actually deliver) • Documented agreements (MoU or similar) that it will happen in the event of a disaster
6.3.3	To what extent has the city engaged with global, federal and state/regional/provincial alliances and networks that offer expertise, funding, or best practices beyond the local and regional resources available for the purposes of **coastal disaster risk reduction** and **coastal resilience**?	For broader **coastal resilience** support, cities should engage with wider organizations, research institutions, and global resilience networks that provide funding, technical expertise, and policy guidance, up to and including global organizations as applicable. These alliances can help integrate best practices and global climate adaptation strategies into local **coastal resilience** planning. **Alliances might include (not exhaustive):** • Universities and city/tech colleges • Resilient Cities Network • Regional Planning Councils and Climate Compacts • UNDRR ARISE Network • MCR 2030

#	Question	Guidance
		• C40 Cities Climate Leadership Group • Global Resilience Partnership • Coastal Zone Management including Federal organizations such as NOAA in the United States of America • Professional or membership organizations for relevant fields (e.g., Urban Land Institute, American Society of Civil Engineers) **Validation** • Membership or engagement with global alliances • Application of international best practices in local initiatives

Create a Maintenance and Adaptive Management Plan (WEDG® Credit 0.4)

Description

When strengthening institutional capacity for coastal resilience, a city should ensure the maintenance, ongoing performance, and adaptive management of plans directly integrate climate resilience, ecological health, and city accessibility.

Design Strategies

- Establish a **combined maintenance and adaptive management plan** specific to a city's needs that**:**
    - Includes operations and maintenance life cycle considerations for critical coastal infrastructure
    - Identifies responsible parties for undertaking operational tasks, maintenance tasks and ongoing monitoring
    - Plans to monitor performance and associated intervals, including applying monitoring protocols and key performance indicators (KPIs)
    - As applicable, sources long-term funding to secure monitoring and adaptive management capabilities

For more details, see the **WEDG® Version 3.0 Manual**, pages 28-31.

Engage a Partner to Study or Monitor the Site (WEDG® Credit 4.12)

Description

When strengthening institutional capacity for coastal resilience, a city should expand capacity for tracking, monitoring, and evaluating coastal and waterfront areas and contribute to a broader body of knowledge about coastal and waterfront issues and best practices.

Design Strategies

- Academic or Research Institution Partnerships
- Citizen Science Organizations
- Non-profit Organizations
- Other Entities such as for-profit companies that supply or install shoreline enhancement products such as ecologically beneficial materials, may have an interest in monitoring the success of these products in the environment overtime.

For more details, see the **WEDG® Version 3.0 Manual**, pages 125-126.

ESSENTIAL 7: UNDERSTAND AND STRENGTHEN SOCIETAL CAPACITY FOR RESILIENCE

The E7 chapter focuses on the **Prevention Period** and primarily addresses the city's civic and social engagement and the ongoing effectiveness thereof[9].

For Essential #7, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 2.1 (Provide Quality Public Access Areas on the Waterfront)**
- **WEDG® Credit 2.2 (Design Sites to Improve Visual and Other Sensory Connections to the Water)**
- **WEDG® Credit 2.4 (Reduce Industrial Impacts to Human Health and Wellbeing)**

***** See the final section of Essential 7 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

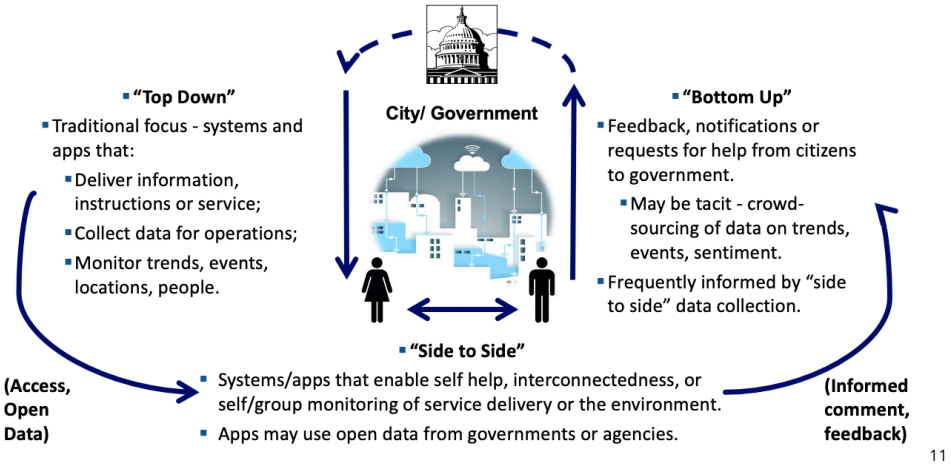
#	Question	Guidance
7.1	**City-level Engagement with Key Stakeholders**	

7.1.1	To what extent is the city's **coastal disaster risk reduction** and **coastal resilience** planning connected and cohesive with a multi-stakeholder, collective action mentality? Is cross-city cohesion developed and maintained?	City connectedness refers to the propensity of a city's population to interact with one another in multiple contexts (such as markets, church, sports, etc.) and assist each other in times of disaster or stress. Connectedness is known to be crucial to any form of resilience, including coastal; the problem is that it can be difficult to measure and assess. The metrics below are proxies for connectedness that may be helpful.
		• Evidence of mutual help from prior emergencies, or in working on **coastal disaster risk** currently - is there city or neighborhood planning or just self-preservation? Examples:
		  ○ Neighborhood buddy plans
		  ○ Friends or relatives that each family could call upon for shelter in the event of evacuation
		  ○ Tradition of extended families caring for their members, or cities of care
		  ○ Collaboration on mitigation planning, implementation and measurement
		  ○ Frequency and level of attendance at meetings
		• High levels of volunteering
		• Active civic organizations such as Rotary, Kiwanis, etc.
		• Frequency of, and levels of participation in neighborhood events generally
		• Evidence that the above spans different minority groups, where applicable
		  ○ Individuals or groups choosing not to participate

[9] Chapter 3 of **ARISE-US Action Guide** addresses city engagement

#	Question	Guidance
		○ High resident turnover ○ Crime and violence (within families and/or the city) ○ Poverty and food insecurity ○ High score on CDC/ADSR Social Vulnerability Index, or in the Social Vulnerability component of the FEMA National Risk Index[10] ○ High incidence of mental health issues ○ High incidence of physical health issues ○ Specific obstacles to engagement – language barriers, lack of meeting places, family role structures etc. ○ Absence of evidence that any of the above worsened after a previous disaster When assessing connectedness, consider block, neighborhood and city scales. Individuals' willingness and ability to mitigate **coastal hazard** risk is addressed below. Cities need to attempt to understand their level of connectedness either using the metrics above, or others. **Validation** • Proof of assessments or evidence of city connectedness analysis • Past evidence of mutual self-help/collective action efforts within the city for **coastal resilience** purposes
7.1.2	To what extent has the city (i.e. the entire population of the area in question) been informed about its **coastal disaster risk profile**? Fully engaged? (City Information – see E6)	City engagement will be through organizations working directly on **coastal disaster risk** and resilience issues, but also organizations serving other purposes that may also serve as "channels" – homeowners associations (HOAs), churches, Kiwanis, Rotary Clubs, 4H, sports teams, etc. who may simply pass on messages, or weave awareness, mitigation and response into their activities. Engagement encompasses all three dimensions shown in the model below – enabling "top-down" dissemination of information and policies from government to citizens; enabling "side-to-side" (neighbor to neighbor, group to group) collaboration and information sharing; and enabling "bottom-up" communication and feedback back to government.

[10] Available from: https://www.fema.gov/flood-maps/products-tools/national-risk-index. This index operates down to the census tract level.

#	Question	Guidance
		 11 Engagement needs to not only be about emergency response actions or flood-proofing, but about all aspects of **coastal disaster risk reduction** - risk data, expectations of what government can actually do and what individuals or families, or businesses, need to do. Engagement can be amplified through collaboration with the education system and employers – see below. Cities need to maximize the engagement of their residents on the dimensions just described. **Validation** • Evidence of at least one organization in each neighborhood working directly on **coastal resilience** issues actively and effectively, both as part of governance (see E1) and in their own "patches" • Use of city organizations (churches, homeowner associations, city centers, Kiwanis, Rotary Clubs, sports teams, etc.) as communications channels to/from local residents. (Also schools and employers – see below) • Evidence of public awareness of - and trust in - emergency communication systems and actionable signals (e.g., sirens, SMS, radio) • Materials/media (see below) in all first languages in the city are available and being used • Evidence of issue-specific communications and discussion • Evidence of effective coordination and leadership from among the many organizations – absence of conflicts, duplication, gaps etc. and clarity as to which org is doing what

[11] **Visual Author:** Dr. Peter Williams, ARISE US

#	Question	Guidance
7.1.3	To what extent is outreach and engagement for **coastal disaster risk reduction** and **coastal resilience** multi-channel and multi-media?	Effective outreach requires both listening and imparting information, in line with the model above. Cities need to develop their listening skills for engagement through such means as conversations, town halls, focus groups, surveys, polls, and so on. Simple emails or newsletters alone will not suffice. All possible channels – social media, e-mails, physical advertising, physical mailers, newsletters, booths at local or county fairs, parades, schools, employers, retailers and contractors (see above), friends and family, etc. – need to be deployed continuously, targeted as appropriate to specific segments of the city. Cities need to create multi-channel strategies for reaching all segments of the population on the topics of **coastal disaster risk reduction** and **coastal resilience**. **Validation** • Evidence of listening activities • Survey (see below) and/or interviews confirming that participants believe that they have been listened to, plus response rates to those surveys • Understanding of citizenry's grasp of facts, their assumptions and attitudes to recommended actions, and how these have changed over time • Evidence of multiple channels in regular use for **coastal disaster risk reduction** purposes • Monitoring of channel effectiveness • Residents receive on average at least 5 -related messages per year
7.1.4	To what extent have vulnerable segments of the city been fully engaged in **coastal resilience** planning? Are required measures in place to assist the vulnerable, impaired, disabled, home-based and/or homeless residents of informal communities? (See also E9)	Vulnerable segments will include different income groups; cultural, ethnic or linguistic groups; educational backgrounds; disabled persons; those without transportation; those with chronic mental or physical health issues; and the elderly or housebound. Cities need to identify and engage with vulnerable segments of the city: impaired, handicapped and/or home-based residents, and those without permanent housing or homes. They need to routinely conduct city cohesion events that include **coastal disaster resilience** plan distribution. **Validation – as above, plus** • Coverage of the whole city • Knowledge of numbers in vulnerable segments and the locations of each person/family in each segment • Evidence of explicit engagement with respect to emergency communications and alerts; cities should pursue digital and non-digital channels • Presence of representatives of all segments in governance (see E1), neighborhood **coastal disaster risk** discussions and activities, including City Disaster Preparedness Plans • Confirmation of their engagement from keys stakeholder representatives
7.1.5	To what extent is outreach and engagement maintained over time	City outreach is a process that must continue and be renewed regularly, in perpetuity. Outreach needs can be driven by income levels, language differences, physical abilities, skills in mitigation actions,

#	Question	Guidance
	with **coastal resilience** stakeholders?	culture and other local factors including trust in government. They will change over time as new needs arise and others decrease, for example as people arrive in or leave the city. **Validation** • Evidence of ongoing activities over a period of years, including participation in regular drills (see E9) • Percentage/numbers of people needing help who request it; and of those requesting help who actually receive it • Percentage of individuals who evacuated last time mandatory evacuation orders were issued
7.1.6	To what extent is there an "on-boarding" process for new city residents with respect to **coastal disaster risk reduction** and **coastal resilience**?	As people move, change in the city inevitably means that new city residents will have to be brought on board with neighborhood plans. Cities need to plan to deal with population change, whether through regular recurring meetings or some other method. **Validation** • Demonstrated implementation of plans to update and engage newcomers to the city on **coastal disaster risk reduction**
7.1.7	To what extent are strategies in place to draw in reluctant participants ("holdouts") to **coastal disaster risk reduction** and **coastal resilience**?	In any city, there will always be "holdouts" who are reluctant to become involved. Strategies such as pointing out how they may already have benefitted and inviting them to "pay it forward", or conducting interviews with former holdouts who decided to participate, may be helpful. **Validation** • Overall participation levels via tracking numbers of known holdouts and conversion rate for holdouts
7.1.8	To what extent have peer-to-peer-neighbor support programs been implemented for **coastal disaster risk reduction** and **coastal resilience**?	As per the "side-to-side" dimension in the graphic above, a neighbor with limited resources to mitigate their own **coastal disaster risk** through property mitigation enhancements (impact-resistant windows, roof clips, clear storm drains, rain gardens, property elevation, etc.) in isolation could be subsidized or offered advice, technical implementation assistance, and material help by property owners nearby. This would be in the spirit of enlightened self-interest: if the neighbor's house has a high level of flood risk there is a danger it will undermine property values and mitigation activities by adjacent owners. Peer-to-peer support could be administered by local governments, HOAs, churches or some other method. Cities need to encourage mutual aid between city residents. **Validation** • Evidence of mutual aid/peer-to-peer efforts for **coastal disaster risk reduction**

#	Question	Guidance
7.1.9	To what extent is the effectiveness of **coastal disaster risk reduction** and **coastal resilience** outreach activities validated?	The effectiveness of communications needs to be assessed regularly and adjustments made as required. Cities need to assess continually the effectiveness of their outreach on **coastal resilience** efforts. **Validation** • Evidence that messages are being acted upon • Regular (say 2-yearly) surveys on effectiveness of **coastal disaster risk** outreach • Understanding of where people get their information from - which channels work best, what is the role of family and friends, work, etc.? • % of local residents who are aware of the current status of city's **coastal disaster risk reduction**
7.2	**City-level Engagement with Education & Academia**	
7.2.1	To what extent do local schools participate in city **coastal disaster risk reduction** and **coastal resilience** efforts, using students to educate and motivate parents?	Some schools today have instruction on natural hazards (hurricanes, tsunamis, wildfires, earthquakes) and personal responses to these. This can be expanded to include **coastal disaster risk**: for example, the dangers of driving through flood water, storm surge dangers, and other climate-related risks. For older students it could then include consideration of the factors that drive flooding or landslides, potential responses in individual homes, neighborhoods and in the landscape, as well as dividends or side benefits (See E3) from flood mitigation, social engagement, and other factors. These themes can be woven into civics, science, sociology, economics, business studies and other classes, as well as into volunteer activities such as canvassing or preparation of materials. Schools may want to partner with non-governmental organizations (NGOs). Cities need to engage with their education providers - schools, city colleges - and in turn utilize them as a means of engagement. **Validation** • Evidence of **coastal disaster risk reduction** material in curricula • Evidence of school and city-college volunteer activity
7.2.2	To what extent do local universities participate in **coastal disaster risk reduction** or other key aspects of **coastal resilience**?	Universities can be engaged through environmental & ocean science, building science, architecture, civil engineering, meteorology, public administration, politics and sociology, and many others on (as examples): risk analysis; landscape management; ecosystem protection and enhancement; flood mitigation strategies for the neighborhoods surrounding campuses; benefit assessments; city engagement; and many other activities. These could be curriculum-driven, or voluntary. Cities need to engage with local universities, if they have them, as a source of skilled help. **Validation** • Evidence of such engagement (if a college or university is present in the area)

#	Question	Guidance
7.3	**City-level Engagement with Business**	
7.3.1	To what extent do local businesses, large and small, identify **coastal disaster risks** as an area that needs to be engaged with?[12]	Sadly, it is all too common for businesses to take the view that natural disasters are "someone else's problem", despite the obvious risks of disruption, loss of income, loss of premises, loss of supplies and equipment, and loss of workforce – and despite the often-obvious fact that local governments cannot mitigate the issue away, and cannot deal with it alone. Securing business engagement is therefore critical. Cities need to engage with businesses (and also other large employers such as military bases) directly. **Validation** • % of local businesses engaged meaningfully in **coastal disaster risk reduction** and preparation for their own activities and assets and/or in the city • % of national companies in the local area engaged meaningfully, as above
7.3.2	To what extent do all businesses have business continuity plans (BCPs) that deal with the specifics of **coastal disaster risks** in the city? Are resilience response drills practiced regularly? (For Insurance - see E3) (For Emergency Response Plan contents - see E9)	BCPs are essential to expedite the return to regular commercial activity and thus to restore the economic life of the city. BCPs need to specifically address the mitigation of, and response to, **coastal disaster risks** in each location including impacts on the workforce (who will of course be essential to business continuity). They also need to address anticipated evacuation needs, insurance issues, beneficial collaboration with other businesses (for example where they may share the same building), and how business will restart after a coastal event when services may be disrupted. Cities need to strongly encourage businesses to create BCPs. Micro-, and small-to-medium enterprises (SMEs) may be approached in cooperation with local business organizations and chambers of commerce. **Validation** • % of local businesses with BCPs containing effective **coastal disaster risk reduction** and emergency response content • % of local businesses with "business interruption insurance" and "supply chain interruption insurance" sized to requirements and fit-for-purpose
7.3.3	To what extent have employers, business organizations such as chambers of commerce and/or labor unions been leveraged as a communications channel to their	Employers and unions, especially large ones, have captive audiences in their workforces, and a shared interest with government and the city in **coastal disaster risk reduction** – for example, if the employer's own premises are threatened, or if their workers lose their homes or cannot come to work such that productivity will be lost.

[12] ARISE-US publishes a separate scorecard to assess the effectiveness with which SMEs have been engaged on disaster risk reduction efforts. Available from: https://www.preventionweb.net/publication/sme-scorecard

#	Question	Guidance
	workforces and as a source of best practices for **coastal resilience**?	Business organizations such as Chambers of Commerce can have a multiplier effect by enabling engagement with multiple businesses at once. The key is for businesses and unions to realize that their offers of help are in their own interests as well as the city's. Cities need to engage business organizations in their area. **Validation** • Evidence of major employer and/or business organizations (e.g. Chambers of Commerce) collaborating on **coastal disaster risk reduction** (awareness, adaptation and mitigation) • Evidence of major labor unions, similarly engaged on the topic of **coastal disaster risk reduction** • # of businesses using government content • Emergency preparedness of the city is of interest to employers
7.3.4	To what extent have major employers been approached as a potential source of best practices and financial support for **coastal disaster risk reduction**? (see also E3)	Comment as above. As mentioned, the key is for businesses to recognize that their offers of assistance are in their own interests as well as the city's. Cities need to approach large businesses in their area for financial support for **coastal disaster risk reduction** activities. **Validation** • Evidence of meaningful allocation and donation of resources (project implementation, social capital, funding & financing, technical assistance) by employers to **coastal disaster risk reduction**
7.3.5	To what extent have major employers been approached as a potential source of employee incentives for supporting **coastal disaster risk reduction** in the event of a **coastal disaster**? (see also E3)	Comment as above. In addition, businesses (including in this context, other large employers such as military bases) may: • Provide employees with time to volunteer for **coastal disaster risk reduction** or emergency response activities. This is especially applicable to those with relevant skills such as project management, engineering, etc. • Provide employees on a secondment basis, and view **coastal disaster risk reduction** as an opportunity for staff up-skilling • In some countries (for example, Japan is one) businesses enter into MOUs with governments in their area that, in the event that an emergency is declared, each business will provide certain things – say warehousing, earthmoving equipment or trucks, premises for shelters, food, and so on. This practice exists, but is rare in the US, for example. As mentioned above, the key is for businesses to recognize that their offers of assistance are in their own interests as well as the city's. Cities need to approach large businesses in their area to agree to provide material support in the event of a **coastal disaster** and in service to **coastal disaster risk reduction** capacity-building. **Validation** • Evidence of MOUs for supply of goods and services specific to each organization • Evidence of volunteer activity such as key performance indicators for employer commitments

#	Question	Guidance
7.3.6	To what extent do major employers support their own staff in enhancing their knowledge of and agency for **coastal resilience**?	In some hurricane-prone parts of the US, larger employers today maintain stocks of materials, such as tarpaulins that may be required to keep houses habitable until roofs are repaired, thus allowing employees to return to work more quickly. The same model could be expanded, for example with small grants towards property flood mitigation, or discounts negotiated with local vendors or insurers; emergency childcare; using bulk buying to negotiate emergency rental discounts, and so on. Employees benefit if fewer days are lost due to employees having to deal with flood or wind damage to their property. Such steps will also serve to boost **coastal disaster risk** awareness. Businesses may also have a policy of paid time off during government-mandated evacuations. Cities need to collaborate with employers in their area to support their staff in becoming more **coastal disaster risk** resilient, thereby benefiting both the city and themselves. **Validation** • Evidence of such activities and policies such as those outlined above
7.3.7	To what extent have retailers been engaged in **coastal resilience** activities?	Retailers may have a specific role to play in the business response to **coastal disaster risk** in an area. Examples that apply here may include: • Hardware stores running displays or promotions on window hardening or generators, perhaps with presentations on how to proceed • Gardening stores can offer similar options with saltwater-resistant plants • Food and hardware stores maintaining "surge" capacity for post **coastal disaster** supplies • Displaying hurricane preparedness materials at check-outs These and other such steps will also help to boost **coastal disaster risk** awareness. Cities need to engage with retailers in their area to secure their active participation in **coastal disaster risk reduction**. **Validation** • Evidence of such activities taking place in the local market
7.3.8	To what extent are local contractors involved in helping with property mitigation enhancements in service to **coastal resilience**?	Local contractors could be persuaded to create disaster-proofing packages or tune-ups such as drain clearance, sandbagging, servicing deployable water intrusion prevention, etc., much like heating engineers often do with HVAC systems, to make it easy to for homeowners to engage. For example, some US cities actively engage contractors in raising buildings on pilings to make them more floodproof, and reinforcing roof structures against high winds. Cities need to encourage local contractors to provide property mitigation enhancements at set rates, perhaps offering endorsements for contractors that agree to help. **Validation** • Evidence of such packages available in the local market]

#	Question	Guidance
7.4	**City-level Engagement with Landlords & Landowners**	
7.4.1	To what extent have local landlords and landowners been engaged as part of the city's outreach process in **coastal disaster risk reduction**?	Landlords (whether residential or business) and landowners have a responsibility to help their tenants understand and engage with **coastal disaster risk reduction** and emergency response. This is aside from their self-interest in doing so. Many businesses that rent their space may not have engaged with landlords to assess property risk, and landlords may resist changes to that pattern, needing persuasion. Companies that own large numbers of properties can be shown that they have insurance coverage gaps that need to be addressed for responsible risk management. Small landlords can collaborate with tenants on **coastal disaster risk reduction** opportunities. Cities need to encourage landlords to assist their tenants to engage with **coastal disaster risk reduction** and emergency response. **Validation** • % of rental properties and business and domestic tenants fully prepared for **coastal disaster risk reduction**
7.4.2	To what extent have local agricultural landowners been engaged as part of the city's outreach process in **coastal disaster risk reduction**?	Landowners (farmers/growers, those with large coastal landholdings) have a responsibility to address coastal disaster risks sourcing on their land (for example, landslides, commercial runoff, direct pollution of floodwaters), as these may transfer to habitats and businesses around them. This is aside from their self-interest in doing so. Cities need to encourage landowners to address emergent **coastal disaster risks** arising from their land. **Validation** • Engagement of landowners in mitigation activities as above • Completeness of mitigation on the land in question

Provide Quality Public Access Areas on the Waterfront (WEDG® Credit 2.1)

Description

When understanding and strengthening societal capacity for coastal resilience, a city should create or improve high quality public access areas on the waterfront that maximize interaction with the water – and are shaped by city priorities – to promote equitable, engaging and healthy waterfronts. Waterfronts are often flagship sites in a city – they are desirable places to develop and provide public space; are critical to foster environmental stewardship, programming, and education; and are an essential source of city identity; and the only places where water-dependent activities like fishing and boating can take place.

Design Strategies

- Design to increase accessibility
- Design for a variety of sensory types
- Design to improve health and wellbeing

For more details, see the **WEDG® Version 3.0 Manual**, pages 59-63.

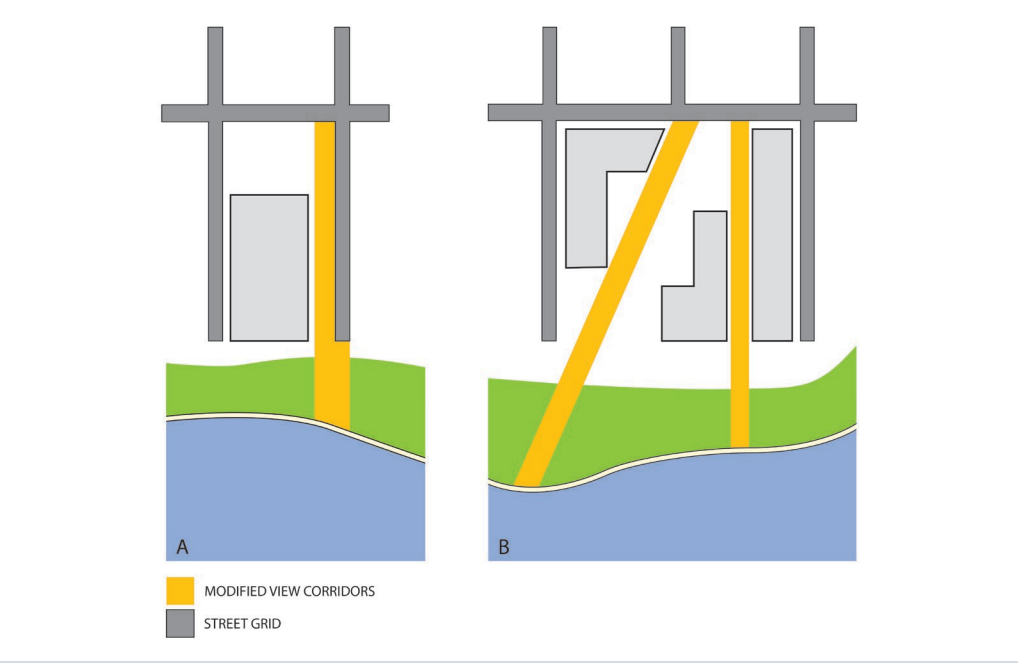
Design Sites to Improve Visual and Other Sensory Connections to the Water (WEDG® Credit 2.2)

Description

When understanding and strengthening societal capacity for coastal resilience, a city should enhance and maximize visual connections to the water from upland areas to create a welcome and inviting environment. Visual corridors provide unobstructed views from upland streets to the waterfront and help enhance city connections to the water. View corridors also promote sensory connections to water, such as the ability to see, touch, or hear water, which can improve physical and mental health.

Design Strategies

- Site and orient buildings; extend views to the water; balance publicly accessible space and view corridors; design to incorporate a range of elevations from which people can view the waterfront; create unimpeded views over landscapes, especially of natural features such as mountains or wetlands; balance expansive views and more enclosed places of refuge through taller, vertical elements; create temporal connections to views and lighting at different times of day.



In addition to alignment with the **street grid** as shown above, **view corridors** can be expanded or enhanced to provide more direct visual connections with the water. For more details, see the **WEDG® Version 3.0 Manual**, pages 64-65.

Reduce Industrial Impacts to Human Health and Welfare (WEDG® Credit 2.4)

Description

When understanding and strengthening societal capacity for coastal resilience, a city should minimize the adverse impacts of industrial operations to the surrounding city. Industrial activities on waterfront sites are often accompanied by dust, airborne debris, pollution, and odor due to engine exhaust, fumes, on-site activities, and wind carrying fine material particles. Industrial infrastructure might also obstruct views and connections to the waterfront. Additionally, operations may produce noise levels that can negatively affect nearby sensitive sites like resides and public areas.

Design Strategies

- Suppress dust and odor by relocating their sources away from sensitive sites; dampen intrusive noises by relocating their sources away from sensitive sites, incorporate visual barriers to on-site and off-site industrial operations; provide wayfinding signage for visitors; use landscaping such as berms, vegetated screens, or shade trees; update fleets to electric vehicles to reduce exhaust emissions.

For more details, see the **WEDG® Version 3.0 Manual**, page 68.

ESSENTIAL 8: INCREASE INFRASTRUCTURE RESILIENCE

The E8 chapter is the last to focus on the **Prevention Period** and primarily addresses the **coastal resilience** of key physical infrastructure systems, both those owned by the city itself and those owned by third parties such as utilities (i.e., energy, water) or life science/healthcare companies. Categories of questions are not presented in a particular sequential order from a disaster perspective.

For Essential #8, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 1.1 Avoid or Reduce Risk from the Waterbody –** See E2
- **WEDG® Credit 3.3 (Protect the Working Edge)**
- **WEDG® Credit 4.8 (Use Renewable and Resilient Energy Sources)**

***** See the final section of Essential 8 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
8.1	**Infrastructure – First Response**	
8.1.1	Given the two incident types ("most probable" incident & "most severe" incident in E2), to what extent are critical infrastructure assets at risk of loss or damage in the event of an **acute coastal disaster**?	Critical infrastructure assets including emergency response stations, maintenance facilities, communications facilities, healthcare facilities, water storage facilities, and equipment storage, is essential for responding to **coastal hazards** but may be vulnerable to damage or loss. **Coastal hazards** can compromise access, damage facilities, and disrupt communications. For example, flooding may block access roads or inundate facilities, hindering response efforts. Cities must assess the vulnerability of critical infrastructure to ensure its continuous operation during **coastal disaster events**. Where vulnerabilities are identified, cities should develop adaptation strategies, such as elevating facilities, securing backup power supplies, creating water storage facilities, or lobbying facility owners (e.g., other response organizations) to implement improvements. Improvements can be permanent or temporary. For example, cities could use portable flood walls to prevent storm surge from reaching critical infrastructure and remove them when the threat passes. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of critical infrastructure facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability.

#	Question	Guidance
8.1.2	To what extent are Fire, Police and/or Law and order assets at risk of loss or damage in the event of an **acute coastal disaster**?	Fire and Police service assets, including police stations, maintenance facilities, communications facilities and equipment stores, are critical to city response and management during a **coastal disaster** but may themselves be vulnerable to loss or damage. Access may also be lost with road damage or blockage, or in the event of communications outages, destroying or at least hindering effectiveness. Cities need to understand the vulnerability of their police stations and other law and order assets in the event of a **coastal disaster** and they need to minimize those vulnerabilities, or where applicable lobby facility owners (other police services) for them to be minimized. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of police service facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2 • External review by a risk management or engineering specialist confirms reduced vulnerability
8.1.3	To what extent is the emergency coordination center at risk of loss or damage in the event of an **acute coastal disaster**?	Emergency coordination centers (if separate from fire or police facilities) are critical to city response and management during a **coastal disaster** but may themselves be vulnerable to loss or damage. Access may also be lost with road damage or blockage, or in the event of communications outages, destroying or at least hindering effectiveness. Cities need to understand the vulnerability of their emergency response center(s) in the event of a **coastal disaster** and minimize those vulnerabilities, or where applicable lobby facility owners to minimize them. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of emergency response centers to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2 and implemented plans for reducing or managing risk to these facilities
8.1.4	To what extent are backup facilities available during an **acute coastal disaster** for first response infrastructure? (See also E10)	While backup facilities will presumably be further away, first responders will still require a secure base to operate from during emergencies caused by **coastal hazards** such as flooding, storm surge, or erosion. Emergency response centers, if compromised, will need to be re-established elsewhere to maintain operations during and after such events. Backup facilities must be resilient to **coastal hazards** and accessible under emergency conditions. Cities need to ensure there are documented plans identifying and providing access to alternative first response facilities, and equipment, in the event of inaccessibility or loss of primary facilities.

#	Question	Guidance
		Validation • Designation of a backup emergency control center alongside the main one, equipped to the same operational and technical standard as the primary facility, and continuously supported and maintained to ensure full functionality at any time in areas with limited local resources • Designation of sources of back-up equipment, similarly • Coordination with regional and national emergency services to help strengthen fallback capabilities
8.1.5	Is there adequate fuel available to operate response vehicles and systems in the event of an **acute coastal disaster**?	Emergency vehicles, power and other systems will need fuel - which may be difficult to obtain in the aftermath of a **coastal disaster**. Cities need to ensure that their emergency response infrastructure has access to sufficient fuel to operate until normal fuel supplies are resumed. **Validation** • Evidence of access to emergency fuel supplies sized to support the expected duration and extent of a worst-case **coastal disaster scenario** from E2
8.2	**Infrastructure - Communications**	
8.2.1	To what extent are the communications systems at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of communication systems (cellphone, internet, landlines where still used) to loss of service is a critical issue because emergency response systems, most or all other city infrastructure systems, and many economic and social systems are likely to rely upon them. Given the **coastal disaster scenarios** in Essential 2: • Which critical communications assets (cellphone towers, above-ground trunk cables, etc.) are in areas of high **coastal disaster risk** and have not been hardened against wind and flood vulnerability? • What areas and population segments in the city are vulnerable to loss of service from each? • What is the potential duration of service loss, given likely time to restore? • What is the potential for service to be overwhelmed/swamped by users and what recovery actions can be taken?" • What alternative or back-up modes of service exist (see below)? In the case of assessing risk of communication system failure, it is essential to include audible warning systems. In the event of a mobile network or internet outage, these systems often remain the last operational channel to warn the public. We recommend that cities evaluate how communication is ensured between the control center and individual sirens and assess how vulnerable this communication is in the event of disruption to mobile or internet networks. In many cases, sirens rely on GSM/LTE or IP-based communication, which may be compromised during **coastal disaster events**. Cities need to understand the potential of loss of communications service, including links to warning and alert systems, in the event of a **coastal disaster**, and they need to work with external communications

#	Question	Guidance

		companies (where applicable) to minimize potential service loss. One possibility might be to negotiate an emergency contract with Starlink, or comparable system, to provide first responders with communications for emergency response.
		
		Validation
		• Presence of a documented risk analysis (extent and duration of vulnerability) of communications systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities
		• Access to backup systems such as Starlink
		• External review by a risk management or engineering specialist confirms reduced vulnerability
		• Evidence of a technical audit of the siren communication infrastructure, with particular attention to:
		  ○ Whether redundant channels are in place (e.g., radio + GSM)
		  ○ Whether sirens can be remotely triggered during service disruption, and
		  ○ Whether local or manual activation is available as a backup

8.2.2	To what extent are back-up communications facilities available for use during an **acute coastal disaster**? (see also E10)	Backup facilities include alternative communications routes/circuits and backup power supplies, for example those for cellphone towers. One issue that has been identified with backup power is that generator fuel tanks may not provide power for long enough, and the backup fails before power is restored or before the communications company can refuel the generator. Cities need to understand the level of backup service they can expect and for what duration, as well as whether this will be adequate in view of the **coastal disaster scenarios** in Essential 2. **Validation** • Evidence of a documented understanding of backup capabilities for communications • High probability of adequacy, as assessed by a qualified engineer or risk specialist
8.3	**Infrastructure – Energy**	
8.3.1	To what extent are the city's electricity supply systems at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of electricity systems to loss of service is a critical issue due to the high level of dependency upon them. Given the **coastal disaster scenarios** in Essential 2: • Which critical electricity assets (towers, substations, above-ground cables, local solar or wind generation, local energy storage etc.) are in areas of high **coastal disaster risk** (or high post-event landslide or flash flood risk) and have not been hardened? • What areas and population segments in the city are vulnerable to loss of service from each? • What is the potential duration of service loss, given the likely time to restore? • What alternative or back-up modes of service exist (see below)?

#	Question	Guidance
		Cities need to understand the risk of loss of electricity service in the event of a **coastal disaster** - both duration and extent - which may vary in different parts of their area, and they need to lobby external electricity companies (where applicable) to minimize vulnerability to service loss. There also must be greater transparency regarding the interconnections between critical infrastructure assets, such as how electricity supply disruptions can impact water treatment facilities, hospitals, etc. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of electrical systems to loss of service and understanding of interdependencies between critical assets, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.3.2	To what extent are back-up electricity facilities available for use during an **acute coastal disaster**? (see also E10)	Back-up facilities include alternative delivery circuits and backup power supplies, both for critical assets and, if applicable, for the city. Cities need to understand the level of back-up service they can expect during a coastal emergency, for what duration, and whether this will be adequate in view of the **coastal disaster scenarios** in Essential 2. They should investigate alternative power supplies for emergency response such as existing and new technologies coming online now (i.e., portable solar panels and wave power generators that supply continuous, sustainable power and don't require fuel delivery). **Validation** • Evidence of a documented understanding and preparation of backup capabilities • High probability of adequacy, as assessed by a qualified engineer or risk specialist
8.3.3	To what extent do residential properties have backup power supplies for use during an **acute coastal disaster**?	Backup power for individual homes can clearly take the load off city facilities and will be critical in supporting applications such as water filtration systems, pumps, and in-home medical equipment in the event that the primary energy supply is disabled. Cities need to understand which homes have, and which especially need, backup power, and make plans to provide accommodation for those that do not. For homes without backup power, clear communication plans should outline access to city facilities with centrally located power for heating, cooling, and other essential services during outages. **Validation** • Maps of which houses have and especially need backup power • Plans for helping those that need backup power but do not have it
8.3.4	To what extent are the city's gas supply systems (distribution pipelines) at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of gas supply systems to damage and the risk of explosion is a critical risk, especially during hurricanes, storm surges, or flooding. Loss of service can also be a critical issue if the city relies heavily on gas-powered infrastructure, such as water treatment plants or heating systems. While most of the gas infrastructure is underground, it may be vulnerable to land movements. Also, it will emerge

#	Question	Guidance
		above ground for consumer access and may also do so for pressurization, inspection facilities and other purposes. Given the **coastal disaster scenarios** in Essential 2: • Which elements of gas infrastructure are in landslide or subsidence-prone areas? • Which critical gas assets above-ground are in areas of high flood risk and have not been hardened? • What areas and population segments in the city are vulnerable to loss of service? • What is the potential duration of service loss, given likely time to restore? • What alternative or back-up modes of service exist (unlikely)? Cities need to understand the risk of gas service loss in **coastal disaster events** – both duration and extent. This understanding will enable them to lobby external gas companies (where applicable) to minimize vulnerability to service loss. **Validation** • Evidence of a documented risk analysis (extent and duration of vulnerability) of gas systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.4	**Infrastructure - Water**	
8.4.1	To what extent are the city's water supply systems at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of water systems to loss of service is a critical issue because of the level of dependency upon them. Water resources may be contaminated by sediment runoff or from leaks prompted by infrastructure failure, physical assets may be liable to flood or landslide damage, and water systems can be contaminated. Some cities, or at least some properties within the city, may use wells as their primary water supplies which, by virtue of being distributed, may be more resilient than centralized systems. Given the **coastal disaster scenarios** in Essential 2: • Which critical water supply assets (water resources, pipes, pumping and treatment plants, etc.) are in areas of high **coastal disaster risk** (or high post-landslide or flash flood risk) and have not been hardened? • What areas and population segments in the city are vulnerable to loss of service from each? • What is the potential duration of service loss, given likely time to restore? • Can the supply system be segmented (for example into pressure zones or district metered areas) in such a way as to isolate **coastal disaster risk** damage? • What alternative or back-up modes of service exist (see below)?

#	Question	Guidance
		Cities need to understand the risk of water supply service loss in **coastal disaster events** – both duration and extent. This understanding will enable them to lobby external gas companies (where applicable) to minimize vulnerability to service loss. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of water systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.4.2	To what extent can the city's water system support firefighting in the event of an **acute coastal disaster**?	The water system itself represents a significant resource, but it is also essential in limiting vulnerabilities stemming from infrastructure-induced fires. During Hurricane Sandy in 2008, for example, several cities experienced fire outbreaks but lacked adequate water pressure and access to fight the fires effectively. Given this example and other **coastal disaster scenarios**, does the system cover the entire city (or are some parts reliant on wells or other systems that may be less adequate)? • Does system have sufficient hydrants and access points to enable a quick response throughout the city? • Can the system generate enough water pressure to support firefighting efforts during coastal events? • Is there sufficient water stored in the system for sustained discharge during firefighting operations? • Does the city have access to backup power supply to power the flood pump and drainage systems in place? Cities must assess the readiness of their water systems to respond to fire risks during coastal events, especially in areas that rely on external or third-party utilities. **Validation** • Evidence of documentation of the system's firefighting capabilities • Absence of weaknesses relative the **coastal disaster scenarios** in Essential 2, as assessed by a qualified engineer or risk specialist
8.4.3	To what extent are back-up water supply facilities or other sources of drinking water available for use during an **acute coastal disaster**? (See also E10)	Some parts of the city, at least, may have access to lakes, rivers, or secondary wells which, as stated, may be more resilient than centralized systems and may provide additional water. Alternatively, there may be connections to other water systems that offer some backup water supply capability. Cities need to understand which parts of their area have back up water supplies as an input to risk management for the area, and how readily available these supplies are for distribution. **Validation** • Evidence of analysis of areas and properties with some form of viable backup supply • Can courts quickly authorize emergency access to private waters?

#	Question	Guidance
8.4.4	To what extent are the city's wastewater treatment systems, septic tanks, and wastewater treatment plants at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of wastewater systems processing sewage or stormwater is a critical issue because of the implications for human and environmental health if they are damaged. As with water systems, wastewater systems (sewers, pump stations, treatment plants, outfalls) may be vulnerable to damage from **coastal hazards**, such as storm surges, saltwater intrusion, flooding, erosion, or sediment and chemical loads in wastewater from inundation and post-event runoff. Some cities, or at least some properties within the city, may use septic tanks as their primary system which, by virtue of being distributed, may be more resilient than centralized systems. However, they may also be more prone to overflowing and causing contamination when flooded. Cities need to understand the vulnerability of the wastewater system(s) throughout their areas. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of wastewater systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.5	**Infrastructure – Roads & Transportation**	
8.5.1	To what extent is the city's road system at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of the city's road network to damage or loss of access from a **coastal disaster** is a critical issue, both for evacuation and post-event recovery. Damage may come from floodwater, debris such as downed power lines or trees, or post-event landslides. Loss of access may also result from wind activity, flood overflow, or other forms of debris. Given the risk scenarios in Essential 2: • What is the vulnerability of the road system? • Are there potential choke points where, for example, parts or all of the city are only accessed by a single road that may be vulnerable to blockage in the event of a **coastal hazard**? Examples include areas at risk of flooding, landslides, or where there might be a narrow bridge that will hold up traffic and impede evacuation (see also Essential 9). • Where there are alternative routes, can these handle expected volumes of traffic when the main route is out of action? Cities need to understand the vulnerability of their road networks to damage or loss of access in the event of a **coastal disaster**, keeping in mind that vulnerable points could be many miles from the city. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of the road network to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability

#	Question	Guidance
8.5.2	To what extent is the city's other transportation infrastructure (rail, ports, airports, etc.) at risk of loss or damage in the event of an **acute coastal disaster**?	Vulnerability of other transportation infrastructure (rail, seaports, airports, as applicable) to damage or loss of access from a **coastal disaster** may be critical for post-event recovery. Damage may come from flooding, standing water debris, or post-event landslides. Loss of access may also result from storm surges, erosion, or other coastal impacts. Given the **coastal disaster scenarios** in Essential 2: • What is the vulnerability of other transportation systems to damage or loss of access in the event of a **coastal disaster**? • To what extent are these other systems being relied upon to alleviate post-coastal pressure on the road system, or would their loss of these system(s) exacerbate that pressure (see above)? Cities need to understand the vulnerability of their other transportation systems to damage or loss of access in the event of a **coastal disaster**, keeping in mind that rail links, for example, may be severed many miles from the city. Similarly, airport flooding and ports could have significant regional implications. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of other transportation systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities. • External review by a risk management or engineering specialist confirms reduced vulnerability
8.6	**Infrastructure – Healthcare & Education**	
8.6.1	To what extent is the city's healthcare infrastructure at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of healthcare facilities (for example, hospitals, outpatient/ambulatory care facilities, old-people's homes, assisted living, supply warehouses, ambulance stations) to loss or damage in the event of a **coastal disaster** is clearly critical for both the immediate and longer-term health of the city. Temporary loss of service may also be a key issue, for example from the loss of power, water or road access, or breakdown in the supply of key medications. It is vital to consider ambulatory care facilities, which may form the main access point for healthcare in outlying areas. In addition there are, sadly, known instances of assisted living and convalescent facilities where evacuation needs were clearly overlooked during a disaster. Given the **coastal disaster scenarios** in Essential 2, to what extent are healthcare facilities at risk? What backup systems (alternative facilities, power, water, sanitation) are available? What is the risk of access to these facilities being flooded?

#	Question	Guidance
		Cities need to understand the vulnerability of healthcare facilities and the people in them in the event of a **coastal disaster** and they need to lobby external health companies (where applicable) to minimize that vulnerability. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of healthcare facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability • Presence of backup generators for health care systems
8.6.2	To what extent is healthcare data for city residents at risk of loss or damage in the event of an **acute coastal disaster**?	Healthcare data may be vulnerable to loss due to **coastal hazards** if computing or data storage facilities are damaged, resulting in risks to city residents seeking treatment. Updated information and robust backup systems are critical to ensure continuity and data recovery during and after such events. Ideally, data will be backed up off-site at a secure location many miles from the city and will be available through a "hot standby" arrangement. Given the **coastal disaster scenarios** in Essential 2: • To what extent is healthcare data at risk? • Are there backup arrangements in place to protect against data loss, including off-site storage in secure locations? • Is data security compliant with federal standards for critical information? Cities need to understand the risks to the healthcare data of their residents, and the presence of backup arrangements to protect it. **Validation** • Confirmation that either no data is stored in the city or that it is backed up to a secure location in a different region with reinforced security measures and accessibility post-event
8.6.3	To what extent is the city's education system infrastructure at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of education facilities (schools, universities) to loss or damage in the event of a **coastal disaster** is critical where they are used as shelters, and for children's education and for the longer-term vitality of the city. Temporary loss of access may also be a key issue, for example from loss of power, water, sanitation or road access. Given the **coastal disaster scenarios** in Essential 2, to what extent are education facilities at risk? Are there backup tools such as flashlights and blankets available? In particular, education facilities need to be equipped with reliable audible mass warning systems (e.g., electronic sirens) to support timely evacuation. Integration with the city's early warning infrastructure significantly reduces risk to students and staff during **coastal disaster events**.

#	Question	Guidance
		Cities need to understand the vulnerability of education facilities in the event of a **coastal disaster** and they need to lobby external education agencies (where applicable) to minimize that vulnerability. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of education facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.7	**Infrastructure – Administrative**	
8.7.1	To what extent is the city's administrative infrastructure at risk of loss or damage in the event of an **acute coastal disaster**? (See also E3 for role of insurance if applicable to your region)	The vulnerability of the city's administrative infrastructure (offices, supply warehouses, depots, etc.) for the applicable tiers of government and other agencies to loss, damage or loss of access may be critical for emergency response and will be crucial for post-event recovery. This definition would also include post offices, welfare offices, DMVs and the like. Loss of access would also include loss of communication access (phones, internet, etc.) Cities need to understand the vulnerability of administrative infrastructure in the event of a **coastal disaster** and lobby owning agencies/departments to minimize that vulnerability. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of administration facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.7.2	To what extent is administrative data for city residents at risk of loss in the event of an **acute coastal disaster**?	Administrative data, including personal records, infrastructure drawings, financial data and many other items may be vulnerable to loss from a **coastal disaster** where computing or data storage facilities are damaged, resulting in inconvenience and, conceivably, risks to city residents, we well as excessive additional costs for the administration. Ideally, data will be backed up off-site at a location in a different region from the city and will be available by "hot standby" arrangement. Cities need to understand the risks to the administration data, and the presence of backup arrangements to protect it. **Validation** • Confirmation that no data is stored in the city (i.e., cloud storage), or if it is, that it is also backed up to a location in a different region that can be accessed post-event
8.7.3	To what extent are prisons (if present in the city) at risk of loss or damage in the event of an **acute coastal disaster**?	Prisons may be major local employers and may house people that present a danger to the public. Even though the city may have no say in the running of the prison, it must understand the vulnerability to damage or a breach of security in the event of a **coastal disaster**.

#	Question	Guidance
		While cities may not be responsible for prisons within their area, they should lobby prison agencies to provide data on **coastal disaster risk** vulnerability and arrangements for safeguarding the public in the event that prisoners need to be relocated during inundation and extreme flooding events. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) for prison facilities to loss, damage or loss of service, using the same risk scenarios as those referenced in Essential 2 • External review by a risk management or engineering specialist confirms reduced vulnerability • Evidence of plans for moving prisoners safely during a **coastal disaster event**
8.8	**Infrastructure – Cascading and Multi-System Failures**	
8.8.1	To what extent does the city understand the location of its critical assets and the interconnections between them, in the event of an **acute coastal disaster**?	Few cities have a comprehensive list of their critical assets or understand how they are interrelated, particularly in the context of **coastal hazards**. Some cities may know their major assets but not the full set and not the interconnections; others, may know all their assets, but again, not the interconnections; and still others may have data on all assets and interconnections but it has not been updated recently. Weaknesses in understanding critical interconnections can lead to cascading failures. Coastal cities must recognize the interconnectedness of critical infrastructure, such as power grids, water and sanitation, roads and traffic signals, and prepare for such cascading failure scenarios. Cities need to have an inventory of their critical assets (including those owned by other entities) that details what other "'upstream" assets each asset depends on, and in turn what "downstream" assets depend on it. Critical gaps often arise because private sector entities are reluctant to share information about their assets; this lack of collaboration needs to change to improve resilience planning. **Validation** • Evidence of a complete and up-to-date critical asset inventory for all major asset systems (those listed under this Essential) with links between them identified • Evidence of planning to deal with cascading "failure chains" known to exist

Protect the Working Edge (WEDG® Credit 3.3)

Description

When increasing infrastructure resilience in a coastal setting, a city should protect the working edge from structural damage over time due to active use and reduce the overall working edge of sites, where feasible. Working docks require adequate fendering to protect them from wear and tear over time, and particularly during storms and other high-water events.

Design Strategies

- Employ appropriate fendering strategies into the final design and consider bolstered mooring and fendering strategies to keep vessels attached with little damage during storm events, flood events, and inclement weather
- Design with low- and high-water levels in mind due to climate-induced variability
- Consider opportunities for ecological enhancements of fendering structures, such as material encasements of structural elements.
- Develop the working edge of sites with marine habitats and ecology in mind

For more details, see the **WEDG® Version 3.0 Manual**, page 93-94.

Use Renewable and Resilient Energy Sources (WEDG® Credit 4.8)

Description

When increasing infrastructure resilience in a coastal setting, a city should generate resilient and renewable energy including off-the-grid energy infrastructure for outdoor site features and auxiliary structures where feasible.

Design Strategies

- Increasing the use of renewable energy such as wind, solar, tidal or wave (hydropower), biomass or biogas, or geothermal reduces the carbon footprint of development. Generation is one concern, but distribution can be fatal flaw. Renewable energy systems are more useful if there is electricity storage capabilities; (batteries).
- For maritime operations, provide electric cold ironing which fosters reduced carbon emissions by providing shore-side electrical power to vessels at berth.

For more details, see the **WEDG® Version 3.0 Manual**, page 115-116.

ESSENTIAL 9: ENSURE EFFECTIVE DISASTER RESPONSE

The E9 chapter is the only chapter to focus on the **Response Period** and primarily addresses effectiveness of **coastal disaster** warning and emergency response capabilities.

For Essential #9, the following WEDG® V3.0 credits can provide additional guidance, illustrative practices and design strategies:

- **WEDG® Credit 1.4 (Establish an Emergency Preparedness and Response Plan)**

***** See the final section of Essential 9 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
9.1	**Detection, Alert & Warning Systems**	
9.1.1	To what extent are early warning and alert systems available that provide coverage for the entire population of the city before and during a **coastal disaster**?	Early warning systems for coastal events will vary in their timescales from several days in the case of an approaching hurricane or typhoon, to possibly a few minutes or hours in the case of a tsunami or coastal landslide. They will need to differentiate between hazards - with those differentiations thoroughly understood by the general public - as the appropriate responses may be different (a single undifferentiated siren will probably not suffice). Graduation between levels of urgency may also be needed, for example "advisory" where a hurricane is expected and it would be prudent to prepare; "alert" that evacuation may be soon be required; and "evacuate now". It is important to avoid "false positives" as these will undermine trust in the system. It is also important for neighboring cities or other alarm system operators to coordinate on action thresholds, as inconsistencies between areas will create confusion and undermine effectiveness. Digitally excluded groups (e.g., elderly, children, disabled, homeless) are often missed by mobile alerts, highlighting the need for redundant systems such as audible sirens. Warning systems need to be equipped with alternative communication channels (see below) and back-up power supplies. Improved warnings may enable an improved risk assessment in Essential 2 by allowing better preparation or enabling more people to move out of harm's way (reducing vulnerability). Cities need to ensure that their **coastal hazard** warning and detection systems offer clear, differentiated, coordinated and timely warnings.

#	Question	Guidance
		Validation • 100% of city area covered by timely, high specificity detection systems for event monitoring purposes • Evidence of avoidance in signaling false positives
9.1.2	To what extent do warning and detection systems reach all residents of the city, via multiple media before and during a **coastal disaster**?	To reach the entire city, including residents who may not have cellphones, internet access or TV, warning and detection systems need to use as many different media (TV, SMS/text, radio, social media, web, signage, sirens) as possible, to maximize the probability of being seen and heard. Messaging is a very strong form of contact as it spans smartphones and older devices and can readily be delivered in multiple languages (see below). As above, improved warnings may enable an improved risk assessment in Essential 2 by allowing better preparation or enabling more people to move out of harm's way (reducing vulnerability). Cities need to invest in multi-channel warning capabilities to ensure they reach all residents. They need to encourage city residents to subscribe to messaging-based alerts. **Validation** • 100% of city area covered by timely, high specificity detection and warning systems • Warning systems should complement each other to ensure no one is left behind. Digital alerts may not reach vulnerable groups and are less effective during night-time disasters when people are asleep or offline. Audible mass warning systems (sirens) are critical in such cases, as they can wake residents and alert outdoor populations. Their effectiveness should be confirmed through acoustic coverage analysis.
9.1.3	To what extent are warning and detection systems available in all the languages spoken in the city, and to what extent have they been evaluated for impact and effectiveness before a **coastal disaster**?	Additionally, to reach the entire city, all warning systems need to display content in all languages spoken in the city, to ensure messages are understood and capable of being acted upon appropriately. Warning systems need to employ carefully chosen content to maximize the probability of their being heeded. They also need to address disability needs, for example deafness or blindness. Audible mass warning systems can support multilingual preparedness by broadcasting pre-recorded voice messages in multiple local languages, making instructions accessible even to those without digital access. It's equally important that the public is trained to understand the meaning of sirens – or at least knows that clear instructions will follow immediately after the alarm. This should be part of regular pre-disaster education efforts. As above, improved warnings may enable an improved risk assessment in Essential 2, for example, by allowing better preparation or enabling more people to move from harm's way (reducing vulnerability).

#	Question	Guidance
		Cities need to ensure that their detection and warning systems deliver content in all languages spoken in the area, and that it is worded to ensure that action is taken. They need to encourage city residents to subscribe to messaging-based alerts. **Validation** • 100% of city residents have access to warnings of **coastal disaster events** in their own languages and according to their abilities
9.2	**Emergency Response - Planning**	
9.2.1	To what extent are there up-to-date emergency response plans that address the **coastal disaster scenarios** identified in Essential 2?	Emergency response plans need to cover, as a minimum: • Command and control - overall command, coordination with other agencies and cities, roles, responsibilities procedures (see Essential 1) • Evacuations for hospitals, jails, schools (see below), hotels and other places with large numbers of (possibly, vulnerable) occupants • Communication systems and backup systems • Critical asset management (including likely "failure chains" – see Essential 8) • Fire service response • Medical response • Law and order response • All external resources • Public information • Triage policies Plans need to be updated regularly to take account of changing risks and local factors (for example, road closures due to repair work, wind directions, storm surge projections). Cities need to create and maintain effective emergency response plans. **Validation** • Evidence of recently up-to-date emergency response plans for **coastal disaster scenarios**
9.2.2	To what extent are emergency response plans integrated with those of other responders and key stakeholders for **coastal disasters**? (See also E6 for data sharing)	Emergency planners need to ensure that all emergency responders (fire, police, medical, also critical infrastructure/asset operators) are: • Operating from the same set of assumptions, especially where their assets or activities depend on one another (for example, if power is lost, do all parties understand the backup run time of cellphone tower generators?) • Planning their responses and activities to be consistent and interoperable with one another Coordination between stakeholders should also cover warning system activation protocols. All key responders should have a shared understanding of how and when mass warning systems are triggered,

#	Question	Guidance
		who is authorized to activate them, and how they integrate with other communication channels. This helps avoid delays or conflicting signals during critical response operations. Cities need to ensure that emergency plans embrace all key responders, and that each understands what the others can and will provide. This will be especially critical where assets are known to be dependent on one another for their function (see Essential 8). **Validation** • Sign off from all key responders that they agree the emergency plan and will perform as per expectations in the document
9.2.3	To what extent are city organizations' and education districts' plans integrated for **coastal disasters**? (See also E7 for city engagement)	City organizations such as faith-based centers or City Emergency Response Teams (CERTS) may have formed plans to act as communicators, or to provide shelters or emergency distribution centers. Education districts may also fall into this group. These plans need to be validated and incorporated into the city's main emergency plans. **Validation** • Clear integration of city organization or education district emergency plans into the main emergency plans and sign-off from the organizations in question
9.2.4	To what extent are the city's emergency response capabilities communicated to the public in the city with respect to **coastal disaster events**? (See also E7 for city engagement)	Experience shows that members of the public frequently overestimate the ability of first responders to respond to them during a disaster, either in a timely manner or at all. This can lead to a dangerous sense of complacency, whereby city residents either do not do "their" part in preparing for disasters or respond inappropriately. This puts them at risk and places more strain on first responders. Cities need to ensure that residents fully understand what they can reasonably expect from first responders (and by when) as well as from other key service providers (water, communications, energy, sanitation, etc.) **Validation** • All city residents show a well-grounded understanding of what to expect in a **coastal disaster event**, and what to do – this should be repeated via regular survey
9.2.5	To what extent are drills held that require all emergency responders and relevant city organizations to practice for an active **coastal disaster response** together?	It is critical for emergency plans to be practiced regularly, and for those practices to involve all responders (as defined above, including emergency/first responders, medical services and operators of critical infrastructure systems) who need to contribute to the **coastal disaster response**. Practices need to be based on **coastal disaster scenarios** that address the risks identified in Essential 2. There also needs to be a review after drills to evaluate what worked and what needs improving. Cities need to provide for **coastal disaster event** emergency response plans to be practiced at least annually, and for remedial action to be taken as indicated. **Validation** • Annual drills encompassing all responders. • Learning and improvement loop from drills.

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9.2.6	To what extent are drills held that engage the public in practicing for an active **coastal disaster response**?	If possible, some drills should engage the city (especially those who live in particularly at-risk areas) as participants - not just onlookers. Drills should be as realistic as possible, for example including mock shutdowns of critical infrastructure. They also need to address the needs of disabled people and those for whom English is not a first language. They become a valuable form of city engagement (see E7). Cities need to provide for their residents' inclusion in drills and practices where possible. **Validation** • Residents of the city are engaged in drills and practices on a regular basis
9.3	**Emergency Response - Implementation**	
9.3.1	To what extent can emergency responders access, from their own resources or via mutual aid, the equipment they need to deal with the **coastal disasters** within the required response time?	Emergency responders need to be able to access the equipment (vehicles, earthmovers, aircraft, pumps, tools, communications, personal safety gear and all associated logistics, etc.) they need to respond, should the risks identified in Essential 2 materialize. These may come from their own resources, neighboring cities (perhaps via mutual aid agreements), other tiers of government, or private sources (perhaps via Memoranda of Understanding). Cities must ensure that responders' equipment needs are met promptly. **Validation** • Equipment needs are identified and availability is known to be adequate for average and worst-case **coastal disaster scenarios** in Essential 2
9.3.2	To what extent can emergency responders access, from their own resources or via mutual aid, the personnel they need to address **coastal disasters** within the required response time?	Just as with equipment, emergency responders need to be able to access the personnel they need from internal or external sources. Cities need to be sure that personnel needs will be met rapidly. **Validation** • Personnel needs are identified, and availability is known to be adequate for average and worst-case **coastal disaster scenarios** from Essential 2
9.3.3	To what extent do emergency responders have "surge" or reserve capacity such as personnel and equipment for ongoing essential tasks (e.g., law and order, or emergency medical care) for **coastal disaster events**?	Emergency responders need additional surge or back up capacity to meet with other, "regular" needs that the city will have as the **coastal disaster event** is being dealt with, from internal or external resources. This will include police, fire and hospitals. Where volunteers are to be used, the roster needs to be up-to-date and available. Cities need to ensure that this backup capacity will be available and from where it will be activated. **Validation** • Back-up resource needs are identified with contributions sized by reference to estimates of need
9.3.4	To what extent are equipment and processes used by different emergency responders interoperable with each other for **coastal disaster events**?	Emergency response in some locations has been hindered in the past by incompatibilities between agencies and infrastructure operators in communication systems, equipment (vehicles, pumps, hoses, power tools and so on), and processes including alert, warning and evacuation thresholds and protocols.

#	Question	Guidance
		Gaps in this coordination can lead to delay or inconsistent event response. Cities must ensure that such incompatibilities are eradicated in advance of an event, and that clear standards for the relevant equipment or processes are defined, shared and implemented. **Validation** • Absence of incompatibilities is proven by actual experience, or by drills and detailed review, or by certified compliance with a corresponding standard
9.3.5	To what extent have arrangements been made to help vulnerable individuals or populations before and during **coastal disaster events**?	There are, sadly, known instances of people in wheelchairs drowning in floods because no one was available, or knew, to help them. People with specific kinds of disabilities, or groups with lower incomes and resources (for example, those who do not own their own transportation), may therefore require additional assistance to prepare their homes for an oncoming **coastal disaster** or to evacuate. Some cities maintain registers of those who need help, where those affected apply to be registered. The city itself may then help them, or neighborhood volunteers may do the work. Cities need to ensure that those who need additional help will in fact receive it. **Validation** • Evidence of an up-to-date list of those needing extra help and designated means of helping each person planned for
9.3.6	To what extent have arrangements been made in advance of searching for survivors as well as removing and moving human and animal remains after the peak of the **coastal disaster**?	Inevitably, after a major disaster there will be a need to search for survivors and to find, identify and move human and animal remains. Cities need to understand where help will come from for this specialized and time-consuming effort. **Validation** • Evidence of plans sized in line with a worst-case **coastal disaster scenario** from E2
9.3.7	To what extent are law and order resources adequate to prevent looting and theft, and other tasks, in the aftermath of a **coastal disaster event**?	Unfortunately, looting abandoned homes is a known phenomenon during and after disasters of all kinds. Other law and order workloads may also increase due to factors such as blocking access to roads and locating missing people, among others. Cities need to ensure they have access to adequate law and order resources to deal with post-event workloads, perhaps via mutual aid arrangements with other areas. Digital security systems (cameras) may also reduce the burden on law and order resources, although consideration needs to be given to the extent to which cameras and communications are themselves vulnerable to flood or wind damage. There may also be a role for homeowner associations, neighborhood watch teams and other volunteer groups once people have been allowed back into the affected area. These arrangements need to be made in advance of the event. **Validation** • Evidence of plans sized in line with a worst-case **coastal disaster scenario** from E2.

#	Question	Guidance
9.3.8	To what extent have arrangements been made to care for displaced and injured animals (e.g., pets, livestock, wildlife etc.) in response to a **coastal disaster**?	Especially in rural areas, it has proven be a major exercise in helping people find accommodation for animals they own (pets or livestock), and to deal with short- or long-term injuries to them. There may also be injured or displaced wildlife that requires help. Animal impacts accordingly need to be included in **coastal disaster scenario** assessments (see E2); evacuation plans need to address caring for animals and livestock (see E9); and post-event plans need to include surge capacity for veterinarians, perhaps via mutual aid arrangements with other areas. **Validation** • Evidence of plans sized in line with a worst-case **coastal disaster scenario** from E2.
9.4	**Evacuation Plans, Shelter & Staples**	
9.4.1	To what extent does the city have viable evacuation plans for all population segments and in all **coastal disaster scenarios**?	Evacuation demands will depend on the event itself, where people are located, the road layout, access to vehicles, the ability to drive, the terrain and so on. They may also depend on the willingness of people to evacuate, even in the face of evident and undeniable personal danger. Cities need evacuation plans that take full account of their circumstances as described above, including assumptions about residents that won't heed even mandatory evacuation warnings. **Validation** • Evidence of credible evacuation plans for all population segments of the city in the event of a **coastal disaster**
9.4.2	To what extent do individuals in the city have a coastal flood response plan that includes evacuation plans?	All city residents need an emergency plan for dealing with **coastal disaster events** that includes: • Gathering family members • Gathering up pets, personal documents and key possessions • Securing houses and apartments, to the extent possible • Evacuation - both the route and destination • Emergency kit, with minimum contents defined by a standard reference list **Validation** • % of households with such a plan, regularly re-measured or re-assessed
9.4.3	To what extent do all schools have effective evacuation plans in response to a **coastal disaster**?	Self-evidently, schools contain hundreds of vulnerable children or teenagers congregated in one place – an unavoidable concentration of risk. Schools need to understand **coastal disaster risk** in the city and have robust evacuation plans for use as required. Cities need to have effective evacuation plans for schools. **Validation** • Evidence of evacuation plans for all schools when responding to a **coastal disaster event**

#	Question	Guidance
9.4.4	To what extent does the city have safe emergency shelter available on a ready, communal basis for those affected by a **coastal disaster event**? (See also E10 for personal or family accommodation needs)	Cities may need to rely on schools, churches, sports centers, malls and the like to provide very short-term communal emergency shelters before people move on to their own emergency accommodation (see Essential 10 - in some cases people and families may be evacuated directly to their own accommodation). Shelters need to take account of the specific needs of men, women, children and the disabled, and to provide for servicing and public order. Shelters may also be locations for the distribution of emergency funds. Third party owners of shelters should be engaged in advance of any hazardous **coastal disaster event** through MOUs or similar. Cities should estimate the likely need for this type of shelter and plan. **Validation** • Evidence of emergency accommodation plan, sized with credible reference to estimated need
9.4.5	To what extent does the city have safe shelter for pets and livestock in the event of a **coastal disaster event**?	Cities may also need to plan for the safe short-term sheltering of pets (including horses) and livestock, whether within the area or by evacuation to another area. Cities should estimate the likely need for this type of shelter and plan for it to be met. **Validation** • Evidence of sufficient emergency accommodation for pets and livestock, sized with credible reference to estimated need
9.4.6	To what extent are emergency food, water and staple goods/essentials available to those in shelters in the event of a **coastal disaster**?	Those in shelters will need access to food (including for those with dietary restrictions), pet food, water and staple goods such as spare clothes, hygiene and sanitary items, toys, access to TV, communications, etc. Cities need to provide for these essentials in response to a **coastal disaster**. **Validation** • A credible emergency accommodation plan, as described above, should address these needs
9.4.7	To what extent is emergency fuel or transportation available for those needing to leave the area temporarily before or during a **coastal disaster event**?	It is in the city's and individuals' interest to encourage people to leave communal shelters, either to temporary accommodation (see E10), to healthcare facilities. or to relatives. Cities may need to provide emergency fuel distribution, funds for fuel or alternative transportation. Cities need to think through how they will enable city residents to transport themselves from the immediate locale of the **coastal disaster event**. **Validation** • Evidence of credible emergency transportation plans sized to meet estimated need

Establish an Emergency Preparedness and Response Plan (WEDG® Credit 1.4)

Description

When ensuring effective **coastal disaster response**, a city should protect health and safety of its residents by planning for emergency conditions, which includes effective communications and operations both prior to and following extreme events. Create an emergency preparedness plan for human safety prior to an extreme weather event, particularly considering the most vulnerable cities, such as those with impaired mobility, overburdened cities, or environmental justice cities.

Design Strategies

Establish an **emergency preparedness and response plan** specific to a city's needs that:

- Defines goals for safety and recovery after an extreme event
- Establish an emergency network of on-site team leaders, as well as applicable local, city, state and national entities
- Create an education and outreach strategy about the risks before, during, and after an extreme event
- Establish a pre- and post-emergency communication network between all relevant stakeholders to ensure holistic event response
- Maintain a map of vulnerable assets and hazardous substances within the floodplain and a list of strategies for elevating or securing those assets prior to an event.
- Ensure that critical infrastructure is protected
- Outline "Go-bag" components to be used in an emergency and encourage residents to have their supply kit stocked and available.

For more details, see the **WEDG® Version 3.0 Manual**, pages 54-55.

ESSENTIAL 10: EXPEDITE RECOVERY AND BUILD BACK BETTER

The E10 chapter is the only chapter mainly focused on the **Recovery Period** and primarily addresses the extent to which preparation has been made in advance for the immediate and longer-term aftermath of a **coastal disaster event**.

For Essential #10, the full WEDG® V3.0 manual and its appendices and case studies can provide additional guidance, illustrative practices and design strategies on building waterfront sites bottom-up and connecting networks of assets that can build resilience and perform together during and after **coastal disasters**.

#	Question	Guidance
10.1	**Housing & Emergency Services**	
10.1.1	To what extent have accommodation arrangements been made in advance with hotels and deployable lodgings etc. for the local population in the immediate recovery period – whether in the local area or in surrounding regions?	One of the observed after-effects of major **coastal disasters** is the scramble for evacuees and displaced people to find accommodation, at reasonable rates, once they leave emergency shelters. This can be addressed through identification in advance of potential accommodation and agreement on nightly rates to prevent gouging. Cities need to identify sources of emergency housing for when residents leave emergency shelters. Emergency housing can also include vessels (i.e., cruise ships). **Validation** • Memoranda of Understanding (MOUs) exist for emergency accommodation at specified nightly rates for evacuees, sized to deal with the worst-case **coastal disaster scenario** in E2 and with all necessary infrastructure • Understanding exists of how far off a dispersal will be needed in any given area based on the order of magnitude of evacuations • If applicable, track record of rapid response to disasters in this geographical/physical area
10.1.2	To what extent has the risk of loss to government facilities including those accessible by the public been anticipated and planned for the **recovery period**? (See also E8)	This applies to facilities such as post offices or welfare centers that cannot be hardened but are accessed by the public. Staff shortages, where staff living in the area directly affected by the **coastal disaster** are not available – due to the need to attend to their families or homes, or due to having been evacuated – will also be an issue. The loss of these services, especially in remote areas, would impose a burden on the local population and hinder their ability to access services they may need. Cities need to ensure that they and other branches of government have made adequate plans for continuity of service from their facilities. **Validation** • Presence of credible plans and provisions to remediate damage and continue to provide service (may require mutual aid), sized to deal with worst case **coastal disaster** scenario from E2, and provide for temporary access. • If applicable – track record of rapid response to disasters in this physical area.

#	Question	Guidance
10.1.3	To what extent has the risk of loss and damage to government data and systems relating to infrastructure, citizens, and all areas of government activity been anticipated and planned for a **coastal disaster recovery period**? (See also E8)	After the Tohoku earthquake in Japan in 2011 the resulting tsunami destroyed the system holding citizens' dental records, making identification of bodies difficult and resulting in dislocation for citizens in the longer term. After Hurricane Katrina, the city government of New Orleans was unable to process payroll for its workers, and a local company had to be provided and financially underwrite payroll service on an emergency basis. If not cloud-based to begin with, all city/government data and systems that might be in harm's way from a **coastal disaster** (i.e., in buildings that cannot be fully flood or wind-hardened) need to be backed up to another location at least 50 miles distant, ideally with a "hot standby" arrangement, activated as needed. **Validation** • Cloud hosting confirmed to be in use for all relevant systems • Otherwise, presence of backup arrangements, with regular testing
10.1.4	To what extent have policies and arrangements for expediting repair and reconstruction permits been identified in advance of a **coastal disaster recovery period**?	One of the most significant issues experienced by towns and cities attempting to restore their business and residential areas after a **coastal disaster** has been the length of time required for building or homeowners to navigate the permitting process. In addition, there is frequently a tension between the desire to expedite rebuilding by loosening permit requirements temporarily – while not reducing future resilience by replicating the same weaknesses that existed before. Cities should evaluate, in advance, arrangements for addressing this issue, and how (if at all) they should relax normal codes and standards to expedite immediate recovery. **Validation** • Policies for permit stringency and compliance in a post-event period • Additional permitting resources (if needs be through work-sharing arrangements/MOUs with neighboring cities or districts) to expedite applications • Arrangements for help for those filing permit applications
10.1.5	To what extent have vendors and contractor lists been put in place in advance, that include pricing, to reduce the risk of predatory behavior in the aftermath of a **coastal disaster event**?	One frequent complaint in the aftermath of many disasters is that repair and rebuilding contractors charge exorbitant prices; and that many of those presenting themselves as qualified to carry out the work are unqualified or fraudulent. Cities should vet contractors in advance of an event, much as some fire departments do today with contractors for smoke remediation and rebuilding after house fires. They should also agree upon set prices for hourly rates or specific tasks post-disaster, even if these are renegotiated annually. **Validation** • Evidence of list of contractors, validated for suitability and insurance coverage (if applicable to city), with agreed upon hourly rates (these may need to be renegotiated annually) • List to be sized to deal with worst-case **coastal disaster scenario** from E2 and updated annually.

#	Question	Guidance
10.1.6	To what extent is there sufficient building safety inspection capability to assess all affected properties in the aftermath of a **coastal disaster** event?	Building inspectors may be faced with large numbers of properties to be inspected and red tagged. Cities need to make sure they have access to enough inspectors, familiar with local building styles and methods, perhaps through mutual aid arrangements with other areas. **Validation** • Evidence of plans sized in line with worst-case **coastal disaster scenario** from E2
10.2	**Healthcare Services**	
10.2.1	To what extent has the risk of loss and damage to critical healthcare infrastructure (hospitals, clinics, convalescent facilities, elderly care facilities) been planned for the **recovery period**?	Hospitals, medical centers, outpatient facilities, doctors' offices and pharmacies can be, and have been, damaged or destroyed in **coastal disasters**, resulting in loss of ready access to care and medications, especially in remote areas. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate, just when a surge capacity is needed to deal with additional injuries and the likely increase in hospitalizations from all causes that are known to accompany **coastal disasters**. Cities need to confirm that the plans of service providers include adequate remediation and service delivery capability, including facilities, staff, supplies and medications. **Validation** • Evidence of credible service provider plans and provisions to provide service (may require mutual aid with other providers) in the worst-case **coastal disaster scenario** from E2, and to provide temporary facilities • If applicable – track record of rapid response to disasters in this geographical/physical area
10.2.2	To what extent has surge capacity in healthcare been planned for, along with levels of longer term (chronic) conditions resulting from a **coastal disaster**?	Post-disaster hospitalizations may increase due to physical injuries, exacerbation of pre-existing conditions, environmental contamination or stress-induced events such as heart-attacks or strokes. PTSD may also be an issue. Cities need to plan for a potential surge in medical cases after an event, including access to specialists in the types of health issues likely to be encountered. **Validation** • Evidence of planning for surge in hospitalizations in the aftermath of a **coastal disaster event**
10.2.3	To what extent are short and long-term mental health implications from **coastal disasters** planned for in advance, including for those whose socio-economic situations impede access to mental health care?	Disaster implications for mental health are only just now being studied, but it seems likely that they will include short and long term consequences such as: • Large scale Post-Traumatic Stress Disorder (PTSD), both for evacuees and those who lose homes, loved ones, or other property • Exacerbation of existing conditions such as obsessive compulsive disorder (OCD), depression and anxiety • Interrupted access to medications

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		• In turn, impediments to decision-making in choices about relocation, shifts in employment, or about future home hardening Significant percentages of individuals with mental health conditions do not get support even in non-disaster times, and such individuals may be particularly vulnerable to trauma. Also, relationships between therapeutic facilities and vulnerable populations may not have been established, which can exacerbate isolation in the event of a **coastal disaster event**. Cities need to ensure that mental health implications are included in healthcare planning, working with providers. **Validation** • Evidence of effective strategies of local healthcare providers addressing mental health impacts of worst case **coastal disaster scenario** from E2 • Planning for populations with high levels of mental health challenges in the form of extra city outreach • Planning to reduce isolation in mitigation and recovery so that individuals do not have to face these challenges alone
10.3	**Critical Infrastructure**	
10.3.1	To what extent have the requirements to repair communications infrastructure after a **coastal disaster event** been anticipated and planned for? (Temporary backup communications - see E8 and E9)	Especially if above ground, phone, cellphone and internet infrastructure will be at risk of damage from flooding, wind, and perhaps landslides, hindering recovery. Communications staff living in the area directly affected the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of telecommunications service providers include adequate and timely remediation and service delivery capability. **Validation** • Data on backup generator run time – see E8 • Evidence of credible service provider plans and provisions to remediate damage (may include mutual aid) sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area • Presence of backup communications (e.g. satellite) for the city

#	Question	Guidance
10.3.2	To what extent have the requirements to repair the power infrastructure after a **coastal disaster** been anticipated and planned for?	Especially if above ground, power infrastructure will be at risk of damage from wind and trees, which can hinder recovery. Wires left dangling into flood water can pose an electrocution hazard. Energy staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of power service providers include adequate remediation and service delivery capability. **Validation** • Presence of credible service provider/utility plans and provisions to remediate damage (may include mutual aid) sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area • Presence of backup energy supplies for the city
10.3.3	To what extent have the requirements to repair the water supply infrastructure after a **coastal disaster** been anticipated and planned for?	Especially if above ground, water infrastructure will be at risk of damage from flooding and other damage, hindering recovery. Additionally, above- or below-ground water supplies and systems may be contaminated, requiring flushing that can take weeks or months. As with water resources (above) there may be a need for backup water resources (tanks, bottles) which can be arranged in advance on as "as required" basis. Cities need to confirm that the plans of water supply companies/agencies include adequate remediation and service delivery capability. **Validation** • Presence of credible service provider/utility plans and provisions to remediate damage to utility infrastructure (may include mutual aid) sized to deal with worst case **coastal disaster scenario** from E2 • Plans identify arrangements for alternative trucked water supplies, via MOUs with suppliers and agreed-upon fees/rates • If applicable – track record of rapid response to disasters in this geographical/physical area • Presence of arrangements for backup water supplies (e.g. portable water, storage tanks) for the city

#	Question	Guidance
10.3.4	To what extent have the requirements to repair the wastewater treatment infrastructure after a **coastal disaster** been anticipated and planned for?	Especially if above ground, wastewater infrastructure will be at risk of damage from flooding and other damage, hindering recovery. At the extreme, wastewater and sewage may need to be trucked elsewhere for treatment. Cities need to confirm that the plans of wastewater companies/agencies include adequate remediation and service delivery capability. **Validation** • Presence of credible service provider/utility plans and provisions to remediate damage to utility infrastructure sized to deal with worst case **coastal disaster scenario** from E2 • Plans identify arrangements for alternative trucking wastewater, via MOUs with suppliers and agreed-upon fees/rates
10.3.5	To what extent have the requirements to repair the education infrastructure after a **coastal disaster** been anticipated and planned for?	Schools can be, and have been, damaged or destroyed in **coastal disasters**, resulting in loss of ready access to education, especially in remote areas. Staff (including school bus drivers) living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of education service providers include adequate remediation and service delivery capability. **Validation** • Evidence of credible education service provider plans and provisions to provide service (may require mutual aid with other districts) in the worst case **coastal disaster scenario** from E2, and to provide temporary facilities • Plans for temporary online classes if schools are physically damaged and under repair
10.3.6	To what extent have the requirements to repair to the road infrastructure after a **coastal disaster** been anticipated and planned for?	Road infrastructure (surfaces, traffic signals, signage, etc.) will be at risk of damage from **coastal disasters** (especially flooding, coastal erosion or landslides), hindering recovery. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of road service providers and agencies include adequate remediation and service delivery capability. **Validation** • Evidence of credible highway agency plans and provisions to remediate damage (may require mutual aid), sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this physical area

#	Question	Guidance
10.3.7	To what extent has the risk of damage to the rail infrastructure (above ground & below ground systems) after a **coastal disaster** been anticipated and planned for?	Rail infrastructure (track, signals, goods yards, etc.) will be at risk of damage from **coastal disasters** (especially flooding, coastal erosion or landslides), potentially hindering the supply of emergency goods in the short-term and hindering recovery in the longer term. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of rail operators and agencies include adequate remediation and service delivery capability. **Validation** • Evidence of credible rail company plans and provisions to remediate damage (may require mutual aid), sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area
10.3.8	To what extent have the requirements to repair damage to long-distance transit infrastructure (sea- and river-ports, airports) after a **coastal disaster** been anticipated and planned for?	Sea and airport infrastructure will be at risk of damage by **coastal disasters**, potentially hindering the flow of emergency supplies in the short term, and economic recovery in the longer term. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm the short- term plans of sea and airport operators to maintain service and the long- term plans to harden the relevant port infrastructure. **Validation** • Evidence of credible port operator plans and provisions to remediate damage, sized to deal with the worst- case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area
10.3.9	To what extent have the requirements to repair the portable fuel supply and distribution infrastructure after a **coastal disaster** been anticipated and planned for?	The fuel supply infrastructure (propane, diesel, petroleum) as spatialized in gas stations, stock, and transportation will be at risk of damage from **coastal disasters**, hindering recovery. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of gasoline retailers include adequate remediation and alternative supply capability, especially in remote areas. **Validation** • Evidence of credible fuel retailer plans and provisions to remediate damage and maintain supply sized to deal with worst case **coastal disaster scenario** from E2. • If applicable – track record of rapid response to disasters in this geographical/physical area

#	Question	Guidance
10.3.10	To what extent has the risk of damage to banking infrastructure after a **coastal disaster** been anticipated and planned for?	The principal risk here is loss of access to bank accounts and cash, whether over the counter or via ATMs, arising from direct storm damage or where staff living in the area directly affected by the **coastal disaster** are not available – due to the need to attend to their families or homes, or due to having been evacuated. The loss of key banking services, especially in remote areas, would impose a burden on the local population and hinder ability to recover properties and former livelihoods. Cities need to confirm that financial service providers have made adequate plans for continuity of service. **Validation** • Evidence of credible bank plans and provisions to remediate damage, sized to deal with worst case **coastal disaster scenario** from E2, and provide for temporary access • If applicable – track record of rapid response to disasters in this geographical/physical area
10.3.11	To what extent have the requirements to repair the food supply infrastructure after a **coastal disaster** been anticipated and planned for?	The food supply infrastructure (croplands, stock, transportation, stores/outlets) will be at risk of damage from **coastal disasters**, hindering recovery. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the food retailers' plans include adequate backup and alternative supply capability, especially in remote areas. **Validation** • Evidence of credible food retailer plans and provisions to remediate damage even after a severe **coastal disaster** • Process to evaluate damage to crops for farmers so that food that is healthy can still be used with confidence for farmers and consumers • If applicable – track record of rapid response to disasters in this geographical/physical area
10.3.12	To what extent have the requirements to repair the built environment commercial infrastructure after a **coastal disaster** been anticipated and planned for?	The built environment's commercial infrastructure (stock, transportation, stores/outlets) will be at risk of damage from **coastal disasters**, hindering recovery. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Especially in remote areas, cities need to confirm that commercial retailers' plans include adequate back-up and alternative supply capability. **Validation** • Evidence of credible retailer plans and provisions to remediate damage sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area

#	Question	Guidance
10.3.13	To what extent have the requirements to repair the mail delivery infrastructure after a **coastal disaster** been anticipated and planned for?	In the aftermath of a **coastal disaster event** it can be hard for people to receive mail when they may have moved, when mailboxes may have been lost, or when an area has been evacuated so the mail infrastructure is damaged. Despite this, much of the key post-event communication and potentially funds may need to come by mail. Difficulties in delivering this will therefore slow down the recovery. Cities need to understand what contingency plans and arrangements may have been made by the postal agency and incorporate those into their own planning. **Validation** • Evidence of credible plans for continued mail delivery in the aftermath of a **coastal disaster**
10.4	**Economic & Financial Recovery**	
10.4.1	To what extent are there comprehensive plans for the recovery period that restarts economic and social activity after a **coastal disaster**?	Experience has shown that post-event planning is one of the most neglected areas of any in the UN DRR City Disaster Resilience Scorecards. Many issues can be foreseen and planned for in advance – those that arise in the immediate aftermath, and those that are part of the longer-term recovery. **Validation** • Evidence of comprehensive plans addressing the issues in this essential at the required scale • If applicable, experience of implementing those plans after a **coastal disaster event**
10.4.2	To what extent is there sufficient loss adjustment and claims processing capability available in insurance companies to enable speedy property damage assessments in the **recovery period** (not applicable to all regions)?	Insurance assessments, in particular the loss adjustment process and claims processing for conventional insurance, is a frequent cause of hold-ups in enabling cities to recover from **coastal disaster events**. Loss adjusters need to be familiar with local construction techniques. Cities need to work with insurers to ensure that there will be sufficient loss-adjuster capacity after a disaster. **Validation** • Confirmation from major local insurers of their loss adjustment and claims processing capabilities are sized to deal with worst case **coastal disaster scenario** from E2
10.4.3	To what extent do recovery plans recognize the likelihood of significant price increases for all post-event equipment, skills and supplies in the **recovery period**? (Insurance cover – see E3)	In the aftermath of a major **coastal disaster**, local price increases in many items and services essential to the recovery, and potentially items such as food and fuel, are a known issue. In many cases these price rises will be justified – logistics may be difficult or require extended routes to avoid ongoing hazards, or delivery/execution may be hazardous. An allowance for these factors can be planned for in advance. In other cases, price rises may not be justified and may simply represent gouging. This needs to be prevented. Social media and other digital technologies can be used to prevent and address price gouging in real-time. Cities need to plan and budget for dealing with - and minimizing - for post-disaster price/cost spikes. **Validation** • Evidence of enhanced inflation factors in post-event planning and cost budgeting • Evidence of agreements locking in recovery resource prices before **coastal disaster events** occur

#	Question	Guidance
10.4.4	To what extent are emergency lines of credit available from government or banks, and easy to access in the **recovery period**?	In some cases, banks will provide rapid interest-free emergency credit, for example to small businesses to help them carry out repairs and open rapidly after a disaster. In the US, the bank then receives the emergency FEMA credit that would have gone to the small business, but which would have taken longer. In so doing, the business can survive until regular cash-flow is resumed, and in all probability, the bank gets a new customer at zero risk to it (since FEMA is in effect the guarantor). Such arrangements can form an alternative to business continuity insurance. Cities should explore such arrangements and set these up via MOUs in advance. **Validation** • Evidence of agreements with banks setting out emergency credit arrangements and the conditions under which they would apply
10.4.5	To what extent do businesses in the area have business continuity plans ready for the immediate aftermath of a **coastal disaster event**? (See also E6 and E7)	Many businesses do not plan adequately for business continuity in the event of a disaster, including **coastal disaster events**. Businesses that plan for physical loss may overlook the need to plan for loss of staff who need to attend to their own homes and families, or who may have been evacuated. Consequently, many fail and disappear, leaving a permanent economic and social scar in the area and a permanent loss of tax revenue for rebuilding. Cities regularly should encourage businesses to create plans for emergency supply and restocking, data protection, online business formats, and other factors that could hinder their re-opening. **Validation** • % of businesses with continuity plans that maximize the chances of survival beyond the event itself • % of businesses with business interruption insurance • % of businesses that self-identify as prepared **coastal disasters** such as hurricanes or flooding
10.4.6	To what extent have anchor institutions such as large retail employers who depend on local traffic and economic activity, created processes to help more economically vulnerable businesses with less liquidity to have the funds to rebuild in the **recovery period**?	Where a business depends on local economic activity (retailers, gas stations, an anchor at a mall) it may make economic sense for them to find ways to help smaller local businesses become more resilient, so that "eyeball traffic" and spending power are preserved in the aftermath of a disaster. Disaster preparedness and prevention-oriented City Benefits Agreements are designed to have these types of support in place already well before they are actually needed. Cities need to work with larger economic entities in their areas, in advance of **coastal disaster events**, to promote business activity after a disaster. **Validation** • Evidence of such cross-stakeholder agreements for economic activity protection and amplification

#	Question	Guidance
10.4.7	To what extent have arrangements have been made in accounting for fund disbursements during the **recovery period**?	After a **coastal disaster**, cities may be faced with a major influx of donations and relief funds that need to be accounted for. In extreme cases, cities may lose the function of their accounting systems and teams (see the payroll example above). Cities should consider a back-up accounting arrangement either via regional government or by a private sector organization such as an accounting firm. **Validation** • An MOU exists for emergency accounting and financial services for the city to activate during the recovery period
10.4.8	To what extent will funding for displaced people support them until they are able to find new jobs during the **recovery period**?[13]	While emergency funding may help people through the immediate aftermath of a **coastal disaster**, if local businesses have been impacted, it may be some months or years before city residents are able to find work. Many will leave the area, often never to return. Cities need to think through how to secure long-term funding, to protect the economic and social well-being of those impacted by **coastal disaster events** and **chronic coastal stress conditions**. **Validation** • Evidence of credible strategy for long-term funding, sized to deal with worst-case scenario from E2 in city planning and implementation
10.4.9	To what extent is career counselling and retraining available for people whose jobs disappear in the **recovery period**?	Where employers have gone out of business due to a **coastal disaster**, if people are to remain in the area they will need career counselling and training. Such training might usefully embrace roles and skills that are important to disaster resilience – landscaping, home hardening, etc. Cities need to think through how to create contingency plans for counselling and training via MOUs with local city colleges and universities or similar. **Validation** • Evidence of credible strategy for job retraining in city planning and implementation

[13] **Note:** UN DRR has created a Disaster Resilience Scorecard for Cities specifically to assess arrangements for the management of displaced populations.

#	Question	Guidance
10.5	**Environmental Damage Remediation**	
10.5.1	To what extent have requirements to repair likely environmental damage been anticipated and planned for the aftermath of a **coastal disaster event**? (See also E5)	**Coastal disaster** damage to woodland, vegetation, habitats and other natural features or ecosystem services may well arise, for example from septic systems. The possible release of chemical contaminants also needs to be considered along with containment plans. Cities should be able to anticipate some of this damage and plan for remediation or regeneration beforehand. **Validation** • Evidence of consideration for likely environmental damage from worst case **coastal disaster scenario** in E2 and a strategy for remediation (e.g., re-seeding/planting, decontamination) • Remediation should not reintroduce flood or landslide hazard (see Appendix C)
10.5.2	To what extent will environmental remediation make the landscape more resilient than before the **coastal disaster event**?	In anticipating post-event environmental damage, cities may conclude that certain steps could be taken to improve resilience (for example, enabling the regeneration of wetlands or sand dunes). If these steps are not possible today, they should nevertheless be included in planning for a post-disaster recovery period. Cities need to identify in advance of a disaster how they could make their environment more resilient in the aftermath of a **coastal disaster event**. **Validation** • Evidence that plans for remediation will make the environment more resilient than its current state • Evidence that permitting for nature-based approaches have been approved so that recoveries will not be dominated by conventional methods that may not reduce vulnerability against strengthening **coastal hazards**
10.5.3	To what extent have debris removal needs been anticipated and planned for the aftermath of a **coastal disaster event**?	Flood and wind debris poses many hazards after a **coastal disaster**. Their removal can be a major issue – both the removal itself and identifying sites for debris to be disposed of (or recycled), especially given that some of it may be toxic. For example, the debris may become contaminated with medical or industrial waste washed into floodwater, or gasoline, or it may have asbestos content. In some cases that toxicity will persist for many years even after the waste is buried. Removal and remediation strategies should be defined in advance, at least in outline, and contractors retained on MOUs with agreed pricing. Cities need to plan in advance of the event for debris removal and agree MOUs with contractors for this work. **Validation** • Plans identify debris removal as an issue and include provisioning for it • Plans identify removal and disposal arrangements, sized in line with worst case **coastal disaster scenario** (E2), and include MOUs with contractors to execute them, including agreed fee rates

#	Question	Guidance
		• Identification of regenerative or ecologically beneficial approaches to remediation wherever feasible • Contractors have the relevant qualifications to deal with hazardous materials and debris • Financing (or availability of a finance line) is available for the work required
10.5.4	To what extent is tree tagging, removal and disposal planned for, and sized for the aftermath of a **coastal disaster event**?	After hurricanes and floods in heavily wooded areas, felling, removal and disposal of downed and potentially unsafe trees poses major issues in terms of availability of foresters or tree surgeons, haulage trucks and drivers, and lumber mill capacity. Removal strategies should be defined in advance, at least in outline, sized to deal with worst-case **coastal disaster** scenarios from E2, and contractors retained on MOUs with pre-agreed pricing. Cities need to plan for tree tagging and removal and agree on MOUs with contractors for this critical work. **Validation** • Evidence of lumber removal planning sized for scale of afforestation/landscaping • MOUs with forestry/tree surgeon contractors and haulers, including agreed fee rates (may need to be renegotiated annually) • Financing (or availability of a finance line) is available for the work required
10.5.5	To what extent has ground contamination been anticipated and planned for the aftermath of a **coastal disaster event**?	Ground can become contaminated from flooding, for example from gasoline, chemical or sewage leaks. Remediation strategies should be defined in advance, at least in outline, and contractors retained on contracts with pre-specified pricing. Cities need to plan for post-event ground decontamination and agree on MOUs with contractors for this critical work. **Validation** • Plans identify contamination risks – location and nature of chemicals, sensitive locations (e.g. schools, life sciences, passenger transit, public recreation spaces) • Plans identify remediation strategies, sized in line with worst case scenario (see E2), and include MOUs with contractors to execute them, including agreed fee rates (may need to be renegotiated annually) • Financing (or availability of finance line) is available for critical work required
10.5.6	To what extent has the risk of water resource contamination been anticipated and planned for the aftermath of a **coastal disaster event**?	Lakes/reservoirs, creeks, rivers, and even near-to-the-surface groundwater can be contaminated by floods releasing gasoline, diesel and wastewater from sewage treatment plants. If these water resources are part of the drinking water supply, the issue is clear, but even if they are not, environmental damage requiring remediation may occur. Cities will need to address monitoring (from immediately after the **coastal disaster event** – leaving this until weeks or months after may result in people drinking contaminated water), remediation, and the potential need for alternative water supplies (likely to be brought in from external supply chains in the short-term).

#	Question	Guidance
		Validation • Plans identify arrangements for water resource monitoring (pre-event through routine and post-event) • Plans identify arrangements for alternative supplies, including water supplies if required, via MOUs with suppliers and agreed upon fees
10.5.7	To what extent has the risk of contamination from septic tanks and waste removal systems been anticipated and planned for the aftermath of a **coastal disaster event**?	Septic tanks are a known cause of problems after a **coastal disaster event** such as a flooding event. Cities need to know the location of all septic tanks in their spatial domain and make plans for inspecting these after a flood. In the longer term for tanks in especially flood-prone areas, cities should ideally plan to replace these with centralized sewer systems. **Validation** • Knowledge of key indicators and secondary modifiers for septic tank assets • Plans include septic tank inspection within a short period of time after a flooding event
10.6	**Learning Loops**	
10.6.1	To what extent is a process predefined for post-event learning in the aftermath of a **coastal disaster event**?	Responding to any **coastal disaster** will inevitably illuminate things that work well and those that work less well. Assessing this experience can provide valuable learnings for future planning, implementation and event response. Where applicable, cities need to learn from **coastal disaster events** that they experience - what worked, what did not, and what changes need to be made in adaptation and mitigation elements across all ten Essentials. Learning should also apply to future approvals for building and rebuilding (i.e., codes, zoning) to avoid recreating the same vulnerabilities as existed before. **Validation** • Evidence of post-event review process (where applicable) and changes made because of it • If no **coastal disaster** has yet been experienced: demonstration of learning process in post-event planning such as through policy development in building and rebuilding codes and zoning
10.6.2	To what extent are processes in place to learn from other cities' **coastal disaster recovery** successes and failures and to share this with other cities?	The experience of other cities - both similar and dissimilar - can be a powerful learning resource. Cities need to learn from each other on how to plan for post-event recovery – pitfalls, strategies, methods, etc. Do the "sister cities" of your city have different approaches to **coastal resilience** and **coastal disaster recovery**? If so, what can be learned from these sister cities? **Validation** • Evidence of conscious attempts to learn from **coastal disaster** post-event experience from other regions and of changes made because of this engagement

#	Question	Guidance
		• Presence of local experts from other regions where **coastal disasters** have been directly experienced to help make city planning for **coastal disaster risk reduction** tangible and real • Use of case studies and insights from other cities that have experienced **coastal disasters** and/or **chronic coastal stress conditions** • Evidence of sharing the city's own successes and failures (e.g., via academic and commercial releases or via working group participation composed of cities as constituents)

APPENDIX A: GLOSSARY

TERM	WORKING DEFINITION
Coastal Resilience Partnership	A partnership initiated between ARISE US and Waterfront Alliance, Inc. to build capacity for cities and other non-party stakeholders in coastal resilience.
Coastal Resilience Scorecard	Phase 1 of the partnership's efforts – to create a global identification & assessment tool for coastal disaster risk reduction and coastal resilience to allow cities to self-score readiness levels against universal coastal disaster risks – natural and human-induced.
Coastal Resilience Toolkit	Phase 2 of the partnership's efforts – to create a localized marketplace for buyers and sellers of coastal resilience products and services alongside pilot cities completing the Scorecard.
Coastal Disaster (Event)	A coastal disaster (aka coastal disaster event) is a defined occurrence of natural or human-induced catastrophe or extreme adversity in a pre-specified coastal domain, such as a city, site, or asset location.
Acute Coastal Disaster (or Hazard)	An acute coastal disaster is an event that originates, materializes, and ends with catastrophic impacts in a pre-specified coastal domain. Such events may involve rapid intensification of storms, while others may be catalyzed by other singular hydrological events or a linear/cascading sequence of changing coastal conditions.
Chronic Coastal Stress Condition	As opposed to an acute coastal disaster, a chronic coastal stress condition is one that impacts a pre-specified coastal domain over a longer period of time and involves a degree of incrementality/sequencing. For example, sea level rise is not a singular event but a longer-term, slower-moving change that is challenging coastal physical conditions (i.e., shoreline health indicators).
Natural Coastal Conditions	Coastal conditions are measurements of the health of pre-specified coastal domains at any time – they may include natural environment indicators such as soil and sand structure or average surface water levels, for example.
Coastal Zones	Coastal zones refer to the pre-specified domain immediately interfacing with the sea (or inlets of the sea such as estuaries where tides meet the streams, harbors, and ports). Coastal zones are used as a pre-specified coastal domain in the spatial and temporal analysis of coastal resilience for a city – for example, its baseline condition versus its target state (with resilience features fully invested and ready to activate in a disaster).

Hinterland Coastal Zone	The pre-specified domain situated behind the coastal zone stretching as much as 100 miles (or more) back from the sea itself and reaching into the floodplains/watersheds.
Coastal Setting	For the Scorecard, the coastal zone + the hinterland coastal zone make up a coastal setting given the functional relevance from 'ridge to reef' and in particular the relationship of freshwater systems with marine aquatic environments.
Coastal Resilience	**Note:** Adapted from IPCC definition[ix]. The capacity for interconnected social, economic, and ecological coastal systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure.
Resilience Dividends	Also known as co-benefits; these refer to the financial and non-financial (i.e., environmental, socio-economic, operational) benefits materialized from investing with purpose into resilient outcomes. The means by which the dividends are funded and executed are essentially boundless.
Climate Change Mitigation	An action-centric strategy in which climate actors invest in removing and avoiding anthropogenic greenhouse gas emissions.
Climate Change Adaptation	An action-centric strategy in which climate actors invest in adapting measures, activities, and assets to climate-induced, dynamic natural hazards and conditions.
Coastal Disaster Risk Reduction	Similar to traditional disaster risk reduction – the understanding, prevention, mitigation, response, and recovery aspects of defending people and the planet against disasters however defined in coastal settings. Coastal disaster risk is broadly defined by the Scorecard to include singular events as well as chronic stresses or conditions.
Prevention Period	The prevention period is the time available before a disaster strikes – most resilience investments can and should be made during this period. For that reason, 8 of the 10 Essentials focus on prevention as the ultimate mitigant of harm.
Response Period	The response period is the time immediately during a disaster – how humans and systems respond to an imminent and existential threat. The key priorities are human health and safety during a disaster or period of prolonged stress.
Recovery Period	The recovery period begins when the coastal disaster or chronic coastal stress condition has subsided – it's typically a time of devastated systems that require prioritization and preventive planning to maximize recovery efforts. Great care should be taken to focus on enablement a speedy, efficient and resilience-building recovery.

Coastal Disaster Scenario	A coastal disaster scenario is a modeled acute event, chronic coastal stress condition, or other harmful coastal condition, which requires a forecasting (look-forward) tool that builds plausible future states that should be evaluated with the best information possible.
Coastal Hazard	A coastal hazard is generally a naturally occurring event with some cases where human activity (i.e., design) is responsible for a vector of harm on a spatial domain such as an asset.
Coastal Exposure	A coastal exposure can refer to people, properties, plants & equipment that are generally stationary in a coastal setting and exposed to a hazard.
Coastal Vulnerability	A coastal vulnerability is the sensitivity or responsiveness of a coastal exposure to a coastal hazard given internal and external factors.
Coastal Disaster Risk Profile	A coastal disaster scenario will yield a baseline coastal disaster risk profile and allow for the setting of target states (i.e., a resilient profile).
Coastal Ecosystem Services	Like ecosystem services, coastal ecosystem services are the values that the natural environment provides to the human-built environment – it can be physical resources, protection, and intangible value such as health and well-being.
Coastal Nature-based Solutions	Also known as nature-based approaches or nature-based methods; when humans restore nature's valuable qualities and quantities or use nature's design in the built environment. Often halting and reversing nature's destruction can be very cost-effective and revenue-accretive even in shorter-term periods.

APPENDIX B: COASTAL DISASTER RISK & RESILIENCE PHYSICAL DETERMINANTS

Coastal Hazards ("What might happen?")

Geohazard

- Coastal Erosion
- Compressible & Expansive Soils
- Earthquake (Shockwave, Landslides)
- Landslide (non-seismic)
- Liquefaction
- Sand Encroachment
- Subsidence & Uplift

Hydrological

Flooding

- Natural Forms of Flooding incl. Coastal Flooding
- Urban Flooding

Marine Aquatic

- Extreme Wave Event (e.g., Tsunami)
- Marine Ecosystem Degradation
- Marine Pollution (non-point source)
- Marine Pollution (point source)
- Sea-level Rise (SLR)
- Secondary Salinity (incl. Saltwater Intrusion damaging freshwater reserves and structural integrity of buildings)

Meteorological

Extreme Weather

- Extreme Coastal Event (Convective, Low-pressure, Wind)
- Extreme Temperature Event (Cold Spell, Marine Heatwave, Ocean Rise via Warming)

Coastal Exposures ("What is in harm's way?")

- **Human** - Health & Safety, Quality of Life & Economic Livelihoods
- **Built Environment** – Housing, Manufacturing/Warehousing, Workplaces, Life Sciences, Commerce, Education, Tourism & Leisure, etc.
- **Built Environment** - Critical Infrastructure, Energy, Food & Water Systems, and Health Services
- **Natural Environment** – Land, Ecosystem Services, Biodiversity, Public Access to Waterfronts and Coastlines

Coastal Vulnerability ("What and how will the actual impact be?")

Impact Areas

- Casualties / Injuries/ Health & Quality of Life
- Damage to Physical Assets (e.g., Infrastructure, Housing, Utilities)
- Loss of Service or Functions from Disrupted and Damaged Physical Assets (including Cascading Failures due to Interdependence)
- Loss of Economic Activity (Physical and Financial losses, Loss of Employment, Loss of Inbound Investment)
- Loss of Economic Vitality or Livelihoods
- Damage to Ecosystem Services
- City Vitality and Cohesion

Factors

- Design of built and natural environments
- Composition of built and natural environments
- Human intention and activities for built and natural environments

APPENDIX C: UNIVERSAL COASTAL HAZARDS FOR COASTAL DISASTER SCENARIO TOOLS

Geohazard

- **Coastal Erosion**
- **Compressible & Expansive Soil**
- **Earthquake** (Shockwave, Landslides)
- **Landslide** (non-seismic)
- **Liquefaction**
- **Sand Encroachment**
- **Subsidence & Uplift**

Hydrological

- **Extreme Wave Event** (e.g., Tsunami)
- **Marine Ecosystem Degradation**
- **Marine Pollution** (non-point source)
- **Marine Pollution** (point source)
- **Sea-level Rise** (SLR)
- **Secondary Salinity (incl. saltwater intrusion)**
- **Urban Flooding**
- **Natural Flooding** (incl. coastal flooding)

Meteorological

- **Extreme Coastal Event** (Convective, Low-Pressure, Wind Storms - i.e., Hurricane, Typhoon, etc.)
- **Extreme Temperature Event** (Marine Cold Spell, Marine Heatwave, Ocean Rise via Warming)

APPENDIX D: FREQUENTLY ASKED QUESTIONS

What are Waterfront Edge Design Guidelines (WEDG)? How is it connected and/or different from the Scorecard?

The Waterfront Alliance brings deep expertise in resilient waterfront design, codified in WEDG – the gold standard for waterfront sites. WEDG is a national rating system adopted by projects across the U.S. and supported by over 750 accredited practitioners on three continents. WEDG credits are awarded to waterfront projects that incorporate best practices in climate resilience, ecology, and community access and can yield a passing score for verification of an entire site.

Note: completing the Scorecard does not automatically qualify a city or any of its assets for WEDG certification – instead, single sites must be submitted for preliminary review (free) and full accreditation (cost).

Waterfronts are high-value city spaces that support recreation, commerce, and ecological health. However, designing them requires balancing environmental integrity, equitable access, and long-term resilience. Estuarine and riparian habitats are sensitive and have suffered significant loss and damage over the last century due to human activities. Flooding and sea level rise threaten homes and livelihoods, resulting in billions (USD) annually across the globe. As environmental justice concerns intersect with real estate pressures, strong leadership and practical guidance are needed at every scale—local, regional, and national.

How does the Scorecard relate to other coastal disaster risk reduction tools?

We are aware that there are other scorecards and assessment frameworks for assessing coastal risk and responses to it. However, so far as we are aware none of these will be as holistic and comprehensive as this Scorecard. If your city has already used one of the other tools, we suggest you bring the data and answers from that over to this tool and then fill in around it where gaps remain. The Scorecard is not a standard or a taxonomy – it works alongside such credentials and this first version is influenced by WEDG (a site-specific residential) envisioned to a city scale.

What are the terms on which the Scorecard is offered?

The Scorecard is available free of charge to anyone who wishes to use it thanks to the generosity of our partners. Any person or organization that wishes to use it to create for-profit derivatives such as software or consulting services is also at liberty to do this, provided that they do not charge for the Scorecard itself.

While it is thorough, and systematic and while it has been peer-reviewed as set out below, *no warranty is offered as to the Scorecard's completeness or suitability for use in any specific set of circumstances. Users are* ***strongly*** *encouraged to satisfy themselves that the Scorecard is suitable for the purpose at hand and that it contains no erroneous suggestions or omissions when applied to their specific circumstances.*

If you have suggestions for improving the Scorecard, whether just editorial or more substantive, or whether you are a coastal planning and vulnerability expert or perhaps just someone who lives in a coastal zone, we welcome your contributions.

Are Cities' Scorecard data kept confidential if they participate in pilots with ARISE US?

Yes. We do not publish scores or carry out benchmarking that identifies individual cities, because we do not wish to discourage them from using the scorecard if they think they may do poorly. Cities are however at liberty to publish or benchmark their own data if they so choose. In addition, we may publish commentaries or analyses on trends revealed as cities use the scorecard (for example, which Essentials or questions seem to be attracting the highest and lowest scores) without identifying cities either directly or indirectly.

CITATIONS | END NOTES

[i] **Nature**: "Accelerating growth of human coastal populations at the global and continent levels," 2000-2018, Web, accessible on November 5th, 2025.
[ii] **World Economic Forum**: "Sea level rise: everything you need to know," March 25th, 2025, Web, accessible on November 6th 2025.
[iii] **S&P Global**: "Understanding sea-level rise and risks for coastal flooding," December 8th, 2023, Web, accessible on November 5th, 2025.
[iv] **Visual adapted from MCR 2030**: "The Ten Essentials for Making Cities Resilient," Web, accessible on November 5th, 2025.
[v] Cardona, O.D., M.K. van Aalst, J. Birkmann, M. Fordham, G. McGregor, R. Perez, R.S. Pulwarty, E.L.F. Schipper, and B.T. Sinh, 2012: **Determinants of risk: exposure and vulnerability. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation** [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65-108., Web, accessible on November 5th, 2025.
[vi] **IPCC**: "Sixth Assessment Report, Impacts, Adaptation & Vulnerability: "Annex II: Glossary," Web, accessible on November 5th, 2025.
[vii] **California Coastal Commission**: "Laws & Regulations: The Coastal Act, Chapter Web, accessible on November 5th, 2025.
[viii] **EPA**: "About Green Infrastructure," Web, accessible on November 5th, 2025.
[ix] **IPCC:** Sixth Assessment Report (AR6), "Annex II: Glossary," Web, accessible on November 5th, 2025.