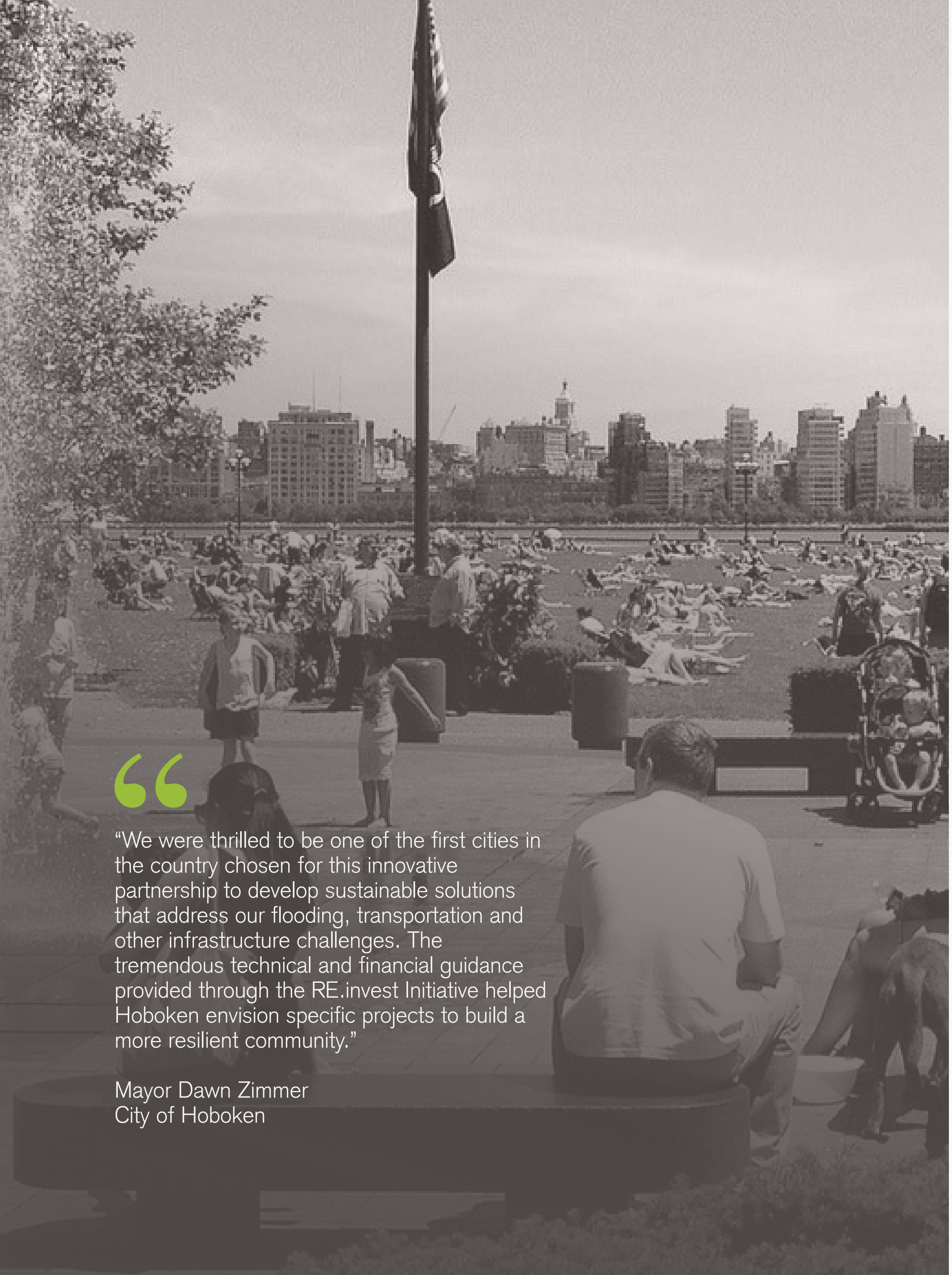
RE invest

FEASIBILITY STUDY 2015

HOBOKEN



“We were thrilled to be one of the first cities in the country chosen for this innovative partnership to develop sustainable solutions that address our flooding, transportation and other infrastructure challenges. The tremendous technical and financial guidance provided through the RE.invest Initiative helped Hoboken envision specific projects to build a more resilient community.”

Mayor Dawn Zimmer
City of Hoboken

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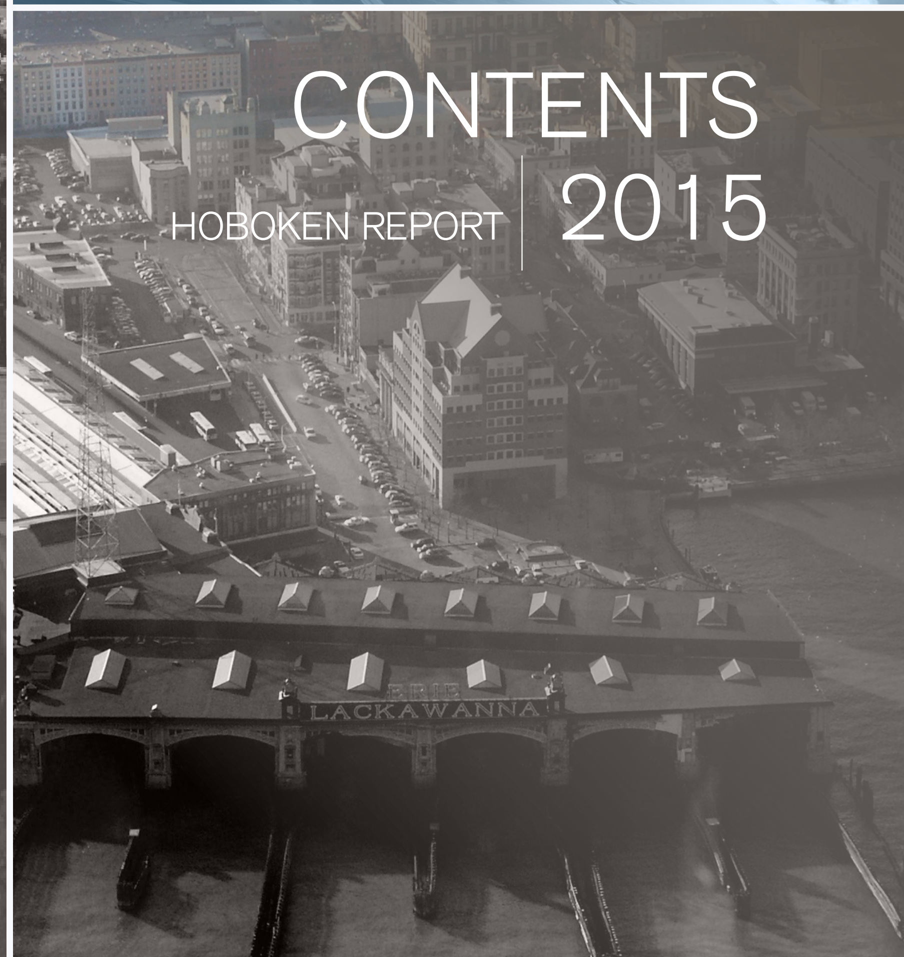

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Introduction

There has been significant coverage in the global media about chronic underinvestment in urban infrastructure. It is clear that governments alone cannot be expected to meet all future infrastructure needs with increasingly constrained public budgets. This is especially true in the face of emerging climate impacts, like more severe storms, that mean future infrastructure systems will need to look and function differently than our current systems.

In the face of these challenges, the RE.invest initiative was designed to reimagine city infrastructure systems—including water, energy, and telecommunications among others—to enhance community resilience and bridge the gap between planning and large-scale project delivery. Designing new types of projects, not just building more of the same, is essential. To this end, RE.invest was launched based on three core ideas. First, resilience is about systems, not just projects. Careful integration, coordination, and sequencing are essential to make sure that when one domino falls it doesn't take down a whole system. In practice that means that green, resilient, and sustainable infrastructure systems are not made up of a few large projects, but many small pieces and parts. Second, cities need to plan for large networks of small projects to align public and private interests and invest at scale. Costs and benefits associated with resilient infrastructure systems are often spread across sectors; therefore, coordination between sectors during project design is critical, not just for government agencies, but also for investors. Third, when it comes to green and resilient systems, success is often something that doesn't happen. The city didn't flood, the power didn't turn off, even though the storm hit. Capturing these benefits over time requires thoughtful design and advance planning.

Over the last decade, the field of sustainable infrastructure investment has focused largely on developing the financial instruments to deliver resources more effectively. This is essential; however, it is only one part of the solution. Cities and communities must also put forward viable, large-scale projects. To bridge this gap, the RE.invest team provided technical support to translate city needs and priorities into financeable projects using a rapid, structured, and replicable project preparation and delivery process designed to generate innovative integrated resilient infrastructure investment opportunities.

In Hoboken, the RE.invest team focused on integrated flood management solutions to complement the city's comprehensive post-Superstorm Sandy Rebuild by Design (RBD) proposal and address frequent flooding issues that limit economic redevelopment opportunities. Beyond identifying the types of infrastructure solutions that are viable given Hoboken's specific needs, the RE.invest team identified relevant legal and financial pathways to support eventual public and private implementation of the proposed solutions.

Overview

As a riverfront community built primarily on marshes, several portions of Hoboken are prone to flooding when rain events occur during high tides. The City has several interrelated challenges, including local flooding, aging infrastructure, and an overextended combined storm water and sewer system— all of which are exacerbated by increasing storm frequency, greater storm surges, and rising sea levels.

For the City of Hoboken, the RE.invest team focused on options for reducing flooding within the City and reducing combined sewer overflows into the Hudson River. The City identified two sites to focus on, a 6-acre industrial parcel slated for redevelopment and a surface parking lot. Both sites could be used to provide infrastructure that improves the City's flood retention capacity.

Figure 1 shows the City of Hoboken (outlined in blue), and the location of the two sites identified by the City. The 6-acre industrial site (BASF site) in the Northwest and the Block 12 site in the Southwest of the City at the intersection of Observer Highway and Harrison Street are highlighted in blue.

While there is significant environmental and economic value to upgrading the entire flood management system, the cost to implement a comprehensive solution is extraordinarily high for a city of Hoboken's size. The set of integrated infrastructure upgrades necessary to protect Hoboken from another Superstorm Sandy is too large an investment for the City to make alone. On the other hand, private sector action alone is unlikely to achieve the scale required to solve the problem. Given this gap, the RE.invest team focused on designing a multi-purpose flood management solution that could meet several local needs and generate more than one type of revenue. To that end, the team assessed a variety of project types and associated legal and financial mechanisms that could either capture and securitize system savings or serve as the basis for long-term public-private-partnerships.

This report captures design concepts developed by the RE.invest team to help the city use the approximately 6-acre superblock site for an underground dual use parking and stormwater retention facility. By bringing together project ideas from multiple sectors, these design proposals open up the potential to capture multiple revenue streams and access new sources of financing.

Figure 1 - Map of Hoboken and Surroundings

Existing Conditions

Location

The City of Hoboken (Hoboken) is an approximately 1 square mile independent coastal city on the west bank of the Hudson River, directly across from Manhattan, New York located between the Lincoln and Holland Tunnels. Hoboken is neighbored by Jersey City, Union City and Weehawken. As of the 2010 United States Census, the City had a population of 50,005.

Hoboken has a temperate climate with four distinct seasons. Temperatures range from the extreme temperatures exceeding 100 degrees Fahrenheit in the summer months to lows below zero degrees Fahrenheit in the winter months.

The City of Hoboken was originally an island, surrounded by the Hudson River on the east and tidal lands at the foot of the New Jersey Palisades on the west. Due to its location and citywide elevation close to sea level, the City has to contend with predicted sea level rise. Based on geographic information system (GIS) data provided by the City, the bedrock depth in Hoboken ranges from -100 feet near the Hudson River to the east to -50 feet to the west near the New Jersey Palisades. Figure 2 shows the range in bedrock depth under the City of Hoboken.[1]

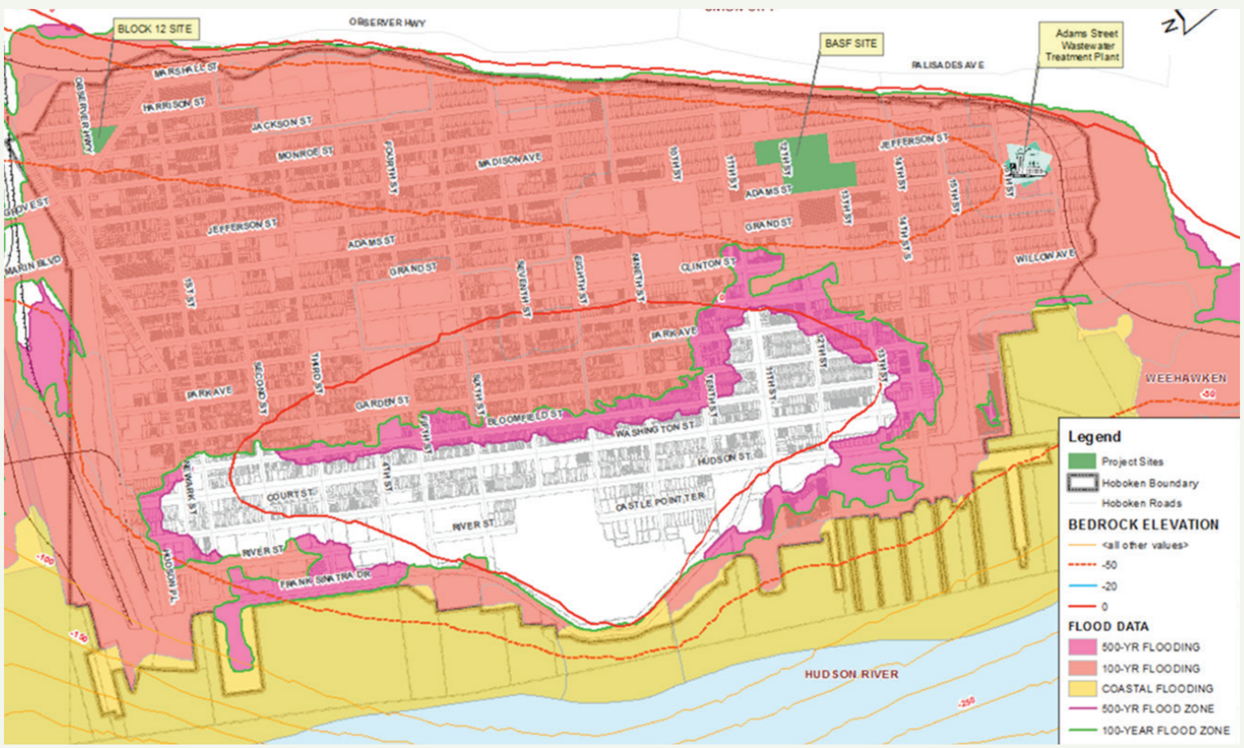

Figure 2 - Hoboken Flood Map & Depth to Bedrock

Hydrology

The entire City of Hoboken is underlain by very shallow groundwater. Estimates for the depth to ground water range from 3-5 feet below the surface. Parts of the City are also identified by the United States Environmental Protection Agency's (US EPA) as containing soil or groundwater contamination. Although the City of Hoboken is located on the west bank of the Hudson River, there are no existing surface streams. Historical streams and creeks have been filled in or were captured in culverts during the historic urbanization of the area.

The City of Hoboken is prone to flooding due to its coastal location on the Hudson River, low topography, the prevalence of impervious surfaces (more than 75% of the City is paved or covered with non-porous materials), and its relatively undersized combined sewer system infrastructure designed to collect

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[1] *The depth to bedrock is an important consideration for subterranean water storage. Areas with deeper bedrock are preferred due to the costs that would be associated with blasting otherwise.*

rainwater runoff, domestic sewage, and industrial wastewater in the same system of pipes. In 2012, the storm surge from Superstorm Sandy affected most low-lying areas of the city with some areas inundated with 4-6 feet of flood water.

Current Federal Emergency Management Agency (FEMA) flood data for the City of Hoboken is included in Figure 2. This map illustrates that most of the City is within the 100-year floodplain, indicated by the salmon colored shaded area. The red shaded area indicates portion of the City within the 500-year floodplain. The 100-year floodplain is defined as the area flooded by a storm having a 1% chance of being equaled or exceeded in a given year, while the 500-year floodplain is defined as the area flooded by the storm having a 0.2% chance of being equaled or exceeded in a given year.

Treatment Plant located in sewershed H7. Refer to figure 4 within this report for a system map of the City of Hoboken Sewer System.

The BASF site, labeled in Figure 3 below, is mostly located within the H5 sewershed. Flushing chambers located along the H5 sewershed boundary allow combined sewer flows within the H7 and H4 sewersheds to drain into the H5 sewershed. The arrows indicate interconnectivity locations and flow direction between the sewersheds.

Recent sewer system upgrades within the southern parts of Hoboken in the H1 sewershed include a new flood pump with a 50 MGD capacity. According a report by EmNet, between December 2012 and August 2013 the new pump was called into service 36 times and

Infrastructure

Hoboken is among the older US cities with historical infrastructure dating back to the mid-1800s. The existing combined sewer system is managed by the North Hudson Sewerage Authority (NHSA) and consists of approximately 30 miles of pipe (including trunk lines and force mains), 2 combined sewer pumping stations, 1 wet weather pumping station, 5 combined sewer overflows (CSO) and an approximately 21 million gallon per day (MGD) capacity waste water treatment plant (Adams Street Facility). A second wet weather pumping station has been designed and construction is planned in the near future. The two existing combined sewer-pumping stations convey flows to a siphon head box from where flow is conveyed to the Adams Street Facility through a 48-inch siphon. The infrastructure is dispersed within seven sewersheds, labeled H1 thru H7 on Figure 3. Areas within a given sewershed are all conveyed to the one main trunk line system within the sewershed. Laterals and smaller diameter pipes are oriented in the north-south direction while trunk lines are oriented west to east where they connect to pump stations (or sewer outfalls during wet weather events) and the interceptor which conveys combined sewer flows north to the Adams Street Waste Water

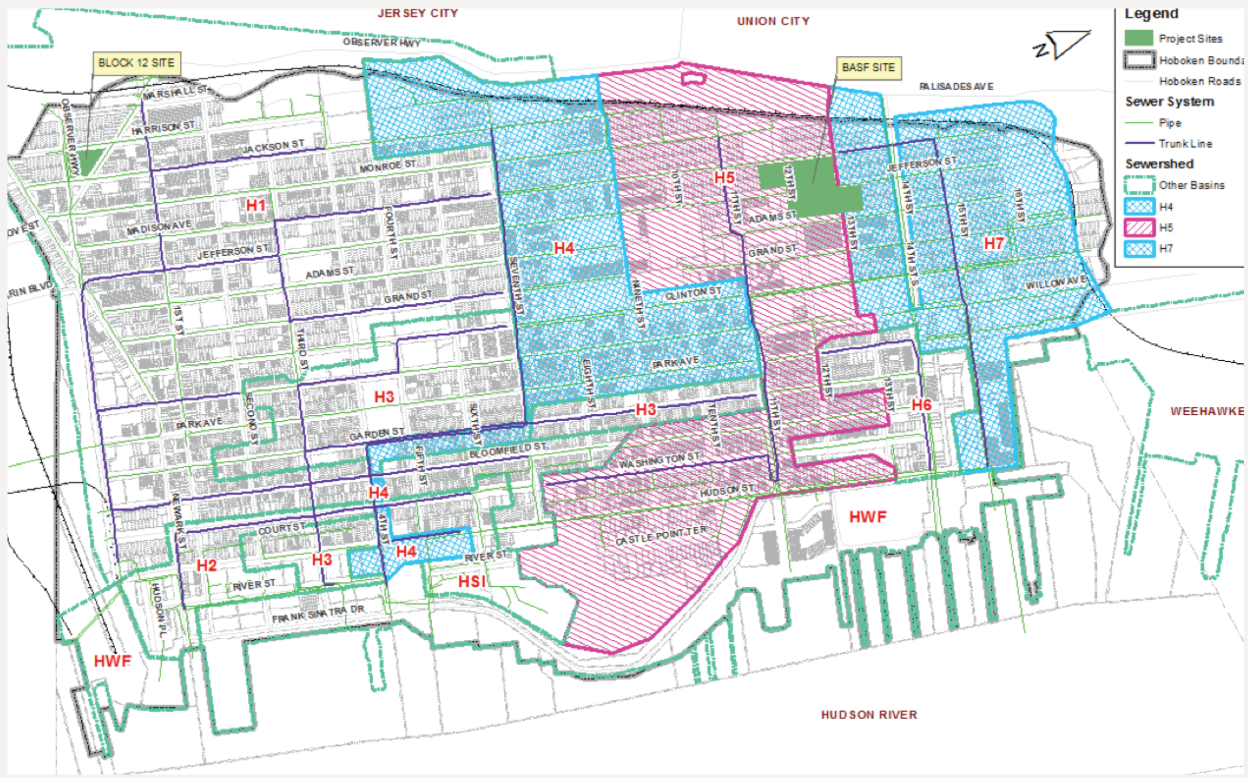

Figure 3: Sewershed Interconnectivity Map

prevented citywide flooding in all but 4 events. The new flood pump was also able to significantly reduce flooding in the southern part of Hoboken by evacuating water quickly and discharging it directly to the Hudson River without treatment.

As of Fall 2012, NHSA completed a $17.6 million H1 Wet Weather Pump Station Project to install an underground sewage pumping station on the waterfront in addition to installing two large wet weather pumps along Observer Highway and Washington Street that will pump approximately 50 million gallons of water per day during heavy rainfall or a five-year rain event. Over the last decade, NHSA spent about $35 million for improvements to Hoboken's combined storm water and sewage infrastructure.

Parking

According to Census data, the population of Hoboken grew by 36.3%, or more than 10,000 people, from 2000 to 2010, adding thousands of new car-owning households and increasing demand for street parking all across the city. According to a recent study conducted by Arup to support development of a Citywide Parking Master Plan, Hoboken has more vehicles per square mile than much larger high-density commuter communities including Brooklyn, NY; Arlington, VA; and Miami Beach, FL. Hoboken's on-street parking inventory stands at approximately 8,900 spaces including residential, visitor, and metered parking and the City owns five public parking garages with a combined 2,850 spaces, of which most are dedicated to monthly parking permit holders and a portion are available to the general public. The parking study found that in 2013, 13,094 residential parking permits were issued for the 8,900 on-street and 2,850 public garage spaces, leaving the remainder to use either privately-owned off-street parking, or storage outside of Hoboken. According to the City of Hoboken, there are 20 privately owned lots with some measure of public access with a combined total of over 6,000 parking spaces. However, surface or sub-surface lots function only on a pay-per-use basis and may not be open to the public at all times.

Parking meter rates are currently $1 per hour, effective from 9am to 9pm Monday through Saturday, with a 2-hour maximum per stay. Garage rates are significantly higher, starting at $4 for a half-hour, never charging less than $10 for a two-hour stay. There is a sliding scale and no limit per household for the purchase of resident permits, with the first permit in a household costing $15, the second $30, and any additional permit $90. In 2013, 13,094 residential parking permits were issued, as well as approximately 3,400 senior visitor permits. Businesses may also purchase permits for the use of their employees in either on-street or garage areas in visirot spaces ($200/year) or resident-only zones ($300/year). In 2013, 1,251 on-street business permits were issued.

The city's population is continuing to expand, development plans include 10,000 units of new housing over the next 10 years. With this growth in the residential population there will come a corresponding increase in the number of cars and demand for accessible and localized parking options.

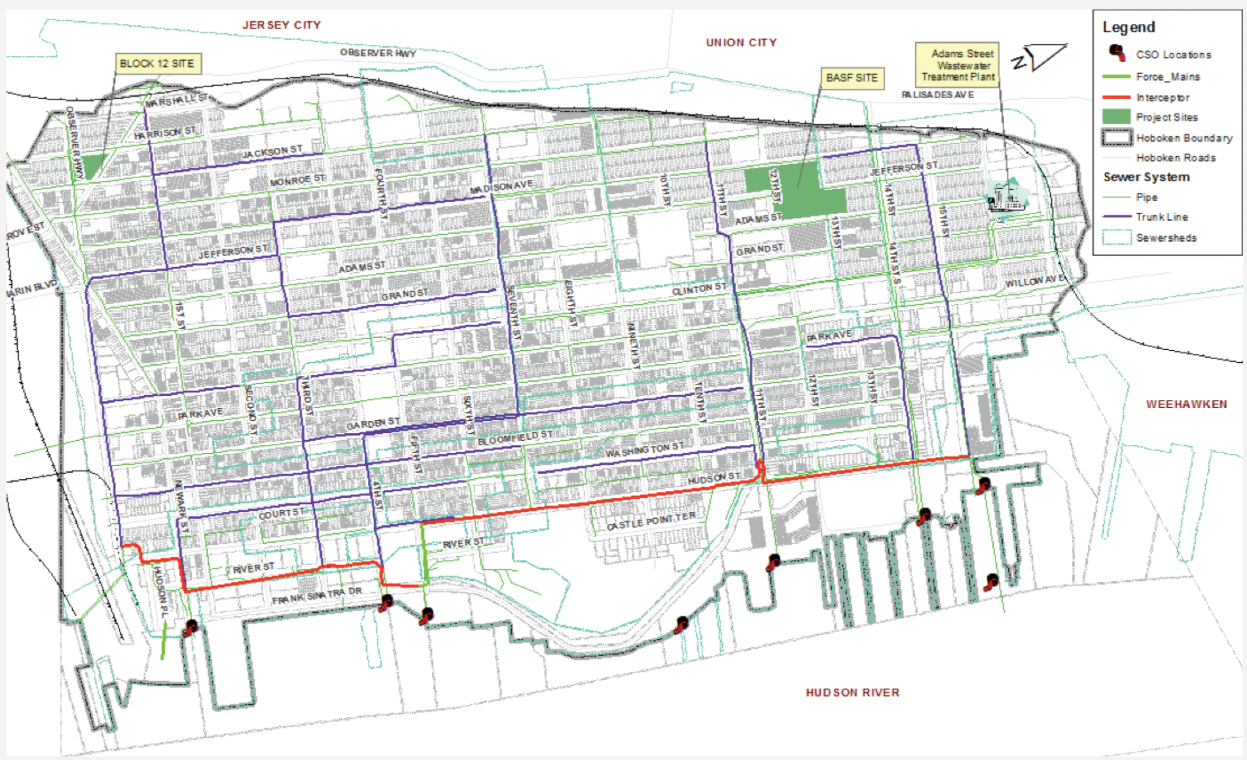

Figure 4: Hoboken Sewer System Map

Enabling Environment

When the City of Hoboken's Master Plan was re-examined in 2010, there was a clear recognition of "the serious ramifications that climate change" could have on the city. The plan emphasized the importance of finding new best practices, which could include soft flood mitigation strategies that complement hard infrastructure investments to manage stormwater runoff. There was also a commitment to "actively pursue non-traditional forms of revenue as well as developing municipal programs that would/could potentially cut after-the-fact cleanup expenditures, i.e., on flooding/stormwater issues." Mayor Dawn Zimmer reiterated these commitments during her 2013 State of the City address noting the comprehensive planning process led by the Planning Board and her support for adding a Green Element to the City's Master Plan in Spring of 2013. Mayor Zimmer spoke specifically about plans to build permanent coastal barriers along the south and north ends of Hoboken, equip roadways with flood break systems, and approve additional flood pumps proposed by the North Hudson Sewerage Authority. The Mayor also supported the development of a micro-grid with hybrid power sources including natural gas and diesel, supplemented by green energy like solar or wind.

In Fall of 2014, The U.S. Department of Housing and Urban Development (HUD) published a notice in the U.S. Federal Register officially allocating $230 million to the state of New Jersey for the Resist, Delay, Store, Discharge project developed for Hoboken, Weehawken, and Jersey City. The flood prevention proposal, produced by a team of firms led by the Office for Metropolitan Architecture (OMA), was one of seven to win funding through the Rebuild by Design competition. Over the coming years, the City intends to leverage these federal funds to support a comprehensive set of projects to support green and grey coastal defense projects (resist); policies to enable the urban fabric to slow down water run-off (delay); a green circuit to trap water (store) and water pumps to support drainage (discharge).

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Engineering Solutions

The City of Hoboken asked the RE.invest team to design a shovel-ready flood management project to help fulfill part of the "store" component of the Rebuild By Design strategy. To this end, the City identified a 6-acre former industrial parcel (brownfield) currently owned by BASF for the RE.invest team to explore design and financing solutions for localized flooding challenges. The City has been engaged in ongoing negotiations with BASF since 2014 to purchase the site and received authorization from City Council to utilize eminent domain for acquisition of the parcel, as needed. The RE.invest team helped the City develop a multi-purpose strategy for the site based on three main site characteristics.

First, the parcel is located primarily in the H5 sewershed, an area where North Hudson Sewerage Authority could use an additional 5 million gallons of daily capacity and all of which is designated in the FEMA Flood Zone. Flushing chambers located along the sewershed boundary force combined sewer flows within the H7 and H4 sewersheds to drain into the H5 area, which is already more susceptible than other areas of the City to frequent flood events even during a period of mild rain because of its very low elevation.

Second, the parcel is located in between two large redevelopment areas, the Western Edge and North End. While the more industrial North End redevelopment plan will be completed in the coming years, the Western Edge redevelopment strategy is currently underway and will prioritize mixed-use development including commercial and residential properties. Given these plans, the City has the opportunity to redesign key public infrastructure (i.e. streets, utility lines, etc.) around the project, making the site a prime flood management location as development expands. The confluence of development interests allows the City to think more creatively about how to leverage this keystone site for greater public investment and economic development.

Third, given the high-density and value of Hoboken's 1-square mile of land, there are very limited opportunities for public land-use outside of currently owned City properties or rights-of-way. This may be the City's best opportunity to obtain such a large parcel of land for utilization in its aggressive flood management strategy.

One key challenge associated with the designated parcel is a history of soil contamination. The site requires location-specific soil removal of up to 10-22 feet, but environmental reviews developed by Excel Environmental Resources, Inc. show that broader ground water management remediation techniques are unnecessary. Remediation would include removal of contaminated soil, confirmation sampling, and management of stormwater during excavation. After completion of the remediation, the excavated space could become part of the larger construction excavation plan. Engineering cost estimates show that all soil remediation and removal costs could be included within subsurface structure construction. The total amount of funding that BASF will be required to contribute towards site remediation would be negotiated as a part of the sale of the parcel.

Below are a set of proposed design solutions developed specifically for the City of Hoboken based on several months of priority setting discussions and data analysis.

Layered Infrastructure Design

The RE.invest team proposed a combined surface and sub-surface plan to utilize 4 contiguous acres of the broader 6-acre BASF site that would include a stormwater detention facility, underground parking garage, and surface park space with integrated green infrastructure. The specific components of the integrated system identified during the engineering design process are described in detail in the following sub-sections.

Structural Components

At the surface of the site, the proposed project design integrated recreational open-space with a series of green infrastructure interventions to increase the flood mitigation potential of the site. The two main design features include:

1. Depressing a majority of the 4-acre site (174,240 SF) a total of 12-inches to add nearly 1.3 million gallons (174,240 CF) of surface detention capacity, and
2. Lining the 4-acres with flow through planter boxes, infiltration trenches and sidewalks/walkways with porous pavement.

The combination of these components is intended to maximize surface stormwater run-off capture and retention to reduce localized flooding.

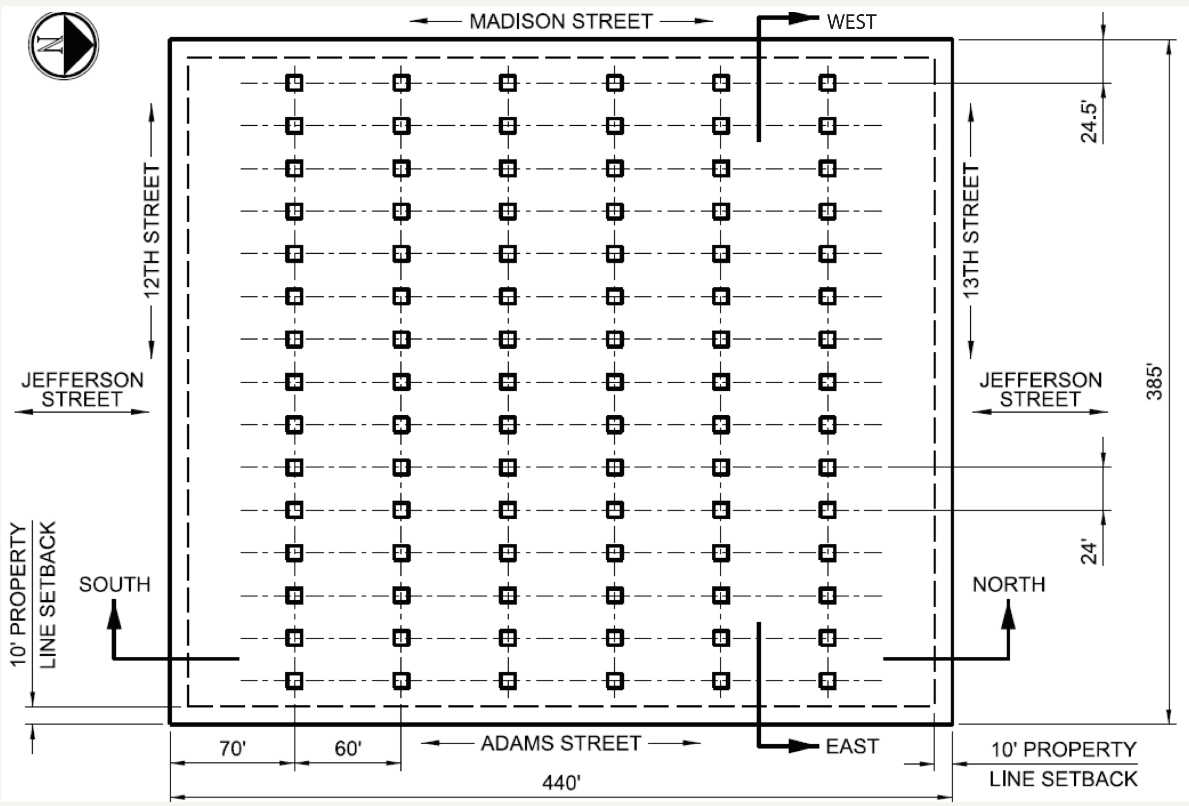

Figure 5: Dual Use Facility Plan View Showing Column Spacing (Not to Scale)

Below ground, the proposed underground dual-use parking/stormwater retention facility would require a complex structural system to support not only the typical dead and live loads for a parking structure, but also additional lateral loads associated with a subterranean structure and surface loads associated with the park space. In addition, the structure would require shoring and dewatering (construction phase and permanent) in addition to ventilation, fire sprinkler systems, plumbing, lighting, signage and code-required head clearances. While specific designs for the retention excavation and shoring systems would require a more detailed structural engineering study to evaluate cost effective alternatives, the RE.invest team developed a proposed layout, included above in Figure 5, for a dual-use parking and stormwater detention facility. This sample design including beam and column spacing was used to produce preliminary cost estimates.

As shown in Figure 5, columns could be placed in a 24' x 60' pattern with transverse beams placed at a 24' spacing center to center while the longitudinal beams could be placed at a 60' spacing center to center. Typical section views along the east-west and north-south axes of the proposed facility are included in Figures 6 and 7. These section views have only been included to show column spacing and do not reflect the layout of parking spaces or required clearances for vehicle turning movements, as those would need to be determined in the detailed final design stage.

Due to shallow ground water depths in the area, the facility would need to be designed to withstand hydrostatic pressures, and would likely require additional weight or foundation anchoring to bedrock in order to counteract any buoyancy effects. In addition, the facility's plumbing system would need to consist of temporary (construction phase) and permanent dewatering systems required to lower the water table and minimize impacts to construction and long-term water infiltration to the facility could be tied into the storm water pump station.

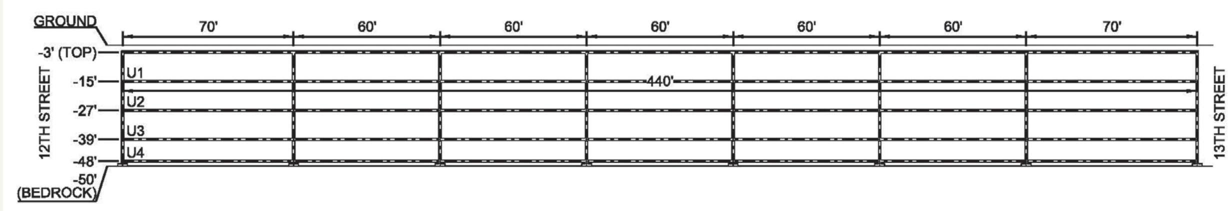

Figure 6: Facility North-South Section View (Not to Scale)

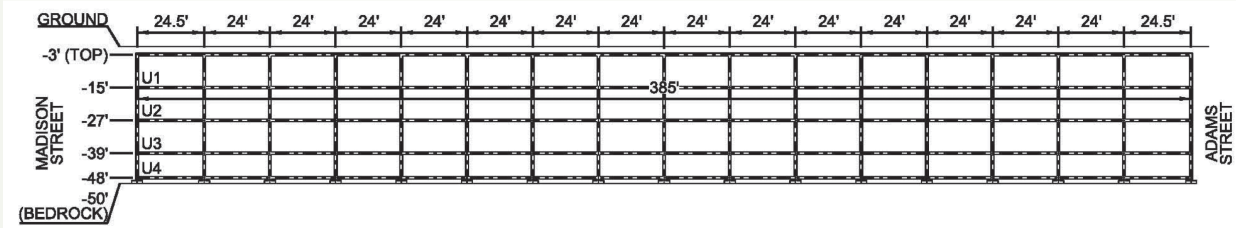

Figure 7: Facility West-East Section View (Not to Scale)

In order to provide fresh air to facility users, the design also included mechanical ventilation to bring outside air into the various levels of the parking facility via an intake system and remove carbon monoxide and other noxious substances and odors to the outside via an exhaust system. A similar system would need to be installed within the underground water storage/retention area.

System Connections

Initial designs focused on local need for additional combined sewer storage capacity. In order to add capacity, the RE.invest team proposed installing a regulator structure along the west-east trunk line along 11th Street east of Adams Street to allow combined sewer flows from an approximately 50 acre (2,142,330 SF) contributory area within the H5 sewershed to be captured and retained by the proposed facility.

Figure 8 provides a schematic of a proposed system that would include a regulator to allow wet weather flows exceeding a predetermined volume to overtop a weir within the regulator and be conveyed to the new dual use facility. During dry weather flows the CSS would function normally and water in the regulator would be conveyed to the wastewater

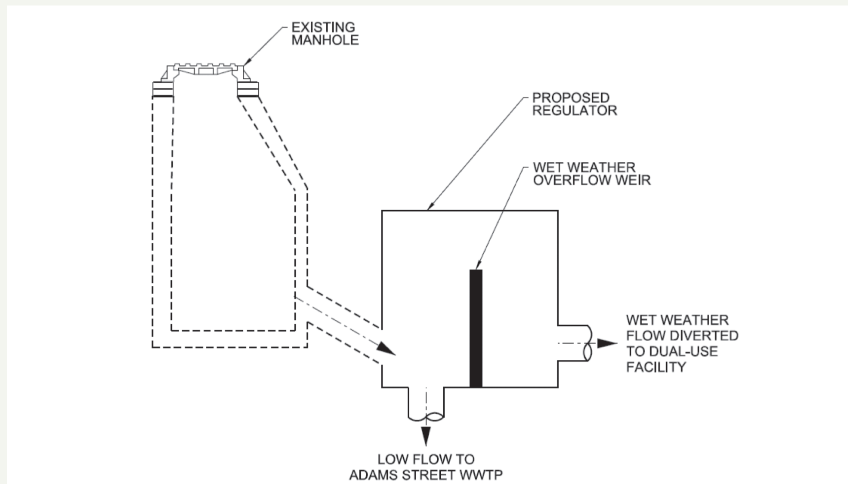

Figure 8: Diversion Structure Operation (Not to Scale)

treatment plant for processing before discharge into the Hudson River. As the storm passes, and when loads at the wastewater treatment plant are reduced, water in the BASF site facility would be pumped back into the trunk line at the regulator. A regulator would be unnecessary should the structure not be used for combined sewer overflow.

To further increase the value of the structure for flood mitigation, the RE.invest team proposed constructing the parking garage entrance ramps and floors with a combination of trench drains and flood drains to collect stormwater from the surface. Analysis determined that based on the location of the site near the upstream ends of the west-east storm sewer trunk lines, the total volume of combined sewer water available for capture would be limited without the construction of additional large diameter pipes to convey sewer flows to the facility. For that reason, in addition to priorities by the North Hudson Sewerage Authority to begin localized sewer separation, the City and RE.invest team eventually adjusted designs to focus on capturing pure stormwater flows – initially from street flooding, and in the longer term by connecting to NHSA's separated storm sewers in the area.

Optimization Scenarios

Estimates of the stormwater volumes available for capture are based on the point precipitation depths for the regional 1-year, 2-year, 5-year and 10-year storms. The point precipitation data for Hoboken was taken from the NOAA Atlas 14 (Volume 2, Version 3), and applied to a contributory drainage area of 50 acres (2,142,330 square feet) to determine surface water flows to the planned facility. The flow depths were not adjusted to account for the level of impervious cover in Hoboken in order to provide a high level more conservative estimate of the surface runoff. The depth in inches was converted to feet and multiplied by the contributory surface areas. Runoff estimates for the point precipitation depths (and different storm depths) are included in Table 1. The adjusted column has been determined by adding a 25% increase in the calculated storm volumes to account for combined sewer flows already present in the pipes as well as peak flow sanitary usage.

Storm Depth (inches)	Storm Categorization	Storm Volume (MG)	Adjusted Volume (MG)*
2.41	1-Year	3.2	4.0
2.92	2-Year	3.9	4.9
3.69	5-Year	4.9	6.2
4.33	10-Year	5.8	7.2

Table 1 - Summary of Contributory Stormwater Runoff Volume

Initially, three different scenarios were considered with various optimization options for parking and water storage. The RE.invest team based these scenarios on the structural dimensions previously provided, recognizing that each level of the facility could accommodate approximately 300 parking spaces (which does not take into account spaces lost due to the provision of required number of ADA compliant parking spaces, elevators, stairs, electrical rooms, etc.). The different optimizations are explained in detail in the following sections. Since the NHSA requested that stored flows be released to the treatment plant over a period of 24 hours or longer, the pump capacities for the various optimization options follow this requirement.

Optimization Scenario 1 – Maximum Parking, Minimum Water Storage
This option would provide approximately 900 parking spaces on three stories and one story of combined sewer storage (approximately 11 million gallons). For this scenario an 11–15 MGD capacity pump would be required to pump the stored combined sewer water back to the Adams Street Wastewater Treatment Plant.

Optimization Scenario 2 – Equal Split Parking and Water Storage
If an even split of the parking and water storage were considered 600 parking spaces and approximately 26 MG of water storage could be provided by the facility. This scenario requires a 25–30 MGD capacity pump.

Optimization Scenario 3 – Minimum Parking, Maximum Water Storage
Where minimum parking is considered, on one level, 300 parking spaces would be provided along with approximately 41 MG of water storage on the remaining three levels of the facility. A 40-45 MGD capacity pumping system would be required.

Table 2 summarizes the parking and water storage potential for the various scenarios. Water storage (in MG) and number of parking spaces are indicated on each floor level. In addition to combined sewer water storage provided within the facility, storm water could also be retained on the facility surface in the depressed playing field area. As illustrated in the table, the minimum storage provided by one level of water storage on level U4 in the proposed 9-foot high fourth story of the facility (11.4 MG) exceeds the volume generated by a 10-year 12-hour storm.

For the various scenarios, different volumes of untreated water need to be pumped back to the Adams Street Wastewater Treatment Plant (WWTP) after a storm subsides. Table 3 shows the various pumping requirements for each scenario. In addition to the pumping rate required for the 24-hour period, extended facility residence times of 48 hours and 72 hours were also investigated to determine the pumping requirements if stormwater flows were pumped back to the WWTP at lower rates. In addition to extending the amount of time it would take for the WWTP to reach capacity, this approach allows for lower cost pumping options.

In addition to these larger capacity pumps for major precipitation events, the City may want to consider the need for lower capacity pumps to evacuate water from more frequent smaller rainfall events.

Additional Design Scenarios

After a robust conceptual design process that examined the viability of these optimization scenarios, the RE.Invest team explored the viability of a smaller 2-level sub-surface structure that would include a single layer of parking with stormwater overflow capacity and a single layer for additional stormwater or combined sewer overflow storage.

At this level, the project would include 300 subsurface parking spaces and~11-22 MG of overflow capacity to mitigate localized flooding depending on final design. Water storage capacity for the individual water storage level of the facility (~11.4 MG) exceeds the volume generated by a 10-year 12-hour storm. Based on this design process, the final RE.invest engineering analyses included identification and costing out of additional sewage system upgrades necessary to accommodate stormwater separation as part of the final design.

Optimization Scenario	Level 1	Level 2	Level 3	Level 4	Total Water Volume (Mg)	Total Parking Spaces
1	300	300	300	11.4	11.4	900
2	300	300	15.2	11.4	26.6	600
3	300	15.2	15.2	11.4	41.8	300

Table 2 - Summary of Contributory Stormwater Runoff Volume

Optimization Scenario	Level 1	Level 2	Level 3	Level 4	Total Water Volume (Mg)	Total Parking Spaces
1	300	300	300	11.4	11.4	900
2	300	300	15.2	11.4	26.6	600

Table 3 - Pumping Flow Rates for Optimization Scenarios 1 & 2

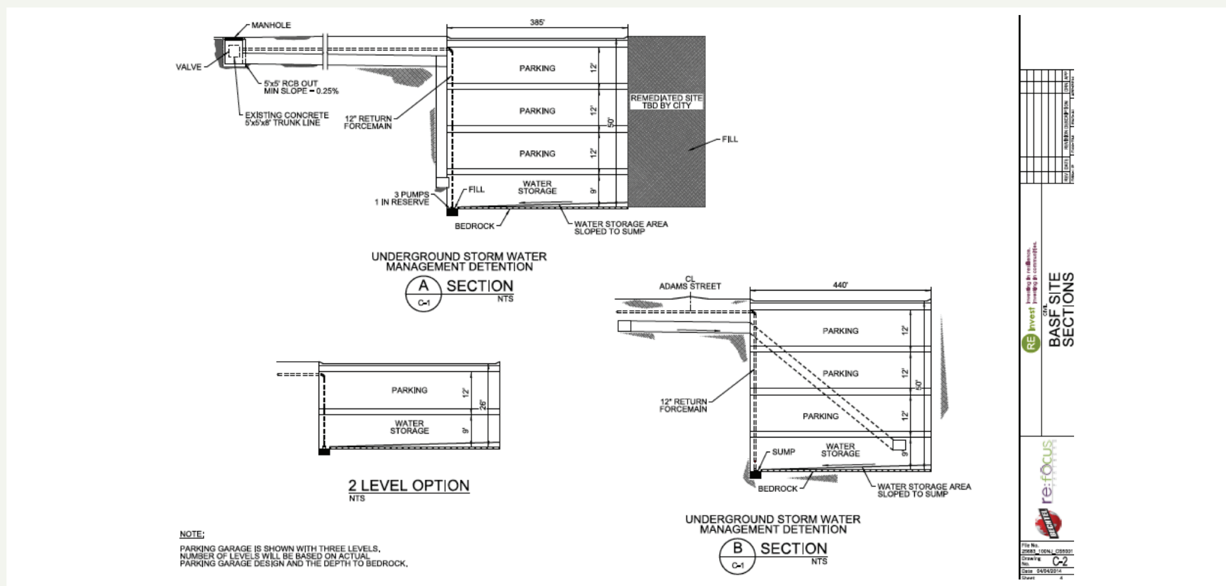

Figure 9 - BASF Site Sections Highlighting Various Scenarios

Cost Estimation & Benefits Assessment

Capital & Operating Costs

Based on the initial optimization scenarios described in the previous section, preliminary quantities and costs were developed for the various design components to support the development of long-term financing and implementation strategies. Detailed background information on the development of costs and all assumptions are included in the Appendix.

For the dual-use facility, the operations and maintenance costs were estimated using a standard value of $200 per parking space with 300 parking spaces used as the standard number of spaces per level. On levels where water storage was provided, the number of parking spaces that would have been provided if the level served as parking, was used and the additional cost anticipated due to baffles and additional equipment was added.

Design Element	Construction Cost ($m)	Annual Operations & Maintenance Cost ($m)	Total ($m)
Subterranean Solutions			
Base Option – 4 Level Parking/0 Levels Water Storage			
Parking Facility	115	115	115.1
No Water Storage or Pumping	0	0	0
Optimization Option 1 – 3 Levels Parking/1 Level Water Storage			
Dual-Use Facility (1.5 mil CF/11.4 MG)	117	0.2	117.2
11-15 MGD Pump	0.2	0.1	0.3
Optimization Option 2 – 2 Levels Parking/2 Levels Water Storage			
Dual-Use Facility (3.6 mil CF/26.6 MG)	126	0.2	126.2
25-30 MGD pump	0.4	0.1	0.5
Optimization Option 3 – 1 Level Parking/3 Levels Water Storage			
Dual-Use Facility (5.6 mil CF/41.8 MG)	131	0.2	131.2
40-45 MGD pump	0.5	0.1	0.6
Surface Green Infrastructure Solutions			
BASF Site Surface Green Infrastructure Features (4250 SF of Permeable Pavement)	0.1	Negligible	

Table 4 – Subsurface Site Construction and Operating Costs

Construction and operating costs for the various optimization options explored for the BASF site are included in Table 4. Operations costs are only included for the water storage portion of the facility and do not take into account maintenance costs associated with the operation of the parking portion of the facility. Table 5 includes a series of base option including a parking facility with no water storage and sub-surface structures for retaining stormwater with no parking capacity for comparison to the dual-use facility. The higher costs as compared to an equivalent 4-story underground parking facility or an above ground facility reflect the higher costs of subterranean construction compared to conventional above-grade construction. This is due to the additional costs associated with excavation, shoring, dewatering, and in this case, contaminated soil remediation down to a depth of approximately 10 feet and removal of remaining clean soil down to bedrock. Pumping costs were estimated at approximately $35,000 dollars per 3 MGD.

Design Elements		
Design Element	Total #	Cost/Unit
Subterranean Solutions		
Base Option – All Parking/No Water Storage		
4-Story Parking Facility	1200 Parking Spaces	115.1
No Water Retention	0.0 MG	0
1-story Water Retention Only	1 MG	$12.84/Gallon
1-story Water Retention Only	5 MG	$5.34/Gallon
1-story Water Retention Only	10 MG	$4.73/Gallon
Optimization Option 1 - High Parking/Low Water Storage		
3-Story Parking Facility	900 Parking Spaces	$130,000/Space
Equivalent 3-Story Parking Facility Cost	900 Parking Spaces	$97,500/Space
1-Story Water Retention	11.4 MG	$2.57/Gallon
Optimization Option 2 - Even Split Parking/Water Storage		
2-Story Parking Facility	600 Parking Spaces	$210,000/Space
Equivalent 2-Story Parking Facility Cost	600 Parking Spaces	$105,000/Space
2-Story Water Retention	26.6 MG	$2.37/Gallon
Optimization Option 3 – Low Parking/High Water Storage		
1-Story Parking Facility	300 Parking Spaces	$436,667/Space
Equivalent 1-Story Parking Facility Cost	300 Parking Spaces	$109,167/Space
3-Story Water Retention	41.8 MG	$2.35/Gallon

Table 5 – Unit Costs per Design Element

In addition to the development of capital costs and operations and maintenance costs every effort was made to develop unit costs in order to quantify the direct and indirect revenue needed to support construction of the proposed facilities and implementation of the recommended green infrastructure elements.

Design element unit cost rates for the different optimization scenarios for the BASF site are included below. The equivalent 4-story parking facility cost is included for each optimization option and as a comparison includes the cost of construction for a 4-story subterranean parking facility housing 1200 parking spaces and estimates for stormwater-only detention facilities. This was used to determine the unit cost per parking space for each of the optimization options. The cost per unit was applied to the number of actual spaces provided for each option and the difference between the total facility cost and the total cost for the number of parking spaces was in turn used to determine a cost per gallon of water retention provided in the facility. Table 6 summarizes this additional analysis.

Based on iterative design feedback from the City, the RE.invest team also developed a specific project estimate based on a structure that would include 1 Level Parking and 1 Level Storage. These total costs are based on conservative assumptions for all site remediation, labor, material, and include a 20% estimate to cover unplanned and unanticipated indirect costs along with a 20% contingency. Additional costs include estimated land acquisition costs of $9.8 million. The estimates do not include cost profiles for suggested system upgrades outside the site boundaries. In addition, these cost estimates include labor, equipment, material costs and subcontracted services.

Scenario	Total Price ($M)	Excavation (CYD)	Excavation (CYD)	Waterproofing (SFT)
4 Levels Parking	114.9	314,202	68,902	252,269
3 Levels Parking & 1 Level Storage	117.3	314,202	69,811	252,269
2 Levels Parking & 2 Levels Storage	125.4	314,202	83,193	252,269
1 Level Parking & 3 Levels Storage	131.2	314,202	96,501	252,269
Smaller Scenarios				
1 Level Parking & 1 Level Storage	85.7	188,521	188,521	252,269
2 Levels Parking & 1 Level Storage	102.7	238,793	238,793	252,269
1- story Water Retention Only (1MG)	12.8	-	-	-
1- story Water Retention Only (5MG)	26.7	-	-	-
1- story Water Retention Only (10MG)	47.3	-	-	-

Table 6 - Subsurface Site Construction and Operating Costs (Part 2)

Potential Beneficiaries & Revenue Sources

In order to structure a financing and implementation plan for a comprehensive flood management system, the RE.invest team worked to define and monetize the direct and indirect benefits of the proposed investment. In the case of Hoboken, there are multiple categories of beneficiaries who would need to be involved in the project implementation and financing, including the following:

- Private Property Owners – Rising sea levels, tidal surges, and unmanaged stormwater flooding impact individual commercial and residential property owners within the City of Hoboken most directly. These property owners already have and will continue to see rising flood insurance premiums coupled with increasing costs for individual property repairs and upgrades. However, because of the high cost of flood insurance and a lack of coordination, most property owners are investing in temporary protection (e.g. sandbags, sump pumps) and regular damage cleanup rather than more cost-effective long-term resilience upgrades. Creating private investment incentives based on property value increases and insurance benefits could provide property owners with capital to invest in preventative upgrades and maintenance and realize greater savings.

- City Government & Utilities – The City of Hoboken and the North Hudson Sewerage Authority are the primary parties responsible for building and maintaining local flood management infrastructure, such as pumps to keep water off the streets and out of local businesses. Given the projected costs of these investments, the City does not have the public funding available or sufficient revenue from its tax base to support all of the necessary infrastructure upgrades. However, the City would be a direct beneficiary of coordinated upgrades to private property that reduce risks and prevent flood damages to public property. In addition to providing direct flood management benefits, underground storage capacity and comprehensive green infrastructure upgrades to catch water where it falls, will help to reduce discharges to comply with new state and federal combined sewer overflow reduction mandates.

- State/Federal Governments – In many cases, State and Federal governments are the primary sources of funding following a disaster. For example, since Superstorm Sandy hit the eastern seaboard in October 2012, FEMA provided nearly $3.9 billion in federal disaster assistance to affected areas. Given the increase in federal disaster declarations and the vulnerability of coastal cities, State and Federal agencies have a direct interest in protecting and increasing the resilience of a coastal city like Hoboken to reduce national disaster risk and financial liabilities.

- Insurance & Re-insurance Firms – The public flood insurance market across the country is saturated and seeing annual double-digit increases in premiums. Private insurance companies see this as an opportunity to enter a new market, which they are doing slowly because they cannot at this point offer a better rate that the heavily subsidized existing insurance market. In the absence of resilience investments, current flood and storm risks are simply too high for insurers, and therefore the premiums they can offer are too high for most consumers. Many of the largest insurance and re-insurance companies have publicly expressed interest in supporting risk reduction measures that could allow them to actively diversify and manage risks—reduce damage payments—and reach new markets and policyholders.

Based on the wide range of projected benefits and potential beneficiaries of the proposed project, the RE.invest team identified the following revenue sources that could be tapped to support eventual project implementation:

- CSO Capacity Payments – Fees and/or Long-Term Lease Agreements
  - NHSA payments for CSO/stormwater detention capacity for regulatory compliance
  - Revenue estimates based on rate-based cost recovery and benefits, including avoided CSOs, wet-weather pumping, peak-load wastewater treatment (electricity and O&M), and emergency services cost savings
- Parking Revenues – Rates and/or Long-Term Contracts
  - Daily, monthly and event rates
  - Option for pre-development long-term contracts for compliance with parking requirements in designated economic redevelopment zones
- Avoided Flood Damages – Reduced damages and/or insurance premiums

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Implementation Strategies

Translating benefits into real sources of revenue requires adequate data to define cost allocations between parties based on projected current and future savings, and structures that make those cash flows more secure. To this end, the RE.invest team recommends that the City of Hoboken pursue a set of strategic public-private partnerships and follow-on data collection activities that would help the City present a compelling case for third party investors to participate in project financing. Described below are a series of legal and financial structures that can be put in place to leverage projected cash flows and help to reduce financial risk.

Ownership Structures

While capital expenses for the proposed integrated flood management system are estimated to be large, the potential value created through reduction of local flooding, and protection against storm damage could feasibly justify the costs. Given that, the RE.invest team focused on options for financing the project as a single structure to capture a set of distributed but related benefits. The most important factors in securing this type of large-scale project finance are clearly defined ownership and management responsibilities that can reliably monetize and secure benefits from green infrastructure and flood protection systems as cash flows. Below is a set of models relevant to Hoboken based on feedback from the City and NHSA. In all cases, financing options include a combination of municipal bonds/debt, private debt, Federal grants or low-interest loans (e.g. HUD CDBG-DR funds), and State grants or low-interest loan funds (e.g. NJ Environmental Infrastructure Trust).

In addition to these traditional sources of financing, the RE.invest team explored options for an experimental privately issued bond in collaboration with philanthropic and impact investment partners based on reduced flood damage and insurance costs in surrounding areas. Each of these models would need to be adapted to match the City's administrative and financial needs and local resident and property-owner preferences.

Public Private Partnership

The proposed public-private partnership structure includes a Special Purpose Vehicle (SPV) that would need to be formed by the City, NHSA and any other relevant partners, including a private parking owner/operator and/or a local development authority (e.g. Hudson County Improvement Authority). In the most basic form, the SPV would serve as the landowner and would be financially responsible for the operations and maintenance of all surface and subsurface infrastructure. Established as the umbrella structure for a set of partners, the SPV would likely not require significant staffing and would instead pass responsibilities and funds along to relevant entities through a set of pre-defined contractual agreements that define management responsibilities, sources of funding, and payback responsibilities. The structure presented in Figure 10 is a basic model of this type of public-private partnership.

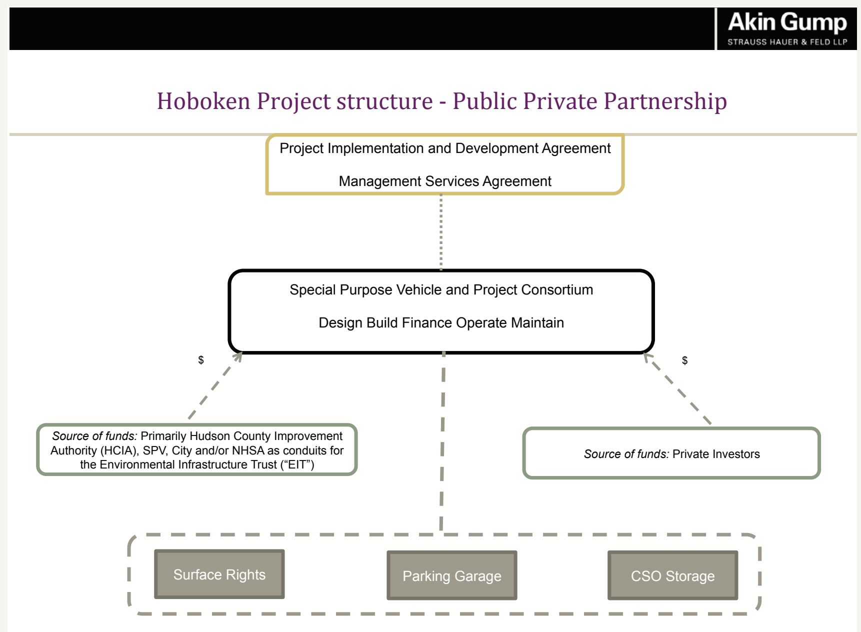

Figure 10: Ownership Structure Option 1 (Public-Private Partnership)

Exclusive City Ownership

Should the City of Hoboken prefer to own the entire structure including surface park space, sub-surface parking garage and stormwater capacity, the RE.invest team developed a model that would allow the City to own the entire project and sub-lease various components of the site plan. The benefit of this structure is it allows the City to access inexpensive capital from the New Jersey Environmental Infrastructure Trust, which provides loans to municipal entities. In addition, it allows the City to define prices and collect all revenue from the parking garage. The structure presented in Figure 11 is a basic model of this type of ownership structure.

Co-operative Ownership

In the case that the City of Hoboken prefers to only own the surface park space and the parking garage, a structure could be designed so that NHSA owns the CSO capacity. This vertical sub-division of land would require that each portion of the infrastructure is financed, and in some cases constructed, separately. Because of the integrated nature of the proposed project, this type of ownership structure would require significant coordination among the parties. The structure presented in Figure 12 is a basic model of this type of ownership structure.

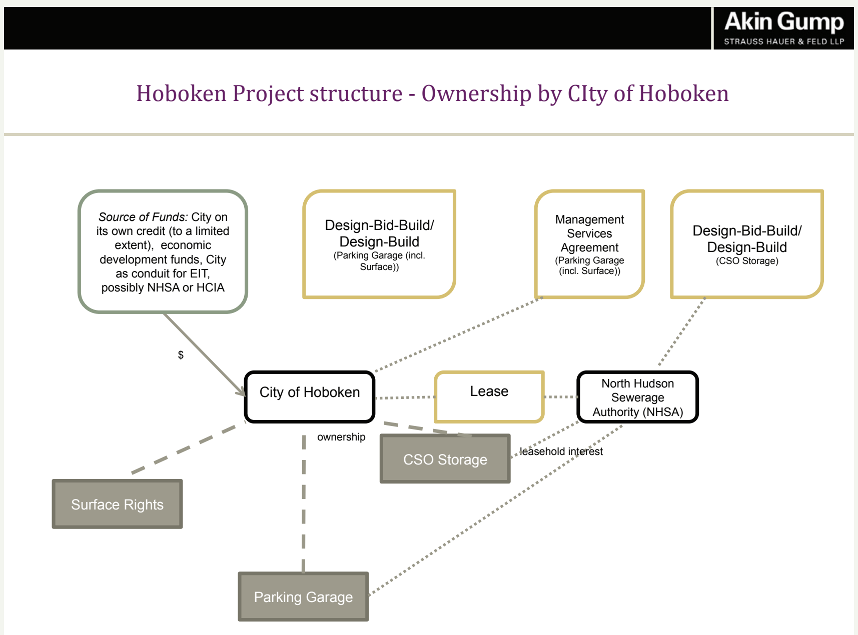

Figure 11: Ownership Structure Option 2 (Exclusive City Ownership)

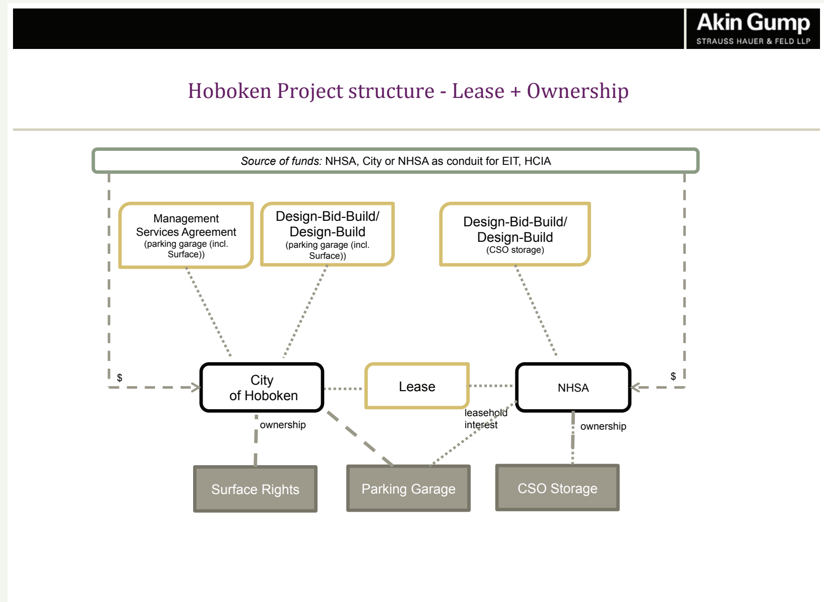

Figure 12: Ownership Structure Option 3 (Co-Operative Ownership)

Data Collection & Public Participation

The three legal structures described above are strategies the City of Hoboken could pursue today accessing capital from New Jersey Environmental Infrastructure Trust and the municipal bond market. At present, there is not sufficient household level data to compel third-party investors to invest in a project of this type. However, the potential benefits to property-owners could be significant. Given the potential value creation and capture opportunity, the RE.invest team has identified a series of partnerships that the City could pursue to increase the viability of private financing for household-level flood management infrastructure investment in future. The activities described below offer a roadmap to streamline data collection, engage property owners, and ensure cost-effective design and construction of a comprehensive package of infrastructure designed to protect city residents.

To successfully implement any comprehensive resilient infrastructure project, the City must systematically engage hundreds of private property owners and managers. The RE.invest team has explored models of participatory engagement that can support coordinated action but also encourage participatory data collection and investment. The following steps are offered as a model for Hoboken to creatively engage its residents in the planning, implementation, and financing of other new resilient infrastructure projects.

Crowdsourcing Data on Unreported Flood Losses

Crowdfunding and crowdsourcing platforms have been used for over a decade to successfully engage individuals in projects and causes. Some examples are Wikipedia (collaborative encyclopedia), Kiva (microfinance), Kickstarter (project funding), FoldIt! (games for health and science), and Kaggle (data analysis prizes and competitions). Government agencies including National Aeronautics and Space Administration (NASA) have also used crowdsourcing tools to engage communities in participatory monitoring and citizen science programs to creatively fill budget shortfalls.

Because there are few property-level sources of data on Hoboken's current and historical losses from storms and flooding, the RE.invest team recommends that the City explore partnerships with one or more small technology firms that have been successfully crowdfunding small scale community projects, to crowdsource data on flood related costs and losses, such as sand bag purchases, mold clean-up services, and wet-dry vacuum rentals or purchases. Using technology to engage residents on local priorities, this type of approach can be applied to engage Hoboken residents to gather data on existing conditions of their flood protection infrastructure and their experiences with flooding. By constructing a detailed profile of losses, the City can then pursue savings-based financing such as a social impact bond.

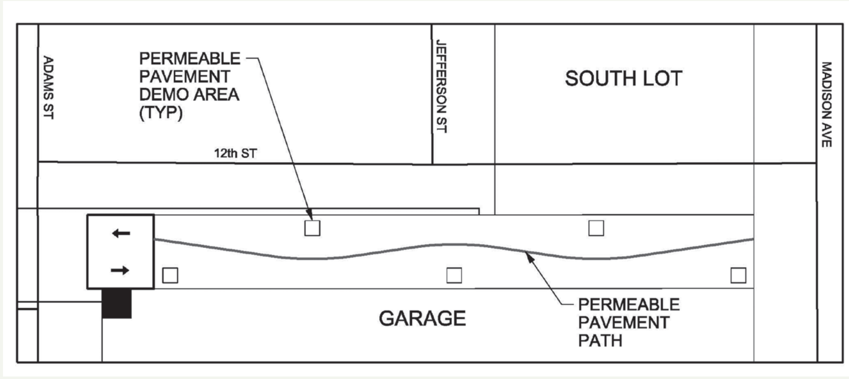

Figure 13: Technology Demonstration Area Site Layout

Other options include partnering with local flood protection or clean-up related small businesses to aggregate data and assess patterns of flood risk and loss or even working with large companies and corporate foundations, such as major credit card companies, to track local expenditures on “indicator” products associated with clean-up or flood related repairs.

Coordinating Corporate Investment (iPark)

The City could also explore a third-party investment strategy that leverages corporate interest in testing and demonstrating new green and/or resilient infrastructure technologies and economic development funds. By integrating “park-lets” into the planned park space, the City of Hoboken could create an opportunity to test and analyze cutting-edge micro or household level water, energy and/or telecom technologies that could be integrated into future capital improvement plans and system retrofits while also revitalizing public spaces for new community uses. Funds collected from companies for the right to demonstrate on these sites could be directed towards implementation and long-term maintenance of high-priority green infrastructure upgrades around the designated site and beyond.

Given this opportunity, the RE.invest team considered how to integrate an area for corporate technology demonstrations into green infrastructure designs on the surface of the facility. The draft site plan included in Figure 9 shows the potential for a 0.52 acre linear area fronting 12th Street as space for an innovation park (iPark). A series of demonstration sites could be placed at various locations alongside a winding permeable pavement walkway underlain by an infiltration trench for storm water capture and be leased by demonstrating companies. A typical site could be a 10-foot by 10-foot 4-6” thick concrete platform, and exhibits could rotate annually. Power to these sites could be generated by small independent solar panel systems at each location. Figure 13 is an iPark Site Layout Map with proposed locations for Technology Demonstration Areas.

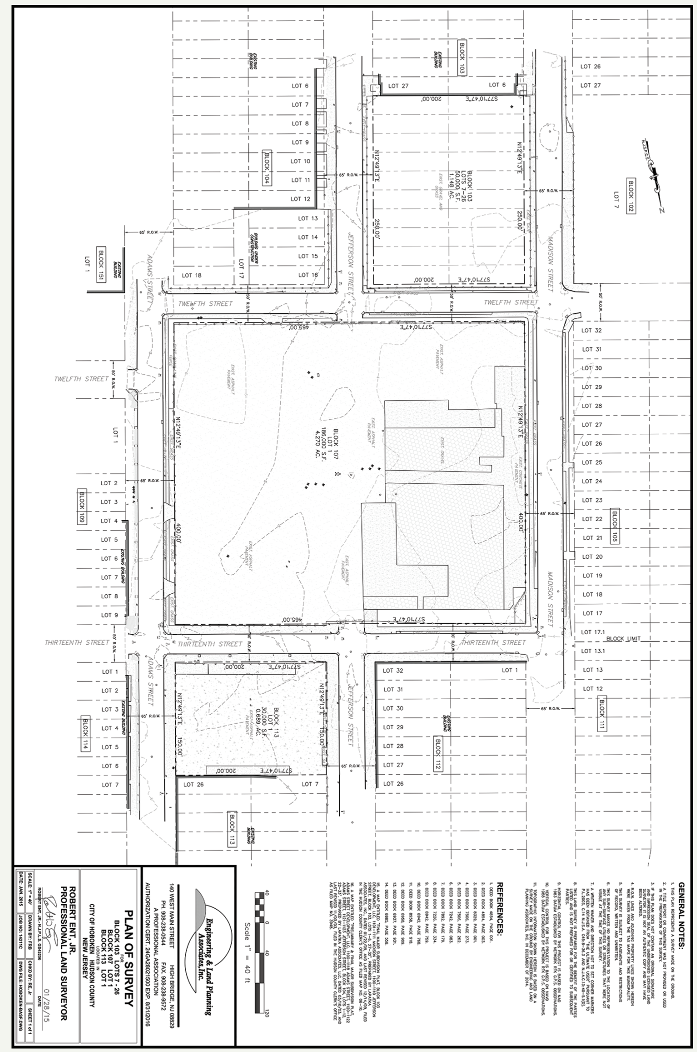

Figure 14: Boundary and Topographic Survey of Site

Innovative Financing

Beyond collecting actionable data, aggregating direct and indirect benefits derived from improved flood management projects is essential to ensuring public support and private investment. For that reason the RE.invest team identified a set of existing and proposed structures, described in this section, to help capture distributed public and private benefits.

Capturing Value

The City of Hoboken's ability to create a special assessment authority or district that can levy taxes and/or fees, offers a unique opportunity for financing comprehensive resilience upgrades like the proposed layered flood water management solution. Across the country, local governments have used these value capture mechanisms and borrowed against future tax revenues (i.e. tax-increment financing, TIF) to incentivize, if not directly finance, investments in areas with high private investment risk. These value capture mechanisms use special district-level taxes and community improvement fees to capture a portion of the value created for private property owners and developers as a result of public investments.

The same mechanisms used to capture value created for private entities by public investment in transport or drainage systems could, in principle, be applied to public investments that reduce disaster or insurance risks to private property-owners. Tax-increment financing is a form of value capture based on borrowing against future increases in market-based land values and associated increases in tax revenues in order to finance projects in higher-risk areas. In Hoboken, by establishing that climate and/or disaster risks are directly impacting property values, TIF or similar types of value capture mechanisms should be available to finance flood management solutions that would reduce those same risks.

More generally, other value capture and savings based financial instruments such PACE bonds for energy efficiency retrofits and upgrades have been deployed with great success to support large-scale investments in private property, such as rooftop solar energy systems. In contrast to TIF mechanisms, PACE and similar instruments do not require the designation of any specific geographic area or district for funding eligibility, giving a city more flexibility to administer a broad program of upgrades.

The data partnership recommendations outlined in this report are intended to help the City to collect enough relevant information to attract third-party investment, described below, to support future financing.

Based on the quantified value these flood management projects create for individual property owners, for the City system as a whole, and for the Federal Government as the "insurer of last resort", the RE.invest team recommends the City consider working with insurance and re-insurance firms to explore options for local catastrophe bonds issuances that can leverage project finance for risk reduction measures.

Redesigning Catastrophe Bonds

Traditionally, insurance instruments do not create new streams of capital for reinvestment in risk reduction measures. However, in recent years a number of insurance models have emerged in the healthcare industry that can be applied to climate and disaster risk management. For instance, in 2006 ICICI Prudential launched a specialized insurance policy for people with Type 2 diabetes and pre-diabetic symptoms. The policy covers not only treatment, but also the cost of a preventative wellness program, and reduces insurance premiums for individuals who demonstrate good control of their condition. Applying this approach to risk management in coastal cities like Hoboken, offers a model for how insurance policies and premiums can be structured to create special funds for investment in upfront risk reduction measures in addition to covering potential losses.

Based on these models, and the fact that insurance is an instrument for reducing the extent of losses for those holding assets in city systems – it is clear that insurance mechanisms can be an important financial instrument to mobilize capital for urban infrastructure upgrading. In the case of Hoboken, the proposed set of flood management infrastructure options are likely to reduce the physical risk of disaster in addition to both the rate of insurance premium increases and total damage claims over time. This combination of benefits provides an opportunity to assess and capture savings to both individual property owners and to major insurance firms.

One of the tools that the insurance industry has developed to hedge their financial risks is a catastrophe bond, a passive financial instrument, where proceeds are held in managed funds and payouts occur if a disaster triggers a pre-determined amount of eligible catastrophic losses. In years where such an event does not occur, the invested funds generate a return that is paid out to private investors willing to assume the risk. These investment interests are very attractive to investors seeking to diversify their portfolios, since disaster risks are generally uncorrelated with other market-based investment risks. An actively structured catastrophe bond would function more like a social impact bond, which is designed to generate funds to finance specific projects that reduce a social ills', costs, or risks over the long-term.

Generally catastrophe bonds are issued by reinsurance firms and/or large public entities (i.e. Mexico's national government or the World Bank) to provide diversification of risk across geographies or sectors. However, re-insurance companies are now exploring their ability to issue private catastrophe bonds that would allow them to build a diverse portfolio of specific kinds of catastrophic risk across a large number of cities. In this structure, private re-insurance companies have an incentive to use a portion of the proceeds to finance resilience upgrades and risk mitigation measures in participating cities in a way that establishes predictable reductions of the risks and damages covered by the bond. For an easy-to-read overview and history of the Cat Bond market from Hurricane Andrew to Hurricane Katrina, see Michael Lewis' In Nature's Casino (New York Magazine, August 2007) or for a current summary of the Cat Bond market landscape, see Leigh Phillips' Cat Bonds: Cashing in on Catastrophe (ICSU, November 2014.)

Given the current market appetite, the RE.invest team recommends that the City consider options for partnering with the New Jersey Environmental Infrastructure Trust and/or State of New Jersey to explore a catastrophe bond similar to Mexico City's current bond structure or the World Bank's June 2014 issuance covering 16 Caribbean islands for storm and flood risks. An important prerequisite for the City is having baseline data that definitively documents not only predictable losses and damages from rising sea-levels and storm surges, but also shows anticipated future savings based on planned resilience investments, such as the proposed stormwater/parking project described in this report.

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Innovations

To address localized flooding challenges and fulfill part of the "store" component of the Rebuild By Design strategy, the City of Hoboken can develop a Resilience Park that integrates a stormwater detention facility, underground parking garage, and surface park space with green infrastructure.

- Design a multi-purpose infrastructure system that combines:
    - An underground parking garage
    - A sub-surface stormwater detention chamber
    - Surface recreational areas with green infrastructure for stormwater capture
- Optimize and scale total project size to match local parking demand and stormwater capacity needs
- Integrate design and construction planning to enable capture of multiple revenue streams for project payback, such as:
    - CSO Capacity Payments – Fees and/or Long-Term Lease Agreements
    - Parking Revenues – Rates and/or Long-Term Contracts
      Surface recreational areas with green infrastructure for stormwater capture
    - Avoided Flood Damages – Reduced damages and/or insurance premiums
- Assess potential "avoided losses" and savings due to both physical and financial risk reduction to support new financing mechanisms

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11. IT Corporation (2001). Preliminary Assessment Report Cognis Corporation Hoboken, New Jersey.

Appendix

Storage Volume Estimates

BASF Site - Annual Flows Detained (50 acre contributory area)	
2142330	Surface Area (sq. ft.)
0.10	Rainfall in feet
223159.38	cubic feet
1669232.13	gallons per 1" rainfall event
1.67	MG
	IF YOU CAN MANAGE THE FIRST 1" OF RAINFALL FOR THE YEAR:
40	inches of rain/year
36	inches of rain/year falling in storm events of 1" or less (90%)
60092356.5	gallons managed and removed from CSO annually
60.09	MG

BASF Site I 1-Year Precipitation (2.41 inches)	
2142330	Surface Area (sq. ft.)
0.20	Rainfall in feet
430251.28	cubic feet
3218279.54	gallons per 1-year rainfall event
3.22	MG

BASF Site I 2-Year Precipitation (2.92 inches)	
2142330	Surface Area (sq. ft.)
0.24	Rainfall in feet
521300.30	cubic feet
3899326.24	gallons per 2-year rainfall event
3.90	MG

BASF Site I 5-Year Precipitation (3.69 inches)	
2142330	Surface Area (sq. ft.)
0.31	Rainfall in feet
658766.48	cubic feet
4927573.23	gallons per 5-year rainfall event
4.93	MG

BASF Site I 10-Year Precipitation (4.33 inches)	
2142330	Surface Area (sq. ft.)
0.36	Rainfall in feet
773024.08	cubic feet
5782220.08	gallons per 10-year rainfall event
5.78	MG

Basis of Estimates

1. LABOR
Labor rates used for Construction are from MEANS – Building Construction Cost Data 2014 edition
Rates are based on Union wages averaged for 30 US cities
Rates used are the sum of wage rates and employer paid fringe benefits such as vacation pay, health and welfare costs, pension costs, training and industry advancement costs and include overhead.
Labor rates used are US National average and are NOT adjusted for regional economies
A Foreman is assigned to each crew.
Labor rates used for Operation & Maintenance are Local Authority advertised rates for 2014 with a 100% mark-up to cover payroll adds. These rates are averaged over 8 cities.

2. EQUIPMENT
Equipment rates used are, generally, taken from Cresco Equipment Rentals, a California based company.
Rates are hourly rates based on a 4 week rental
Rates do not include any down-time.
Rates are increased by 18.4% [Bechtel Equipment Operations (BEO) ratio used] to allow for fuel, oil, lube, maintenance and tires
Where rates are not available from Cresco, other sources such as the internet, Bechtel Equipment Operations etc. are used

3. MATERIALS
Material pricing is generally from the internet. In some cases pricing from recent projects and current estimates are used.
Material pricing includes delivery costs.
Material pricing excludes taxes
Material prices are increased to include the cost of overlap and waste.
Overlap / waste percentages used are:
Concrete 5% // granular materials 20% // geotextiles 15% // pavers 15% //

4. INDIRECT – PRELIMINARY COSTS INCLUDING NON MANUAL
Costs for indirects- preliminary costs, including non-manual, are included at 20% of the direct cost

5. CONTINGENCY
The cost for contingency is included at 20% of cost, excluding profit

6. PROFIT
Profit is included at 10% of total cost plus the 10% profit included in the labor rates

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Conceptual Plans

RE.invest INITIATIVE
HOBOKEN, NJ

DRAWING INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
GENERAL		
1	G-1	TITLE SHEET, LOCATION MAPS & DRAWING INDEX
2	G-2	ABBREVIATIONS, LEGENDS & NOTES
CIVIL		
3	C-1	BASF SITE - PLAN
4	C-2	BASF SITE - SECTIONS
5	C-3	BASF SITE - DETAILS

PROJECT SITE

VICINITY MAP
NTS

BASF SITE
NTS

NOT FOR CONSTRUCTION

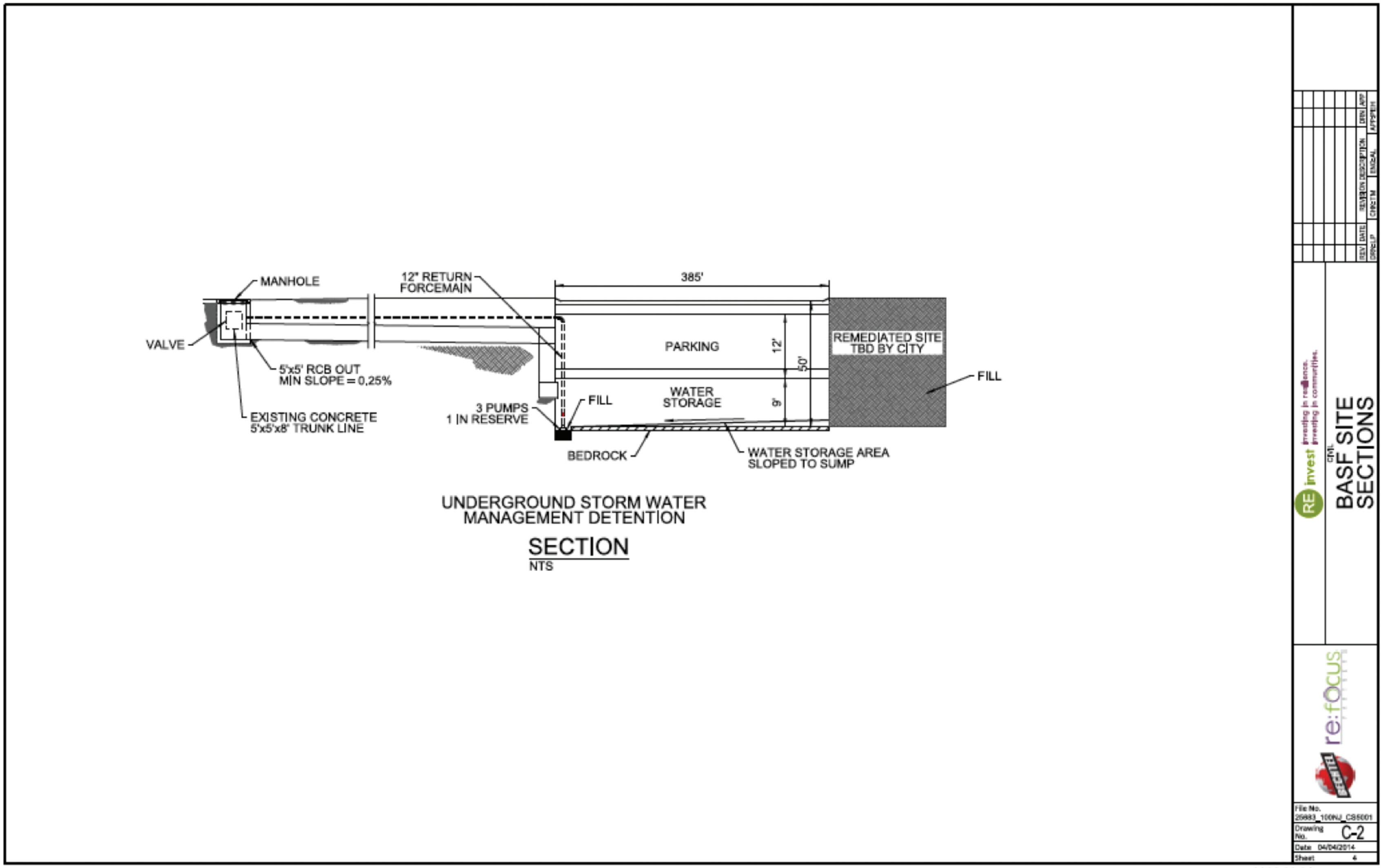
GENERAL
TITLE SHEET, LOCATION MAPS & DRAWING INDEX

RE.invest investing in resilience. investing in communities.

re:focus

File No. 25683_100NJ_GI0001
Drawing No. G-1
Date 04/14/2014
Sheet 1

2014-04-15



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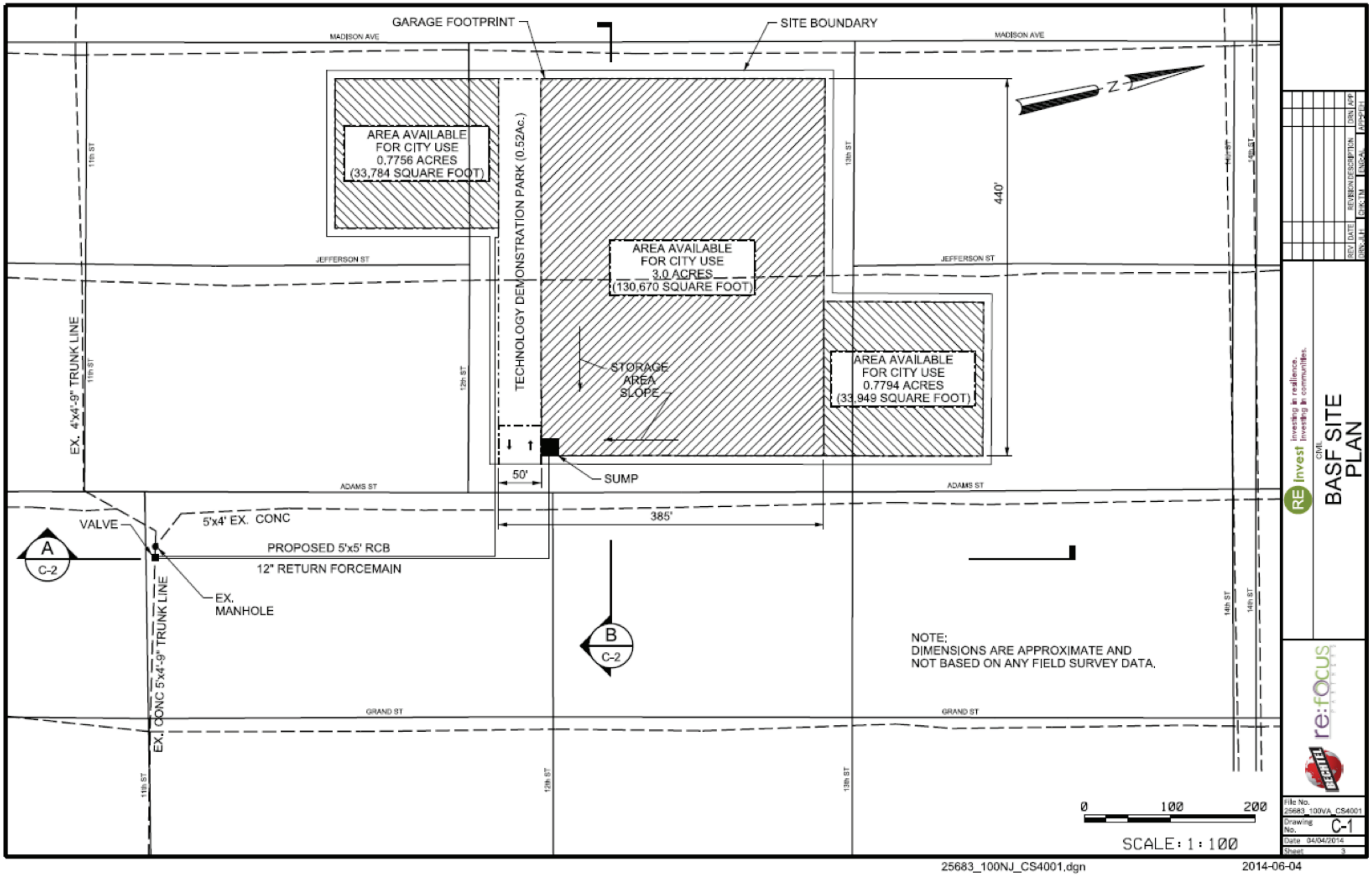
GARAGE FOOTPRINT
SITE BOUNDARY
MADISON AVE
AREA AVAILABLE FOR CITY USE 0.7756 ACRES (33,784 SQUARE FOOT)
TECHNOLOGY DEMONSTRATION PARK (0.52Ac.)
AREA AVAILABLE FOR CITY USE 3.0 ACRES (130,670 SQUARE FOOT)
AREA AVAILABLE FOR CITY USE 0.7794 ACRES (33,949 SQUARE FOOT)
440'
JEFFERSON ST
EX. 4'x4'-9" TRUNK LINE
STORAGE AREA SLOPE
SUMP
50'
ADAMS ST
385'
VALVE
5'x4' EX. CONC
PROPOSED 5'x5' RCB
12" RETURN FORCEMAIN
EX. MANHOLE
EX. CONC 5'x4'-9" TRUNK LINE
A
C-2
B
C-2
NOTE:
DIMENSIONS ARE APPROXIMATE AND NOT BASED ON ANY FIELD SURVEY DATA.
GRAND ST
11th ST
12th ST
13th ST
14th ST
0 100 200
SCALE: 1:100
RE invest
CIVIL
BASF SITE PLAN
re:focus
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Date 04/04/2014
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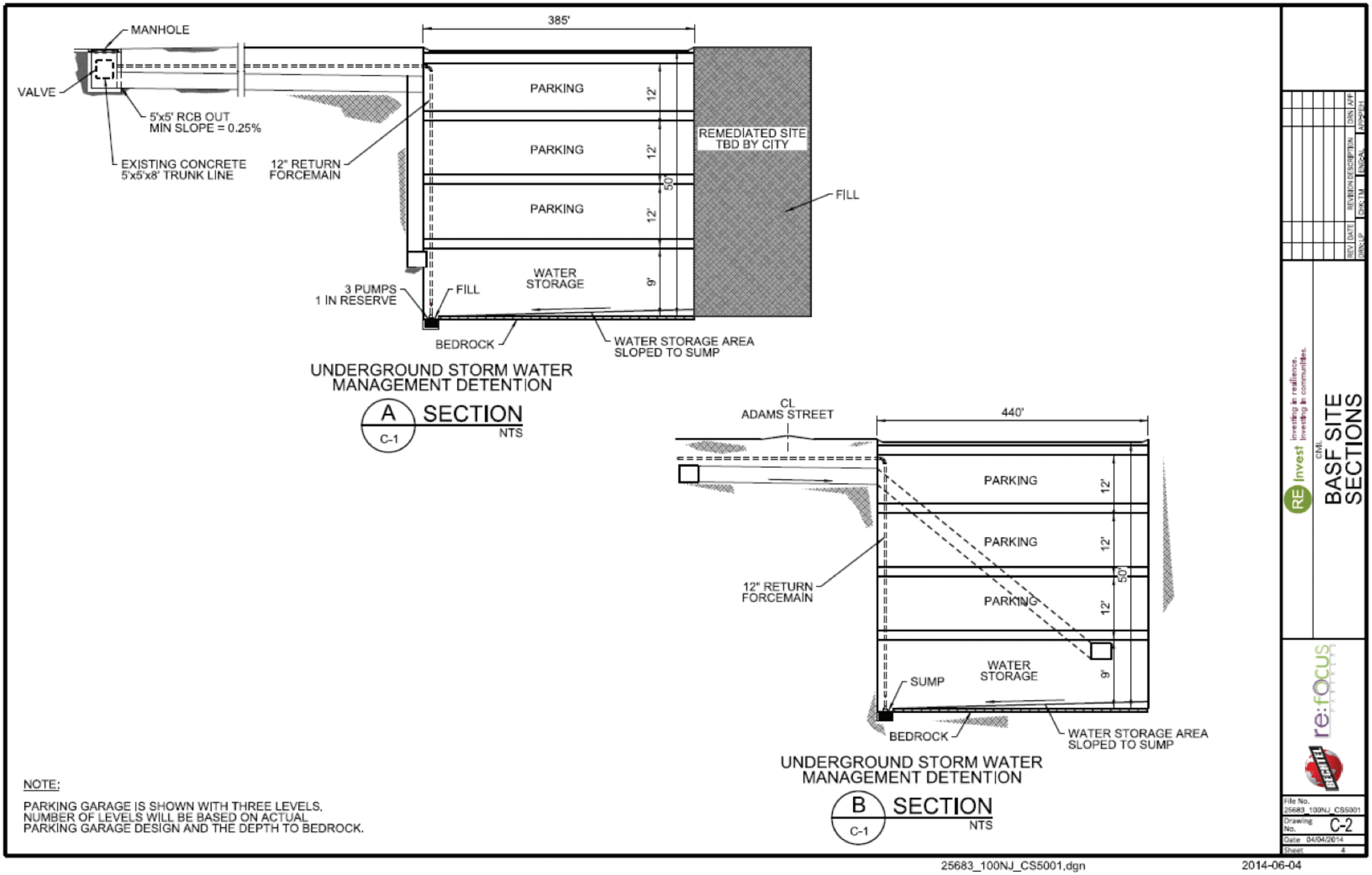
2014-06-04


MANHOLE
VALVE
5'x5' RCB OUT
MIN SLOPE = 0.25%
EXISTING CONCRETE
5'x5'x8' TRUNK LINE
12" RETURN
FORCEMAIN
385'
PARKING
PARKING
PARKING
WATER
STORAGE
12'
12'
12'
9'
50'
REMEDIATED SITE
TBD BY CITY
FILL
3 PUMPS
1 IN RESERVE
FILL
BEDROCK
WATER STORAGE AREA
SLOPED TO SUMP
UNDERGROUND STORM WATER
MANAGEMENT DETENTION
A SECTION
C-1
NTS
CL
ADAMS STREET
440'
PARKING
PARKING
PARKING
WATER
STORAGE
12'
12'
12'
9'
50'
12" RETURN
FORCEMAIN
SUMP
BEDROCK
WATER STORAGE AREA
SLOPED TO SUMP
UNDERGROUND STORM WATER
MANAGEMENT DETENTION
B SECTION
C-1
NTS
NOTE:
PARKING GARAGE IS SHOWN WITH THREE LEVELS.
NUMBER OF LEVELS WILL BE BASED ON ACTUAL
PARKING GARAGE DESIGN AND THE DEPTH TO BEDROCK.
CIVIL
BASF SITE
SECTIONS
re:focus
File No.
25683_100NJ_CS5001
Drawing No.
C-2
Date 04/04/2014
Sheet 4
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2014-06-04