CENAD-PD-P, Economics 19 November 2012

MEMORANDUM FOR RECORD

SUBJECT: Damages Prevented by Corps Projects, Hurricane Sandy

Tropical, Extratropical Storm ("Super Storm") Sandy struck the east coast of the United States at the end of October 2012, with impacts occurring within USACE North Atlantic Division (NAD) boundaries on October 29 and 30. All five NAD districts were impacted by the storm, and areas within New York District (NAN) were subjected to extensive damages. Super Storm Sandy has become the storm of record in many locations along the Atlantic coast of New York and New Jersey with respect to storm surge, wave height, and duration. Storm intensity was greatest along the shorelines of northern New Jersey and southern New York City. At the Battery, the southern tip of Manhattan, storm surges exceeded the historical record by three feet. Wave gauges in New York Harbor measured the largest wave ever recorded there (35 feet). The barometric pressure for Sandy was the lowest ever recorded in the region.

When a storm affects Corps civil works districts, district economists compile damages prevented by Corps projects by producing an estimate of what damages would have been if the Corps project had not been in place and subtracting from that the damages, if any, that occurred with the project in place. The damages prevented estimate for NAD projects from Super Storm Sandy is $1.9 billion, with the greatest proportion of these damages prevented attributable to projects in coastal New York and New Jersey, where the storm's impacts were the strongest. A district by district breakdown of estimated damages prevented is provided below.

District	Estimated Damages Prevented
New England	$ 31,252,000
New York	$ 1,363,731,000
Philadelphia	$ 259,110,000
Baltimore	$ 159,658,000
Norfolk	$ 90,779,000
SUM	$ 1,904,530,000

Estimating damages prevented is both art and science in that a damage prevented is one that has not happened so it cannot be directly observed. Furthermore, damages prevented are not the same thing as the National Economic Development (NED) benefits estimate on which the project is justified for authorization. The NED concept limits the benefit pools for coastal projects to depreciated values of real and personal property. While other damage categories, for example, delay costs or labor market losses are sometimes considered in Corps study efforts, the simplest way to justify a project is on the basis of depreciated replacement value of structures. With limited study resources, Corps planners usually focus on compiling gains in that category when seeking benefits data to be used for project justification. This occurs to the detriment of other real benefits that are less straightforward to measure, such as the protection of physical infrastructure like roads, water, and electric lines.

Determining Project Performance
Performance of the Corps' constructed coastal storm damage reduction projects depends on a number of factors: Storm intensity at the project location, project design, and its pre-storm condition. These considerations are taken, in turn, below.

Storm Intensity
While this was considered approximately a 25-year event in Baltimore, the intensity of the storm in northern New Jersey and New York City well exceeded that of a 100-year event and, in many areas, was closer to a 500-year event in terms of water surface elevation--one of the main determinants of damages in a coastal storm. Indeed, in New York District, the design level of all of the projects was met or exceeded. This explains some of the variation in the damages prevented estimates and damage assessments among the districts.

Project Design
Design of project is another factor that helps to determine the level of damages prevented. While a project may be "designed to an x-year level," the logical question to follow is "Level of what?" For example, there are several projects designed and constructed in the 1970s that do not include dune features because they were designed to protect against erosion, not against storm surge.

Condition of the Project Prior to the Storm
Many coastal projects require the repeated placement of sand (re-nourishment) to keep them at or near the design levels. Some projects were re-nourished to the design level at the time of the storm, while others were not. Furthermore, the design of beach nourishment features has evolved over time and projects that were designed before those designed with the benefit of experience may perform less efficiently under certain conditions.

The three factors described above help explain how damages prevented vary from district to district and from project to project within the districts--even for the same storm event. That said, the estimates themselves reinforce this explanation. The storm did not have the same intensity in all locations. The eye of the storm went over Atlantic City, in Philadelphia District, but the damages and damages prevented are concentrated in New York District – to the north and east of landfall (*i.e.*, the fourth quadrant), where storm intensity was the greatest. Beyond storm-specific factors, damages and damages avoided in New York District are far higher because those areas where the storm struck are very densely populated, comprised of several homes on small lots placed close together. Many also were used commercially, so more damage would be incurred than in a less crowded area.

Estimates of Damages Prevented
In all districts, the starting point for estimating damage prevented was the project authorizing report. In each district, engineering divisions made a preliminary estimate of the storm recurrence interval and indexed the damages associated with that level of storm to current values. This exercise does not take into account considerations that might change the damage pool. For instance, development is constant in many coastal areas and the without-project future condition of an authorizing report is a projection derived at one point in time made with specific assumptions that may or may not come to pass. The earlier the report was prepared, the more

likely it is that subsequent events have altered current conditions from those predicted when the report was written. In many cases, the authorizing reports underpredict damages that would have occurred if the project had not been in place. This possibility, compounded by the fact that Corps reports generally focus on a relatively narrow definition of damages avoided, makes it so that this prediction of damages avoided should be considered biased downward, if at all.

A Note on Areas that had Extensive Storm Damages

There is some difficulty in developing a credible estimate of damages prevented in areas where there were significant storm damages. This was particularly true for the estimates provided for New York District where the design level of all projects was met or exceeded. It must be remembered that the estimate of damages avoided does not preclude the fact that there may have been damages in an area where a project did exist, but that such an area would likely have fared much worse but for the project. For example, in areas of extensive overtopping, significant amounts of sand and water were transported landward and caused damage to many of the residential and commercial buildings behind the project. Although there was significant damage in these areas, the projects provided some benefit in the form of protection against wave attack as the sand absorbed the wave impacts, which limited to amount of pounding to which inland structures and infrastructure were subjected. In the absence of a project, in addition to inundation, there also would have been erosion of the immediate shorefront area and waves breaking immediately upon the shorefront infrastructure. In such cases, the sand absorbed the brunt of the storm, and protected the immediate infrastructure along the coast, leaving infrastructure to which to return.

Because determining what might have happened is particularly difficult in such areas, damages prevented estimates were based on the replacement value of infrastructure that remained protected that would not have, were it not for the project. This appeared to be the most credible way to count damages avoided, as the district had clear evidence that such infrastructure would have likely been destroyed in the absence of the project.. A breach was formed in Mantoloking, which abuts the Sandy Hook to Barnegat project area but does not have the benefit of a Corps project protecting it. The Mantoloking breach cut off the road and disrupted the infrastructure that the road protected. Damages avoided by the Sandy Hook to Barnegat project are the damages to the roadway and associated infrastructure that would likely have occurred were the project not in place. This approach was also taken for the Fire Island to Shores Westerly Project, and the East Rockaway to Rockaway 934 project.

Telling the Story of Damages Prevented – Coney Island and Sea Gate

The Coney Island Coastal Storm Damage Reduction Project performed well during the storm. As a result of the surge height and wave effects, sand was transported up and over the boardwalk; however, the impacts behind the constructed project were minimal. The project was designed to protect against storm surge and erosion, and has a top elevation of +13 ft NGVD. The project was at its design level prior to the storm. The Seagate area, immediately adjacent to Coney Island, was not included in the project, and suffered extreme damages.