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ARTICLE

Cleaning Up Our Toxic Coasts: A Precautionary and Human Health-Based Approach to Coastal Adaptation

ROBIN KUNDIS CRAIG*

Hurricanes in the United States in 2005, 2012, and 2017 have all revealed an insidious problem for coastal climate change adaptation: toxic contamination in the coastal zone. As sea levels rise and violent coastal storms become increasingly frequent, this legacy of toxic pollution threatens immediate emergency response, longer term human health, and coastal ecosystems' capacity to adapt to changing coastal conditions.

Focusing on Hurricane Harvey's 2017 devastation of Houston, Texas, as its primary example, this Article first discusses the toxic legacy still present in many coastal environments. It then examines the existing laws available to clean up the coastal zone—CERCLA, RCRA, and the Coastal Zone Management Act at the federal level, land use planning, and state tort law—both to identify ways in which states and the federal government could more effectively implement existing law and to suggest improvements to these existing laws to more emphatically prioritize the elimination of toxic coastal legacies. It concludes with three specific recommendations that precautionarily prioritize human health considerations in coastal management as a means of reducing coastal toxicity in the Anthropocene.

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I. INTRODUCTION

When Hurricane Harvey, a Category 4 hurricane, made landfall on the central Texas coast, just north of Corpus Christi, on August 25, 2017,[1] it demonstrated both the power and the danger of coastal storms in ways that should be relevant for U.S. coastal policy throughout the 21st century. First, Harvey was huge and repeatedly battered the Gulf Coast. At its first landfall, the hurricane was 280 miles in diameter and had 130 mile-per-hour winds.[2] It moved north to Houston the next day, remained there for four days, then made landfall, a third time, on August 29, at Port Arthur and Beaumont, Texas, near the Louisiana border.[3] While Hurricane Harvey concentrated its force on Texas and Louisiana, "[i]t affected 13 million people from Texas through Louisiana, Mississippi, Tennessee, and Kentucky."[4] The storm killed 88 people[5] and left thousands more homeless.[6]

Second, Hurricane Harvey brought record-breaking rainfall—and subsequent unprecedented flooding—to the Gulf Coast.[7] As noted, the hurricane stalled out over Houston, dropping two feet of rain in the first 24 hours and 40 inches over 48 hours.[8] Two reservoirs overflowed.[9] When the hurricane made landfall for the third time, "[i]t dumped 26 inches of rain in 24 hours" at the Louisiana border,[10] then rained an additional 10 inches on Nashville, Tennessee, on September 1.[11] In an attempt to describe

1. Kimberly Amadeo, *Hurricane Harvey Facts, Damage, and Costs*, THE BALANCE (Aug. 18, 2018), https://perma.cc/74LQ-9JHL.

2. *Id.*; *Hurricane Harvey Aftermath: What Happened and What's Next*, CNN, https://perma.cc/KF95-T6CL [hereinafter *Hurricane Harvey Aftermath*].

3. Amadeo, *supra* note 1.

4. *Id.*

5. *Id.*

6. *Id.*

7. *See* Robin Kundis Craig, *Harvey, Irma, and the NFIP: Did the 2017 Hurricane Season Matter to Flood Insurance Reauthorization?*, 40.3 UNIV. OF ARK. AT LITTLE ROCK L. REV. (forthcoming 2018) for a more comprehensive discussion of Hurricane Harvey's flooding and its potential implications for reauthorization of the National Flood Insurance Program.

8. *Id.*; *cf.* Amadeo, *supra* note 1 ("In comparison, Hurricane Katrina dropped 5-20 inches of rain in just 48 hours. Most of its flooding came from storm surges that overwhelmed the levee system.").

9. Amadeo, *supra* note 1.

10. *Id.*; *Hurricane Harvey Aftermath*, *supra* note 2.

11. Amadeo, *supra* note 1.

the scale of the rainfall, a *Washington Post* reporter noted that "[a]t least 20 inches of rain fell over an area (nearly 29,000 square miles) larger than 10 states, including West Virginia and Maryland (by a factor of more than two)" and "[a]t least 30 inches of rain fell over an area (more than 11,000 square miles) equivalent to Maryland's size."[12] At the storm's peak on September 1, one-third of Houston was underwater,[13] and "[t]otal rainfall hit 51.88 inches in Cedar Bayou on the outskirts of Houston. That's a record for a single storm in the continental United States."[14]

Third, Harvey may be the first hurricane for which scientists agree that climate change made a significant contribution to the storm's severity.[15] While scientists still will not assert that climate change "causes" any particular coastal storm, in December 2017, two research groups concluded that Harvey's record rainfall "was as much as 38 percent higher than would be expected in a world that was not warming."[16] Warmer-than-normal air and ocean water temperatures, sea levels that are six inches higher than 20 years ago, and climate change-affected weather patterns that promote storm stalling may all have contributed to Harvey's record-breaking precipitation.[17] In addition, both studies "found that climate change roughly tripled the odds of a Harvey-type

12. Jason Samenow, *Harvey is a 1000-year Flood Event Unprecedented in Scale*, WASH. POST (Aug. 31, 2017), https://perma.cc/4G3B-2EG2.

13. Amadeo, *supra* note 1.

14. *Id.*; *see also Hurricane Harvey Aftermath*, *supra* note 2.

15. Amadeo, *supra* note 1; *see also* Geert Jan van Oldenborgh et al., *Attribution of Extreme Rainfall From Hurricane Harvey, August 2017*, 12 ENVTL. RES. LETTERS 124009, 10 (2017); Mark D. Risser & Michael F. Wehner, *Attributable Human-Induced Changes in the Likelihood and Magnitude of the Observed Extreme Precipitation during Hurricane Harvey*, 44 GEOPHYSICAL RES. LETTERS 12,457, 12,463 (2017); Henry Fountain, *Scientists Link Hurricane Harvey's Record Rainfall to Climate Change*, N.Y. TIMES (Dec. 13, 2017), https://perma.cc/8D42-UHKV.

16. Fountain, *supra* note 15; *accord* Michael Greshko, *Climate Change Likely Supercharged Hurricane Harvey*, NAT'L GEOGRAPHIC (Dec. 13, 2017), https://perma.cc/Y5EP-YMCR (reporting the same 38 percent high). *See also* Oldenborgh et al., *supra* note 15, at 124009 (reporting 15 percent as most probable); Risser & Wehner, *supra* note 15, at 12,463 (reporting 18 to 19 percent as most probable).

17. Amadeo, *supra* note 1; *see also* German Lopez, *How Global Warming Likely Made Harvey Much Worse, Explained By a Climatologist*, VOX (Aug. 28, 2017), https://perma.cc/K65Z-QQ8X.

storm."[18] Thus, as climate scientists have long predicted,[19] it appears that climate change is already increasing the likelihood of more severe hurricanes.

Finally, and of particular relevance to this Article, Hurricane Harvey demonstrated, in immediately comprehensible ways, the latent toxicity of the United States' coasts. For example, among other issues, "Harvey flooded 800 wastewater treatment facilities and 13 Superfund sites . . . spread[ing] sewage and toxic chemicals into the flooded areas."[20] As will be discussed in more detail in Part II, Harvey, and to a lesser extent Hurricane Irma, caused significant toxic pollutant loading in the communities they affected, particularly Houston. Given the prediction of growing numbers of increasingly severe coastal storms throughout the 21st century,[21] Harvey and Irma make compelling cases for a more precautionary and health-based approach to coastal management that prioritizes: (1) cleaning up current coastal contamination; (2) retrofitting existing coastal facilities that handle hazardous and toxic materials to prevent further coastal contamination; and (3) limiting the siting of additional such facilities in the coastal zone in the future.

This Article explores the toxic risks along the United States' coasts, particularly in light of the increasing threat from coastal storms. It begins in Part II by providing an overview of existing contamination in the United States coastal zones, focusing on the damage that Hurricane Harvey caused in its interactions with Houston's many hazardous waste sites and toxics-handling facilities. Part III then reviews existing legal authorities for dealing with coastal toxicity in both federal and state environmental and tort law. Part IV offers suggestions for a more precautionary and health-based approach to coastal toxicity, emphasizing both cleanup of existing problems and more toxicity-sensitive engagement in coastal land use planning and building codes. The Article concludes that there is much that federal,

18. Greshko, *supra* note 16; *see also* Oldenborgh et al., *supra* note 15, at 1.

19. *E.g.*, IPCC, CLIMATE CHANGE 2014: SYNTHESIS REPORT 53 (2014) (discussing the fact that cimate change is likely to make coastal storms more intense), *available at* https://perma.cc/PMB6-7WGA [hereinafter 2014 IPCC SYNTHESIS REPORT].

20. Amadeo, *supra* note 1.

21. 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 53.

coastal-state, and local governments could do to reduce toxicity exposure along the coasts during coastal storms, emphasizing that these measures also make considerable sense as climate change adaptation strategies.

II. THE UNITED STATES' TOXIC COASTS

A. An Overview of Coastal Toxicity in the United States

The United States is a coastal nation. As of 2010, over half of the U.S. population (excluding Alaska) "lived in one of the nation's 673 coastal counties."[22] "Between 1960 and 2008, the national coastline population rose by 84 percent, compared with 64 percent inland, according to the Census Bureau."[23] Moreover, coastal U.S. populations continue to grow at a faster pace than inland populations,[24] despite significant hurricane seasons in 2005 (Katrina), 2012 (Sandy), and 2017 (Harvey, Irma, and Maria). Thus, any risks to coastal populations pose a significant *national* problem.

The nation's coasts receive toxic and hazardous pollution and exposure from a number of sources. For example, upstream agricultural and urban runoff carries pesticides, oil, grease, heavy metals, pathogens, pharmaceuticals, and other contaminants downstream to coastal communities and ecosystems;[25] mercury has shown up in California coastal fog banks.[26] In addition, between 1918 and 1970, the Department of Defense disposed of chemical weapons in the ocean, including sulphur mustard and

22. NAT'L OCEAN SERVICE, COASTAL HAZARDS: PREPARING FOR THE THREATS THAT FACE OUR COASTAL COMMUNITIES, https://perma.cc/ZNN7-3YAB; *see also* Sarah G. McCarthy et al., *Coastal Storms, Toxic Runoff, and the Sustainable Conservation of Fish and Fisheries*, 64 AM. FISHERIES SOC'Y SYMP. 1, 2 (2008), https://perma.cc/QJ3Y-8UA (noting that this land area represents only 17 percent of the United States).

23. Jeff Donn, *U.S. Coastal Population Continues to Grow Despite Lessons of Past Storms*, THE DENVER POST (Sept. 16, 2017), https://perma.cc/U64U-T2DD.

24. *Id.*

25. *Id.*; *see also* National Institutes of Health, *U.S. Medical Library: ToxTown: Runoff*, https://perma.cc/H8JX-6S7Y.

26. Alison Hawkes, *Toxic Fog? Mercury Showing Up in Coastal California Fog Banks*, KQED SCI. (Dec. 18, 2015), https://perma.cc/W7PT-BWCE.

chemical nerve agents, along all three U.S. coasts.[27] However, the Department concluded in a 2016 report to Congress that these wastes do not pose a significant threat to human health or the environment and that removal is not warranted.[28] Facilities emitting air pollutants, including power plants and waste incinerators, can also be sources of coastal toxic exposure.[29]

The underappreciated but far more worrisome sources of coastal toxics with respect to hurricanes and sea-level rise, however, are land-based contaminated sites—landfills, illegal hazardous waste disposal sites, and legacy toxic waste dumps—and ongoing facilities that handle toxic and hazardous substances. Assembling some sense of how significant a risk these sites pose, however, requires much digging through multiple sources. At the federal level, for instance, the U.S. Environmental Protection Agency ("EPA") tracks hazardous disposal sites through the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA," often referred to as Superfund).[30] Just a glance at the EPA's map[31] of sites listed on the National Priorities List ("NPL")[32] indicates that many coastal cities contain significant concentrations of these highly-toxic Superfund sites, especially Seattle, Washington; San Francisco, California; Los Angeles, California; Houston, Texas; Baton Rouge, Louisiana; Pensacola, Florida; Tampa/St. Petersburg, Florida; Jacksonville, Florida; Wilmington, North Carolina; and essentially the entire Atlantic coast from Norfolk, Virginia, north to Portland, Maine.

27. DAVID M. BEARDEN, CONG. RESEARCH SERV., RL33432, U.S. DISPOSAL OF CHEMICAL WEAPONS IN THE OCEAN: BACKGROUND AND ISSUES FOR CONGRESS 2 (2007), https://perma.cc/W6KQ-83CU.

28. U.S. DEP'T. OF DEF., RESEARCH RELATED TO EFFECT OF OCEAN DISPOSAL OF MUNITIONS IN U.S. COASTAL WATERS: A REPORT TO CONGRESS 2 (2016), https://perma.cc/34WB-PCJK .

29. *See, e.g.*, TOXICS ACTION CENTER, TOXICS IN MASSACHUSETTS: A TOWN-BY-TOWN PROFILE 12-16 (2010) [hereinafter *Toxics Action Center*], https://perma.cc/HJX3-LAF5 (discussing air pollution as a toxicity problem in Massachusetts and providing maps of power plants and waste incineration facilities that show where these sources are located along the coast).

30. 42 U.S.C. §§ 9601–9675 (West 2018).

31. *Superfund National Priorities List Map*, U.S. ENVTL. PROT. AGENCY, https://perma.cc/6LVT-2N5Y [hereinafter *Superfund Map*]; *see also Cleanups in My Community Map*, U.S. ENVTL. PROT. AGENCY, https://perma.cc/X4U6-7Q92 [hereinafter *My Community Map*].

32. 42 U.S.C. § 9605(c)(1); *Superfund Map, supr*a note 31.

The EPA regulates ongoing industrial facilities that could pose hazardous or toxic waste problems through the federal Resource Conservation and Recovery Act ("RCRA").[33] Releases at hazardous waste treatment, storage, and disposal ("TSD") facilities require corrective actions—that is, cleanups.[34] While the EPA does not keep cleanup statistics in terms of inland versus coastal communities, its "Cleanups in My Community" map indicates that RCRA corrective action sites are approximately as prevalent as NPL sites, roughly doubling the federally-actionable contaminated toxic sites along the U.S. coasts.[35]

State-specific information can also help to flesh out our understanding of the latent toxicity of the nation's coasts. In Massachusetts, for example, RCRA large-quantity hazardous waste generators, CERCLA NPL sites, and state-designated Tier 1 hazardous waste sites are concentrated along the coast.[36] Together with landfills, power plants, and incinerators, these sites produce a rather pronounced coastal toxic load, especially around Boston.[37] As the Toxics Action Center has summarized:

> Massachusetts has thousands of potential and identified hazardous waste sites awaiting cleanup, some of the worst air quality in the nation, and rivers and lakes polluted by industrial contaminants and toxic mercury. Asthma and cancer rates are some of the highest in the country, and both can be linked to environmental causes. Massachusetts is also plagued by economic disparities. Poor urban areas are often the most overburdened by toxic pollution.[38]

Although characterization of the toxic burden and risks facing citizens living on the United States' coasts remains incomplete, scientists, as well as federal and state agencies, have compiled enough data to suggest that coastal residents should be concerned. For example, between 1991 and 1997, the National Oceanic and Atmospheric Administration ("NOAA") analyzed 1,543 surface sediment samples from 25 estuaries and marine bays—i.e., the

33. 42 U.S.C. §§ 6901–6992k.
34. *Id.* §§ 6924(u), (v).
35. *My Community Map*, *supra* note 31.
36. *See* TOXICS ACTION CENTER, *supra* note 29, at 11, 19, 21 (providing maps).
37. *See id.* at 26 (showing the cumulative concentration of toxic facilities).
38. *Id.* at 4.

sediments closest to shore—from all three U.S. coasts (Gulf, Atlantic, and Pacific), concluding that about 6 percent of the coast was toxic; the EPA's parallel study calculated that 7 percent of the coast was toxic.[39] However, tests based on sub-lethal effects on marine organisms suggested a much broader problem, with 25 to 39 percent of the U.S. coasts returning toxic results.[40]

Another indicator for concern comes from the EPA's semi-regular National Coastal Condition Reports, which contain summaries of fish tissue contamination by region, providing another indicator of coastal toxic exposure.[41] Specifically, the fish tissue assessment looks at the concentration of various toxics—arsenic, cadmium, mercury, selenium, chlordane, DDT, dieldrin, endosulfan, endrin, heptachlor epoxide, hexachlorobenzene, lindane, mirex, toxaphene, polycyclic aromatic hydrocarbons ("PAHs"), and polychlorinated biphenyls ("PCBs")—in fish, and assesses coastal conditions based on risks to human health through fish consumption.[42] In the latest National Coastal Condition Report from 2012, 13 percent of U.S. coasts, overall, were in poor condition for fish tissue contamination, but regions ranged from zero percent in poor condition (southeastern Alaska and Guam) to 20 percent in poor condition along the northeast coast (although, notably, the calculations did not include the area of the Gulf of Mexico's dead zone).[43] Another 13 percent of U.S. coasts, overall, were in fair condition,[44] indicating that, in total, over one-quarter of the nation's coasts face some risk from toxicity. The EPA further noted that areas "in poor and fair condition were dominated by samples with elevated concentrations of total PCBs, total DDT, total PAHs, and mercury."[45]

The National Institutes of Health ("NIH") has compiled data from the EPA's Superfund database for CERCLA and its Toxic Release Inventory ("TRI") database for the federal Emergency

39. Edward R. Long, *Spatial Extent of Sediment Toxicity in U.S. Estuaries and Marine Bays*, *in* MONITORING ECOLOGICAL CONDITION IN THE WESTERN UNITED STATES 391, 391, 403-05 (2000).

40. *Id.*

41. U.S. ENVTL. PROT. AGENCY, NATIONAL COASTAL CONDITION REPORT IV (2012), https://perma.cc/YVM3-7RZ3.

42. *Id.* at 25.

43. *Id.* at tbl. ES-2.

44. *Id.* at fig. 2-10.

45. *Id.* at 49.

Planning and Community Right-to-Know Act ("EPCRA"),[46] as well as several other sources of information from both the federal government and Canada,[47] to create TOXMAP,[48] a map of releases of specific toxic chemicals across the United States. Designed originally to facilitate emergency response,[49] EPCRA requires all U.S. facilities releasing listed toxic and hazardous substances at or above reportable thresholds to report those releases,[50] which the EPA then complies into the TRI database.[51] TOXMAP makes clear that larger cities, whether coastal or not, generally endure the greatest concentrations of toxic releases. Nevertheless, as was true for the EPA's "Cleanups in My Community" map, many coastal areas light up particularly brightly on the NIH's TOXMAP—Seattle, San Francisco, and Los Angeles on the Pacific coast; Houston, New Orleans, and Tampa on the Gulf coast; Milwaukee, Chicago, and Detroit along the Great Lakes; and almost all of Florida's and the northeastern states' Atlantic coasts.[52]

Such compilations and characterizations of "standard" toxicity, however, do not paint the full picture of coastal toxic risk. Coastal storms and hurricanes can dramatically increase coastal communities' acute and even longer-term toxic exposure. Moreover, toxic sites and infrastructure along the coast pose long-term concerns in the face of global sea-level rise. Hurricane Harvey provided a particularly graphic example of how storms can interact with coastal toxicity to pose significant human health concerns.

B. Hurricane Harvey and Houston, August-September 2017

Hurricanes in the United States dramatically illuminate the latent toxicity of coastal zone infrastructure and reveal the fact that invading seawater threatens both unusually high emissions

46. 42 U.S.C. §§ 11001–11050 (West 2018).

47. *TOXMAP Fact Sheet*, U.S. DEP'T. OF HEALTH & HUMAN SERVICES, https://perma.cc/Y3E7-SXPZ.

48. *TOXMAP Home Page*, U.S. DEP'T. OF HEALTH & HUMAN SERVICES, https://perma.cc/XUQ7-RUXJ.

49. 42 U.S.C. § 11003(a).

50. *Id.* §§ 11002, 11023.

51. *Toxic Release Inventory (TRI) Program*, U.S. ENVTL. PROT. AGENCY, https://perma.cc/P3RD-AX7W.

52. *TOXMAP Home Page*, *supra* note 48.

of hazardous air pollutants and a toxic soup of sewage, oil, and hazardous chemicals from coastal businesses (such as dry cleaners and auto repair facilities), industrial sites, Superfund sites, and toxic waste facilities.[53] While the full threat of dissolved and mixing toxic chemicals has not yet been fully realized as a result of a major U.S. coastal storm, some have come alarmingly close. For example, after Hurricane Katrina devastated New Orleans in 2005, "hazardous substances such as volatile organic compounds ("VOCs"), lead, and arsenic were detected in the air, soil, and sediment samples," and "the potential for a toxic release of hazardous substances after a storm exist[ed]."[54] Similarly, after Hurricane Sandy hit "New York and New Jersey in 2012, officials had to monitor 247 Superfund sites—one of which, the Gowanus Canal, overflowed into people's homes."[55]

1. Waste-Related Spills During Hurricane Harvey

Hurricane Harvey's 2017 flooding of the Houston area—the United States' fourth largest city—may produce one of the most toxic legacies of U.S. hurricanes. To begin, Harvey inundated thirteen of the Houston area's forty-one hazardous waste sites,[56] and the city contains "several other highly toxic sites managed by

53. Kathryn Lane et al., *Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment*, 2013 J. ENVTL. & PUBLIC HEALTH 1, 2 (2013); *see also* Danny D. Reible et al., *Toxic and Contaminant Concerns Generated by Hurricane Katrina*, 36 THE BRIDGE 5, 5 (2006), https://perma.cc/7PD2-LB59.

54. Lane et al., *supra* note 53, at 5; *see also* Steven M. Presley et al., *Assessment of Pathogens and Toxicants in New Orleans, LA Following Hurricane Katrina*, 40 ENVTL. SCI. & TECH. 468, 468 (2006), https://perma.cc/8PHU-C8AW ("Concentrations of aldrin, arsenic, lead, and seven semivolatile organic compounds in sediments/soils exceeded one or more United States Environmental Protection Agency (USEPA) thresholds for human health soil screening levels and high priority bright line screening levels.").

55. Emily Atkin, *America Has a Toxic Waste Hurricane Problem*, THE NEW REPUBLIC (Sept. 8, 2017), https://perma.cc/69RK-MG6F; *see also* Elizabeth A. Harris, *In Brooklyn, Worrying About Not Only Flooding but What's in the Water*, N.Y. TIMES (Nov. 5, 2012), https://perma.cc/SMK8-PRG8 (reporting on the Gowanus Canal Superfund site overflow).

56. Atkin, *supra* note 55; *see also* Troy Griggs et al., *More Than 40 Sites Released Hazardous Pollutants Because of Hurricane Harvey*, N.Y. TIMES (Sept. 8, 2017), https://perma.cc/G3K2-TYA9.

the Texas Commission on Environmental Quality."[57] (Notably, a few weeks later, Hurricane Irma was even worse in terms of threatened superfund sites: eighty such sites stood in Hurricane Irma's path through Florida).[58] The *New York Times* described Harvey's floodwaters as "a stew of toxic chemicals, sewage, debris and waste . . . Runoff from the city's sprawling petroleum and chemicals complex contains any number of hazardous compounds. Lead, arsenic and other toxic and carcinogenic elements may be leaching from some two dozen Superfund sites in the Houston area."[59]

The worst of the inundated waste sites was the San Jacinto Waste Pits, a "dioxin-laden federal Superfund site whose protective cap was damaged by the raging San Jacinto River."[60] The highly contaminated waste pits are located "right next to homes and schools, and that has frightened residents for decades."[61] The site consists of two waste pits in the middle of the San Jacinto river, where a paper mill dumped its wastes, specifically dioxin and furans, during the 1960s.[62] Paper companies used dioxin to bleach paper white, and the compound is toxic at parts per *quadrillion*.[63] Temporary concrete caps installed in 2011 were supposed to keep the pits from further contaminating the river, but Hurricane Harvey caused the river to rip through them,[64] releasing contamination.

However, smaller waste spills were also noteworthy. For example, W&P Development Corp. owns "an industrial park where about 100,000 gallons of oily wastewater were reported to have spilled into the San Jacinto from August 29 to August 31. The site

57. Darryl Fears & Brady Dennis, *Houston's Polluted Superfund Sites Threaten to Contaminate Floodwaters*, WASH. POST (Aug. 29, 2017), https://perma.cc/3HUH-FGRM.

58. Atkin, *supra* note 55.

59. Hiroko Tabuchi & Sheila Kaplan, *A Sea of Health and Environmental Hazards in Houston's Floodwaters*, N.Y. TIMES (Aug. 31, 2017), https://perma.cc/UKQ6-V2BK.

60. *Hurricane Harvey's Toxic Impact Deeper Than Public Told*, CBS NEWS (Mar. 22, 2018), https://perma.cc/U77X-S72D [hereinafter *Toxic Impact*].

61. Rebecca Hersher, *EPA Takes Toxic Site Flooded by Harvey Off Special Cleanup List*, NAT'L PUBLIC RADIO (Apr. 16, 2018), https://perma.cc/86NF-XJ2F.

62. *Id.*

63. WILLIAM BOYD, THE SLAIN WOOD: PAPERMAKING AND ITS ENVIRONMENTAL CONSEQUENCES IN THE AMERICAN SOUTH 198 (2015) (emphasis added).

64. Hersher, *supra* note 61.

was formerly Champion Paper Mill and a landfill there received wastes including turpentine- and lead-contaminated soil and mercury until 2008."[65]

Wastewaters also proved to be problematic. "The largest spill, by far, was at ExxonMobil Corp.'s Olefins Plant in Baytown, east of the ship channel. Two days after Harvey hit, some 457 million gallons of stormwater mixed with untreated wastewater, including oil and grease, surged into an adjacent creek."[66] Floodwaters also became contaminated with sewage, and tested floodwater samples revealed *E. coli* bacteria concentrations ten to eighty times higher than the EPA's recommendations for recreational water quality (the recommendation for drinking water is zero), although all the tests for heavy metals revealed concentrations below the EPA's levels of concern.[67]

2. Petroleum-Related Spills in Houston During Hurricane Harvey

Houston has more sources of toxicity than just waste sites. "Some 500 chemical plants, 10 refineries and more than 6,670 miles of intertwined oil, gas and chemical pipelines line the nation's largest energy corridor."[68] The city is, of course, famous for its oil industry, including oil refineries. Needless to say, record flooding and oil refineries don't mix well. For example, "storage tanks holding crude oil, gasoline and toxic contaminants failed when storm water from Harvey caused them to collapse, spilling at least 145,000 gallons of fuel and polluting the air."[69] Benzene contamination of the air proved particularly troubling. "Preliminary air sampling in the Manchester district of Houston showed concentrations of up to 324 parts per billion of benzene"—a concentration "above the level at which federal safety officials recommend special breathing equipment for workers."[70] In late August 2017, ExxonMobil acknowledged "that Hurricane Harvey

65. *Toxic Impact*, *supra* note 60.

66. *Id.*

67. Susan Scutti, *Sewage, Fecal Bacteria in Hurricane Harvey Floodwaters*, CNN (Sept. 15, 2017), https://perma.cc/33CM-7S8L.

68. *Toxic Impact*, *supra* note 60.

69. ECOWATCH, *Hurricanes Irma and Harvey Cast Spotlight on Toxic Sites in Our Midst* (Sept. 12, 2017), https://perma.cc/Z9LF-8DSX.

70. Tabuchi, *supra* note 59.

damaged two of its refineries, causing the release of hazardous pollutants"—specifically, high emissions of volatile organic compounds and over one million pounds of sulfur dioxide,[71] both of which are regulated air pollutants under the Clean Air Act.[72] Initial reports from Texas regulators indicate that, because of Hurricane Harvey, "the region's massive petrochemical industry released more than 2 million pounds of harmful pollutants into the air as of Aug. 29"—"roughly 40 percent of what the entire Houston region released in 2016 . . . ."[73] As of October 2017, the EPA was still assessing three reported spills at US Oil Recovery, described by news outlets as "a former petroleum industry waste processing plant contaminated with a dangerous brew of cancer-causing chemicals."[74]

Numerous other petroleum-related spills also occurred. Flooding in Panther Creek, for example, caused several releases, including a "460,000-gallon gasoline spill at a Magellan Midstream Partners tank farm and nearly 52,000 pounds of crude oil from a Seaway Crude Pipeline Inc. tank."[75] Residents of Galena Park, a mostly Latino neighborhood, were subjected to more than one dozen releases within a two-mile radius as a result of Harvey, including a gasoline spill at the Magellan terminal initially reported at 42,000 gallons but eventually revealed to be ten times bigger.[76] In addition, "[t]he spill ranked as Texas' largest reported Harvey-related venting of air pollutants, at 1,143 tons."[77]

3. Chemical Spills in Houston During Hurricane

71. Steven Mufson, *ExxonMobil Refineries are Damaged in Hurricane Harvey, Releasing Hazardous Pollutants*, WASH. POST (Aug. 29, 2017), https://perma.cc/6CNZ-MTYN.

72. *Criteria Air Pollutants,* U.S. ENVTL. PROT. AGENCY, https://perma.cc/77QW-R9UY.

73. Adam Allington, *Flooded Houston Facing Air Threat, Too, With Toxic Gas Releases*, BLOOMBERG ENV'T. 1 (2017) (quoting Elena Craft), https://perma.cc/4W2K-R8VS.

74. Michael Biesecker & Frank Bajak, *Hurricane Harvey: Floodwaters 'Caused Chemical Spill' at Houston's Dirtiest Toxic Waste Plant*, INDEP. (Sept. 19, 2017), https://perma.cc/4BEP-7Z93.

75. *Toxic Impact*, *supra* note 60.

76. *Id.*

77. *Id.*

Harvey

As noted, Houston is also home to, or near, 500 chemical plants, many of which were flooded. As CBS News reported in March 2018:

> Nearly half a billion gallons of industrial wastewater mixed with storm water surged out of just one chemical plant in Baytown, east of Houston on the upper shores of Galveston Bay. Benzene, vinyl chloride, butadiene and other known human carcinogens were among the dozens of tons of industrial toxins released into surrounding neighborhoods and waterways following Harvey's torrential rains.[78]

Some of the chemical releases created acutely dangerous conditions. For example, on August 28:

> [A]n 18-inch pipeline leak at Williams Midstream Services Inc. unleashed a plume of [hydrogen chloride gas] near the intersection of two major highways in La Porte, southeast of Houston, where the San Jacinto River meets the 50-mile ship channel. It's the petrochemical corridor's main artery that empties into Galveston Bay.[79]

The resulting toxic cloud of hydrochloric acid spread about one-quarter mile through the industrial neighborhood, forcing people to remain inside lest the vaporized acid burn their skin and lungs or suffocate and kill them.[80] At the Channel Biorefinery & Terminals, "some 80,000 gallons of methanol spilled from a tank rupture into Greens Bayou, which enters the ship channel just downstream of the Magellan terminal. Highly flammable and explosive, methanol can cause brain lesions and other disorders."[81]

Many other notable chemical releases occurred in and around Houston during Harvey. Royal Dutch Shell PLC's Deer Park complex on the ship channel's south bank released more than 3,000 pounds of benzene and the company initially reported a 1,000-pound release of phenol, "which can burn skin and be potentially

78. *Id.*
79. *Id.*
80. *Id.*
81. *Toxic Impact*, *supra* note 60.

fatal . . . ."[82] The Chevron Phillips Chemical Company plant in Baytown released "[a]bout 34,000 pounds of sodium hydroxide, or lye, which can cause severe chemical burns, and unpermitted airborne emissions, including 28,000 pounds of benzene . . . ."[83]

One of the worst hit chemical plants during Hurricane Harvey was the Arkema chemical plant, about twenty miles northeast of Houston,[84] which is considered one of the most hazardous plants in Texas.[85] Harvey's rains inundated the plant, causing it to lose power, which in turn led to a loss of refrigeration.[86]

> The plant manufactures organic peroxides commonly used in everyday products like kitchen countertops, industrial paints, polystyrene cups and plates, and PVC piping. The materials must be kept very cool, otherwise there is "the potential for a chemical reaction leading to a fire and/or explosion within the site confines," Arkema said.[87]

Arkema itself reported the sequence of events as follows:

> The plant made extensive preparations prior to Hurricane Harvey. We have backup generators at the site solely for the purpose of being a redundant power supply for refrigeration necessary for the safe storage of products. We also brought in diesel powered refrigerated tank trailers and additional fuel as a further redundancy. Employees safely shut down all operations on Friday, August 25, prior to the hurricane's landfall. We left a small "ride-out" crew on site to address situations that could arise at the site during the storm to protect the safety and security of the community. The site lost primary power early Sunday morning August 27. The additional back-up generators subsequently were inundated by water and failed. On Monday, August 28 temperature sensitive products were transferred into 8 diesel-powered refrigerated containers where they currently reside. We evacuated the ride-out crew on Tuesday, August 29 for their safety. As of August 30, most of the refrigeration units have

82. *Id.*

83. *Id.*

84. Julia Bagg et al., *Crosby, Texas, Chemical Plant Explodes Twice, Arkema Group Says*, NBC NEWS (Aug. 31, 2017), https://perma.cc/GMA8-W33F.

85. Julie Turkewitz et al., *New Hazard in Storm Zone: Chemical Blasts and 'Noxious' Smoke*, N.Y. TIMES (Aug. 31, 2017), https://perma.cc/Q8T8-5XU8.

86. *Id.*

87. Bagg et al., *supra* note 84.

> failed due to flooding. The site itself is now completely flooded and inaccessible except by boat. In conjunction with the Department of Homeland Security and the State of Texas, Arkema has set up a command post in an off-site location near the plant.[88]

"With the power out and cooling systems failing, volatile organic peroxides exploded multiple times over the course of a week, producing towering pillars of fire and thick plumes of black smoke."[89] In all, "[m]ore than 200 residents had to evacuate because of the chemical fumes and noxious smoke caused by [the fire], and 21 people sought medical attention."[90] In particular, "15 public safety officers were treated at a hospital after inhaling smoke from chemical fires that followed the explosions."[91] These "sickened first responders" later filed suit, "as have Harris and Liberty counties, which claim the company violated numerous environmental and safety regulations."[92]

4. Houston's Post-Harvey Toxic Exposure

Houston residents were aware of at least some of the toxic releases around them during Harvey itself: "From Aug. 24 to Sept. 3, callers made 96 reports of oil, chemical or sewage spills across southeast Texas."[93] As of March 2018, however, "reporters catalogued more than 100 Harvey-related toxic releases — on land, in water and in the air. Most were never publicized, and in the case of two of the biggest ones, the extent or potential toxicity of the releases was initially understated."[94] Notably, many of the companies who owned the sites where spills occurred had violated environmental laws in their management of those sites in the past.[95]

88. *Frequently Asked Questions Answered*, ARKEMA INC., https://perma.cc/6AHX-9EZH.

89. Alex Stuckey, *Arkema Officials Were Warned of Flood Risks a Year Before Hurricane Harvey*, HOUS. CHRON. (May 25, 2018), https://perma.cc/73ZY-8UD9.

90. Stephanie Ebbs, *Noxious Chemical Fire During Hurricane Harvey Caused by Failure of 'all levels of protection,' Probe Reveals,* ABC NEWS (May 25, 2018), https://perma.cc/FG2G-4Z5F.

91. Turkewitz et al., *supra* note 85.

92. *Toxic Impact*, *supra* note 60.

93. Griggs et al., *supra* note 56.

94. *Toxic Impact*, *supra* note 60.

95. *Id.*

Perhaps most novel was the air pollution problems that Harvey generated: "from Aug. 23 to Aug. 30, 46 facilities in 13 counties reported an estimated 4.6 million pounds of airborne emissions that exceeded state limits, an analysis by the Environmental Defense Fund, Air Alliance Houston and Public Citizen shows."[96] Air pollution issues continued after the storm as plants that had shut down for the storm released unusual amounts of pollutants in restarting. For example, "[a] giant plastics plant in Point Comfort, about 100 miles southwest of Houston, released about 1.3 million pounds of excess emissions, including toxic gases like benzene, when it restarted after the storm."[97]

Clearly, acute toxic exposures occurred during and immediately after the hurricane. For example, in early September, Houston recorded "a high benzene level of 324 parts per billion—more than three times the level at which federal worker safety guidelines recommend special breathing equipment."[98] Around the San Jacinto Waste Pits, "[p]reliminary data from the EPA indicated that in sediment samples taken around the site, dioxins levels spiked 2,300 times above acceptable levels."[99]

However, because investigations remain incomplete, the longer-term toxic legacy that Harvey gifted to Houston residents is less clear. "Texas regulators say they have investigated 89 incidents, but have yet to announce any enforcement actions."[100] Nevertheless, government monitoring of residual toxicity in Houston has been limited compared to what occurred after previous hurricanes, such as Ike (2008) and Katrina (2005).[101] Academic testing and studies suggest that the storm essentially washed out the city's topsoil, leaving relatively few sites with worrisome levels of petroleum-related toxins.[102] Nevertheless, while residents were initially told that the releases posed no threat

96. Griggs et al., *supra* note 56.

97. *Id.*

98. *Toxic Impact,* supra note 60; *see also* Griggs et al., *supra* note 56.

99. Michael D. Regan, *Health Concerns Swirl in Texas Months after Floods from Harvey Spread Toxic Waste*, PBS NEWS HOUR (Dec. 10, 2017), https://perma.cc/93SV-ZKV9.

100. *Toxic Impact*, *supra* note 60.

101. *Id.*

102. *Id.*

to human health, as of March 2018, the EPA continued to worry about local toxic "hotspots" and the risks that they pose.[103]

C. The Long-Term Threat of Toxic Sea-Level Rise

While hurricanes like Harvey dramatize coastal toxicity and its public health risks for coastal inhabitants, sea-level rise (and the increased storm surge that comes with it) present coastal planners with a far more insidious toxicity problem. First, rising seas make coastal storm events worse; indeed, the exacerbation of storm surge is the most immediate and significant consequence of sea-level rise. According to the Intergovernmental Panel on Climate Change ("IPCC"), "it is *likely* that extreme sea levels (for example, as experienced in storm surges) have increased since 1970, being mainly the result of mean sea level rise."[104]

Second, in many parts of the United States—notably the Gulf Coast—sea-level rise will cause the ocean to progressively inundate and saturate existing toxic infrastructure, potentially condemning emerging coastal communities and ecosystems to a toxic existence. According to the IPCC, global mean sea level rose by 0.19 meters over the period 1901 to 2010, and "[t]he rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia."[105] The IPCC also concluded that the mean rate of global average sea level rise for the period from 1993 to 2010 was nearly twice what occurred from 1901 to 2010.[106]

Sea level rise has two main components: melting land-based ice (glaciers and ice shelves) and expanding volume as the ocean warms.[107] Although the two contributors have been roughly equal until recently, melting ice and disintegrating ice shelves have become significantly more important.[108] Sea level rise will continue

103. *Id.*
104. 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 53.
105. *Id.* at 4.
106. *Id.* at 42.
107. *Id.*
108. Mark F. Meier et al., *Glaciers Dominate Eustatic Sea-Level Rise in the 21st Century*, 317 SCIENCE 1064, 1065 (2007) (arguing that glaciers and ice caps "contribute about 60% of the eustatic, new-water component of sea-level rise [].""); ANTARCTIC CLIMATE & ECOSYSTEMS COOPERATIVE RESEARCH CENTRE, ACE CRC REPORT CARD: SEA LEVEL RISE 2012 4, 10 (2012), https://perma.cc/294T-QHW3

to accelerate through the 21st century and beyond, affecting a projected 95 percent of the ocean area and approximately 70 percent of coastlines worldwide.[109] However, sea level rise will not be uniform across regions. For example, "[s]ince 1993, the regional rates for the Western Pacific are up to three times larger than the global mean, while those for much of the Eastern Pacific are near zero or negative."[110]

The future of the planet's ice presents a worrisome uncertainty, and the increasing pace of polar ice melt has added significant volatility to the art of sea level rise prediction.[111] Studies repeatedly indicate that the Greenland ice sheet and Antarctic ice are melting faster than expected,[112] and the IPCC noted in 2014 that the Greenland and Antarctic ice sheets were losing mass, likely at an increasing rate.[113] It also noted that glaciers around the world have continued to shrink and projected that these glaciers, as well as other ice sheets besides Greenland and Antarctica, will continue to decrease throughout the 21st century, shrinking 15 percent to 85 percent by 2100.[114] The IPCC concluded that knowledge concerning "[a]brupt and irreversible ice loss from the Antarctic ice sheet . . . is insufficient to make a quantitative assessment" of its likelihood.[115] However, the West Antarctic Ice Sheet contains enough ice to raise sea level by five to seven meters (17 to 23 feet).[116] If all of Antarctica melts, sea level will rise approximately 60 meters or almost 200 feet.[117] If both

(noting that while "[t]his present sea-level rise is due to a combination of thermal expansion of a warming ocean and the melting of glaciers and ice sheets," "[o]ver the last decade, the contribution to sea-level rise from melting ice has exceeded that due to thermal expansion of the ocean.").

109. 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 13.

110. *Id.* at 42.

111. Anny Cazenave, *How Fast Are the Ice Sheets Melting?*, 314 SCIENCE 1250, 1251 (2006).

112. *Id.*; J.L. Chen et al., *Satellite Gravity Measurements Confirm Accelerated Melting of Greenland Ice Sheet*, 313 SCIENCE 1958, 1958 (2006), https://perma.cc/PTB8-L3Q6.

113. 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 4.

114. *Id.* at 12.

115. *Id.* at 16.

116. Vivien Gornitz, *Sea Level Rise, After the Ice Melted and Today*, NAT'L AERONAUTICS AND SPACE ADMIN. (Jan. 2007), https://perma.cc/YG34-WAJ6.

117. Antarctic and S. Ocean Coal., *The Antarctic and Climate Change*, at 3, ASOC IP 62, (2006), https://perma.cc/D4X2-52T8.

Greenland and Antarctica melt completely, sea level would rise about 65 meters or approximately 215 feet.[118]

Regardless of which of these ice-melt calamities occur and when, sea-level rise will continue throughout the 21st century,[119] although its exact impact will vary considerably among coastal regions. For example, the U.S. Global Change Research Program (the "Program") has noted that the southeastern region of the United States, which includes the Gulf Coast, is particularly at risk from sea-level rise, while the Northeast's threats arise more from coastal flooding as a result of increased precipitation and coastal storms.[120] In the Southeast:

> Global sea level rose about eight inches in the last century and is projected to rise another 1 to 4 feet in this century. Large numbers of southeastern cities, roads, railways, ports, airports, oil and gas facilities, and water supplies are vulnerable to the impacts of sea level rise. Major cities like New Orleans, with roughly half of its population below sea level, Miami, Tampa, Charleston, and Virginia Beach are among those most at risk.
>
> As a result of current sea level rise, the coastline of Puerto Rico around Rincòn is being eroded at a rate of 3.3 feet per year. Puerto Rico has one of the highest population densities in the world, with 56% of the population living in coastal municipalities.[121]

As the Program is quick to point out, the economic consequences of sea-level rise in the Southeast could be considerable. As one example, "Louisiana State Highway 1, heavily used for delivering critical oil and gas resources from Port Fourchon, is sinking, at the same time sea level is rising, resulting in more frequent and more severe flooding during high tides and storms. A 90-day shutdown of this road would cost the nation an

118. Cazenave, *supra* note 111, at 1250.

119. 2014 IPCC SYNTHESIS REPORT, *supra* note 19, at 58.

120. U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: HIGHLIGHTS 70–73 (2014), https://perma.cc/9ATX-CR9X [hereinafter USGCRP CLIMATE CHANGE REPORT].

121. *Id*. at 73.

estimated $7.8 billion."[122] The Program does not mention, however, the implications for toxic exposures.

Along the Pacific coast, in California, "[s]ea level has risen approximately 7 inches from 1900 to 2005, and is expected to rise at growing rates in this century."[123] Sea-level rise exacerbates existing flooding and erosion problems in California, particularly during coastal storms and extreme high tides, and projections are for increasing damage.[124] In the Pacific Northwest, "the effects of sea level rise, erosion, inundation, threats to infrastructure and habitat, and increasing ocean acidity collectively pose a major threat to the region."[125] The damage to critical coastal infrastructure could be considerable:

> The region's populous coastal cities face rising sea levels, extreme high tides, and storm surges, which pose particular risks to highways, bridges, power plants, and sewage treatment plants. Climate-related challenges also increase risks to critical port cities, which handle half of the nation's incoming shipping containers.[126]

Notably, as discussed above, much of this infrastructure—sewage treatment plants, power plants, urban runoff from highways and ports—is also a source of toxicity.

Thus, even in government reports that acknowledge climate change and describe its projected impacts on U.S. coastal communities in detail, little attention is paid to the existing and potential risks from toxics in the coastal zone. Dealing with this toxic load, however, should be added to climate change adaptation efforts in this country. As part of that effort, the next Part reviews existing laws particularly relevant to reducing the toxic load along the nation's coasts.

122. *Id.* at 73, 90 (discussing the potential for economic disruption in the nation's coastal regions).

123. *Id.* at 92.

124. *Id.* at 78.

125. *Id.* at 80.

126. *Id.* at 78.

III. EXISTING FEDERAL AND STATE LAWS RELEVANT TO COASTAL TOXICITY

A. Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA")

As noted, Congress enacted CERCLA in 1980 to promote the cleanup of existing toxic sites. In that sense, CERCLA is best characterized as retrospective environmental law (i.e., providing for cleanup liability *after* a hazardous release has already occurred) rather than proactive or preventive. Nevertheless, CERCLA and its state analogs remain important legal vehicles for promoting the cleanup of existing toxic sites along the coast.

CERCLA is triggered by the release—past or present—of hazardous substances from a facility.[127] Because CERCLA was one of the last major federal environmental statutes that Congress enacted, it defines "hazardous substances" by referencing earlier legislation—toxic pollutants under the Clean Water Act, hazardous wastes under the Resource Conservation and Recovery Act, hazardous air pollutants under the Clean Air Act, and imminently hazardous chemicals under the Toxic Substance Control Act.[128] However, the EPA can also designate additional "hazardous substances" particularly for CERCLA.[129]

The EPA also designates "reportable quantities" of hazardous substances.[130] In order to facilitate effective responses to new releases of hazardous substances, CERCLA requires "[a]ny person in charge of a vessel or an onshore or offshore facility" to immediately report releases of hazardous substances in excess of the relevant reportable quantities to the National Response Center as soon as that person knows of the release.[131] CERCLA defines "release" broadly to include "any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment," except for the many kinds of "releases" that are regulated under other

127. 42 U.S.C. § 9603(a) (West 2018).

128. *Id.* § 9601(14) (defining "hazardous substance" by cross-referencing these statutes).

129. *See id.* §§ 9601(14)(B), 9602(a).

130. *Id.* § 9602(a).

131. *Id.* § 9603(a).

statutes.[132] Thus, pesticide applications regulated under the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA") and pollutant discharges regulated under the Clean Water Act are exempt from CERCLA's reporting requirement.[133] Otherwise, failures to report releases of hazardous substances and false reports are subject to criminal penalties.[134]

Section 104 of CERCLA authorizes the President of the United States—who has since delegated this authority to the EPA—to respond to releases of hazardous substances through removal and remedial actions.[135] Removal actions are the government's immediate response to a spill or release, designed primarily to contain the hazardous substances and limit the threat to the public.[136] Remedial actions, in contrast, are "actions consistent with permanent remedy . . . ."[137] Both such cleanup actions must be consistent with the National Contingency Plan,[138] which establishes "procedures and standards for responding to releases of hazardous substances, pollutants, and contaminants . . . ."[139]

Alternatively, the EPA can order abatement actions under section 106 of CERCLA.[140] As a practical matter, the primary difference between a section 104 cleanup and a section 106 cleanup is that under section 104, governments perform the cleanup and seek reimbursement, while under section 106, potentially responsible parties ("PRPs") perform (and generally pay for) the cleanup themselves, subject to federal and/or state supervision.[141] The EPA must notify the affected state before ordering a section 106 abatement action[142] and "shall promulgate regulations providing for substantial and meaningful involvement by each State in initiation, development, and selection of remedial actions

132. *Id.* § 9601(22).
133. *Id.* § 9603(e).
134. *Id.* § 9603(b).
135. *Id.* § 9604(a)(1).
136. *See id.* § 9601(23) (defining "remove" and "removal").
137. *See id.* § 9601(24) (defining "remedy" and "remedial action").
138. *Id.* § 9604(a)(1).
139. *Id.* § 9605(a).
140. *Id.* § 9606(c).
141. Cooper Indus., Inc. v. Aviall Servs., Inc., 543 U.S. 157, 161 (2004) (citing Key Tronic Corp. v. United States, 511 U.S. 809, 814 (1994)).
142. 42 U.S.C. § 9606(a).

to be undertaken in that State."[143] The affected state also has a right to concur (or not) in the federal government's selection of certain remedial actions and a right to intervene in or bring a relevant action if the state objects to the remedy that the federal government chooses.[144]

Section 107 is the heart of CERCLA's liability scheme. First, section 107 identifies four categories of PRPs:

> (1) the owner and operator of a vessel or a facility;
> (2) any person who at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of;
> (3) any person who by contract, agreement, or otherwise arranged for disposal or treatment, or arranged with a transporter for transport for disposal or treatment, of hazardous substances owned or possessed by such person, by any other party or entity, at any facility or incineration vessel owned or operated by another party or entity and containing such hazardous substances; and
> (4) any person who accepts or accepted any hazardous substance for transport to disposal or treatment facilities, incineration vessels or sites selected by such person, from which there is a release, or a threatened release which causes the incurrence of response costs . . . .[145]

These PRPs become liable for four kinds of costs and damages:

> (A) all costs of removal or remedial action incurred by the United States Government or a State or an Indian tribe not inconsistent with the national contingency plan [response costs];
> (B) any other necessary costs of response incurred by any other person consistent with the national contingency plan;
> (C) damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from such a release [natural resources damages]; and

143. *Id.* § 9621(f)(1).
144. *Id.* § 9621(f)(2)(B).
145. *Id.* § 9607(a)(1)–(4).

(D) the costs of any health assessment or health effects study [required under section 104].[146]

Finally, section 107 provides PRPs with only three defenses: (1) if the release and resulting damages were caused solely by "an act of God"; (2) if the release and resulting damages were caused solely by "an act of war"; or (3) if the release and resulting damages were caused solely by "an act or omission of a third party other than an employee or agent" of the PRP, and with no contractual relationship with the PRP, if the PRP exercised "due care" and "took precautions against foreseeable acts or omissions of any such third party and the consequences that could foreseeably result from such acts or omissions . . . ."[147] Otherwise, PRPs can pursue a variety of settlement options with the governments[148] and contribution actions against each other.[149]

CERCLA's basic goal is thus to have the people or companies who created a contaminated site pay to clean it up. However, Congress also created a Hazardous Substance Superfund,[150] funded through a tax on chemical and oil companies, to pay for the cleanup of "orphan" sites.[151] This tax "expired in 1995, and it has not been reinstated,[152] with the result that Congress has been appropriating money to the Superfund through the normal federal budget process.

While CERCLA remains an important legal aspect of promoting coastal cleanups, contamination removal under its auspices has been notoriously slow in many circumstances, and nothing in the act requires governments to prioritize sites by location (say, in the coastal zone). The San Jacinto Waste Pits that flooded during Hurricane Harvey provide an apt example. As

146. *Id.* § 9607(a)(4)(A)–(D).

147. *Id.* § 9607(b).

148. *Id.* § 9622.

149. *Id.* § 9613(f)(1).

150. *Id.* § 9611.

151. "Orphan" sites are those for which no financially viable PRPs can be found. *See Summary of the Conmprehensive Environmental Response, Compensation, and Liability Act*, U.S. ENVTL. PROT. AGENCY, https://perma.cc/9NQG-TP4C.

152. NAT'L PUB. RADIO (NPR), *As Tax Expires, EPA Struggles To Clean Up Superfund Sites* (Aug. 6, 2010), https://perma.cc/7V6C-WYU9; Bryan Anderson, *Taxpayer dollars fund most oversight and cleanup costs at Superfund sites*, WASH. POST (Sept. 20, 2017), https://perma.cc/Z2NN-HP7K.

noted, the site first became contaminated in the 1960s, and it has long been known for its toxicity. For example, "the Texas Parks and Wildlife Department warns people should not eat fish and crabs from the area because the animals may be contaminated," and the EPA added the site to the CERCLA NPL in 2008.[153] After Harvey, then-EPA Administrator Scott Pruitt put the San Jacinto Waste Pits on a list of special sites deserving of his personal attention, the EPA announced a $115 million plan to remove contaminated material from the site, and a court approved an agreement whereby two companies would come up with a plan to clean up the site.[154] However, in April 2018, Pruitt removed the San Jacinto Waste Pits from his special list, leaving the companies with twenty-nine months—more than two years—to formulate their cleanup plan.[155] Cleanup at the site, even after Harvey, is expected to take more than four years.[156]

B. Resource Conservation and Recovery Act ("RCRA")

Congress enacted the Solid Waste Disposal Act ("SWDA")[157] in 1976, but after the 1980 amendments it has become much more commonly known as the Resource Conservation and Recovery Act ("RCRA"). Unlike CERCLA, RCRA is proactive, seeking to prevent new contamination from hazardous waste. Specifically, Congress found that "although land is too valuable a national resource to be needlessly polluted by discarded materials, most solid waste is disposed of on land in open dumps and sanitary landfills" and that "disposal of solid waste and hazardous waste in or on the land without careful planning and management can present a danger to human health and the environment . . ."[158]

RCRA applies to "solid waste," which the statute defines as:

> any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial,

153. Hersher, *supra* note 61.
154. *Id*; *see also* Regan, *supra* note 99 (reporting the same figures).
155. Hersher, *supra* note 61.
156. Regan, *supra* note 99.
157. 42 U.S.C. §§ 6901–6992k.
158. *Id*. §§ 6901(b)(1)–(2).

> commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial sources which are point sources subject to permits under section 1342 of Title 33 [the Clean Water Act], or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended . . . .[159]

From there, RCRA regulation depends on whether solid waste is hazardous or not.

Nonhazardous solid waste is subject to RCRA Subtitle D. Under these provisions, states received the primary authority to regulate non-hazardous solid waste. First, they were expected to enact state solid waste management plans.[160] In order to receive federal approval, these state plans had to meet six statutory requirements.[161] Most importantly, states had to forbid new open dumps within their borders and provide for the closing or upgrading of all existing open dumps.[162] As part of these controls, states were expected to implement permit programs for solid waste management facilities to control their intake of hazardous waste.[163] In addition, new disposal could only occur at sanitary landfills.[164] Under Congress's requirements, all new, replacement, and expanded landfills had to be built with at least two liners and leachate collection systems and had to provide for groundwater monitoring.[165]

RCRA regulation, however, focuses far more stringently on hazardous waste, which is regulated under Subtitle C. A "hazardous waste" is "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—

159. *Id.* § 6903(27).
160. *Id.* § 6943(a)(1).
161. *Id.* § 6943(a).
162. *Id.* § 6943(a)(2)–(3).
163. *Id.* § 6945(c)(1)(A).
164. *Id.* § 6944(b).
165. *Id.* § 6924(o)(1)(A)(i)–(ii).

(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or

(B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.[166]

The EPA had the responsibility to "develop and promulgate criteria for identifying the characteristics of hazardous waste, and for listing hazardous waste[,]" and to actually list hazardous wastes subject to RCRA's Subtitle C requirements, "taking into account toxicity, persistence, and degradability in nature, potential for accumulation in tissue, and other related factors such as flammability, corrosiveness, and other hazardous characteristics."[167] It identified characteristics that made wastes hazardous—ignitability,[168] corrosiveness,[169] reactivity,[170] and toxicity[171]—but also listed specific types of hazardous wastes from various types of industries and industrial processes.[172]

Subtitle C seeks to regulate hazardous wastes from "cradle to grave"—that is, from initial creation to eventual (safe) disposal. Hazardous waste generation is "the act or process of producing hazardous waste."[173] Hazardous waste generators must keep records that identify the hazardous wastes that they generate, label those wastes properly, store the waste in appropriate containers, begin RCRA's manifest system to track the waste, and provide information and reports about the waste.[174] Hazardous waste transporters, in turn, must keep records about the waste they transport, continue the manifest system, refuse to transport improperly labeled hazardous waste, and deliver the waste only to permitted treatment, storage, and disposal ("TSD") facilities.[175]

166. *Id.* § 6903(5).
167. *Id.* § 6921(a).
168. 40 C.F.R. § 261.21 (2018).
169. *Id.* § 261.22.
170. *Id.* § 261.23.
171. *Id.* § 261.24.
172. *Id.* §§ 261.31–.33
173. 42 U.S.C.A. § 6903(6).
174. *Id.* § 6922(a).
175. *Id.* § 6923(a).

RCRA rigorously regulates these TSD facilities, requiring permitting, financial responsibility, contingency plans, recordkeeping, and strict compliance with storage, handling, and disposal requirements.[176] In addition, as noted above, TSD facilities become liable for corrective actions—that is, for cleanups at and beyond the TSD facility if hazardous wastes escape.[177]

Several facilities located in and near Houston during Hurricane Harvey were regulated under Subtitle C. For example, the Arkema Chemical Plant in Crosby, Texas that caught fire was regulated as a RCRA large quantity hazardous waste generator under the Handler ID TXD043750512.[178] Until 2011, the plant shipped all of its wastes off-site, but by 2013, it was generating over 16,000 tons of hazardous waste and handling most of that waste on-site.[179] It produces a variety of hazardous wastes, including toxic metals (arsenic, cadmium, chromium, lead, mercury, selenium, and silver), toxic benzene, and toxic tetracholoroethylene, among several others.[180] Nevertheless, until Harvey, the chemical plant was relatively compliant with RCRA; the State of Texas had taken only two informal (letter-based) enforcement actions under RCRA against the plant, although the facility had not been inspected since October 2013.[181]

C. Coastal Zone Management Act ("CZMA")

The federal Coastal Zone Management Act ("CZMA")[182] essentially bribes coastal states with federal consistency requirements, money, and technical assistance into engaging in proactive coastal planning and management.[183] Specifically, the Act encourages states to create Coastal Zone Management Programs that meet 16 detailed requirements,[184] most of which are

176. *Id.* § 6924(a).

177. *Id.* § 6924(v).

178. *RCRA Info Facility Information – Arkema Crosby Plant*, U.S. ENVTL. PROT. AGENCY, https://perma.cc/U2TZ-DC6C.

179. *Id.*

180. *Id.*

181. *Detailed Facility Report – Arkema Crosby Plant*, U.S. ENVTL. PROT. AGENCY, https://perma.cc/8PTT-HZNG.

182. 16 U.S.C.A. §§ 1451–1466 (West 2018).

183. *See id.* §§ 1455–56.

184. *Id.* § 1455(d).

easily classified as land (and sometimes water) use planning[185] or governmental organization, authority, and procedures.[186] A few requirements are fairly specific; for example, coastal states must address energy facilities in the coastal zone (including their impacts),[187] coastal erosion,[188] and nonpoint source pollution.[189]

The delineated components of a Coastal Zone Management Program are certainly broad enough to allow a state to prioritize coastal toxicity.[190] However, nothing in the Act explicitly mentions toxics, toxicity, or hazardous waste.

Like all coastal states except Alaska, Texas implements an approved Coastal Zone Management Program, which it first adopted in 1997.[191] The state's goals for its program center around Coastal Natural Resource Areas ("CNRAs"). Those goals are:

- To protect, preserve, restore, and enhance the diversity, quality, quantity, functions, and values of CNRAs;
- To ensure sound management of all coastal resources by allowing for compatible economic development and multiple human uses of the coastal zone;
- To minimize loss of human life and property due to the impairment and loss of protective features of CNRAs;
- To ensure and enhance planned public access to and enjoyment of the coastal zone in a manner that is compatible with private property rights and other uses of the coastal zone;
- To balance the benefits from economic development and multiple human uses of the coastal zone, the benefits from protecting, preserving, restoring, and enhancing CNRAs, the benefits from minimizing loss of human life and property, and the benefits from public access to and enjoyment of the coastal zone;

185. *Id.* § 1455(d)(2), (9), (11), (12), (13).
186. *Id.* § 1455(d)(3)–(7), (10), (14)–(16).
187. *Id.* §§ 1455(d)(2)(H), (8).
188. *Id.* § 1455(d)(2)(I).
189. *Id.* §§ 1455(d)(16), 1455b.
190. *See id.* §§ 1456b(a)(2), (4)–(6).
191. TEX. GEN. LAND OFFICE, TEXAS COASTAL MANAGEMENT PROGRAM: 2015-16 BIENNIAL REPORT -2 (2016) https://perma.cc/2CBF-FQ3D.

- To coordinate agency and subdivision decision-making affecting CNRAs by establishing clear, objective policies for the management of CNRAs;
- To make agency and subdivision decision-making affecting CNRAs efficient by identifying and addressing duplication and conflicts among local, state, and federal regulatory and other programs for the management of CNRAs;
- To make agency and subdivision decision-making affecting CNRAs more effective by employing the most comprehensive, accurate, and reliable information and scientific data available and by developing, distributing for public comment, and maintaining a coordinated, publicly accessible geographic information system ("GIS") of maps of the coastal zone and CNRAs at the earliest possible date;
- To make coastal management processes visible, coherent, accessible, and accountable to the people of Texas by providing for public participation in the ongoing development and implementation of the CMP; and
- To educate the public about the principal coastal problems of state concern and technology available for the protection and improved management of CNRAs.[192]

In addition, however, Texas is pursuing a coastal resiliency program, with public meetings focused on "increasing economic and environmental vulnerabilities, resulting from population growth, increased storm intensity, and shoreline erosion" and on "planning for changing conditions and future storm hazards along the coast."[193] In addition, the Program "is developing the Master Plan, a long-term framework intended to mitigate damage from future coastal natural disasters and preserve and enhance the state's coastal natural resources and assets."[194] Nevertheless, although coastal infrastructure is clearly part of these discussions and resiliency planning, none of the identified strategies—"1) restoring Texas's beaches and dunes; 2) bay shoreline stabilization

192. *Id.* at 3.
193. *Id.* at 10.
194. *Id.*

and estuarine wetland restoration (living shorelines); 3) stabilizing the GIWW; 4) freshwater wetland and coastal uplands conservation; 5) delta and lagoon restoration; 6) oyster reef creation and restoration; 7) rookery island creation and restoration; and 8) plans, policies, and programs"[195]—acknowledge coastal toxicity as a possible problem.

Toxicity consciousness may emerge in some parts of Texas at a more local level. For example, using grants from the Coastal Zone Management Program, Galveston Bay engaged both in a contaminated seafood warning program to educate subsistence and recreational fishers, especially in low-income and Spanish-speaking immigrant communities, "about the risk of consuming seafood contaminated with toxic substances" and a program to educate boaters about their wastes—most recently, the illegality of sewage discharges but with additional issues slated for future years.[196] These developments thus suggest that Galveston might be one of the Texas coastal municipalities that is most open to dealing more proactively with coastal toxicity problems.

D. State and Local Land Use Planning

Unlike environmental and natural resource regulation, land use planning is usually the particular province of municipalities, and this aspect of local law can be critical to dealing with climate change and its impacts. C40, "a network of the world's megacities committed to addressing climate change,"[197] has underscored the importance of land use planning as follows:

> Land use planning provides the strategic framework for the growth of a city, determining the physical uses of space that will influence how people live and move, for generations to come. Cities have significant authority over land use policies and regulations. . . . It is particularly important that cities have a good plan for how they will address growth, because as C40

195. *Id.*
196. *Id.* at 16, 18, 22, 26.
197. *About C40*, C40 CITIES, https://perma.cc/RGC3-H4CC.

> research has shown, the planning decisions made today will have a major impact on the carbon emissions of tomorrow.[198]

By this organization's international count, "79% of cities have the power to set land use policies and regulations and 81% are responsible for carrying out the function of land use planning."[199]

Land use planning is also relevant to latent and cumulative toxicity concerns. Indeed, "[l]and use data are increasingly understood as important indicators of potential environmental health risk in urban areas where micro-scale or neighborhood level hazard exposure data are not routinely collected."[200] In 2003, a National Academy of Public Administration panel reported to the EPA that municipalities could use land use law more effectively to reduce residents' cumulative toxic exposures. Most directly, "local planning and zoning authorities could be used to reduce adverse impacts where industrial and residential areas are located near each other."[201] Notably, however, the report also advocated greater coordination and interaction between states and local governments to best deploy land use planning tools. For example, it recommended that states take steps to ensure local government participation in environmental permitting decisions (such as RCRA permitting decisions made through delegated federal authority), because "[t]hrough active involvement, local governments can help ensure that proposed environmental permits contain the conditions necessary to protect public health and the environment at the community level."[202] The report saw great promise for such increased cooperation, concluding that "[i]f state and local officials make creative and aggressive use of existing legal authorities, it may be possible to resolve the environmental and public health concerns of community residents."[203]

198. LAND USE PLANNING: NETWORK OVERVIEW, C40 CITIES, https://perma.cc/2ZCP-HPDT.

199. *Id.*

200. Jason Corburn, *Urban Land Use, Air Toxics and Public Health: Assessing Hazardous Exposures at the Neighborhood Scale*, 27 ENVTL. IMPACT ASSESSMENT REV. 145, 145 (2007).

201. NAT'L ACAD. OF PUB. ADMIN., ADDRESSING COMMUNITY CONCERNS: HOW ENVIRONMENTAL JUSTICE RELATES TO LAND USE PLANNING AND ZONING 18 (2003), https://perma.cc/6ELE-FBNL.

202. *Id.*

203. *Id.* at 19.

Houston is infamous, however, for its *lack* of land use planning: "The city of Houston proper is unique among large US cities in that it has no traditional use-based zoning (ala-Sim City: residential here, commercial there, etc.) . . . ."[204] However, that doesn't mean that development is completely haphazard. The city itself "regulates land use in many other ways, such as minimum-parking requirements. Many neighborhoods have homeowners associations and deed restrictions that limit what can be built. And Houston's suburbs largely do have zoning."[205]

Notably, in the immediate wake of Harvey, both local and national pundits debated the contribution of Houston's land use planning to the severity of the flooding, particularly in terms of wetlands destruction and building in floodplains.[206] Less flamboyant were several pre-Harvey examinations of the relationship between Houston area's land use planning and residents' potential toxic exposure. For example, Houston passed a hazardous materials ordinance in 1996 that prevents hazardous facilities from locating in neighborhoods that are more than one-third residential.[207] However, like most such laws, this ordinance did not apply to hazardous facilities already in existence, effectively allowing those existing facilities to continue.[208]

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204. Daniel Herriges, *Houston Isn't Flooded Because of Its Land Use Planning*, STRONG TOWNS (Aug. 30, 2017), https://perma.cc/LK4Q-EAXP; *see also* Nolan Gray, *How Houston Regulates Land Use*, MARKET URBANISM (Sept. 19, 2016), https://perma.cc/JLV9-QF45 ("Unlike every other major U.S. city, Houston doesn't mandate the separation of residential, commercial, and industrial developments. This means that restaurants, homes, warehouses, and offices are free to mix as the market allows. As many have pointed out, however, market-driven separation of incompatible uses—think strip clubs and preschools—is common in Houston.").

205. Herriges, *supra* note 204.

206. *Compare id.*, *and* Emily Hamilton, *What Houston's Critics Get Wrong: Land-Use Regulations Weren't to Blame for Hurricane Harvey's Destruction*, U.S. NEWS & WORLD REP. (Sept. 18, 2017), https://perma.cc/2SEU-977B, *with* Ana Campoy & David Yanofsky, *Houston's Flooding Shows What Happens When You Ignore Science and Let Developers Run Rampant*, QUARTZ (Aug. 29, 2017), https://perma.cc/KS2A-WU5D, *and* Shawn Boburg & Beth Reinhard, *Houston's 'Wild West' Growth: How the City's Development May Have Contributed to Devastating Flooding*, WASH. POST (Aug. 29, 2017), https://perma.cc/9PUM-PP2G.

207. Lydia DePillis, How Zoning Impacts Your Proximity to Pollution: Sixty-Five Percent of Houston is Within a Mile of a Toxic Emitter, HOUS. CHRON. (Sept. 20, 2016, 4:13 PM), https://perma.cc/ZL4G-VCM3.

208. *Id.*

A team of economists from the University of Pittsburgh and University of Washington, Bothell, happened to be assessing the long-term effect of zoning in Chicago across Hurricane Harvey's timeframe, drafting their results in 2016 but publishing in May 2018.[209] Because of Houston's resistance to traditional zoning, it served as the researchers' control/counterfactual.[210] Provocatively, 65 percent of Houston lies within one mile of a TRI reporting facility, compared to 30 percent of Austin, 44 percent of Dallas, and 43 percent of San Antonio, "suggest[ing] that land use patterns in relatively un-regulated Houston differ measurably from comparable cities that experienced formal zoning."[211] In addition, the researchers' results for Chicago "strongly suggest that over the long-run urban planning has been effective in creating residential neighborhoods that are distant from undesirable manufacturing uses, and that houses in these neighborhoods are more valuable as a result"[212]—a result the economists clearly view as desirable.

However, it should be noted that there is another way of looking at the researchers' results, which is that Houston's approach to land use has more fairly spread the city's overall toxic burden across its citizens. Notably, the researchers found that areas zoned for manufacturing or commercial use in Chicago were statistically more likely to contain TRI reporting facilities[213]—a result that makes inherent intuitive sense. Such concentration of toxics-emitting facilities, however, is also a primary source of environmental justice concerns, as those who cannot afford the more expensive neighborhoods are forced by economics to live with additional toxic exposure and risk.

Regardless of how land use planning distributes toxic exposures, such exposures remain public health risks. It is better for all concerned to reduce the city's overall toxic burden in the first place. Houston's 1996 hazardous facility ordinance was more akin to Chicago's separation-of-uses approach to land use planning than to a real effort to reduce overall toxicity, but Part IV will discuss

209. *See* Allison Shertzer et al., *Zoning and the Economic Geography of Cities*, 105 J. URBAN ECON. 20 (2018), https://perma.cc/8K8B-D49A.

210. *Id.* at 32.

211. *Id.* at 33.

212. *Id.* at 34.

213. *Id.* at 28.

alternative approaches that better implement a toxicity reduction goal.

E. Tort Law

Tort is the traditional remedy for preventable damage, and four torts in particular are generally associated with releases of toxic materials. Strict liability arises when a defendant engages in inherently dangerous activities or abnormally dangerous conduct.[214] Unlike strict liability, negligence is a fault-based approach to liability that requires a plaintiff to prove that the defendant violated a duty or standard of care, factually and legally causing the plaintiff harm.[215] Trespass applies to a defendant's physical invasion of the plaintiff's real property, such as a physical spilling of toxic materials onto the plaintiff's land.[216] Finally, nuisance allows a plaintiff to recover when a defendant unreasonably interferes with the plaintiff's use and enjoyment of real property.[217] "Public nuisance is an unreasonable interference with rights held by the public in general," while private nuisance "is an unreasonable interference with the rights of a plaintiff who has a possessory interest in the land affected."[218] Like CERCLA, however, tort liability is retrospective and reactive: the damage, in almost all cases, has already occurred.

Hurricane Harvey gave rise to several follow-on lawsuits, many demonstrating how injured plaintiffs can attempt to use tort liability to seek compensation for their exposures to coastal toxicity. The Arkema Chemical Plant in Crosby has become a particularly cogent defendant as a result of the fires and other toxic releases at the plant. In early September 2017, even as Harvey was still winding down, "[s]even police, fire and emergency medical technicians sued Arkema in Harris County District Court for at least $1 million, alleging negligence by the company and executives led flammable organic peroxides stored at the site to

214. ROBIN KUNDIS CRAIG, ENVIRONMENTAL LAW IN CONTEXT: CASES AND MATERIALS 32 (3rd ed. 2012).
215. *Id.* at 32–33.
216. *Id.* at 33.
217. *Id.*
218. *Id.*

ignite after the plant lost power during the storm."[219] Their complaint, filed in the Harris County District Court,[220] alleges that the plaintiffs suffered vomiting and loss of breath while responding to the Arkema fires and asserts causes of action for negligence, gross negligence, and negligence *per se*.[221]

The next month, residents of Crosby, Texas filed a class action lawsuit in the U.S. District Court for the Southern District of Texas, Houston Division, against Arkema,[222] alleging negligence, trespass, nuisance, property damage, personal injury, failure to warn, product liability, ultra-hazardous activity (strict liability), gross negligence, and negligent infliction of emotional distress.[223] They seek punitive damages and are asking the court to pierce Arkema's corporate veil so that its parent corporations may also be held liable.[224] The plaintiffs base their complaints both on the fires at the plant and on releases from two water tanks. They allege that "an estimated 23,608 pounds of contaminants were released from two [water] tanks including: ethylbenzene,mineral spirits, naptha, naphthalene, organic peroxides, trimethylbenzene, tert-butyl alcohol, 2,5 dimethyl-2,5 di(t-butylperoxy)hexane and t-amyl alcohol."[225] In addition, according to the plaintiffs, the smoke and ash from the fire released PAHs, toxic metals like antimony, volatile organic compounds like acetone, dioxins, furans, and a host of other toxic compounds.[226]

What is striking in both cases is not just the plaintiffs' assertions of past injuries during the hurricane and its toxic releases, but their fears for unknown future injuries. Thus, the plaintiff first responders seek not only actual damages for pain already suffered and medical care already received, but also

219. Reuters, *First Responders File Suit Against Arkema Over 'Serious Bodily Injuries' in Houston Chemical Plant Fire After Hurricane Harvey*, CNBC (Sept. 7, 2017, 11:22 PM), https://perma.cc/EWX8-UXGB.

220. *See* Complaint, Graves v. Arkema, No. 2017-58465 (333d Judicial Dist. Ct., Harris County, Tex. Oct. 9, 2017), https://perma.cc/26LH-REZ3 [hereinafter Graves Complaint].

221. *Id.* at 6, 7–9.

222. *See* Complaint, Wheeler v. Arkema, No. 4:17-cv-02960 (S.D. Tx. Oct. 2, 2017), https://perma.cc/7Z57-BKTQ [hereinafter Wheeler Complaint].

223. *Id.* ¶¶ 82–102.

224. *Id.* ¶¶ 104–11.

225. *Id.* ¶ 46.

226. *Id.* ¶ 59.

"[r]easonable and necessary medical care and expenses which will in all reasonable probability be incurred in the future;" "[p]hysical pain and suffering in the future;" "[p]hysical impairment which, in all reasonable probability, will be suffered in the future;" "[l]oss of earning capacity which will, in all probability, be incurred in the future;" "[d]isfigurement in the future;" "[m]ental anguish in the future;" and "[t]he cost of future medical monitoring."[227] The Crosby residents, similarly, seek "[a]n Order establishing a Medical Monitoring Program designed to survey as appropriate and to protect the Class Members from latent, dread disease, funded by the Defendants . . ."[228] These cases, therefore, frame the Arkema flooding, fire, and releases as the source of true toxic torts, plunging the plaintiffs legally into the uncertain world of "futures" cases.[229]

Studies released in May 2018 suggest that the plaintiffs in these cases may have good grounds for their lawsuits.[230] The U.S. Chemical Safety and Hazard Investigation Board found that officials at the Arkema chemical plant had been warned over one year before Harvey that that plant was at risk of flooding, and it concluded in its 154-page report that Arkema "was not prepared for the 6 feet of water that wiped out the facility's power and backup generators."[231] However, as the claims for medical monitoring and future damages show, the latent toxicity around Houston has morphed, because of Hurricane Harvey, into psychologically real and legally cognizable worries for all of the Arkema-exposed plaintiffs about their future health, with the true

227. Graves Complaint, *supra* note 220, at 13.

228. Wheeler Complaint, *supra* note 222, at 32.

229. One of the classic problems of toxic torts is the sometimes very long latency period between exposure to a toxic agent and manifestation of a disease. "Because of these issues, plaintiffs have increasingly sought recovery after exposure but before the manifestation of disease has taken place. These 'futures' cases are among the most hotly debated in toxic tort law." ROBIN KUNDIS CRAIG ET AL., TOXIC AND ENVIRONMENTAL TORTS: CASES AND MATERIALS 668 (2011). Medical monitoring is the least controversial of the three typical futures remedies, which also include fear of disease and enhanced risk of disease. *Id.* at 668–711.

230. Ebbs, *supra* note 90.

231. Stuckey, *supra* note 89 (citing to U.S. CHEM. SAFETY AND HAZARD INVESTIGATION BD., ORGANIC PEROXIDE DECOMPOSITION, RELEASE, AND FIRE AT ARKEMA CROSBY FOLLOWING HURRICANE HARVEY FLOODING (2018), https://perma.cc/ZLT8-AQ2G).

future risks that they face from their exposures during Harvey very unclear.

IV. THREE SUGGESTIONS FOR IMPLEMENTING A PRECAUTIONARY, HUMAN HEALTH-BASED APPROACH TO IMPROVING COASTAL ADAPTIVE CAPACITY IN THE ANTHROPOCENE

It can almost always be said, in almost any context, that governments could improve both their enforcement of environmental and public health laws and their disaster preparedness and response. Analyses of Hurricane Harvey in Houston certainly support these common suggestions for improving coastal responses to hurricanes.[232] Nevertheless, environmental enforcement and disaster response are largely reactionary, rather than precautionary, responses to toxic coasts, effectively focused less on protecting public health than on supporting coastal industry until such industry causes real problems.

Coastal states and municipalities *can* pursue more precautionary, health-based management policies regarding toxics in the coastal zone. Federal law almost always leaves states free to pursue more stringent pollution policies than it requires, and new technologies can help these governments to de-toxify their coastal zones. This Part presents three truly precautionary suggestions that serve to promote coastal public health by reducing the ability of coastal storms and sea-level rise to produce toxic hazards during flooding and inundation.

232. *See generally Toxic Impact*, *supra* note 60 (noting, for example, that many spills were not reported to emergency responders during Harvey and that many of the facilities involved had track records of environmental violations). Notably, the Texas Legislature had actually hampered environmental enforcement at the municipal level. "Two Texas laws enacted since mid-2015 have weakened counties' ability to police polluters. The first caps at $2.15 million what they can collect from polluters in lawsuits. The rest must go to the state. The second law took effect Sept. 1. It obliges counties to give the state right of first refusal on any pollution enforcement cases, which local officials say could mean less punitive action." *Id.*

A. Clean Up Existing Contaminated Sites

While, as Part III discussed, legal authorities exist at both the federal and state levels to clean up existing toxic waste dumps and other hazardous sites, such cleanups have not proceeded as fast as they might, nor has coastal contamination been made a priority. As a result, "[c]ontaminated sites often go for years and sometimes decades without being fully cleaned up."[233]

Finding sufficient funds for these often-expensive cleanups is often part of the problem. As noted, the Superfund tax expired in 1995 and Congress has been funding CERCLA cleanups through annual appropriations. In 2015, the U.S. Government Accountability Office ("GAO") found that both the funding and the effectiveness of CERCLA were declining, sometimes dramatically.[234] Its more specific findings are worth quoting at length:

> Annual federal appropriations to the Environmental Protection Agency's (EPA) Superfund program generally declined from about $2 billion to about $1.1 billion in constant 2013 dollars from fiscal years 1999 through 2013. EPA expenditures—from these federal appropriations—of site-specific cleanup funds on remedial cleanup activities at nonfederal National Priorities List (NPL) sites declined from about $0.7 billion to about $0.4 billion during the same time period. . . . EPA spent the largest amount of cleanup funds in Region 2 [comprising New Jersey, New York, Puerto Rico, the U.S. Virgin Islands, and eight tribal nations[235]], which accounted for about 32 percent of cleanup funds spent at nonfederal NPL sites during this 15-year period. The majority of cleanup funds was spent in seven states, with the most funds spent in New Jersey—over $2.0 billion in constant 2013 dollars, or more than 25 percent of cleanup funds.
>
> From fiscal years 1999 through 2013, the total number of nonfederal sites on the NPL annually remained relatively constant, while the number of remedial action project

233. *Toxics Action Center*, *supra* note 29, at 6.

234. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-15-812, *Trends in Federal Funding and Cleanup of EPA's Nonfederal National Priorities List Sites* 1 (2015), https://perma.cc/VJQ3-NA7G [hereinafter *Trends in Federal Funding*]. "Nonfederal" sites are sites that are not federal facilities, i.e.- sites like military bases that are owned by the federal government. *Id.*

235. *EPA Region 2,* U.S. ENVTL. PROT. AGENCY, https://perma.cc/6H8L-6JQ4.

> completions and construction completions generally declined. . . . The total number of nonfederal sites on the NPL increased from 1,054 in fiscal year 1999 to 1,158 in fiscal year 2013, and averaged about 1,100 annually. The number of remedial action project completions at nonfederal NPL sites generally declined by about 37 percent during the 15-year period. Similarly, the number of construction completions at nonfederal NPL sites generally declined by about 84 percent during the same period.[236]

Perhaps surprisingly to many, despite President Trump's February 2018 overall proposal to slash the EPA's budget, he proposed to maintain CERCLA cleanup funding at $1.1 billion for fiscal year 2019 and has proposed other mechanisms for funding cleanups as part of his infrastructure package.[237] While some of these proposals, like giving CERCLA cleanups "access to financing under the Water Infrastructure Finance and Innovation Act ("WIFIA") lending program to address contamination to water resources," might simply shift existing money from other environmental issues to cleanups, others would expand the grant money available to cleanup both brownfields and NPL sites.[238]

In March 2018, Congress appropriated almost $1.1 billion to the Superfund, although that money can also be transferred to other federal agencies.[239] It also directly provided $80 million in state and tribal assistance grants under CERCLA,[240] over $77 million to the National Institutes of Health for CERCLA-required health studies,[241] and over $74 million to the Agency for Toxic Substances and Disease Registry for health risk assessments under CERCLA.[242] In addition, under the heading of "Infrastructure," Congress added another $63 million for the EPA's CERCLA activities, $650 million for the state and tribal grants program, and $53 million to the EPA's Water Infrastructure

236. *Trends in Federal Funding*, *supra* note 234.

237. Sylvia Carignan, *Trump Proposes New Funding Options for Superfund, Brownfields*, BNA NEWS, https://perma.cc/KJ88-MQX9.

238. *Id.*

239. Consolidated Appropriations Act 2018, Pub. L. No. 115-141, 132 Stat. 348, 664 (2018).

240. *Id.* at 667.

241. *Id.* at 680.

242. *Id.*

Finance and Innovation Program Account for loans.[243] Finally, Congress enacted the Brownfields Utilization, Investment, and Local Development ("BUILD") Act of 2018 through the budget bill, which, *inter alia*, increases the availability of grants and loans for brownfield sites—but not those on the NPL.[244]

However, this is not enough money. Thus, there continue to be calls to reinstate the Superfund tax,[245] and there are also calls to increase the EPA's CERCLA enforcement financing, providing the agency the ability to force the liable parties to pay for cleanups.[246]

Direct citizen actions offer an alternative approach. The ultimate "fix" to coastal cleanups is altered public priorities that can put sufficient pressure on politicians at all levels of government to provide the funding and personnel necessary to expedite de-toxifying actions. In the meantime, citizen lawsuits can sometimes provide a second-best jump-start. Unlike most federal environmental laws, however, CERCLA's citizen suit provision[247] is of limited use to plaintiffs who are not themselves liable under the Act to try to force actual cleanups, because: (1) many of the damages that plaintiffs would seek are not "response costs" recoverable under CERCLA;[248] (2) individuals, NGOs, and cities cannot seek natural resources damages;[249] and (3) CERCLA includes a fairly stringent bar to any citizen suit that challenges an ongoing cleanup, including suits seeking to strengthen that effort.[250] Nevertheless, RCRA's citizen suit provision can often (but not always) fill in, because it allows plaintiffs to bring suit "against any person . . . who has contributed or is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste which may present an

243. *Id.* at 694.

244. *Id.* at 1055–59.

245. Bryan Anderson, *Taxpayer Dollars Fund Most Oversight and Cleanup Costs at Superfund Sites*, WASH. POST (Sept. 20, 2017), https://perma.cc/6FL6-QDA2 (quoting Christina Todd).

246. Elliott Gilberg, *Funding the Superfund*, WASH. POST, https://perma.cc/2YKJ-FFYJ.

247. 42 U.S.C.A. § 9659.

248. *See e.g.*, Lutz v. Chromatex, Inc., 718 F. Supp. 413, 416–18 (M.D. Pa. 1989).

249. *Id.* at 418–19; *see also* City of Toledo v. Beazer Materials & Servs., Inc., 833 F. Supp. 646, 652 (N.D. Oh. 1993).

250. 42 U.S.C.A § 9613(h).

imminent and substantial endangerment to health or the environment . . . ."[251] While litigation also requires money, RCRA allows courts to award costs and attorney fees to successful plaintiffs,[252] and, like most federal environmental citizen suit provisions, it preserves plaintiffs' tort remedies.[253]

Cities can also act to effectuate coastal cleanups. As one example, the City of Emeryville, California, located between Berkeley and Oakland on San Francisco Bay, was essentially one large brownfield site.[254] Specifically, "[a]s large industries began to contract and relocate to other cities in the 1970s, they left behind properties with toxins that had to be cleaned up before other businesses could use them."[255] To address these sites, the City assembled state and federal grants both to clean up properties that it owns and to make loans to private property owners for private remediation.[256] One of the city's current projects will become a greenway; another will be turned into affordable housing.[257]

B. Implement Toxic-Aware Land Use and Waste Management Planning Along the Coast

While cleaning up legacy toxicity remains a significant political challenge, coastal municipalities and states can take a number of other measures to reduce the toxic load on the nation's coasts moving forward. One avenue is to revamp land use planning to more directly address toxicity issues. The National Academy of Public Administration panel, for example, made several recommendations relevant to municipalities seeking to avoid concentrations of toxic and hazardous facilities in particular areas. First, such municipalities should "take steps to eliminate existing nonconforming uses that present public health and environmental hazards."[258] Second, "they should adopt more flexible zoning techniques, such as:

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251. *Id.* § 6972(a)(1)(B).
252. *Id.* § 6972(e).
253. *Id.* § 6972(f).
254. *Brownfield Program*, EMERYVILLE, CA, https://perma.cc/CX3D-TRE2.
255. *Id.*
256. *Id.*
257. *Id.*
258. NAT'L ACAD. OF PUB. ADMIN., *supra* note 201, at 19.

> • Setting up conditional uses that impose restrictions on certain uses that may affect environmental justice issues;
> • Establishing overlay zones that impose additional requirements to provide for additional environmental protections;
> • Using performance zoning to regulate the adverse impacts of nuisance-like activities, such as noise and odor; and
> • Establishing buffer zones in transitional areas between incompatible land uses, especially for industrial uses adjacent to residential areas.[259]

Overall, the panel concluded, "[l]ocal governments can play a primary role in identifying neighborhoods where residents face multiple environmental and public health risks. However, they need help from the other levels of government to develop and implement strategies for reducing risks, taking advantage of each level's unique authorities and expertise."[260]

The Toxics Action Center has also recommended toxicity-reducing actions that states and municipalities can take. First, states and municipalities can act to reduce or eliminate persistent toxic chemicals in the coastal zone.[261] Persistent toxic chemicals are slow to break down and lose their toxicity, and "[t]hese contaminants can cause cancer, birth defects and other reproductive problems, immune system challenges and damage to the nervous and respiratory systems."[262] Massachusetts, for example, "passed the Toxics Use Reduction Act (TURA), creating a highly successful system to assist industrial users of large quantities of toxic chemicals to reduce their toxics use. This program has been good for public health and also resulted in significant cost savings for many participating businesses."[263] Indeed, reports indicate that between 1990 and 1999, businesses in Massachusetts reduced their chemical wastes by 57 percent, reduced their use of toxic chemicals by 40 percent, reduced their chemical emissions by 80 percent—and saved $15 million in the

259. *Id.*
260. *Id.* at 21.
261. *Toxics Action Center*, *supra* note 29, at 5.
262. *Id.*
263. *Id.*

process.[264] Other examples of such state statutes exist, including Oregon's 1989 Toxics Use and Hazardous Waste Reduction Act,[265] which requires any large toxics user in the state to complete a toxics use reduction and hazardous waste reduction plan that identifies alternatives to its current practices.[266]

Second, relatedly, states and municipalities can work to reduce specific uses of toxic materials, and hence residents' direct exposures. For example, in 2001 Massachusetts enacted the Children and Families Protection Act[267] "to reduce children's exposure to harmful pesticides by restricting pesticide use in private and public schools and daycare centers and increasing right-to-know. Unfortunately, the law has been implemented unevenly across the state."[268]

Third, coastal municipalities can work to reduce their overall waste streams, working toward a goal of zero waste. For example, Nantucket, Massachusetts "diverts more than 92% of waste from landfills through aggressive recycling and waste reduction practices and has extended the life of the landfill for decades."[269]

C. Enact Building Codes that Minimize the Potential for Further Toxic Releases

Many industrial facilities in Houston essentially threw up their hands in trying to prevent releases during Hurricane Harvey. The on-site manager of Gulf Coast Energy, for example, declared his facility's release of methanol "'impossible to contain'" in light of the 20-foot floodwaters.[270] Similarly, Arkema Chemicals resists arguments that it failed to prepare its Crosby chemical plant adequately, emphasizing that the flooding during Harvey was "unprecedented."[271]

264. Or. Ctr. for Envtl. Health et al., Presentation to League of Oregon Cities: Sustainability Through Toxics Reduction in Local Government 12 (Sept. 29, 2007), https://perma.cc/92KU-VEUH.

265. OR. REV. STAT. §§ 465.003–.037 (2018).

266. *Id.* § 465.015.

267. MASS. GEN. LAWS ch. 132B, § 6C (2018).

268. *Toxics Action Center*, *supra* note 29, at 7.

269. *Id.* at 6.

270. *Toxic Impact*, *supra* note 60 (quoting Dennis Frost).

271. Ebbs, *supra* note 90.

While lawyers, politicians, scientists, economists, and public health officials can (and do) debate how much preparation is "too much" in light of increasing risks to coastal communities from climate change, coastal storms, sea-level rise, and storm surge, it is worth noting that architects and building engineers having been putting considerable effort into designing "storm-proof" homes and businesses that could greatly reduce toxic contamination from flooding. These efforts range from developing better building materials, such as bendable glass and ultra-high performance concrete,[272] to architectural designs intended to deflect wave and wind energy rather than merely withstand them.[273] Some of these are futuristic and rounded; others—like many of those designed for Brad Pitt's Make It Right Foundation to benefit victims of Hurricane Katrina—simply modify traditional building shapes and incorporate better materials.[274]

How exactly buildings are constructed is often dictated by building codes. Indeed, as one commentator noted, building codes have already been important in reducing hurricane destruction:

> Building codes are the baseline defense against hurricane damage. Improved building codes in Florida (the most stringent in the nation) after 1992's Hurricane Andrew required installing impact windows, using stronger ties between roofs and walls, and securing roof shingles with nails instead of staples, according to the *Wall Street Journal*. And indeed, newer buildings built to code fared better during Hurricane Irma.[275]

Coastal states and municipalities should thus consider these new hurricane-proof designs when updating coastal building codes.

V. CONCLUSION

Public health considerations are an important part of climate change adaptation strategies. As the U.S. Global Change Research Program recognized in 2014, "[p]ublic health actions, especially

272. Zach Mortice, *Hurricane-Proof Construction Methods Can Prevent the Destruction of Communities*, REDSHIFT (Nov. 9, 2017), https://perma.cc/ZM6N-U6X7.

273. *See* Amy Schellenbaum, *19 Examples of Stunning Hurricane-Resistant Architecture*, CURBED (Oct. 30, 2012, 1:15 PM), https://perma.cc/C33C-W42F.

274. *See id.*

275. Mortice, *supra* note 272.

preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As threats increase, our ability to adapt to future changes may be limited."[276]

Coastal adaptation is a complex subject, but discussions about retreat, armoring, and coastal water supplies often ignore or sideline the ever-present issue of coastal toxicity. Coastal storms like Hurricane Harvey, however, make this toxic potential obvious, underscoring its status as both a continuing present threat to public health and a future burden on changing coastlines, migrating coastal communities, and evolving coastal ecosystems. Therefore, a precautionary and health-based approach to coastal climate change adaptation—at all of the federal, state, and local levels—should explicitly and directly address the reduction of coastal toxicity, better employing environmental law, land use planning, toxicity prevention statutes and ordinances, and even building codes to achieve this goal.

276. USGCRP CLIMATE CHANGE REPORT, *supra* note 120, at 34.