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Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System

Final Report of the Interagency Performance Evaluation Task Force

Volume IX – General Appendices

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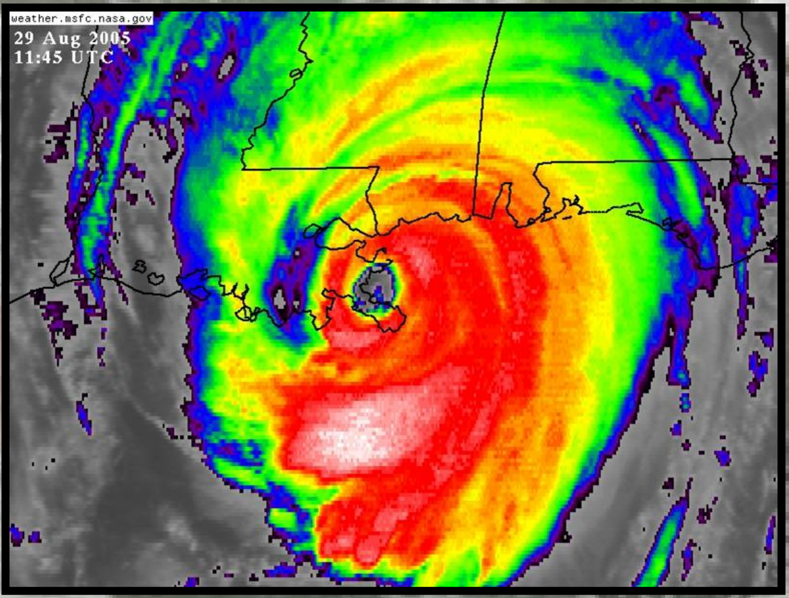
FINAL



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Volume IX
General Appendices

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Appendix A
Data Repository – Organization and Content

The IPET Data Repository is a data management system for storing, delivering, and maintaining the authoritative datasets associated with this study. The Data Repository contains a comprehensive set of data and information about the conditions before and after Hurricane Katrina, a complete history of the hurricane protection projects' construction and maintenance, as well as the information and analytic results of this performance evaluation. The architecture of the Data Repository, described in the Data Collection and Management section of IPET Report 1, is comprised of three main components: an unstructured data component, a GIS data component, and a large datasets component. An overall data manager integrates the data stored in the three components such that users may access all datasets from one central application without having to know which data is stored in which component. Following is a description of each component of the Repository:

Unstructured Data Component

Unstructured data, such as .pdf files, .doc files, .jpg files, .txt files, .ppt files, etc., as well as engineering design files (.dgn) are stored in a Microsoft SQLServer database managed by Bentley ProjectWise Software. Documents are stored with spatial extents corresponding to the geographic area to which they relate. This allows users to search for documents/data by location. Metadata describing each document is stored in the database to facilitate searches by name, type, date, etc. Currently, the following data are stored in this component:

- IPET News Releases
- IPET Presentations
- IPET Reports
- IPET Soil borings and cone penetrometer test data
- IPET Pump Station preliminary performance data for St. Bernard Parish
- USACE Operations Center briefing slides
- Post-Katrina reports
- Photographs of various New Orleans and Southeast La. Sites post-Katrina
- Project Information Reports for the rehabilitation efforts currently underway in New Orleans

- Post-Katrina surveys of the levees and floodwalls
- Aerial videos of the New Orleans and Southeast La. Area
- Annual inspection reports for the maintenance of completed flood control works in the New Orleans District
- NEXRAD hourly gridded multisensor precipitation data for 28,29,30 August 2005
- Pre-Katrina geodetic, geotechnical, hurricane, and miscellaneous reports
- Design Memoranda for the Hurricane Protection Projects within the IPET study area
- Periodic Inspection Reports for the Hurricane Protection Projects within the IPET study area
- Miscellaneous reports related to the Hurricane Protection Projects within the IPET study area
- Plans and Specifications for the some of the Hurricane Protection Projects within the IPET study area
- Contract documents for some of the Hurricane Protection Projects within the IPET study area
- Microstation design files (.dgn) of the Hurricane Protection Projects within the Lake Pontchartrain LA and Vicinity area.

GIS Data Component

GIS is a computer technology that uses a geographic information system as an analytic framework for managing and integrating data, solving a problem, or understanding a past, present, or future situation. GIS provides an automated capability to link information to location data, such as people to addresses or buildings to parcels. The information can be graphically layered to provide a better understanding of how it all works together. A GIS is based on a structured database that describes features (buildings, streets, streams, monitoring wells, etc.) in geographic terms. The visualization component of GIS allows the geographic feature information to be displayed in a map view and supports queries, analysis, and editing of the data. The geoprocessing capabilities of GIS allow users to combine existing datasets, apply analytic rules, and create new derived datasets to support decision making. GIS is generally used as a decision support tool to map the location and description of features, to determine patterns of certain features, to determine what is near a specified feature, to map change in an area, or to perform ‘what-if’ analyses.

USACE enterprise standards have been defined to ensure that GIS is implemented and managed in a manner that facilitates data sharing and interoperability. An important feature of the enterprise GIS architecture is its scalability and repeatability across corporate, regional, district, and field office levels. Scalable refers to its ability to accommodate a range in volumes of data and users, while repeatable means that this configuration can be replicated at corporate, regional, district, and field levels.

GIS is a fundamental component of this performance evaluation. GIS is being used to perform structural, hydrologic, economic, and risk analyses and visualizations. The Hurricane Protection System (levees, pumping stations, floodwalls), breach locations, roads, water bodies, parish boundaries, levee districts, digital elevations, and high water marks are just a few of the real-world objects represented as GIS features (Figure A-1).

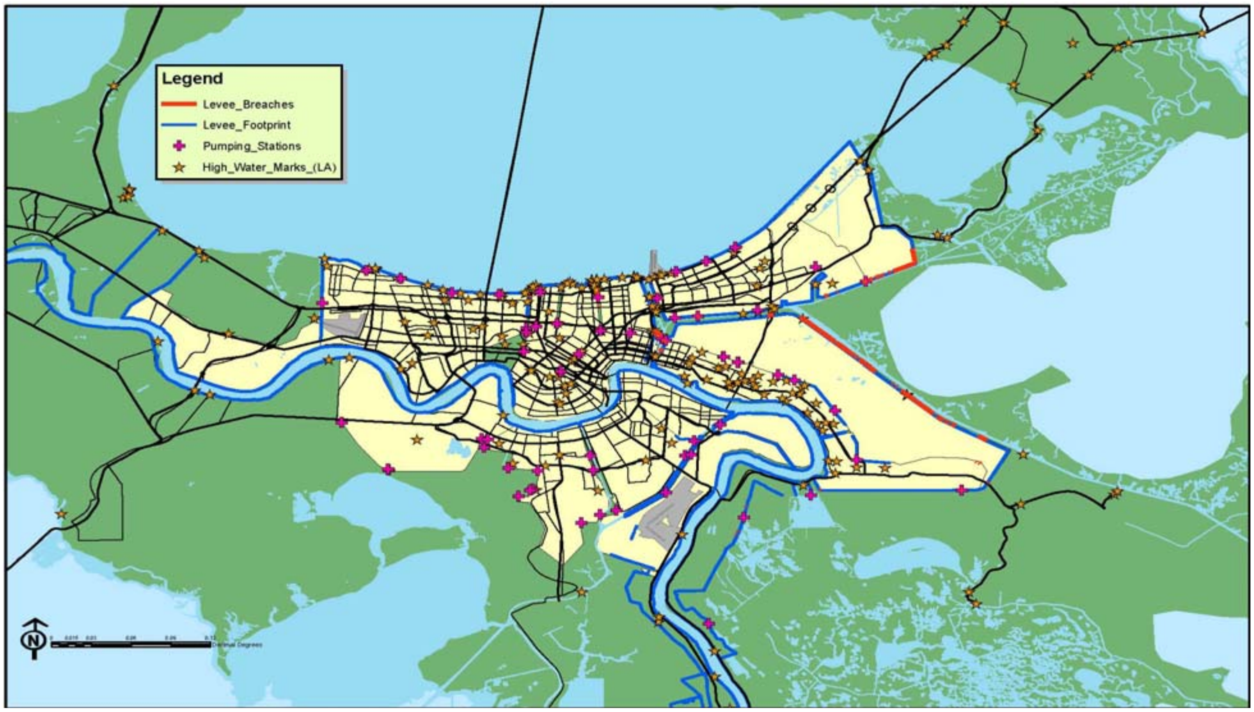


Figure A-1. Example of GIS Features Displayed in ArcGIS

To assure that we are maximizing the effectiveness and efficiency of our geospatial resources within IPET, TFG, TFH, TFX, MVD Forward and MVN, a Geographic Information System (GIS) working group was established. The working group consists of representatives from TFG, TFH, MVD Forward, MVN, and each IPET Task. This group conducted weekly conference calls to coordinate GIS efforts and to facilitate a smooth transition of IPET GIS data to MVN at the conclusion of the performance evaluation. The IPET GIS component was designed and implemented according to the Corps GIS Enterprise Architecture. Data are stored in an Oracle database on a USACE Central Processing Center server. Metadata is being collected and stored according to the FGDC metadata standard. Web Mapping Services are being developed to deliver some of the data layers and documents produced by the IPET. All USACE GIS users can request and receive access information to connect to this data. GIS data that is being developed by MVN, MVD Forward, TFG, and TFH will be sent to the IPET Data Manager for inclusion in this enterprise GIS database.

All IPET-generated raster products, vector data products and data sets will be replicated on MVN servers in Oracle databases. This will allow quick retrieval of large raster and vector products at MVN and provide a mirrored back up system at MVD to protect against data loss from catastrophic events.

A list of IPET GIS data layers is provided below.

Layer Name	Layer Description	Data Source
CENSUS_C2K_BLKGRP_X	Blockgroup point data for total population and housing	Census Bureau
ESRI_ADI	ESRI U.S. Areas of Dominant Influence (ADIs)	ESRI
ESRI_AIRPORTS	ESRI U.S. GDT Airports	ESRI
ESRI_AREACODE	ESRI U.S. Telephone Area Code Boundaries	ESRI
ESRI_CITIES	ESRI U.S. Cities	ESRI
ESRI_DTL_CNTY	ESRI U.S. Counties	ESRI
ESRI_DTL_ST	ESRI U.S. States	ESRI
ESRI_GBLDINGS	ESRI U.S. Geographic Names Information System Building	ESRI
ESRI_GCEMETRY	ESRI U.S. Geographic Names Information System Cemetery	ESRI
ESRI_GCHURCH	ESRI U.S. Geographic Names Information System Church	ESRI
ESRI_GGOLF	ESRI U.S. Geographic Names Information System Golf Locale	ESRI
ESRI_GHOSPITL	ESRI U.S. Geographic Names Information System Hospital Locale	ESRI
ESRI_GLOCALE	ESRI U.S. Geographic Names Information System Proper Names	ESRI
ESRI_GPPL	ESRI U.S. Geographic Names Information System Populated Place	ESRI
ESRI_GSCGOOLS	ESRI U.S. Geographic Names Information System Schools	ESRI
ESRI_GSUMMIT	ESRI U.S. Geographic Names Information System Mt Summits	ESRI
ESRI_HIGHWAYS	ESRI U.S. Geographic Names Information System Highways	ESRI
ESRI_INSTITUT	ESRI U.S. Geographic Names Information System U.S. GDT	ESRI
ESRI_INTERSTAT_SHIELD	Interstate shields	ESRI
ESRI_INTRSTAT	ESRI U.S. Geographic Names Information System Interstate Highways	ESRI
ESRI_LALNDMRK	ESRI U.S. Geographic Names Information System Landmarks	ESRI
ESRI_MAJRDNET	ESRI U.S. Geographic Names Information System Major roads network	ESRI
ESRI_MJRRDS	ESRI U.S. Geographic Names Information System major roads	ESRI
ESRI_MJWATER	ESRI U.S. Geographic Names Information System Major water bodies	ESRI
ESRI_MSA	ESRI U.S. Metropolitan Statistical Areas	ESRI
ESRI_PARKS	ESRI U.S. Geographic Names Information System Parks	ESRI
ESRI_PLACES	ESRI U.S. Geographic Names Information System Places	ESRI
ESRI_RAIL100K	ESRI U.S. Geographic Names Information System Railroad	ESRI
ESRI_RECAREAS	ESRI U.S. Geographic Names Information System Recreation Areas	ESRI
ESRI_RETLCNTR	ESRI U.S. Geographic Names Information System Retail Centers	ESRI
ESRI_RIVERS	ESRI U.S. Geographic Names Information System Rivers	ESRI
ESRI_ROADS	ESRI U.S. Geographic Names Information System Roads	ESRI
ESRI_ROADS_RT	ESRI U.S. Geographic Names Information System U.S. Road Routes	ESRI
ESRI_STATES	ESRI U.S. Geographic Names Information System States	ESRI
ESRI_TRACTS	ESRI U.S. Geographic Names Information System Census Tracts	ESRI
ESRI_TRANTERM	ESRI U.S. GDT Transportation Terminals	ESRI
ESRI_URBAN	ESRI U.S. Urbanized Areas	ESRI
ESRI_URBAN_DTL	ESRI U.S. National Atlas Urbanized Areas	ESRI
ESRI_USROUTE	ESRI U.S. National Transportation Atlas U.S. Highway Routes	ESRI
ESRI_ZIP3	ESRI U.S. Three-Digit ZIP Code Areas	ESRI
ESRI_ZIP_POLY	ESRI U.S. ZIP Code Areas represents five-digit ZIP Code areas	ESRI
ESRI_ZIP_USA	ESRI U.S. ZIP Code Points represents five-digit ZIP Code areas	ESRI
G2908901NE	5 Meter DEM from Lidar LSU Atlas	LSU
HIGHWATERMARKS_USGS_FEMA_LA	High water marks collected by USGS and FEMA for LA	USGS/FEMA
HIGHWATERMARKS_USACE_LA	High water marks collected by USACE LA	CHL
HIGHWATERMARKS_MS	High water marks collected by CHL for MS	CHL
Levees_and_Floodwalls	Levee centerlines in the CEMVN digitized from the best available	MVN

Layer Name	Layer Description	Data Source
	imagery	
K_28089_H2_04	3001 Inc. 1ft true color imagery - post-Katrina (42 files)	3001 inc.
LANDUSE_MRLC	Multi Resolution Land Cover	USGS
LEVEES	MVN levee layer with section names	MVN
LEVEE_CENTERLINE	Center of levees	MVN
LEVEE_DISTRICTS	Levee District boundaries	MVD
MVK_LEVEE_FOOTPRINT	footprints of the Ms. River levees within MVN	MVK
MVN_LANDSAT	LANDSAT of the IPET study area	TEC
NEWEST_LIDAR_MOSAIC_15_SEPT	LIDAR_MOSAIC_15_SEPT_New Orleans area	TEC
NEW_ORLEANS_001_001_RGB	True color 1-meter air photos	Jeff Lillycrop
NEW_ORLEANS_001_001_CIR	Color IR 1-meter air photos	Jeff Lillycrop
NORTH_MS_RIVER_001_011_RGB	True color 1-meter air photos	Jeff Lillycrop
NORTH_MS_RIVER_001~011_CIR	Color IR 1-meter air photos	Jeff Lillycrop
PEARLINGTON_009_001_RGB	True color 1-meter air photos	Jeff Lillycrop
PEARLINGTON_009~001_CIR	Color IR 1-meter air photos	Jeff Lillycrop
SE_NEW_ORLEANS_001~001_CIR	Color IR 1-meter air photos	Jeff Lillycrop
SE_NEW_ORLEANS_001~001_RGB	True color 1-meter air photos	Jeff Lillycrop
SOUTH_MS_RIVER_001~001_CIR	Color IR 1-meter air photos	Jeff Lillycrop
SOUTH_MS_RIVER_001~001_RGB	True color 1-meter air photos	Jeff Lillycrop
SW_NEW_ORLEANS_001~029_CIR	Color IR 1-meter air photos	Jeff Lillycrop
SW_NEW_ORLEANS_001~029_RGB	True color 1-meter air photos	Jeff Lillycrop
NHD_STREAMS	National Hydrologic Dataset Streams USGS	USGS
NOE_PEAK	Estimated peak water depth for New Orleans East	MVK
NOE_DEM	Digital Elevation Model for the New Orleans East Levee District, derived from 1999 LIDAR measurements, 5-m resolution	MVK
NOE_SEP12…NOE_SEP28	Estimated water depth for the specified day's inundation for New Orleans East	MVK
NO_LEVEE_BREACHES	New Orleans Levee Breaches not attributed	TFG
NO_LEVEE_FOOTPRINT	Footprints of all levees within the IPET study area	MVN
NO_DEM	Digital Elevation Model for the New Orleans Metro area, derived from 1999 LIDAR measurements, 5-m resolution	MVK
NO_PEAK	Estimated peak water depth for New Orleans	MVK
NO_SEP12…SEP27	Estimated water depth for the specified day's inundation for New Orleans	MVK
PLAQUEMINESLODTM	PLAQUEMINES lower parish Digital Terrain Model	MVN
PLAQUEMINESUPDTM	PLAQUEMINES upper parish Digital Terrain Model	MVN
PUMPING_STATIONS	Pumping station locations within the IPET study area	CHL
SSURGO_JEFFERSON	SSURGO Soils for the stated Parish	USDA - NRCS
SSURGO_ORLEANS	SSURGO Soils for the stated Parish	USDA – NRCS
SSURGO_PLAQUEMINES	SSURGO Soils for the stated Parish	USDA - NRCS
SSURGO_ST_BERNARD	SSURGO Soils for the stated Parish	USDA - NRCS
SSURGO_ST_CHARLES	SSURGO Soils for the stated Parish	USDA - NRCS
SSURGO_ST_JOHN_THE_BAPTIST	SSURGO Soils for the stated Parish	USDA - NRCS
STATSGO	STATSGO Soils for the IPET study area	USDA - NRCS

Layer Name	**Layer Description**	**Data Source**
STBERN_PEAK	Estimated peak water depth for St. Bernard	MVK
STB_A_DEM	Digital Elevation Model for the St. Bernard Levee District, part 1	MVK
STB_B_DEM	Digital Elevation Model for the St. Bernard Levee District, part 2	MVK
STB_SEPT16…Sept28	Estimated water depth for the specified day's inundation for St. Bernard	MVK
STUDYAREAPARISHES	Parish boundaries in the IPET study area	USGS
USGS_GNIS03	USGS Geographic Names Information System 03	USGS
USGS_HUCS8DIGIT	USGS 8 digit hydrologic units	USGS
USGS_QUADS24K	USGS 24K quads	USGS
preKatrinaleveefloodwalmaxel	maximum levee/ floodwall elevations extracted from the adjusted pre-Katrina DEMs	IPET
Stcharles_storageareas	Basin delineation of St. Charles Parish used in the Risk and Losses analyses	IPET/HEC
Stbernard_storageareas	Basin delineation of St. Bernard Parish used in the Risk and Losses analyses	IPET/HEC
Plac_storageareas	Basin delineation of Plaquemines Parish used in the Risk and Losses analyses	IPET/HEC
Orleanswest_storageareas	Basin delineation of Orleans Parish West Bank used in the Risk and Losses analyses	IPET/HEC
Orleans_storageareas	Basin delineation of Orleans Parish East Bank used in the Risk and Losses analyses	IPET/HEC
Noe_storageareas	Basin delineation of New Orleans East basin used in the Risk and Losses analyses	IPET/HEC
Jeffwest_storageareas	Basin delineation of Jefferson Parish West Bank used in the Risk and Losses analyses	IPET/HEC
Jeffeast_storageareas	Basin delineation of Jefferson Parish East Bank used in the Risk and Losses analyses	IPET/HEC
Reach_line	endpoints of a levee reach	MVN
Reach_text	labels for levee reaches	MVN
Organizational_control_levees	defines which organization is in control of which levee, i.e., Local, Federal, etc.	MVN
Existing_Elevation	labels for levee reach elevations; should be used for labeling the Levees_and_Floodwalls layer with existing elevations	MVN
non_existing_reach	label markers for planned levee reaches	MVN
Proposed_Design_Elevation	labels for levee reach proposed elevations; should be used for labeling the Levees_and_Floodwalls layer with proposed elevations	MVN
Other_structures	Point features, such as pumps, locks, floodgates, diversion structures, and other relevant structures	MVN
Levee_Damage_reports	levee damage points	TFG

Large Datasets Component

Large Datasets, such as LIDAR, imagery, and Digital Elevation Model (DEM) data, are stored on a terabyte server, with metadata and geospatial extents of each dataset stored in an Oracle SDO database. Currently, the following datasets are available:

- LIDAR data for both pre-Katrina and post-Katrina timeframes at varying resolutions and spatial extents
- DEM datasets derived from LIDAR data
- Existing pre-Katrina DEM datasets provided by other organizations
- Post-Katrina 1-ft. Imagery collected by 3001, Inc. and GE-Hardin
- Bathymetric survey data for the lower Mississippi River, 17th Street Outfall Canal, London Avenue Outfall Canal, and the Inner Harbor Navigation Canal (IHNC).

Digital Bathymetric Survey Data

High resolution bathymetric surveys collected following the storm by various agencies for selected areas are stored in the large datasets component of the Repository. The spatial extents of these datasets are shown in Figure A-2. The bathymetry data for the IHNC and the lower Mississippi River were originally converted to raster format using MicroStation Inroads. The processing steps for making the data available for IPET involved converting from rotated raster data sets to ERDAS Imagine Elevation files. All elevations are relative to the NAVD88 (2004.65) vertical datum. No vertical datum adjustments were made to the original bathymetric data. The Post-Katrina outfall canal bathymetric data were delivered as XYZ point data. The points followed a dual-beam sonar track and represented a sparse data set, as show in Figure A-3. The data were converted into a raster DTM surface using the QT modeler software. QT modeler uses a modified TIN to Raster technique with smoothing options. The data were converted to DTM with 1 ft. vertical resolution.

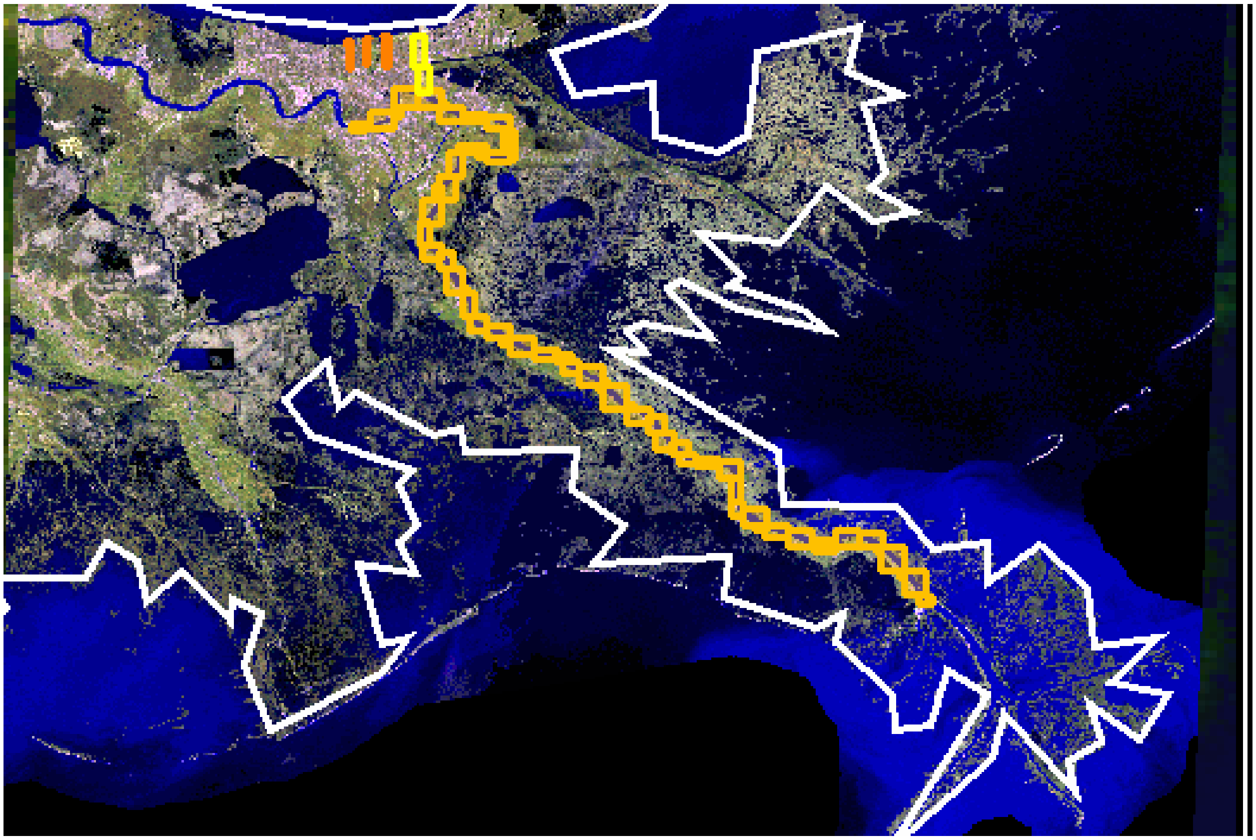


Figure A-2. Spatial Extent of the Bathymetric Survey Data for the Lower Mississippi River, IHNC, and Outfall Canals

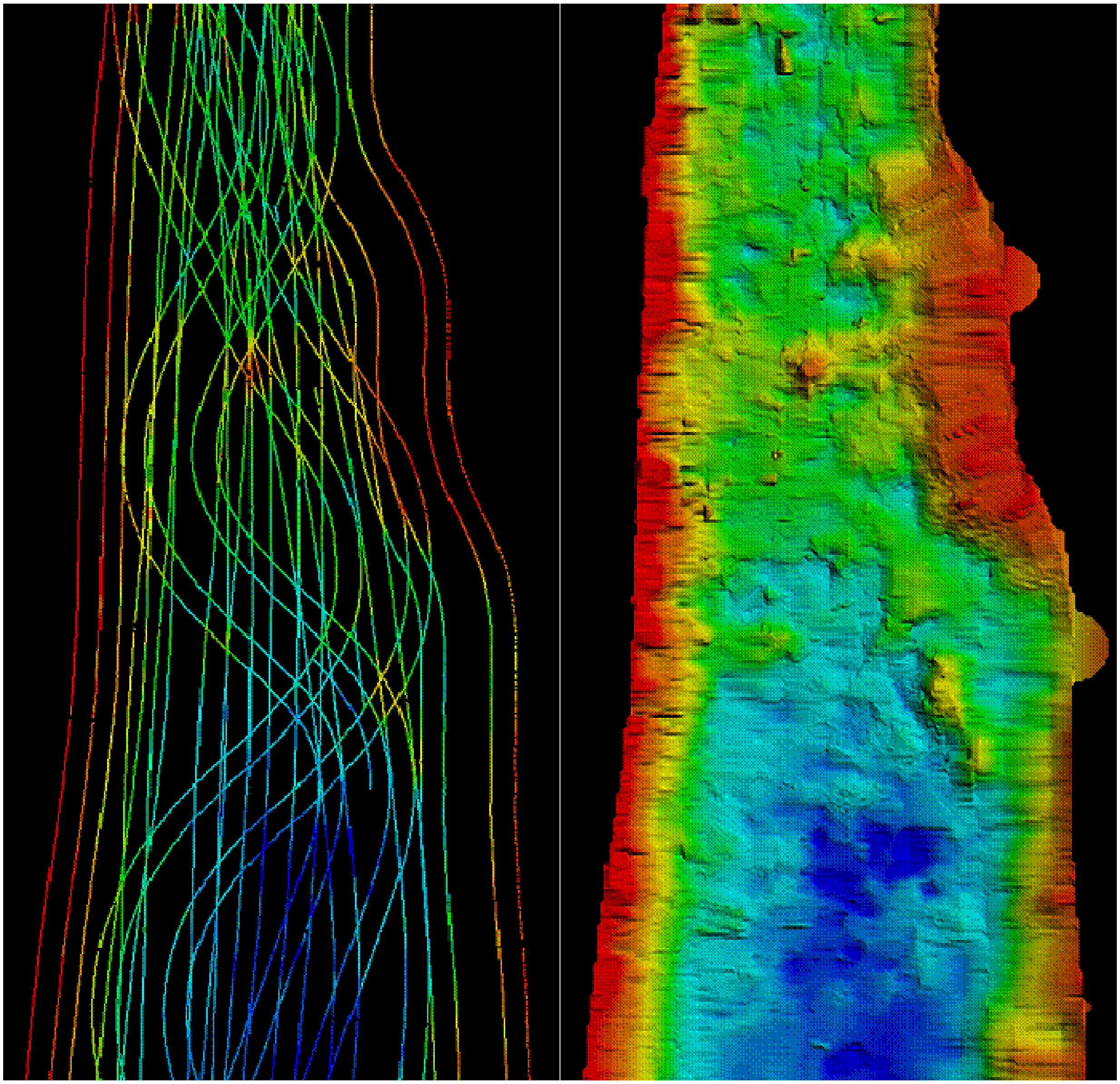


Figure A-3. Images of the XYZ bathymetric data (on left) and the converted raster DTM surface. (on right)

Digital Elevation Models (DEMs)

The development of accurate terrain surfaces was a critical element of this component. Numerous LiDAR surveys were conducted within the affected areas both prior to and after the storm. However, most of the computational modeling required that LiDAR point cloud data be converted into surface representations. Furthermore, the vertical accuracy of the NGS control network used by these LiDAR surveys was compromised due to continued soil consolidation and the resultant settling within the affected areas. A new vertical datum epoch was established and all LiDAR and resultant surface representations were required to be adjusted to conform to this new elevation standard. This section will document the processing procedure for the various LiDAR and elevation data sets that have been developed for the IPET study. In addition to the LiDAR surveys, ground surveys conducted over a significant number of years were also available for use by the modeling teams. These surveys, while not having the spatial completeness of the LiDAR data sets, provide a more accurate representation of the levee elevations. However, because of the vertical datum issues in the study area, many of these surveys required adjustments to the NAVD88 (2004.65) elevation datum.

LiDAR Surveys

Several LiDAR surveys were identified that covered portions of the IPET study area, as listed in Table A-1. The spatial extents and horizontal resolution of each data set is unique depending on the purposes for which the survey was originally conducted. Some data sets were developed into surfaces before they were obtained by IPET while other data sets required the development of a non-discrete elevation surface.

Table A-1
Digital Elevation Models and Associated Sources Used for the IPET Study

DEM	Source	Collected by	Year Collected	Postings	Coverage
Pre-Katrina 1ft. Levee	LIDAR	John E. Chance Inc.	2000	Horizontal ~1ft.	Levees alignments surrounding East Orleans, Pontchartrain South Shore, St. Bernard Parish (MRGO, ICWW)
Post-Katrina 2ft. Levee	LIDAR	John E. Chance Inc.	2005	Horizontal ~2ft.	Levee alignments surrounding East Orleans, St. Bernard and Plaquemines
Post-Katrina 3ft. Levee	LIDAR	Joint Airborne Lidar Bathymetry Technical Center of Expertise	Jan-06	Horizontal ~3ft.	Levee alignment and back of levees for Pontchartrain South Shore, London Ave. Canal, 17th St. Canal, IHNC
Pre-Katrina 15ft. Interior	LIDAR (existing DEM from http://atlas.lsu.edu)	3001, Inc.	2003	Horizontal ~15ft.	All surface areas in Southern Louisiana
Pre-Katrina 3ft Interior	Rapid Terrain Visualization (RTV)	Topographic Engineering Center	2005	Horizontal ~3ft	Surface areas within Central Orleans Parish

The IPET modeling teams required the data to be in a surface format so that cross sections and profile information could be generated. Furthermore, the teams also requested the surface model to be as detailed as possible. Previous to IPET, DEM surfaces had already been generated for two of the LiDAR surveys. This work did not replicate these previous efforts but simply utilized the existing DEM's generated from the LiDAR data. The other three surveys required additional processing to create surface models. The following paragraphs describe the data and processing steps that were accomplished for each data set.

Pre-Levee-1ft. The John E. Chance survey was conducted using the Fli-Map, helicopter based LiDAR system. The point cloud data was collected at extremely high spatial resolution with significant overlap between survey paths. This produced a point cloud data set of several hundred million points, located only along the major levee corridors. The original horizontal datum for this data set was State Plane – Zone 1702 (Louisiana South) – US Survey Feet. Figure A-4 shows the spatial extents of this data set. Because of the extreme density of data and the need for very high spatial resolution data sets, it was determined that a 1ft horizontal DEM elevation surface could be created for the areas covered by this survey. To do this, the following processing steps were conducted:

1. The LiDAR data points from each survey line were separated into 1.875 arc minute tiles according to the tiling system described previously in this document. This tile interval was chosen in response to the need for 1ft spatial resolution in the final surface DEM's. Because of this resolution requirement, standard quadrangle (7.5 arc minute) or quarter quadrangle (3.25 arc minute) tiles created resulting raster files with greater than 20,000 x 20,000 grid cells.

2. The XYZ points contained in each file were processed by the ESRI ArcInfo software using an Inverse Distance Weighted (IDW) algorithm. The following ArcInfo command was used to develop these DEM surfaces.

```
gridData = idw( pointData.gen, #, #, 2, SAMPLE, 5, 03, 01)
```

This command generates a raster surface with 1 ft horizontal resolution by searching the five closest LiDAR points within a 3 ft radius of the cell center.

Three primary, yet competing, factors influenced the selection of the processing algorithm used to convert the LiDAR XYZ points into a continuous surface representation:

1. Small errors in the vertical resolution of LiDAR XYZ points from subsequent passes over the same geospatial area. This can cause a developed surface to exhibit hedgerows that are problematic for hydrologic modeling software.
2. Sharp elevation changes over a short distance. Such situations occur at the edges of buildings or along the top of levee walls.
3. Small errors in the horizontal resolution of the LiDAR XYZ points that produce near but not exact representations of a vertical surface.

In order to eliminate the effects of the first error, an algorithm that smooths these irregularities is preferred. The Inverse Distance Weighted (IDW) algorithm is one example. IDW samples a number of points from the area surrounding the raster cell being interpolated to compute the elevation at that cell. This reduces the impact of small vertical errors and eliminates the "hedgerow" effect caused by such errors. However, because IDW utilizes surrounding points, it cannot identify areas where sharp elevation changes occur and is not well suited to solve the problems exhibited by the second problem.

One algorithm that can incorporate these sharp changes is a Triangulated Irregular Network (TIN). TIN's can represent sharp changes in elevation over a short distance. However, they do not resolve the hedgerow effect directly. Furthermore, because of factor three above, the points representing the vertical feature may produce spikes in the resulting TIN or DTM surface. Therefore, a TIN representation may not be able to resolve any of the three factors described above.

Based on these factors, it was determined that the IDW interpolation methodology produced the best surface for a majority of areas. However, due to the problems described previously, caution is advised when using the elevations from derived surfaces in areas where levee flood walls are present.

3. The deviation surface discussed previously was then used to adjust the elevations of the IDW derived surfaces so they would conform to the NAVD88 (2004.65) elevation datum. This was done by first splitting the deviation surface into the same 1.875 arc minute tiles as the LiDAR data; then using the ArcInfo GRID algebraic command set, the deviations were subtracted from the elevation surface.

Figure A-4. Spatial Extent of the Pre-Levee 1ft DEM

Pre-Interior-15ft. This data set was derived from the 5 meter elevation data developed by 3001, inc. for FEMA and distributed by Louisiana State University on the atlas.lsu.edu website. Figure A-5 shows the spatial extents of this data. The elevation data was tied to the older NAVD88 control elevations. Elevation surfaces were previously created and so no further processing of the LiDAR data points was required. The processing steps for this data set include the following:

1. The data set was re-projected from UTM Zone 15N to State Plane Louisiana South and re-sampled to a horizontal resolution of 15.0 ft using bi-linear interpolation.
2. The deviation surface discussed previously was then used to adjust the elevations of the elevation surfaces so they would conform to the NAVD88 (2004.65) elevation datum. This was done by first splitting the deviation surface into the 3.75 arc minute USGS quarter quad tiles; then using the ArcInfo GRID algebraic command set, the deviations were subtracted from the elevation surfaces.

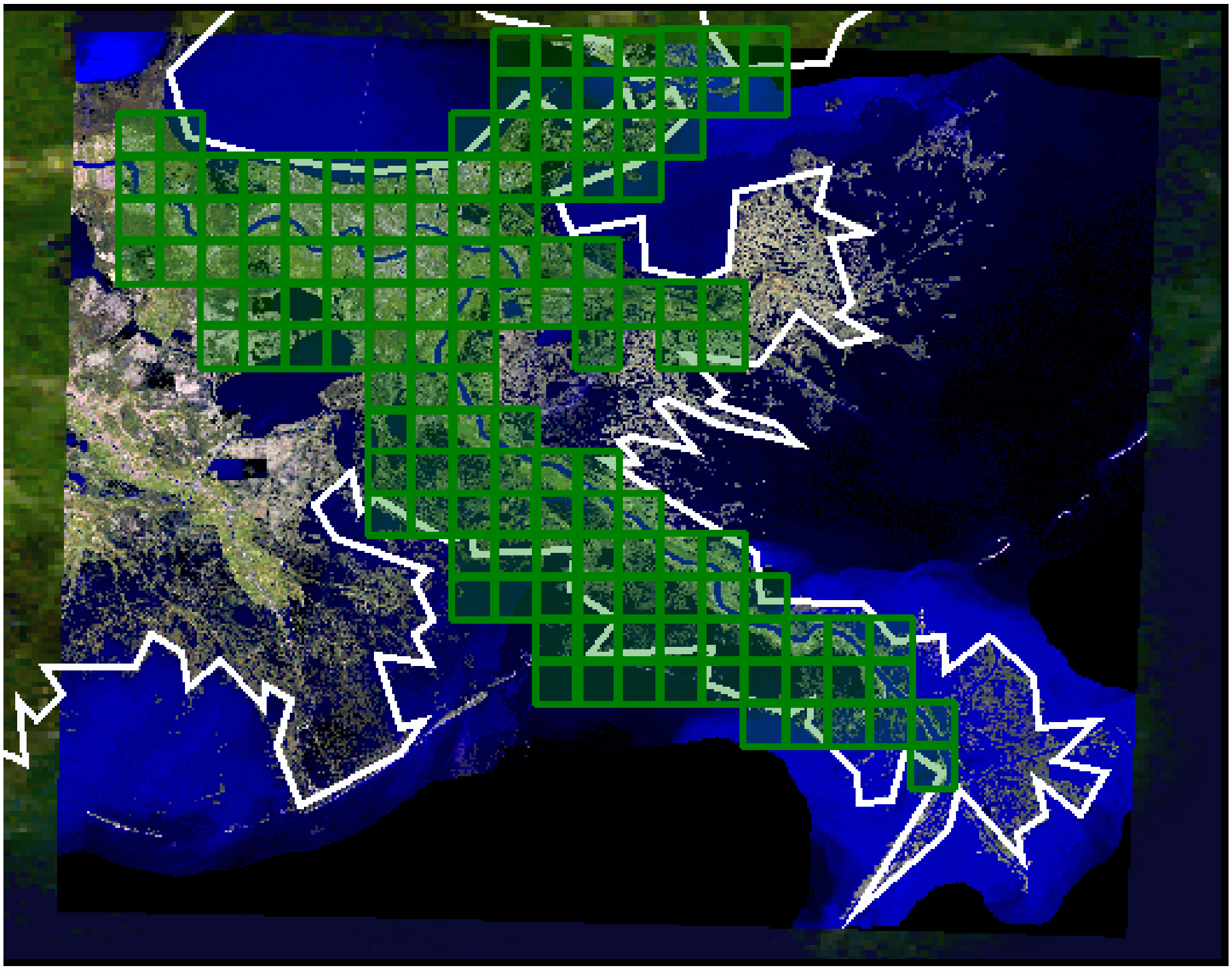


Figure A-5. Spatial Extent of the Pre-Interior 15ft DEM

Pre-Interior-3ft. This data set was derived from the LiDAR collected by the Rapid Terrain Visualization group at USACE-ERDC-TEC. Figure A-6 shows the spatial extents of this data. Elevation surfaces were created prior to delivery of this data to IPET. First return and last return LiDAR surfaces were delivered in this data set. Only the last return data was utilized. Processing steps for this data set include the following:

1. Raster cells were converted to point data representing the center of the raster cell.
2. Elevation values were converted from spherical coordinates based on the WGS84 datum to NAVD88 (2004.65) using the GEOID03 methodology.
3. The data set was re-projected from UTM Zone 15N to State Plane Louisiana South and re-sampled to a horizontal resolution of 3.0 ft using bi-linear interpolation.
4. The cell center points were then split into 1.875 arc minute tiles
5. Raster surfaces were then re-created by first creating a TIN from the data points and then sampling a new raster surface from the TIN.

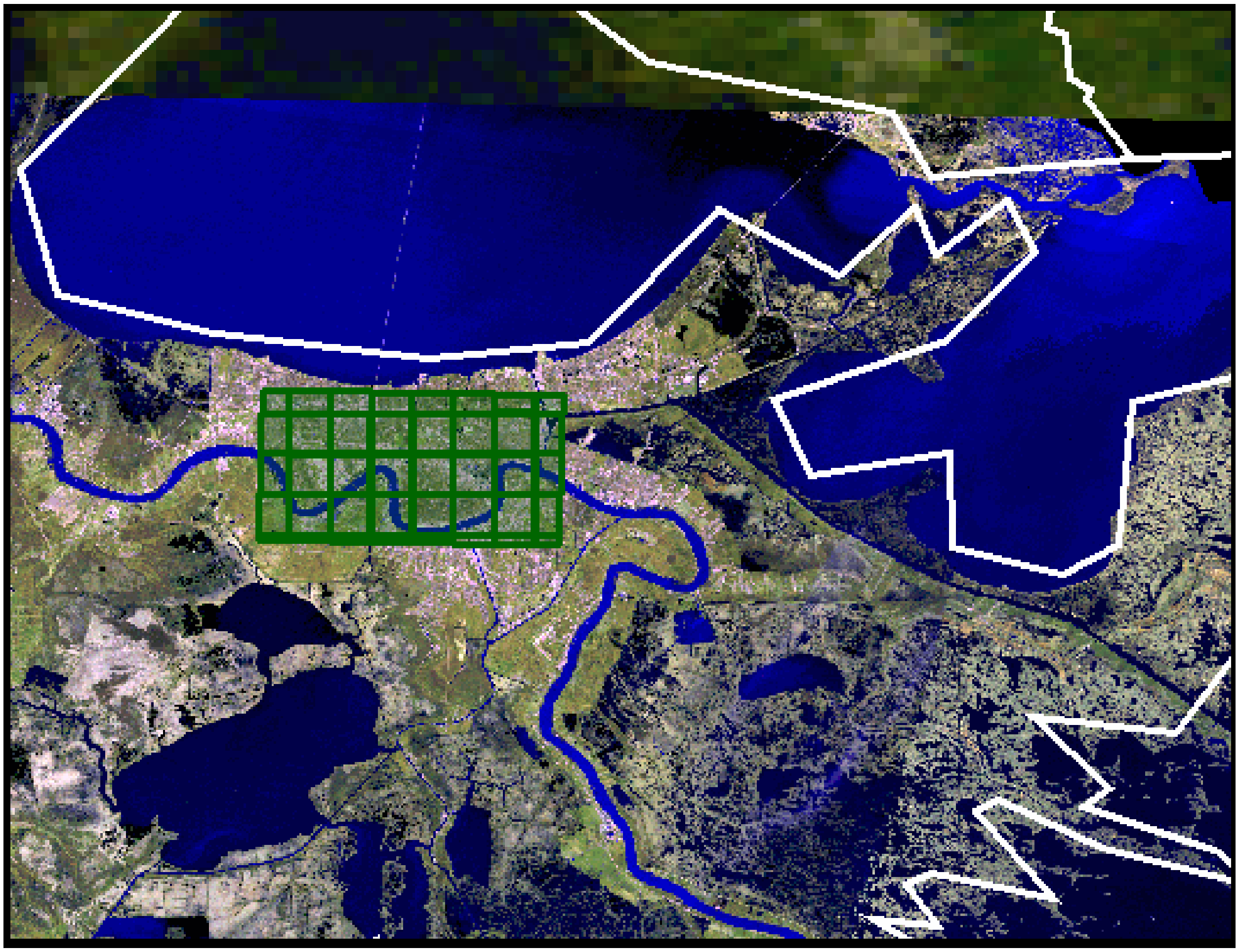


Figure A-6. Spatial Extent of the Pre-Interior 3ft DEM

Post-Levee-2ft. This data set was derived from a LiDAR survey conducted by John E. Chance using the Fli-Map system shortly after Hurricane Katrina. The survey was confined to areas very near the major levee systems in East Orleans Parish, Chalmette Parish and Plaquemines Parish. The elevation values for this survey were delivered with reference to the NAVD88 (2004.65) vertical datum. Figure A-7 shows the spatial extents of this data. The survey processing steps for this data set include the following:

1. The LiDAR data points from each survey line were separated into 1.875 arc minute tiles according to the tiling system described previously in this document.
2. The XYZ points contained in each file were processed within the ESRI ArcInfo GIS program using an Inverse Distance Weighted (IDW) algorithm. The following ArcInfo command was used to develop these DEM surfaces.

```
gridData = idw( pointData.gen, #, #, 2, SAMPLE, 5, 06, 02)
```

3. This command generates a raster surface with 2 ft horizontal resolution by searching the five closest LiDAR points within a 6 ft radius of the cell center. The decision to use this approach was explained previously.

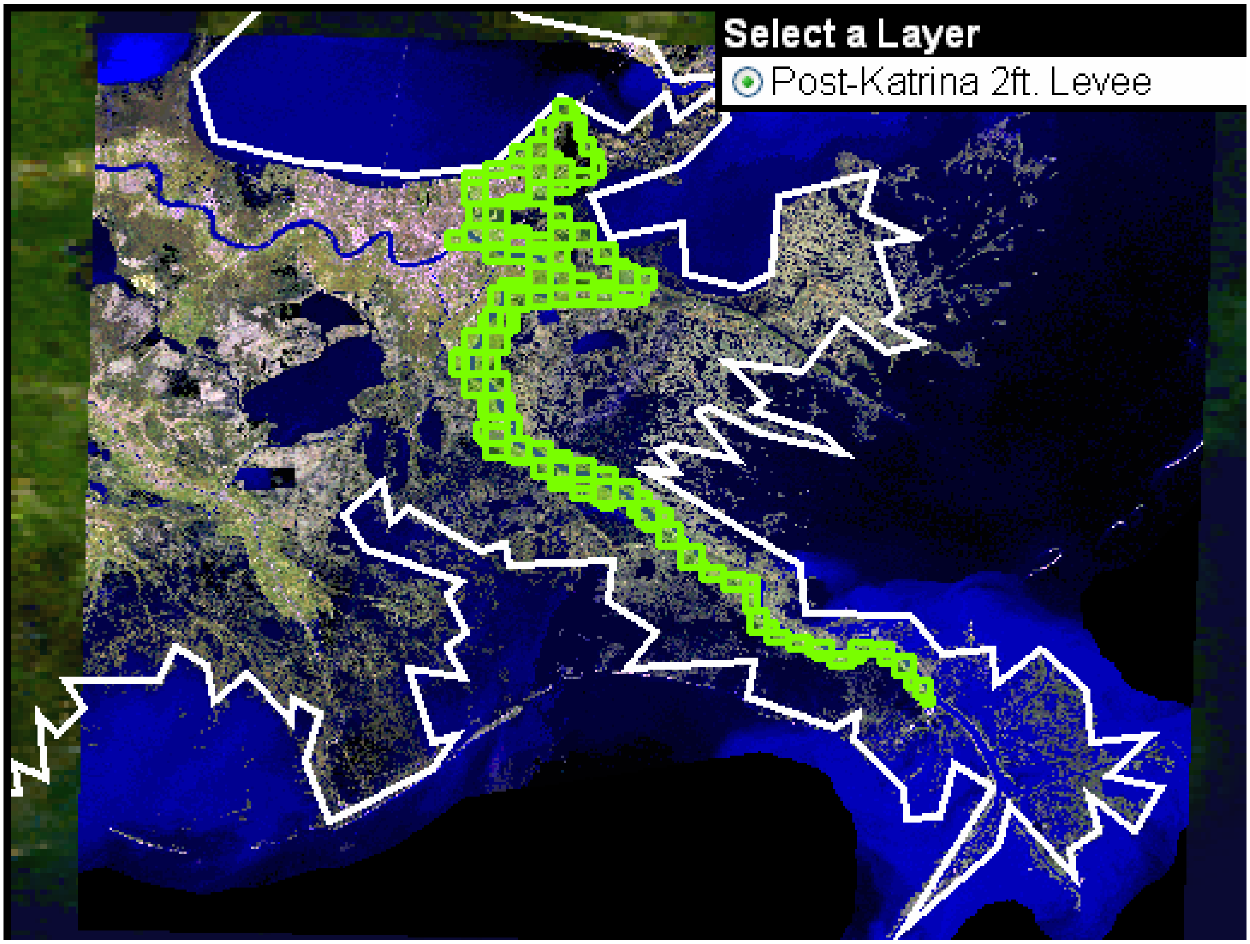


Figure A-7. Spatial Extent of the Post-Levee 2ft DEM

Post-Levee-3ft. This data set was derived from a LiDAR survey conducted by the Joint Airborne Lidar Bathymetry Technical Center of Expertise using the SHOALS-3000 system shortly after Hurricane Katrina. The survey covered areas near the south shore of Lake Pontchartrain and the primary outfall canals. The elevation values for this survey were delivered with reference to the NAVD88 (2004.65) vertical datum. Figure A-8 shows the spatial extents of this data. The survey processing steps for this data set include the following:

1. The LiDAR data points from each survey line were separated into 1.875 arc minute tiles according to the tiling system described previously in this document.
2. The XYZ points contained in each file were processed within the ESRI ArcInfo GIS program using an Inverse Distance Weighted (IDW) algorithm. The following ArcInfo command was used to develop these DEM surfaces.

```
gridData = idw( pointData.gen, #, #, 2, SAMPLE, 5, 12, 03)
```

3. This command generates a raster surface with 3 ft horizontal resolution by searching the five closest LiDAR points within a 12 ft radius of the cell center. The decision to use this approach was explained previously.

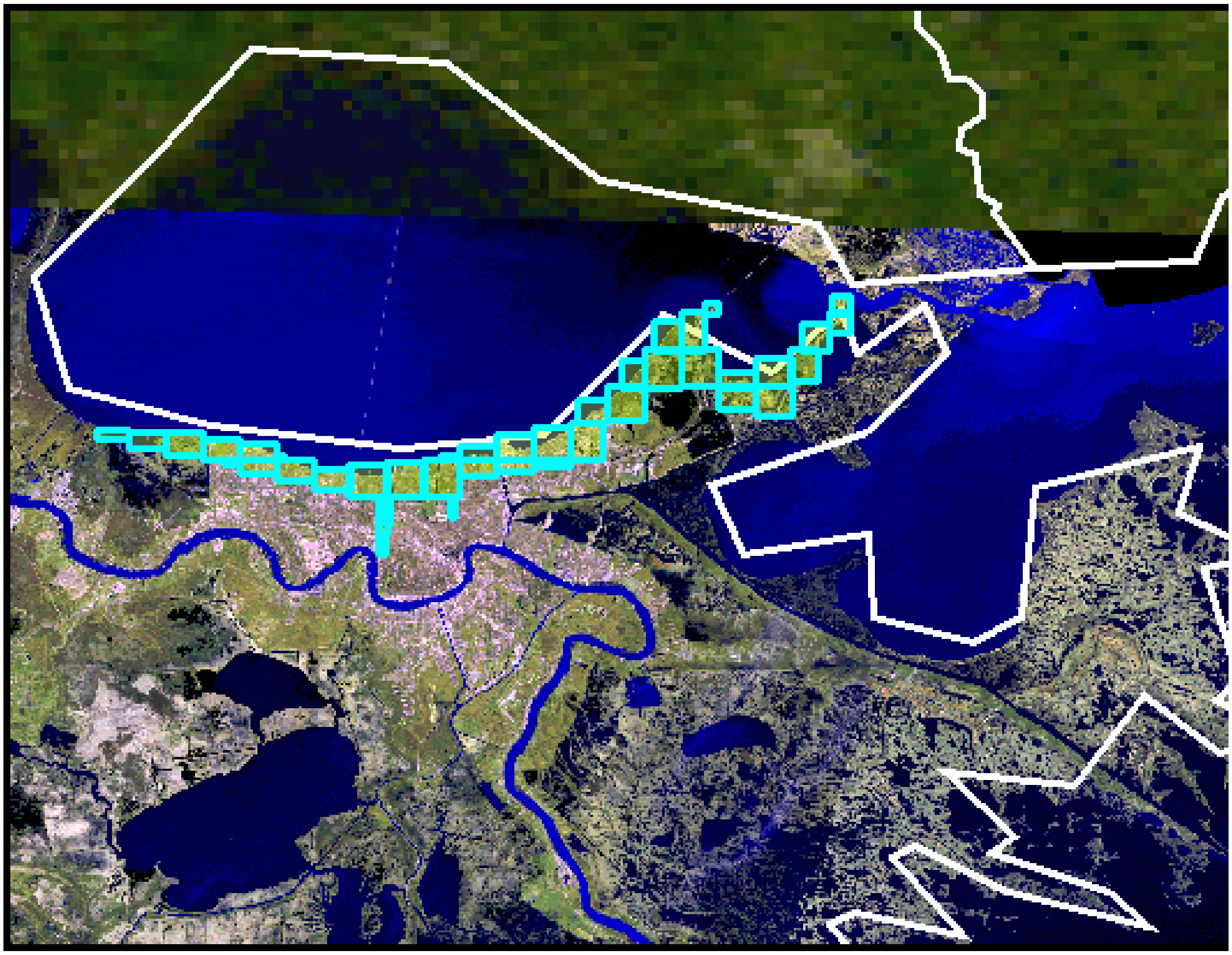


Figure A-8. Spatial Extent of the Post-Levee 3ft DEM

Vertical Datum Adjustments

Because all LiDAR and ground surveys conducted prior to Hurricane Katrina used outdated elevation control, they required adjustments to be in conformance with the NAVD88 (2004.65) elevation datum. This section will discuss the methodology utilized to make these adjustments.

Only a small number of control stations were available in the affected areas which had updated NAVD88 (2004.65) elevations. Most of the control stations that were used in the original LiDAR and ground survey observations were not updated prior to this study. Therefore, it was not possible to directly shift the vertical elevations to the proper values. An indirect method was selected in which a deviation surface was developed utilizing the stations for which elevation control was known. The table below indicates the available control stations, old NAVD88 elevations and the NAVD88 (2004.65) elevations.

STATION	PID	Lat	Lon	Old NAVD88 Elev (US Survey Feet)	New 2004.65 Elev (US Survey Feet)	Diff
L 278	AT0332	29.87615875555560	-89.89594031944440	7.39	6.92	0.47
N 278	AT0351	29.87516515555560	-89.95616993888890	5.31	4.79	0.52
Q 368	AU2123	29.87585119166670	-90.11533822500000	2.80	2.33	0.47
G 365	AU2110	29.91097798333330	-90.21286312222220	1.12	0.79	0.33
E 299	AU0332	29.91392784166670	-90.34488892222220	2.72	2.30	0.42
G 165	AU0316	29.83271346388890	-90.46164717500000	1.58	1.21	0.37
876 1899 B TIDAL	AU2310	29.66723475277780	-90.10932137222220	0.46	0.03	0.43
B 369	AU2163	29.76818572500000	-90.10046901944440	6.48	6.04	0.44
V 375	AT0760	29.91709741666670	-89.97167838333330	2.92	2.33	0.59
J 370	AT0733	29.31729959444440	-89.38827714166670	-3.99	-4.04	0.05
S 188	AU0520	29.96675348055560	-90.22925131388890	8.10	7.71	0.39
A 148	AU0429	29.98916315000000	-90.08728192222220	6.28	5.81	0.48
WASTE WELL 2 RESET	BH1089	30.02297626666670	-89.91299944722220	5.09	4.69	0.40
C 189	BH1119	30.07347194166670	-89.84052781111110	2.61	2.07	0.54
PIKE RESET	BH1164	30.16657738333330	-89.73740822500000	8.63	8.14	0.49
A 193	BH1212	30.23872298055560	-89.61955755555550	2.88	2.46	0.42
S 379	BJ3744	30.05094205833330	-90.54047153055550	14.70	14.14	0.56
REGGIO 2	AT0804	29.84464421111110	-89.75900855277780	5.62	5.02	0.60
876 1724 TIDAL 11	AT0685	29.26479975833330	-89.95752265833330	3.99	3.12	0.87
N 221	AU1291	29.20458551111110	-90.04007175833330	6.17	5.45	0.73
H 359	AU2042	29.15725589444440	-90.17542961944440	5.38	4.76	0.62
G 358	AU2028	29.46079473055560	-90.30865718333330	3.30	2.69	0.61
F 220	AU1091	29.60520827500000	-90.48985493055560	6.21	5.58	0.63
B 358	AU2014	29.72775913055560	-90.59796179444440	11.08	10.63	0.45
N 367	AT0731	29.35230480000000	-89.45713212222220	1.54	1.12	0.43
X 276	AU0272	29.73704631111110	-90.83763516944440	6.13	5.35	0.79
CLUB	AU0286	29.78561673888890	-90.78471878611110	16.30	15.39	0.91
194/2 CAP	AU1510	29.99564758333330	-90.81309936666670	19.55	18.67	0.88
C 195	AT0458	29.53677862222220	-89.76309890000000	2.31	1.57	0.74
G 95	BJ0710	30.00065352500000	-90.42914642777780	27.83	27.13	0.70
MILAN 2	AT0200	29.46826213333330	-89.68159164444450	0.02	-0.49	0.51
A 152	AT0407	29.62460792777780	-89.90296365000000	2.85	2.20	0.66
D 194	AT0357	29.86033619722220	-89.97097324444450	6.02	5.51	0.51
EMPIRE AZ MK 2 1934 1966	AT0231	29.39392922777780	-89.60315771944440	0.42	-0.03	0.46
R 194	AT0376	29.72955933888890	-89.98809776111110	5.10	4.56	0.54
C 279	AT0247	29.36397300277780	-89.55622931111110	-0.33	-0.75	0.43
R 210	BK1406	30.22743360277780	-93.18711595277780	13.09	12.37	0.72
E 356	BK2249	30.23716077777780	-93.26610417500000	12.94	12.24	0.70
4164 LAGS RESET 1959	BK1468	30.21722974166670	-93.37606345833330	11.56	11.06	0.51
D 211	BK1484	30.05078393055560	-93.34153183333330	4.52	3.97	0.55
TT 147 USGS	AV0338	29.93692009722220	-93.37537985000000	7.10	6.73	0.37
V 211	AV0346	29.87880749444440	-93.42583932500000	3.98	3.61	0.37
F 212	AV0360	29.77185718333330	-93.45135065000000	3.78	3.41	0.37

STATION	PID	Lat	Lon	Old NAVD88 Elev (US Survey Feet)	New 2004.65 Elev (US Survey Feet)	Diff
M 212	AV0375	29.80413348611110	-93.34906991666670	3.94	3.41	0.53
10 V 28	BK1612	30.17266846388890	-93.17958646944440	16.53	15.52	1.02
D 215	AV0426	29.86043003888890	-93.08769595277780	3.18	2.23	0.95
C 213	AV0399	29.81574498611110	-93.12290411388890	3.14	2.36	0.78
V 212	AV0390	29.78777296944440	-93.25111426388890	4.36	3.81	0.55
R 295	BJ0634	30.10661751944440	-90.98559804166670	31.06	30.31	0.75
P 228	AU1624	29.94167900277780	-91.02303238611110	19.92	19.09	0.83
Z 221	AU1436	29.58898177777780	-90.72041203611110	5.41	4.79	0.62
R 227	AU1415	29.60564701388890	-90.83880958333330	5.71	4.82	0.88
R 155	AU1126	29.54606370000000	-90.33909516666670	4.80	4.13	0.67
JESSE	AU1255	29.23506302222220	-90.20977578055560	1.88	1.21	0.66
G 233	AU1299	29.49936572777780	-90.57718260000000	4.01	3.41	0.60
S 233	AU1309	29.38575998611110	-90.62007700555550	10.16	9.55	0.61
E 191	BJ1655	30.01868861111110	-90.73071530555560	15.16	14.40	0.76
B 201	AU0179	29.70762715555560	-91.38332858888890	9.57	8.89	0.68
V 275	AU0193	29.71457853611110	-91.30079006666670	7.37	6.56	0.81
F 198	AU0218	29.69410220000000	-91.20446501388890	8.55	7.81	0.74
R 277	BJ2179	30.00569186666670	-91.82160140555560	17.50	17.32	0.17
D 171	BJ2147	30.11994220000000	-91.93498643055560	34.19	33.92	0.27
28 A 015	BK0241	30.21272475277780	-92.00656476388890	35.81	35.33	0.48
U 266	BK0223	30.23505585833330	-92.05556958611110	37.72	37.37	0.35
Q 164	BK0208	30.23485655000000	-92.16349483055560	34.83	33.96	0.87
416	BK0182	30.21409605833330	-92.31459121111110	20.84	19.88	0.96
X 267	BK0159	30.18045488611110	-92.47690235555560	14.94	14.17	0.77
P 163	BK0696	30.19307612222220	-92.61104272500000	12.38	11.32	1.06
K 267	BK0662	30.23182740000000	-92.72382836944440	18.82	18.11	0.71
LACAS AZ MK	BK0629	30.23143250277780	-92.91667467777780	20.37	19.59	0.78
A 4172	BK1435	30.23127168333330	-93.02133605277780	19.81	19.06	0.75
Q 359	AU2033	29.33524856944440	-90.24317305277780	3.68	3.02	0.66
DREUX 2	AU3293	29.28998594722220	-90.64839448055560	2.30	1.94	0.36
RIVER MISSISSIPPI MP 65	BJ1112	30.08235757777780	-90.90296724444450	20.83	20.14	0.69
D 380	AV0573	29.88869226111110	-92.16745968888890	3.30	3.12	0.18
57 V 35	AV0250	29.84219327222220	-92.21070087500000	4.05	3.71	0.34
57 V 120 LADTD	BK0907	30.02094995277780	-92.59878431944440	7.08	6.23	0.84
X 215	AV0079	29.65077187777780	-92.46970240833330	4.64	3.81	0.83
DOLAND AZ MK	AV0295	29.71865680277780	-92.73188140833330	2.81	2.23	0.58
E 380	AV0571	29.83260546111110	-92.30699571944440	16.93	16.73	0.19
L 223	AV0171	29.75809473888890	-92.32981732222220	4.86	4.49	0.36
F 382	AV0566	29.67840651388890	-92.36325317500000	4.24	3.71	0.53
ALCO	BJ1342	30.02681192500000	-90.11283625833330	6.59	6.14	0.45
SAVOIE RESET	AU3539	29.64629676666670	-90.68853480000000	7.31	6.59	0.71
U 362	BJ3209	30.30209426111110	-91.84800177222220	20.93	20.73	0.20
A 374	BH1811	30.07537505833330	-89.94397706666670	-0.64	-1.20	0.56

The following steps were utilized to create the elevation deviation surface:

1. The location and elevation of the available NGS (National Geodetic Survey) control points for the New Orleans area were obtained from (USACE-ERDC-TEC). These control point locations have both the old (epoch varies) and new (2004.65 epoch) elevation values obtained from NGS.
2. The deviations from the old elevation to the new elevations were computed for each point using the following equation: dev = old_elv – new_elv. Since all new elevation data is lower than the old data, all deviation values were positive. The data was converted to feet using the following conversion factor: 1 m = 3.28083333 ft.
3. The location and deviation values were converted into ESRI generate format. Only those control points where both old and new elevations were known were converted.
4. The deviation values at these control points were used to create a raster deviation surface with 1000' horizontal spacing using the following ArcInfo command: idw0_100 = idw(adjust.gen, #, #, 2, SAMPLE, 12, #, 100, 3227549.1114483, 181878.84143203, 3936932.6150204, 733296.72876957)
5. The deviation surface was then rounded to three decimal places to reduce interpolation artifacts using the following ArcInfo command: idw1_100 = (float(int((idw0_1000 * 1000) + .5)) / 1000)
6. Each raster tile from the pre-Katrina data sets was then converted to the new datum by subtracting the deviation surface from the elevation data.

LiDAR Data Accuracy

The typical stated vertical accuracy for most LiDAR surveys is ± 15 cm (.5 ft). However, it should be noted that the actual vertical accuracy of the resultant DEM's may be greater (worse) than this. This is due to a number of factors:

- The laser pulses used to measure the elevation do not always make contact with the ground. This is especially true when vegetation can obstruct the LiDAR pulse. Bare Earth Algorithms can be employed to identify many of the LiDAR data points which are obstructed by vegetation. However, these algorithms do not eliminate all such points, especially in areas with grasses or other short vegetation types that do not have significant variance in elevation between the first response and last response of the LiDAR pulse.
- DEM processing using the IDW algorithm tends to provide a local "smoothing" to the data. While this produces a DEM surface that is more consistent with the perception of how the ground surface should actually be, it may not represent the actual ground surface. Other interpolation algorithms have different, but equally limiting characteristics.
- There are only a small number of locations where the new NAVD88 (2004.65) elevations are known, and still fewer where they are directly coincident with the collected LiDAR data. For this reason, the vertical transformation approach employed within IPET is not capable of providing absolute accuracy.

- The stated vertical accuracy for LiDAR surveys (± 15 cm) is on the same magnitude as the vertical displacement from the old NAVD88 epoch to the current 2004.65 NAVD88 epoch. Because of this, the variation in the data set may overwhelm or at least shadow the elevation difference between elevation epochs

LiDAR and Elevation Data Organization

Data was organized in tiles at 1.875 minutes of arc latitude and longitude to facilitate the storage of extremely high resolution raster data sets without creating extremely large data files. The naming convention used for the tiles follows a similar pattern as the USGS quadrangle naming convention with slight modifications. File names are based on three primary grid systems. The first order grid is comprised of one degree block. These are spaced every one degree of latitude and longitude. The second order grid splits the primary grid into 64, 7.5 x 7.5 minute blocks. These are equivalent to the USGS quadrangles. The third order grid splits the quadrangles into 16, 1.875 x 1.875 arc minute blocks. Each file name is derived from the following convention:

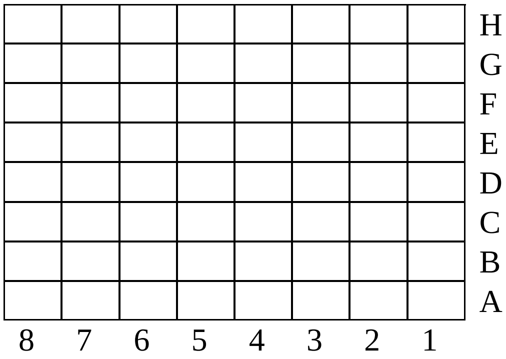
YYXXX2233

where:

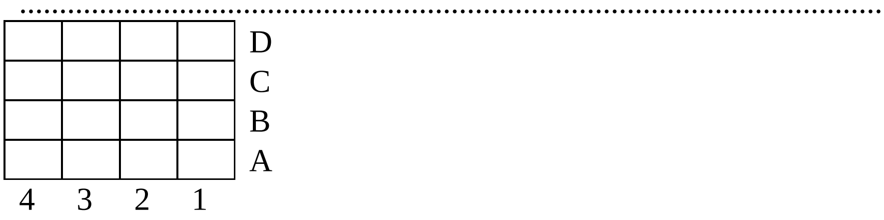
YY – degree of latitude of the southeast corner of the first order grid
XXX – degree of longitude of the southeast corner of the first order grid
22 – two-digit alphanumeric identifier for the second order grid
33 – two-digit alphanumeric identifier for the third order grid

The following schematic illustrates how the second order grid is organized.

……



The third order grid is organized similarly, but on a smaller scale.



As an example, the following Lat/Lon coordinate pair would be located in the corresponding data file:

Latitude	**Longitude**	**File**
N 30º 02’ 25.23423”	W 90º 14’ 34.234425”	30090A2B4

Overall Data Manager

An overall data manager integrates the data stored in the three components such that users may access all datasets from one central application without having to know which data is stored in which component. The Bentley ProjectWise software provided the integrating mechanism to manage the overall data environment. The large data sets component is integrated into ProjectWise as an html document such that the large data sets web portal is displayed when a user opens the document. The GIS component is integrated using the ProjectWise Geospatial Connector. The ProjectWise software provides both a desktop client interface and a web interface to support user access of the data.

The taxonomy for the IPET Data Repository is organized according to Pre-Katrina and Post-Katrina data. While the Pre-Katrina data is organized primarily according to New Orleans Hurricane Protection Projects names and the type of data stored (as shown in Report 1, Appendix G), the Post-Katrina data is organized as follows:

- (IPET) Interagency Performance Evaluation TaskForce
  - Field Survey – Task 6 Survey Support
  - High Water Marks
  - History
  - Miscellaneous
  - News Articles
  - News Releases
  - Presentations at meetings
  - Reports
  - Soils
  - Structures
- Region Wide Data
  - Basemap

  - Presentations
  - Reports
- Damage Survey Reports
  - Orleans DSR Support Info
- Lake Pontchartrain LA and Vicinity
  - Cooperation Agreements
- Photographs
  - Chef Menteur Hwy US 09 – 2005 Oct
  - Entergy Plant – Paris Rd and GIWW – 2005 Sep
  - Helicopter Tour – 2005 Nov 15
  - Ingram Barge in Lower 9th Ward
  - Intercoastal Pumphouse – 2005 Oct 05
  - Lake Pontchartrain LA and Vicinity
  - MRGO – Mississippi River – Gulf Outlet
  - MS River Levee East Bank Vic Pointe A La Hache LA – 2005 Oct
  - New Orleans Docks – 2005 Oct
  - Plaquemines Parish – 2005 Nov
- Project Information Reports
  - Jefferson Plaquemines St Bernard Pumping Stations
  - Lake Pontchartrain LA and Vicinity
  - New Orleans to Venice
  - West Bank of the MS River in the Vicinity of New Orleans
- Survey
  - Floodwall Survey Profiles
  - HYPACK
  - Miscellaneous Surveys
  - Multi-Beam Channel Data
  - Single-Beam Channel Data
  - Topographic Surveys
- Videos - Aerial
  - New Orleans East
  - Plaquemines Parish Lower
  - Plaquemines Parish Upper
  - St. Bernard Parish

As of 20 March 2007, there were over 11,000 documents/datasets stored in the IPET Data Repository.

Participants

This appendix is the result of work accomplished by the following list of individuals that actively participated on this project during the period October 2005 through May 2006, and directly or indirectly contributed to this report.

Name	Agency
Denise Martin	USACE/ERDC-ITL
Harold Smith	USACE/ERDC-ITL
David Stuart	USACE/ERDC-ITL
Rob Wallace	USACE/ERDC-CHL
Dan MacDonald	USACE/ERDC-CRREL
Tom Rodehaver	SAIC
Milton Richardson	USACE/ERDC-ITL
Blaise Grden	USACE/ERDC-ITL
Edward Huell	USACE/ERDC-ITL
Greg Walker	USACE/ERDC-ITL
David Moore	USACE/ERDC-ITL
Amanda Meadows Hines	USACE/ERDC-ITL
Tim Pangburn	USACE/ERDC-CRREL
Don Stauble	USACE/ERDC-CHL
Mary Claire Allison	USACE/ERDC-CHL
Aaron Byrd	USACE/ERDC-CHL
Barb Comes	USACE/ERDC-CHL
Maureen Corcoran	USACE/ERDC-GSL
Eileen Glynn	USACE/ERDC-GSL
Bob Larson	USACE/ERDC-GSL
Benita Abraham	USACE/ERDC-GSL
Darla McVan	USACE/ERDC-CHL
Bernice Bass	USACE/ERDC-GSL
Glenda Brandon	USACE/ERDC-GSL
Vickey Davis	USACE/ERDC-GSL
Beverly DiPaolo	USACE/ERDC-GSL
Vikki Edwards	USACE/ERDC-GSL
Tina Holmes	USACE/ERDC-GSL
Sharon McBride	USACE/ERDC-GSL

Tiffany Mims	USACE/ERDC-GSL
Leonard Paulding	SAIC
Sue Wolfe	USACE/ERDC-GSL
Hannah Jensen	USACE/ERDC-CRREL
Timothy Reardon	USACE/ERDC-CRREL
Amy Stender	USACE/ERDC-CRREL
Charlie Whitten	USACE/ERDC-GSL
Gary Hawkins	USACE/MVN
David McDaniel	USACE/MVN
Cheri Loden	USACE/ERDC-GSL
Hattie Smith	USACE/ERDC-GSL
Jay Ratcliff	USACE/MVN
Lester Flowers	USACE/ERDC-GSL
Alfredo Thomas	USACE/ERDC-GSL

Appendix B
IPET Public Website

The IPET Public Website (*https://ipet.wes.army.mil*) was created on Nov. 2, 2005 to provide access to documents and datasets associated with the IPET study that have been legally cleared for public access. A standard protocol for posting documents was established in conjunction with ERDC, MVD, MVN, and USACE HQ Offices of Counsel, the U.S. Department of Justice and the DoD Task Force. The taxonomy for the IPET Public Website is organized according to Pre-Katrina and Post-Katrina data/documents. Pre-Katrina data are organized primarily according to New Orleans Hurricane Protection Project names and the type of data stored.

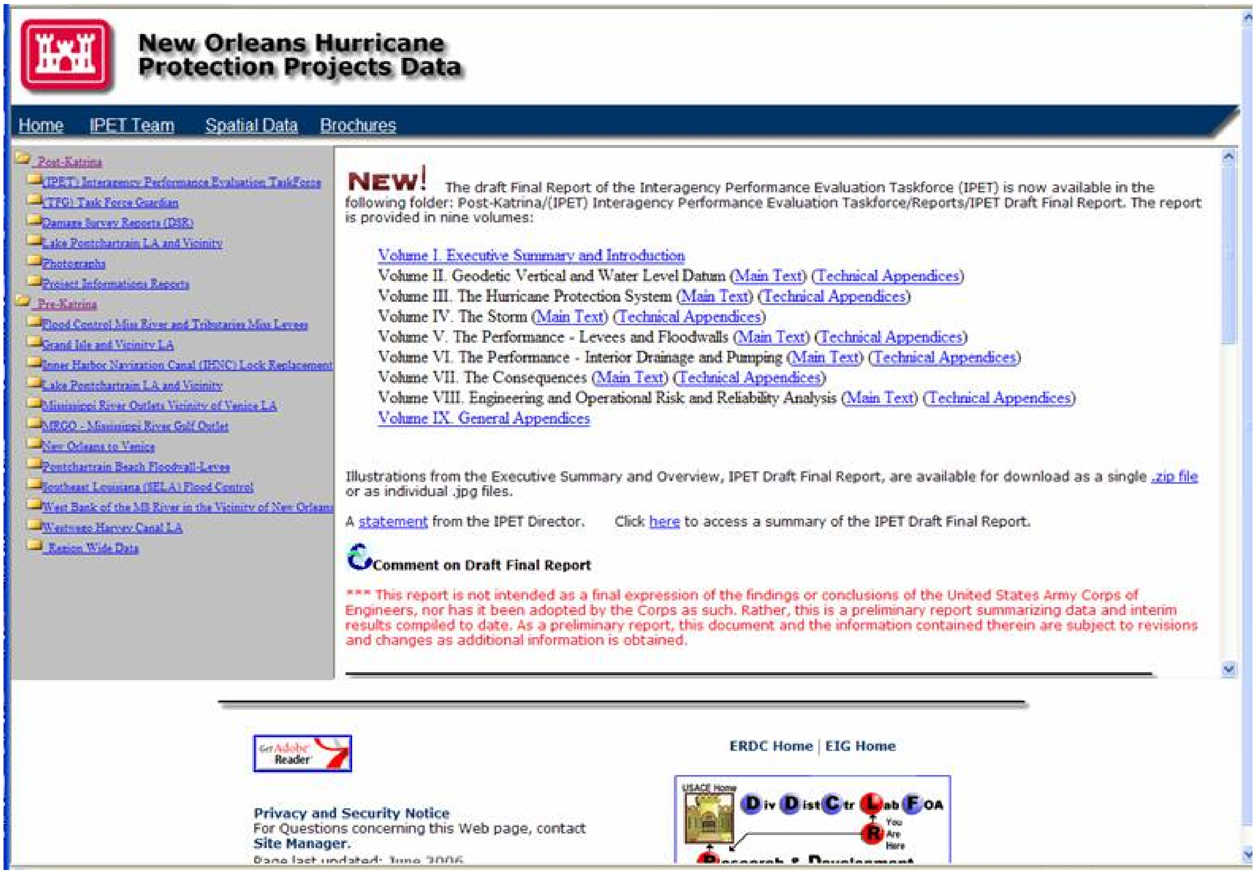
- Region Wide Data
    - Annual Inspection of Completed Works Program
    - Climate
    - Reports
- Flood Control Miss River and Tributaries Miss Levees
    - Design Memoranda (DM)
    - Periodic Inspection Reports (PIR)
    - Reports
- Grand Isle and Vicinity LA
    - Design Memoranda (DM)
    - Reports
- Inner Harbor Navigation Canal (IHNC) Lock Replacement
    - Design Doc Reports (DDR)
- Lake Pontchartrain LA and Vicinity
    - Agreements
    - Contracts
    - Design Memoranda (DM)
    - Hydrology
    - Plans and Specifications
    - Reports
- Mississippi River Outlets Vicinity of Venice LA
    - Design Memoranda (DM)
- MRGO – Mississippi River Gulf Outlet
    - Agreements

    - Design Memoranda (DM) and Reconnaissance Report (RR)
    - Reports
    - Surveys
- New Orleans to Venice
    - Design Memoranda (DM)
    - Periodic Inspection Reports (PIR)
    - Plans and Specifications
    - Reports
- Pontchartrain Beach Floodwall-Levee
    - Design Memos and Reports
    - Plans and Specifications
- Southeast Louisiana (SELA) Flood Control
    - Design Memoranda (DM)
    - Reports
- West Bank of the MS River in the Vicinity of New Orleans
    - Design Memoranda (DM), Feasibility (FR), Reconnaissance Reports
- Westwego Harvey Canal LA
    - Design Memoranda (DM)
    - Reports

The Post-Katrina data are organized as follows:

- (IPET) Interagency Performance Evaluation Task Force
    - Field Survey Data
    - Presentations
    - Reports
    - Soils
- (TFG) Task Force Guardian
- Lake Pontchartrain
- Photographs
    - Chef Menteur Hwy US 90
    - Entergy Plant – Paris Rd and GIWW 2005.09(Sep)
    - Helicopter Tour 2005.11(Nov)15
    - Lake Pontchartrain LA and Vicinity
    - MRGO – Miss River Gulf Outlet
    - MRGO Air Products 2005.10(Oct)05
    - MRGO and GIWW Levee West Boh Bros Contr 2005.09(Sep)30 and 10(Oct)05
    - Miss River Levee East Bank Vic Pointe A La Hache 2005.10(Oct)
    - New Orleans Docks
    - Orleans Canal Pumphouse 2005.09(Sep)30
    - Orleans Lakefront
    - Plaquemines Parish 2005.11(Nov)

Users may view a list of the available documents, view a selected document in the website's view window or in a separate window, and download a specific file to their computer. Since most of the files posted on the site are in .pdf format, a link to install the Adobe Acrobat Reader is provided. Also, a link to the New Orleans District Advertised Solicitations website is provided. The website contains quick links to the most recently published IPET reports as well as a link to submit comments on those reports. A link to a map-based 'Spatial Data' interface was added in May 2006. This interface allows users to access LIDAR, imagery, and Digital Elevation Model (DEM) data used in the IPET study.



NEW! The draft Final Report of the Interagency Performance Evaluation Taskforce (IPET) is now available in the following folder: Post-Katrina/(IPET) Interagency Performance Evaluation Taskforce/Reports/IPET Draft Final Report. The report is provided in nine volumes:

Volume I. Executive Summary and Introduction
Volume II. Geodetic Vertical and Water Level Datum (Main Text) (Technical Appendices)
Volume III. The Hurricane Protection System (Main Text) (Technical Appendices)
Volume IV. The Storm (Main Text) (Technical Appendices)
Volume V. The Performance - Levees and Floodwalls (Main Text) (Technical Appendices)
Volume VI. The Performance - Interior Drainage and Pumping (Main Text) (Technical Appendices)
Volume VII. The Consequences (Main Text) (Technical Appendices)
Volume VIII. Engineering and Operational Risk and Reliability Analysis (Main Text) (Technical Appendices)
Volume IX. General Appendices

Illustrations from the Executive Summary and Overview, IPET Draft Final Report, are available for download as a single .zip file or as individual .jpg files.

A statement from the IPET Director. Click here to access a summary of the IPET Draft Final Report.

Comment on Draft Final Report

*** This report is not intended as a final expression of the findings or conclusions of the United States Army Corps of Engineers, nor has it been adopted by the Corps as such. Rather, this is a preliminary report summarizing data and interim results compiled to date. As a preliminary report, this document and the information contained therein are subject to revisions and changes as additional information is obtained.

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For Questions concerning this Web page, contact **Site Manager.**
Page last updated: June 2006

Figure B-1. Screen Capture of the Frontpage of the IPET Public Website

Metrics are collected daily on number of website hits. As of March 20, 2007, there were over 4,800 documents/datasets posted to the IPET Public Website. Requests have been submitted for the approval to post additional documents/datasets to the Public Website. The website had the largest one-day total number of hits (3309) on 1 June, 2006, coinciding with the public release of the IPET draft Final Report.

```
_Post-Katrina
  (IPET) Interagency Performance Evaluation TaskForce
      IPET Leadership Bios.pdf
      IPET-Panel-HQ-NR-revised.pdf

    Field Survey Data
      3001 Survey Report
          IPET - Survey Report.pdf
          IPET Cross-section Description Code List.pdf

      Hurricane Protection Levee Profiles
          06-021 - Violet Canal Profile.EM
          06-021 - Violet Canal Profile_1.EM

        TFG-profiles
            IHNC-nwb.830.txt
            IHNC-nwb.dat
            IHNC-nwb.em.txt
            IHNC-swb.em.txt
            IHNCneb1.em.txt
            IHNCneb2.830.txt
            IHNCneb2.dat
            IHNCneb2.em.txt

      Raw Field Data
          ipet6bdat.zip
          ipet6bssf.zip

        All TBM GPS Observation Log Sheets
            Days_004-006 and 356.pdf
            Day_010-014.pdf
            Day_021.pdf.pdf
            Day_033.pdf
            Day_034.pdf
            Day_037.pdf
            Day_047.pdf
            Day_346.pdf
            Day_347.pdf
            Day_350.pdf
            Day_352.pdf
            Day_353.pdf
            Day_354.pdf
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    - Day_355.pdf
    - Mid-Lake Gage Day 039.pdf

- IPET 6A
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    - PIKE0092.dat
    - REG20091.dat
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    - V3750092.dat

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- OP023521.dat
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- OP183521.dat

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- IHNCWEST.dc
- IPET6SSBPLHWM.dc
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- patch2.dc
- patch3.dc
- patch4.dc
- patch5.dc
- patch6.dc

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  - IPET6_FieldBook 060851.pdf

- IPET6_FieldBook 060852.pdf
- IPET6_FieldBook 060854.pdf
- IPET6_FieldBook 060855.pdf
- IPET6_FieldBook 060856.pdf
- IPET6_FieldBook 060857.pdf
- IPET6_FieldBook 060859.pdf

TG1--LiDAR Check Surveys

- 06-021 Violet Canal Levee Profile.EM
- 06-034 Chalmette Loop Sections.em
- Homeplace BorowPit.em
- IHNC-nwb.em
- IHNC-swb.em
- IHNCneb1.em
- IHNCneb2.em
- Jeff Parish Flood Wall.em
- ORLEANS.em

030 - London Ave. Canal

- codes.dat
- FW London Canal South.htm
- RE London Canal files for Survey of 010406.htm

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- LS010106.830
- LS010106.em
- LS010106.rpt
- LS010106.xyz

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- LS010206.830
- LS010206.em
- LS010206.rpt
- LS010206.xyz

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- LS010306.xyz

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- LS010606.rpt
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- LN010906.xyz
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- London South for Jan 11th.msg.msg
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  - codes.dat
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       ipet6apatch2rtk.pdf
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       ipet6apatch5rtk.pdf
       ipet6apatch6rtk.pdf

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                   PATCH1_4111-FLDWALL-HORZ.JPG
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- PATCH1_4111-HORZ.JPG
- PATCH1_4111.JPG
- PATCH1_6111.JPG
- PATCH1_A111.JPG

RTK

- PATCH1.dc
- PATCH1.JOB

PATCH2

PATCH2_Lidar_Check_Log.pdf

PIC

- PATCH2_3111-ASPHALT.JPG
- PATCH2_3121.JPG
- PATCH2_4111.JPG
- PATCH2_A111.JPG
- PATCH2_A131-.JPG
- PATCH2_A131-SLOPE1.JPG
- PATCH2_A131-SLOPE2.JPG
- PATCH2_A131.JPG
- PATCH2_BLDG ROOF CORNERS-HORZ.JPG
- PATCH2_CONC FLDWALL-HORZ.JPG

RTK

- PATCH2.dc
- PATCH2.JOB

PATCH3

PATCH3_Lidar_Check_Log.pdf

PIC

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- PATCH3_4111-CONC.JPG
- PATCH3_4111.JPG
- PATCH3_6111.JPG
- PATCH3_6131-SLOPE.JPG
- PATCH3_6131-SLOPE1.JPG
- PATCH3_A131-SLOPE.JPG
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RTK

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                  PATCH6.job

Post-Katrina
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       Buras3.em
       Buras4.em
       BURASFW.EM
       EMPIRE2.EM
       Gravole.em
       HAPPY1.em
       HAPPY2.em
       HAPPY3.em
       HAPPY3chk.em
       HAPPY4.em
       HMPlace.em
       MRL_BLD_L3.em
       MRL_GPLD_L1.em
       MRL_GPLD_L2.em
       MRL_GPLD_L3.em
       MRL_WPLD_U1.em
       MRL_WPLD_U2.em
       site3.em

    026 - Sunrise Pump Station
        Sunrise Pump Station
           ED-SS-P EM
                  SUNRISE.em

    Hayes Pump Station
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          HAYES_M.EM
          Hayes_TBM.PDF
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- Violet Canal
  - 06-023_GPS_FINALADJ.pdf
  - VIOLET.em
  - VIOLETT_NETWORK_UPDATE.pdf

- TG1--LIDAR Check Surveys-JALBTCX Hi-Altitude
  - LIDAR PATCHES_From-3001
    - LIDAR
      - PATCH1
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        - PATCH1_Lidar_Check_Log.pdf

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          - PATCH1_4111-HORZ.JPG
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          - PATCH2_CONC FLDWALL-HORZ.JPG

        - RTK
          - PATCH2.dc

- PATCH2.JOB

- PATCH3
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  - PATCH3_Lidar_Check_Log.pdf

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    - PATCH3_4111-CONC.JPG
    - PATCH3_4111.JPG
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    - PATCH3_6131-SLOPE1.JPG
    - PATCH3_A131-SLOPE.JPG
    - PATCH3_A131-SLOPE1.JPG
    - PATCH3_CANOPY ROOF CORNERS-HORZ.JPG

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    - PATCH3.dc
    - PATCH3.job

- PATCH4
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  - PATCH4_Lidar_Check_Log.pdf

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    - PATCH4_4111-CONC.JPG
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  - PATCH6
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Boring

- NO District Borings.pdf
- Other Borings_3 total.pdf

CPTs

- 14a.cpd
- LAC1.CPD
- LAC2.CPD
- LAC3.CPD
- LAC4.CPD
- nlon-1.cpd
- nlon-10.cpd
- nlon-10con.pdf
- nlon-11.cpd
- nlon-11con.pdf
- nlon-12.cpd
- nlon-12con.pdf
- nlon-13.cpd
- nlon-13con.pdf
- NLON-14.05C.cpt
- nlon-14.cpd
- nlon-14acon.pdf
- nlon-14con.pdf
- NLON-15.05C.cpt
- nlon-15con.pdf
- nlon-1con.pdf
- nlon-2.cpd
- nlon-2con.pdf

South London

- London South CPT and Boring Locations Map.pdf

Borings

- 1G Lab Testing.pdf
- 2G Lab Testing.pdf
- LAC05-1G.pdf
- LAC05-2G.pdf
- Vicksburg District Borings.pdf

- CPTs
  - dlon-21con.pdf
  - Readme on No Interpetations.txt
  - SLON-1.05C.cpt
  - slon-1.cpd
  - SLON-10.05C.cpt
  - slon-10.cpd
  - slon-10con.pdf
  - slon-1con.pdf
  - SLON-2.05C.cpt
  - slon-2.cpd
  - SLON-2A.05C.cpt
  - slon-2con.pdf
  - SLON-3.05C.cpt
  - slon-3con.pdf
  - SLON-5.05C.cpt
  - slon-5.cpd
  - slon-5con.pdf
  - SLON-7.05C.cpt
  - slon-7.cpd
  - slon-7con.pdf
  - SLON-8.05C.cpt
  - slon-8.cpd
  - slon-8con.pdf
  - SLON-9.05C.cpt
  - slon-9.cpd
  - slon-9con.pdf

- _Read - Boring and CPT
  - CPT Notes.pdf
  - ERDC CPTS and Borings information 1.pdf
  - ERDC CPTS and Borings information2.pdf

- (TFG) Task Force Guardian
  - TFG Boring List 4-7-06.pdf

- Damage Survey Reports (DSR)
  - DSR - Levee and Floodwall - New Orleans East.pdf
  - DSR - Levee and Floodwall - Plaquemines (Redacted).pdf
  - DSR - Levee and Floodwall - St. Bernard (03 Oct 2005).pdf
  - DSR - Pumping Stations - Jefferson Drainage Revised (19 Dec 2005)(Redacted).pdf
  - DSR - Pumping Stations - Orleans Drainage (Redacted) .pdf
  - DSR - Pumping Stations - Plaquemines Drainage (Redacted).pdf

DSR - Pumping Stations - St Bernard Vol 1 - Inspection Report (Redacted).pdf
DSR - Pumping Stations - St Bernard Vol 2 - Photo Index.pdf

Orleans DSR Support Info (Levee Floodwall Observation)
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    L119.pdf
    L120.pdf
    L124.pdf
    L46.pdf
    L50.pdf
    L51.pdf
    L52.pdf
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    L60.pdf
    L67.pdf
    L72.pdf
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    L83.pdf
    L88.pdf
    L90.pdf

Lake Pontchartrain LA and Vicinity
  Agreements
    Cooperation Agreement - Orleans Levee District (21 Oct 2005).pdf
    Cooperation Agreement - Supp 1 OLD and SWB (27 Jan 2006)_r.pdf
    Cooperation Agreement - Supp 1-A   OLD and SWB (27 Jan 2006) Redacted.pdf
    Cooperation Agreement - Supp 2 OLD EJLD SWB FJDD SFJDD PJ CNO (25 Jan 2006)_r.pdf
    Cooperation Agreement - Supp 2-A - OLD EJLD SWB FJDD SFJDD PJ CNO (25 Jan 2006) Redacted.pdf

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      Chef Menteur Hwy US90.pdf

    Photographs originals
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      Entergy Plant - Paris Rd and GIWW.pdf

    - Entergy Plant 2005.10(Oct)05 George Sills.pdf

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    - 2005.10(Oct)05 George Sills
      - New Orleans (George's Pics) 169.jpg
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      - New Orleans (George's Pics) 171.jpg
      - New Orleans (George's Pics) 172.jpg
      - New Orleans (George's Pics) 173.jpg

- Helicopter Tour 2005.11(Nov)15
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    - Helicopter Tour 2005.11(Nov)15.pdf

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- Lake Pontchartrain LA and Vicinity
  - 17th Street - 2005 Sep Oct Nov
    - Photographs combined in pdf
      - 17th St Breach Cypress Trees roots.pdf
      - 17th Street 2005.09(Sep)10.pdf
      - 17th Street 2005.09(Sep)26 Breach.pdf
      - 17th Street 2005.09(Sep)28 Breach.pdf
      - 17th Street 2005.09(Sep)28 East Wall Levee.pdf
      - 17th Street 2005.09(Sep)28 Lake Front.pdf
      - 17th Street 2005.10(Oct)02 Breach Damage .pdf
      - 17th Street 2005.10(Oct)02 _Yule.pdf
      - 17th Street 2005.10(Oct)03 Breach Damage.pdf
      - 17th Street 2005.10(Oct)12.pdf
      - 17th Street 2005.10(Oct)13 House Pools.pdf
      - 17th Street 2005.10(Oct)17 Clock Survey.pdf
      - 17th Street 2005.10(Oct)18 Profiles.pdf
      - 17th Street 2005.10(Oct)19 Peat Survey.pdf

17th Street 2005.10(Oct)21 Peat Survey.pdf
17th Street 2005.10(Oct)31 Peat Survey.pdf
17th Street 2005.11(Nov)02.pdf
17th Street 2005.11(Nov)14 Canal Damage .pdf
17th Street 2005_EV.pdf

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17th Street Slide Block Cores 2005 Oct Nov
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17th St Slide Block Core 1 - Eustis B-15 02Nov2005.pdf
17th St Slide Block Core 2 - Eustis B-15 01Nov2005.pdf
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    - 9th Ward 2005.10(Oct)04.pdf
    - 9th Ward 2005.10(Oct)26.pdf

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IHNC - Inner Harbor Navigation Canal
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IHNC 2005.10(Oct)04_Sills_Vroman.pdf
IHNC 2005.10(Oct)25_Sills_Vroman.pdf
IHNC 2005.10(Oct)26_Sills_Vroman.pdf
IHNC East 2005.11(Nov)14_Dunbar.pdf
IHNC East Barge Site 2005.09(Sep)27_Dunbar.pdf
IHNC East Florida Bridge Area 2005.09(Sep)27_Dunbar.pdf
IHNC East Lake View Airport 2005.10(Oct)13_Dunbar.pdf
IHNC East North 2005Sep Oct_Dunbar.pdf
IHNC East South 2005.09(Sep)10_Dunbar.pdf
IHNC Lock 2005.10(Oct) and 11(Nov)_Dunbar.pdf
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IHNC West 2005.11(Nov)09.pdf
IHNC West RR Gate Area_Dunbar.pdf
IHNC West South 2005.09(Sep)10_10(Oct)02_Dunbar.pdf
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IHNC - 2005.10(Oct)25 Sills_Vroman
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Inner Harbor view inside CPT truck.jpg
Inner Harbor view inside CPT Truck_1.jpg
Inner Harbor view of CPT Truck.jpg
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Inner Harbor view of gas main through wall.jpg
Inner Harbor view of gas main through wall_1.jpg
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Inner Harbor view of possible seepage.jpg
Inner Harbor view of road next to levee.jpg
Inner Harbor view of road next to levee_1.jpg
Inner Harbor view of sheetpile at south breach.jpg
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Inner Harbor view of wall at north end of south breach.jpg
Inner Harbor view of watermain through wall.jpg
Inner Harbor view sheetpile at south breach.jpg

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    Inner Harbor sinkholes_1.jpg
    Inner Harbor sinkhole_2.jpg
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    Inner Harbor view of landside face of south breach.jpg
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    Inner Harbor view of landside face of south breach_5.jpg
    Inner Harbor view of landside of north end of south breach.jpg
    Inner Harbor view of landside of north end of south breach_1.jpg
    Inner Harbor view of landside of north end of south breach_2.jpg
    Inner Harbor view of landside of north end of south breach_3.jpg
    Inner Harbor view of sandbag.jpg
    Inner Harbor view of scour at north breach.jpg
    Inner Harbor view of scour at north breach_1.jpg
    Inner Harbor view of scour at north breach_2.jpg
    Inner Harbor view of scour at north breach_3.jpg
    Inner Harbor view of stumps landside of south breach.jpg
    Inner Harbor view of wall at south end of south breach.jpg

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IHNC East - South 2005.10(Oct)10_Dunbar
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IHNC East North MRGO North - 2005.10(Oct)05_Dunbar
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IHNC East North MRGO North Cold Storage 2005.10(Oct)05_Dunbar
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IHNC East North RR Bridge 2005.10(Oct)05_Dunbar
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- P1010136.JPG
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IHNC Lock - 2005.10(Oct) and 11(Nov)
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IHNC West - 2005.11(Nov)05_Dunbar
- P1010020.JPG
- P1010021.JPG
- P1010022.JPG
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- P1010024.JPG

IHNC West - N Clairborne Ave Bridge 2005.09(Sep)27
- IHNC-West, Claiborne Bridge Area.ppt
- P1010145.JPG
- P9250001.JPG
- P9250002.JPG

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IHNC West - RR Bridge Area 2005.09(Sep)27
IHNC West, RR Gate Area.ppt
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IHNC West Central - 2005.10(Oct)02_Dunbar
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IHNC West RR xing 2005.10(Oct)_Dunbar
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IHNC West South 2005.09(Sep)10_Dunbar
- P1010115.JPG

- IHNC West South 2005.10(Oct)02_Dunbar
  - P1010067.JPG
  - P1010074.JPG
  - P1010075.JPG
  - P1010076.JPG
  - P1010077.JPG

- London Canal
  - Movie Clips
    - London Canal - North Site 2006.10(Oct)26_Sills_Vroman.mpg
    - London Canal 2006.10(Oct)26_Sills_Vroman 160.mpg

  - Photographs combined in pdf
    - 2005.10(Oct)25-28_Sills_Vroman.pdf
    - London - North Site 2006.04(Apr)12_Const QC.pdf
    - London - South Site 2005.10(Oct)25-28_Sills_Vroman.pdf
    - London Canal - North Site 2005.10(Oct)05_Sills_Vroman.pdf
    - London Canal East (Overtopped) 2005.09(Sep)26_Dunbar.pdf
    - London Canal North 2005.09(Sep)10 Sep28Breach East Wall Neighborhood_Dunbar.pdf
    - London Canal Northwest 2005.10(Oct)   11(Nov)_Dunbar.pdf
    - London Canal Robert E Lee Breach 2005.09(Sep)26 _Dunbar.pdf
    - London Canal South 2005.09(Sep)10 10(Oct)28_Dunbar.pdf
    - London Canal Southwest 2005.10(Oct)26_Dunbar.pdf

  - Photographs originals
    - London - East Robert E Lee Area 2005.09(Sep)26_Dunbar
      - London East 26 Sept 2005_Dunbar.ppt
      - P1010001.JPG
      - P1010002.JPG
      - P1010003.JPG
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London - North 2005.09(Sep)10_Dunbar_P1010050-69
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London - North 2005.09(Sep)28 Breach East Wall_Dunbar_P1010018-41
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London - North 2005.09(Sep)28 Breach Neighborhood_Dunbar_P1010042-44
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London - North Site 2005.10(Oct)02 Sills_Vroman
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New Orleans (George's Pics) 099.jpg
New Orleans (George's Pics) 100.jpg
New Orleans (George's Pics) 101.jpg
New Orleans (George's Pics) 102.jpg
New Orleans (George's Pics) 103.jpg
New Orleans (George's Pics) 104.jpg
New Orleans (George's Pics) 105.jpg
New Orleans (George's Pics) 106.jpg
New Orleans (George's Pics) 107.jpg
North London Canal_10_02.jpg
North London Canal_Chunk of Peat on sand_10_02.jpg
North London Canal_Downstream Damage_10_02.jpg
North London Canal_Downstream Damage_10_02_02_01.jpg
North London Canal_Downstream Damage_10_02_02_02.jpg
North London Canal_Downstream Damage_10_02_03.jpg
North London Canal_East Wall Sink Hole_10_02.jpg
North London Canal_East Wall Movement_10_02.jpg
North London Canal_East Wall Scour_10_02.jpg
North London Canal_East Wall Side Damage_10_02.jpg
North London Canal_East Wall Sinkhole_10_02_01.jpg
North London Canal_East Wall Sinkhole_10_02_02.jpg
North London Canal_East Wall Soil Upheave_10_02.jpg
North London Canal_East Wall Soil Upheave_10_02_01.jpg
North London Canal_Eorsion Around Lightpole_10_02.jpg
North London Canal_Landside of East Wall_10_02.jpg
North London Canal_Landside of West Wall_10_02.jpg
North London Canal_Levee Failure_10_02_01.jpg
North London Canal_Levee Failure_10_02_02.jpg
North London Canal_Norht End of Wall Failure_10_02_02.jpg
North London Canal_North End of East Wall_10_02.jpg

North London Canal_North End of Wall Failure_10_02.jpg
North London Canal_North End of Wall Failure_10_02_01.jpg
North London Canal_North Failure Section_10_02.jpg
North London Canal_River Side of West Wall_10_02.jpg
North London Canal_Road Damage_10_02_02.jpg
North London Canal_Seepage_10_02.jpg
North London Canal_Seepage_10_02_01.jpg
North London Canal_Soil Wedge_10_02.jpg
North London Canal_South Failure Section_10_02.jpg
North London Canal_Water_10_02.jpg

London - North Site 2005.10(Oct)05 Sills_Vroman
New Orleans_part1_10_05 001.jpg
New Orleans_part1_10_05 002.jpg
New Orleans_part1_10_05 003.jpg
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- New Orleans_part1_10_05 035.jpg
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- New Orleans_part1_10_05 039.jpg
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London - North Site 2005.10(Oct)13 Sills_Vroman
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London - North Site 2005.10(Oct)17 Sills_Vroman
- Photos 032.jpg
- Photos 033.jpg
- Photos 034.jpg
- Photos 035.jpg
- Photos 036.jpg
- Photos 037.jpg
- Photos 038.jpg

London - North Site 2005.10(Oct)21 Sills_Vroman
- North London Peat Block.jpg
- North London Peat Block_1.jpg
- North London Predrilled Hole_1.jpg
- North London Predrilled Hole_2.jpg
- North London Predrilled Hole_3.jpg
- North London Predrilled Hole_4.jpg
- North London Swimming Pool_1.jpg
- North London Swimming Pool_2.jpg
- North London Swimming Pool_3.jpg
- North London Swimming Pool_4.jpg

- North London Tree Stump.jpg

London - North Site 2005.10(Oct)25 Sills_Vroman
- North London drilling on the east side.jpg
- North London view east of canal in neighborhood under house.jpg
- North London view east of canal in neighborhood.jpg
- North London view east of canal in neighborhood_1.jpg
- North London view east of canal in neighborhood_10.jpg
- North London view east of canal in neighborhood_11.jpg
- North London view east of canal in neighborhood_12.jpg
- North London view east of canal in neighborhood_13.jpg
- North London view east of canal in neighborhood_14.jpg
- North London view east of canal in neighborhood_15.jpg
- North London view east of canal in neighborhood_16.jpg
- North London view east of canal in neighborhood_2.jpg
- North London view east of canal in neighborhood_3.jpg
- North London view east of canal in neighborhood_4.jpg
- North London view east of canal in neighborhood_5.jpg
- North London view east of canal in neighborhood_6.jpg
- North London view east of canal in neighborhood_7.jpg
- North London view east of canal in neighborhood_8.jpg
- North London view east of canal in neighborhood_9.jpg

London - North Site 2005.10(Oct)27 Sills_Vroman_011-13
- Photos 011.jpg
- Photos 012.jpg
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London - North Site 2005.10(Oct)28 Sills_Vroman_024-28
- Photos 024.jpg
- Photos 025.jpg
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- Photos 027.jpg
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London - Northwest 2005.10(Oct)14_Dunbar_P1010017-26
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London - Northwest 2005.10(Oct)26_Dunbar_PA260006-26
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London - Northwest 2005.11(Nov)09_Dunbar_ P1010018-19
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London - Northwest 2005.11(Nov)14_Dunbar_P1010029
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London - South 2005.09(Sep)10_Dunbar_P1010071-88
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London - South 2005.10(Oct)_Dunbar_P1010001-49
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London - South Site 2005.10(Oct)02_Sills
- New Orleans (George's Pics) 108.jpg
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London - South Site 2005.10(Oct)05 Sills_Vroman
- New Orleans_part1_10_05 052.jpg
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- New Orleans_part1_10_05 054.jpg
- New Orleans_part1_10_05 055.jpg
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London - South Site 2005.10(Oct)13 Sills_Vroman
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London - South Site 2005.10(Oct)17 Sills_Vroman
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Photos 054.jpg

London - South Site 2005.10(Oct)24 Sills_Vroman
South London view CPT Truck.jpg
South London view from south end.jpg
South London view from south end_1.jpg
South London view of construction.jpg
South London view of construction_1.jpg
South London view of construction_2.jpg
South London view of construction_3.jpg
South London view of construction_5.jpg
South London view of construction-_10.jpg
South London view of construction-_4.jpg
South London view of construction-_6.jpg
South London view of construction-_7.jpg
South London view of construction-_8.jpg
South London view of construction-_9.jpg
South London view of CPT Truck.jpg
South London view of CPT Truck_1.jpg
South London view of Hesco baskets.jpg
South London view of torn out Hesco.jpg

London - South Site 2005.10(Oct)25 Sills_Vroman
South London displacement in canal.jpg
South London displacement in canal_1.jpg
South London displacement in canal_2.jpg
South London displacement in canal_3.jpg
South London view holes north of clay fill.jpg
South London view of boring.jpg
South London view of boring_1.jpg
South London view of boring_2.jpg
South London view of boring_3.jpg
South London view of boring_4.jpg
South London view of boring_5.jpg
South London view of soil block landside of repair.jpg
South London view of soil block landside of repair_1.jpg

London - South Site 2005.10(Oct)26 Sills_Vroman
South London view of holes north of clayfill.jpg
South London view of holes north of clayfill_2.jpg
South London view of set casing and boring.jpg
South London view of setting casing.jpg

South London view of soil displacement.jpg
South London view of soil displacement_1.jpg
South London view of soil displacement_3.jpg
South London view of soil displacement_4.jpg
South London view of soil displacement_5.jpg
South London view of soil displacement_6.jpg
South London view of tornout Hesco.jpg
South London view west side of canal.jpg

London - South Site 2005.10(Oct)27 Sills_Vroman
  Photos 001.jpg
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London - South Site 2005.10(Oct)28 Sills_Vroman
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London - Southwest 2005.10(Oct)26_Dunbar_PA260029-69
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Appendix C
IPET Project Management Plan

Contents

1 IPET Business Model & Processes

1.1 Introduction

Hurricane Katrina struck the coasts of Louisiana, Mississippi, and Alabama on 29 August 2005. This hurricane caused the greatest loss of life and property damage to the New Orleans metropolitan area, St. Bernard Parish, Plaquemines Parish and the Mississippi Gulf Coast in recorded history. Hurricane Katrina created breaches in the floodwalls along the 17th Street Canal, the London Avenue Canal, and the Inner Harbor Navigation Canal. Water flowed from Lake Pontchartrain through the breaches and inundated large urban areas in New Orleans to depths of up to 20 feet, and the levees in St. Bernard Parish and Plaquemines Parish were overtopped and in many locations severely damaged, causing the inundation of substantial additional urban areas.

The levels and magnitudes of destruction, the extensive damage to the flood protection system and the catastrophic failure of a number of structures raised significant issues about the integrity of the flood protection system prior to the storm and the capacity of the system to afford future protection even after repairs.

In response to Hurricane Katrina and these issues the Chief of Engineers, U.S. Army Corps of Engineers (USACE), established the Interagency Performance Evaluation Task (IPET) Force on October 10, 2006. Prior to this the Corps of Engineers had deployed a team to New Orleans to ensure that perishable idata important to the analysis of system performance was preserved. The Corps also stood up a team to map out a strategy for the conduct of a performance analysis. These actions evolved into the IPET. The Task Force mission was to provide credible and objective scientific and engineering answers to fundamental questions about the performance of the hurricane protection and flood damage reduction system in the New Orleans metropolitan area. These facts were used as they are developed to assist in the reconstitution of hurricane protection in New Orleans in the ongoing repair phase and are currently being used for planning and evaluating alternatives for more effective hurricane protection in the future. As such, the IPET effort was directly supporting ongoing repairs while laying the foundation expected future investment in hurricane protection for New Orleans. The findings of the IPET effort were also intended to provide a stimulus for identifying and implementing changes in hurricane protection engineering practice and policies.

1.2 The Scope of Effort

The activities of the Task Force represented an unprecedented in-depth analysis accomplished in a very short time frame. The sense of urgency was to gain as much knowledge as possible to support the ongoing reconstruction of the hurricane protection system in New Orleans and vicinity prior to the coming hurricane season. This effort was feasible only because of the unique integration of the capabilities and expertise of a diverse team of experts from within and external to the Corps of Engineers coupled with the most advanced technical tools and methods. This includes the very special expertise represented by the American Society of Civil Engineers External Review Panel and the National Research Council Committee on New Orleans Regional Hurricane Protection Projects who provided continuous peer review and strategic oversight, respectively, for the effort.

The performance analysis area of interest comprised the entire New Orleans metropolitan area and vicinity to include the areas protected by hurricane protection projects located in the Orleans, St. Bernard, St Charles, Jefferson, and Plaquemines Parishes. This includes over 350 miles of levees and floodwalls, 71 major pumping plants and a multitude of related structures. Some of the analysis required consideration of the entire Gulf of Mexico. Information of a side variety of types and scales was needed to support the analyses, most of which had to be assembled, validated and managed prior to initiating the technical analyses.

The technical work spanned a broad scope of effort including comprehensive documentation of how the structures that comprised the system were designed and built, correcting the elevations of local geodetic reference points and measuring the true elevation of all of the significant structures associated with the hurricane protection system, simulating the time history of storm surge and wave conditions experienced by the structures at any location in the region, determining the specific forces that the structures experienced and especially those at the time of breaching, characterizing and modeling the flooding that occurred from the storm and the performance of the many pump plants that exist to remove water from New Orleans proper, characterizing losses that resulted from flooding and accomplishing a system wide risk and reliability assessment.

The Task Force itself was comprised of over 150 experts from government (federal, state and local), industry and academia, most eminent in their respective fields. The unique and complex mission of the task force, the highly sophisticated analyses required, and the necessity to integrate products of these analyses while continuously handing off lessons learned to those designing and building the repairs, all within a time frame of approximately 7 months, presented an organizational and leadership challenge.

1.3 Objective

The objective of this document is to describe the organization and management model and processes used for the IPET. It is appropriate to understand the lessons learned from the IPET experiences for purposes of guiding future task force efforts that are challenged to deal with complex issues, participation of individuals from a wide variety of organizations and geographic locations, public visibility and a very short time frame.

The work of the IPET is being accomplished as a number of interrelated tasks, each the focus of a team co-led by an expert from the Corps of Engineers and an expert from an external organization. The IPET is partnering with other organizations conducting related studies and analyses to maximize effectiveness within the short time frame of the study.

1.3.1 Leadership and Tasks

The fundamental study architecture, the initial 10 technical teams, was evolved from ideas that the original Corps Headquarters action team that was charged with developing a position paper on establishing a study effort to determine the facts about the performance of the HPS. In many ways the leadership and management model for IPET mimics that of the high end strategic consulting firms that use a largely virtual business model to do complex and multi-team projects in accelerated time frames. This model encourages diverse self-managed teams that cooperate under the framework of a total strategy for achieving project objectives. The IPET was initially composed of ten inter-related teams, each having dual leadership (one from in the Corps and one from outside the Corps) to provide additional sources of objectivity, ideas, outreach and coordination. This scheme brings a greater diversity of talent and experience to every part of the program. While each task had a specific scope of work, the key ingredient for leadership has been identifying the interdependencies of the tasks to get to a final comprehensive performance evaluation. As the work of the task teams has progressed, the efforts have been deliberately consolidated to drive product compatibility and seamless integration. As such, all hydrodynamic work has been brought together, all physical performance evaluation, all consequence assessment and all risk assessment. The existing teams, with the exception of the geodetic datum team, are effectively parallel to the five mission questions being answered. IPET also used a variety of key individuals to provide close ties to other agencies and their activities. An example of this is coordination with FEMA on their efforts to re-define flood maps for New Orleans. The leaders of the Risk team are engaged, but a senior coastal engineer from ERDC is a constant participant in all activities and communications between the Corps, FEMA and IPET.

1.3.2 People

Perhaps the most important and effective factor in the ability to manage and lead a diverse group of teams is the quality of the people involved. As the management gurus say, good people can be productive in any business model. While that is the case, we have endeavored to create a business model that takes advantage of and magnifies their capabilities. The people involved in IPET are largely very experienced and very accomplished in their fields. Given a clear objective, they are able to make quick decisions individually and in concert with others that accelerate the ongoing work. They also have a network that provides for rapid outreach for special information, opinions, and analysis. This is an effective time machine that has allowed IPET to move quickly through some steps that would normally consume much more time.

1.3.3 Project Management

While our self-reliant teams need less support, they do need some, which is provided by a formal project management function that, while virtual, has provided the program/project architecture that glues the effort together, provides financial management and administrative support and allows the teams to focus on the technical analysis. A part of the PM activities has been the development of a detailed management schedule and plan, see Appendix X, Volume 9, that inter-relates all work efforts and provides a critical path for the entire effort. There is a full time Project Manager assigned to IPET and that individual has administrative support to assist in the day to day activities of that office. A critical component of project management is the communication of the task leaders among themselves to ensure that there are no surprises and to manage any necessary changes in schedules.

1.3.4 Assets

Having the exceptional R&D infrastructure of the ERDC available to the IPET is a major advantage and enabler for this work. Capturing a substantial portion of the time on the DOD's newest super computer for hydrodynamic analysis has dramatically accelerated the progress and scope of the IPET efforts to model surges and waves. Having priority access to the Army Centrifuge and the established ERDC ties to the RPI Centrifuge and European centrifuge experts at the GeoDelft has enabled physical modeling for the breach sites to occur in an unprecedented time frame. Physical hydraulic modeling of the 17th Street Canal provides a valuable compliment to numerical modeling, offering details on wave and sloshing phenomena and the impact of debris on flow, unavailable from other sources. Availability of these and similar experimental assets such as drilling and soils testing capabilities and the support infrastructures associated with them (provided through ERDC and the New Orleans District and their contractors) are allowing IPET analysis to progress at an unusually rapid pace. Perhaps the greatest barrier to progress was early on, and involved establishing spending authorities and contractual relationships with the many members of the IPET teams outside the government that were essential to the work.

Communications: Communication was perhaps the most critical aspect of our leadership, management and coordination. The first task in this area was to develop a communications strategy and plan to, in effect, communicate how IPET would communicate. The Communications Strategy was published in IPET Report 1. The primary components included using a virtual office, exploitation of virtual conferencing and a professional and dedicated public affairs capability.

First, we set up and use a virtual office using the "Groove" package. Within Groove there are workspaces for each major team, an overall work space for all teams and workspaces for special activities such as the ASCE ERP, Task Force Guardian and so on. Groove is the common denominator for coordination, access to information as it is developed and input from multiple sources, individual, team and external, for development of information or products. It allows informal group communications within the workspace as well as communications with external entities such as Corps HQ personnel who are taking the IPET findings and acting on those related to professional practice and policy and Task Force Guardian, putting the IPET results to work in the reconstruction of the HPS.

A second major communication approach is routine phone conferences to discuss intra and inter-team issues across the entire leadership team. This happens at a prescribed time each week and includes representatives from Corps HQ, New Orleans District, Task Force Guardian, Task Force Hope and the Mississippi Valley Division. It also happens frequently for subsets of leadership and individual or multiple teams during each week. These communications are at the discretion of the team leaders, but are reported on at the weekly conference to maintain awareness of the level of interaction ongoing.

IPET had a full-time Public Affairs Officer to assist in external communications, managing interface with the media and crafting accurate messages for the public. The IPET PAO is involved in all leadership communications and manages all external information releases. The PAO coordinates all IPET communication activities with the ASCE, USACE HQ, Task Force Guardian, New Orleans District, Task Force Hope and other agency pubic affairs functions as appropriate.

The IPET public web site has provided over 4200 documents on the New Orleans HPS as well as the IPET reports and other communications.

2 Scope

2.1 Introduction

Hurricane Katrina struck the coasts of Louisiana, Mississippi, and Alabama on 29 August 2005. This hurricane caused the greatest loss of life and property damage to the New Orleans metropolitan area, St. Bernard Parish, Plaquemines Parish and the Mississippi Gulf Coast in recorded history. Pumping stations were provided in New Orleans, as integral parts of the hurricane protection systems, to remove storm drainage from inside the protected areas. Hurricane Katrina created breaches in the floodwalls along the 17th Street Canal, the London Avenue Canal, and the Inner Harbor Navigation Canal. Water flowed from Lake Pontchartrain through the breaches and inundated large urban areas in New Orleans to depths of about 20 feet, and the levees in St. Bernard Parish and Plaquemines Parish were overtopped and inundated other urban areas.

A performance evaluation is broadly defined as an investigation of a damaged facility or deteriorated equipment using observation, testing and deduction to determine the cause of the damage or deterioration.

2.2 Background

Historically, some hurricane protection had been provided to metropolitan New Orleans in a few areas but it was not until Hurricane Betsy hit the city in 1965, causing more than 8 billion dollars of damage (in 2002 dollars) and losing 75 lives, that a comprehensive hurricane protection program was initiated. The New Orleans and Southeastern Louisiana region consists of three hurricane protection projects.

2.2.1 Lake Pontchartrain, LA, and Vicinity Hurricane Protection Project

The “Lake Pontchartrain, La., and Vicinity Hurricane Protection Project” was authorized in 1965 and was modified in 1974, 1986, 1990, and 1992. The project lies between the Mississippi River and Lake Pontchartrain, and is located in St. Bernard, Orleans, Jefferson, and St. Charles Parishes in southeast Louisiana, (generally the greater New Orleans metropolitan area), and also includes a mitigation dike on the west shore of the lake. The project was designed to protect residents from surges in Lake Pontchartrain driven by storms up to the Standard Project Hurricane (SPH). The SPH is equivalent to a fast-moving category three hurricane. The project includes:

1. New levee from the Bonnet Carré Spillway East Guide Levee to the Jefferson-St. Charles Parish boundary
2. Floodwall along the Jefferson-St. Charles Parish line

3. Enlarged levees along the Jefferson and Orleans Parish lakefronts

4. Parallel protection (levees, floodwalls, and flood proofed bridges) along the 17th Street, Orleans Avenue, and London Avenue outfall canals

5. Levees from the New Orleans lakefront to the Gulf Intracoastal Waterway (GIWW)

6. Enlarged levees along the GIWW and Mississippi River-Gulf Outlet (MR-GO)

7. New levee around the Chalmette Area.

2.2.2 The West Bank Hurricane Protection Project

Urbanization into the wetlands and the potential hurricane threat led to construction of the West Bank hurricane protection project on the right descending bank of the Mississippi River. The project is located in Orleans, Jefferson and Plaquemines Parishes, and in metropolitan New Orleans on the west bank of the Mississippi River. The “West Bank and Vicinity, New Orleans, Louisiana, Hurricane Protection Project” was authorized in 1999 by combining three projects that were authorized in 1986 and 1996. The project is designed to protect residents on the west bank from storm surges from Lake Cataouatche, Lake Salvador and other waterways leading to the Gulf of Mexico driven by storms up to the SPH. The project includes:

1. 22 miles of earthen levee and 2 miles of floodwall extending from the Harvey Canal south to the V-levee near the Jean Lafitte National Historical Park and back up to the town of Westwego.
2. The Lake Cataouatche area eliminated the west-side closure in Westwego, and added about 10 miles of levee and 2 miles of floodwall
3. The East of Harvey Canal area has a sector floodgate in the Harvey Canal and about 25 miles of levee and 5 miles of floodwall.

2.2.3 The New Orleans to Venice Project

Just south of New Orleans, hurricane protection is provided by the “New Orleans to Venice Project”. This project is located along the east bank of the Mississippi River from Phoenix, Louisiana, (28 miles southeast of New Orleans) down to Bohemia, Louisiana, and along the west bank of the river from St. Jude, Louisiana, (39 miles southeast of New Orleans) down to the vicinity of Venice, Louisiana. The project was authorized in 1962, as the “Mississippi River Delta at and below New Orleans, Louisiana Project” and later renamed as the “New Orleans to Venice Project”. The project will protect residents from hurricane tidal overflows created by storms with a return period of 100 years. The protected area encompasses approximately 75% of the population and 75% of the improved lands in the lower Mississippi River delta region.

2.3 Purpose

The purpose of this performance evaluation and independent review is to provide credible, objective engineering and scientific answers to fundamental questions about the operation and performance of the hurricane protection projects in the New Orleans metropolitan area that were flooded by Hurricane Katrina.

2.3.1 Four Questions IPET Should Answer

1. What were the storm surges and waves generated by Hurricane Katrina and did overtopping occur?
2. How did the floodwalls, levees and drainage canals, acting as an integral system, perform and breach during and after Hurricane Katrina?
3. How did the pumping stations, canal gates and road closures, acting as an integral system, operate in preventing and evacuating the flooding due to Hurricane Katrina?
4. What was and what is the condition of the hurricane protection system before and after Hurricane Katrina and, as a result, is the New Orleans protection system more susceptible to flooding from future hurricanes and tropical storms?

2.3.2 IPET Objectives

1. Understand available design and construction information
2. Understand the emergency operating plan for major storms, including storms exceeding the authorized level of protection
3. Evaluate the performance during the storm
4. Evaluate the performance in recovering from the flooding
5. Evaluate the capacity of the hurricane protection features after permanent repairs are complete
6. Identify lessons learned and ways to potentially improve the performance of the existing hurricane protection system at the authorized level of protection

The scope of the performance evaluation and independent review should not include hurricane evacuation plans, coastal restoration or flood plain management alternatives; and the analysis and findings should be clearly focused so it can be completed in a timely manner. The performance evaluation, independent review, and list of potential improvements should be completed within six months from the date that it is given notice to proceed.

2.4 Description of Work and Services

The work required for the performance evaluation and independent review includes the following tasks covering the hurricane protection projects located in the Orleans, St. Bernard, St Charles, Jefferson, and Plaquemines East Parishes.

2.4.1 Data Collection and Reliability of Instrumentation – Task 1

Data should include information about the conditions before and after the storm:

a. Original design documents

b. Construction and as-built record

c. Profile, topographic and section surveys

d. Inspection reports

e. Field Investigations and Inspections

f. Public interviews, forums or meetings

g. Levee design heights and latest survey data on actual levee heights

h. Levee properties including soil borings and test results near breaches and away from breaches. Photos and descriptions of exposed levee sections during excavations required for permanent repairs. Cross- sections of an area after levee repairs.

i. Aerial Photography & Videos

j. Analyses by other agencies or private firms

k. Surge heights, wind speed and direction, and waves (height, period and direction) time history with emphasis in the vicinity of the subject floodwalls and levees.

l. All photos and videos of erosion patterns at/or near breaches and other areas. Measurement of erosion depth and breadth at a few locations. More photos and videos once the water is evacuated and we have access to the levee toes.

m. Wall deflections in areas with and without erosion behind the wall

n. Evidence of wall yielding in breached and other areas

o. Pump station layouts showing locations and elevations of all equipment which could become inoperable due to potential inundation

p. Detailed list of which pumps and other equipment were operable or not, both before and after the storm

There should be a Central Data Manager or Contractor who has the lead responsibility for organizing and supporting this effort. All data shall be easily accessible to all members of the team. The database architecture will be based on the USACE Geospatial Architecture as outlined in the Corps Enterprise Architecture (CEA). All data (District and project files) shall be geolocated (scanned if necessary) and loaded into an Oracle database that is registered to ESRI's Spatial Data Engine (SDE). This will allow for the data to be retrieved in three different manners:

1. High level overview of the entire project, through a web map interface
2. GIS application developers can have direct access to the geospatial data to create specialized maps or analysis
3. Modelers or database administrators will have direct access to the data through oracle to run models or generate reports.

All contracts for debris removal, repair or reconstruction should include provisions for photographing (including time lapse cameras if available) or videotaping the existing condition of the project features and equipment after the storm and flooding, and all important conditions discovered as the work progresses. All contract photos or videos should be clearly identified, organized and filed for future use.

The PAO should contact the major news networks and publishers to obtain copies of appropriate photos and videotape taken during the first week after the storm.

2.4.2 Baseline Interior Drainage Numerical Model – Task 2

This analysis should use the HEC software Hydrologic Modeling System (HMS) and River Analysis System (RAS) to identify the hydrologic response of the flooding area to the Hurricane Katrina storm event as if the line of protection had remained intact and the project had operated as it was planned and designed. It should include an estimate, in a time series, of the volume of water entering the flooding area. The existing CEMVN interior drainage models should be updated to ensure interconnectivity and volume continuity, and then used to perform a pooling analysis by identifying the rainfall-runoff relationship from the storm and estimating the volume of water entering the flooding area by seepage; and to perform a pumping analysis by modeling the pumping capacities to determine the evacuation rates.

2.4.3 Interior Drainage Numerical Model – Task 3

The analysis should use the HEC software HMS and RAS to identify the hydrologic response of the flooding area to the Hurricane Katrina storm event corresponding to the actual operation and performance of the protection project. It should include an estimate, in a time series, of the volume of water entering the flooding area due to overtopping or breaching the line of protection. This analysis is necessary to develop the hydrologic data and response of the flooding area (volumes and heights of water entering and exiting the city) to the Hurricane Katrina event. The existing CEMVN interior drainage models should be updated to ensure interconnectivity and volume continuity, and then used to perform a:

a. Pooling analysis by identifying the rainfall-runoff relationship from the storm and estimating the volume of water entering the flooding by seepage,

b. Breaching analysis by modeling the failure rates of the floodwalls and levees, and the volumes of water exchanged between different water levels based on rating curves,

c. Pumping analysis by modeling the pumping capacities to determine the evacuation rates

2.4.4 Numerical Model of Hurricane Katrina (Storm Surge & Wave) – Task 4

This analysis will provide a hindcast of the specific hydrodynamic conditions experienced by the existing hurricane and flood protection projects during Hurricane Katrina, and it will provide data about the water levels and wave conditions (heights, periods, directions, energy spectra) that were experienced by the line of protection along the New Orleans and southeastern Louisiana coastlines. This analysis is necessary to analyze the influence of the storm surge and waves on any overtopping of the floodwalls and levees and ultimately flooding of the city. This analysis will use the ERDC-developed and supported software products, ADCIRC (circulation and storm surge), PBL (wind and atmospheric pressure), WAM (basin-scale waves), STWAVE (local waves), and build upon MVN’s high-resolution ADCIRC model of the New Orleans and southeastern Louisiana coast to estimate the locations of any overtopping and the water levels acting on the floodwalls and levees. Results of this analysis will be compared to all wave sensor data, high water marks and water surface hydrographs that might be available. This analysis is already in progress, and detailed wind fields, surge fields, and water level and wave time series are being developed at numerous nodes throughout the Lake Pontchartrain region, and into Lake Borgne, the Mississippi River, the MRGO and various New Orleans canals. Preliminary analyses will use readily available information, but subsequent analyses will include enhanced wind fields and coupled surge and wave modeling to develop a time history of hydrodynamic impacts along the New Orleans shore and into the canals. A phased approach will be taken, providing the 75%, 90%, and 95% solutions as new and better information on winds, water levels, topography, and structure crest elevations becomes available during the course of the work. The results of these analyses will provide input required by other tasks, particularly the task involving estimates of wave heights formed or amplified in the canals, and the extent of waves running up onto the levees or overtopping the floodwalls.

2.4.5 Storm Surge, Wave and Breaching Physical Models – Task 5

2.4.5.1 Hydrodynamic Forces at Floodwalls and Levees

This task will develop a time series of local hydrodynamic conditions (including static and dynamic pressure distributions along floodwall and levee surfaces and any time-varying overtopping rates) contributing to floodwall and levee performance, using boundary conditions taken from larger scale studies in the vicinity of canal entrances and other sites of interest (from Task 4). These results should provide valuable information to understand how breaching started and progressed. Hydrodynamic estimates along with an understanding of their potential importance to floodwall and levee performance inside canals as well as in other areas will be generated in the following steps.

2.4.5.1.1 Performance evaluation of general site characteristics

Initial investigations will be conducted to identify the most probable breaching modes and their relationships to hydrodynamic forcing. Locations of breaching and any overtopping sites will first be examined to determine the degree of commonality and/or dissimilarity existing among these sites (i.e. relative positions of breaches along canals, levee elevations at breaching points, local design variations, local canal characteristics, proximity to bridges, foundation materials, etc.). Site visits, reviews of available records, and analytical models will be used to form hypotheses for possible failure scenarios. It is anticipated that performance evaluations conducted under other tasks will provide key additional information and will be coordinated into the Task 5 effort.

2.4.5.1.2 Numerical modeling of canal-scale variations in hydrodynamic forcing

Wave and water level conditions from Task 4 will be used as boundary conditions for waves and water levels propagating into the canals and other areas as required. Standing waves due to partial reflections along the length of the canals and/or from steep-sided levees outside of canal areas will be important phenomena that must be reproduced accurately. Such standing waves will be very three-dimensional due to incident wave obliquity and complex reflective surfaces within the canals and on steep-sided slopes. In addition to local wave fields, coincident currents and wind- and wave-driven setup within the canals and/or close to steep-sided levees will need to be resolved.

2.4.5.1.3 Numerical modeling of local wave and water level characteristics in the vicinity of levee breaches

Local-scale numerical models will develop wave characteristics in the vicinity of levee breaches. This scale will like use a very fine scale coupled circulation model and wave model, including complex and highly nonlinear hydrodynamic effects via robust hydrodynamic models such as Boussinesq wave and current models and Navier Stokes models.

2.4.5.1.4 Estimates of local time-varying overtopping rates

Wave overtopping is potentially a primary cause of floodwall and levee breaching. Normally, wave overtopping is computed from empirical data from physical models or prototype measurements. However, overtopping from waves in a canal and/or in hurricane drive conditions has not been well quantified. A physical model may be required to determine the overtopping rates for realistic local wave conditions in the canal. The overtopping will feed back to modify local wave fields within the canal. Studies of local overtopping will follow a dual course, one using numerical Navier Stokes methods and a second using an undistorted physical model no smaller than a 1 to 10 scale. The resulting overtopping rates will provide valuable information relative to the role of overtopping to floodwall and levee breaching.

2.4.5.1.5 Investigation of loading due to hypothetical barge impacts on levee walls

It has been hypothesized that barge impacts may have contributed to at least one levee breaching. Analytical models will be used to initially investigate this potential mode. Details of this breaching mode will be further investigated using the numerical hydrodynamic models.

2.4.5.1.6 Coordination with other groups

Two final elements of the work to be conducted under this task will be the coordination of Task 5 efforts with other groups investigating the causes of the floodwall and levee breaches in the New Orleans area and the proper communication of our results for use in structural and geotechnical response models conducted under Task 7.

2.4.5.2 Centrifuge Modeling of Floodwall and Levee Performance

Some of the causes of floodwall and levee breaching are foundation instability, sheetpile yielding and/or interlock rupture, concrete joint rupture, erosion, and overtopping or seepage flow through the levee. Ample information relates to centrifuge modeling of levee and small dam performance subjected to extreme flooding events. Several centrifuge model studies have been performed on the stability of slopes under seepage flow, the phreatic surface developed in stable embankments, overtopping, and effect of soil type on levee breaching due to seepage flow, pore water pressure response, and hydraulic fracturing.

The levee systems in and around New Orleans can be readily modeled in the ERDC centrifuge and subjected to flooding events. Models can be constructed to duplicate the geometry and natural material actually used in the New Orleans levees (relative density, compaction, moisture content, etc.). The scaled model will then be spun up to the appropriate centrifugal acceleration and subjected to the loading event. The load can be a steady rise in water elevation (at any rate desirable) with or without overtopping or a steady rise in water elevation with associated wave action, or a rise in water elevation associated with flow parallel to the levee. Several models can be constructed and tested with varying loads and material types.

The ERDC centrifuge is capable of handling models up to maximum dimensions 1.2 by 1.2 meters and weights up to 8.8 tons. The model can be subjected to a centrifugal acceleration of 10 to 350 g's. All pertinent scaling relationships for centrifuge modeling are clearly developed. Constructing a scaled model of a floodwall and levee, then subjecting the model to a centrifugal acceleration equal to the scaled value will place the model in the exact same loading event as the full scale floodwall and levee. The model will then respond the same as the floodwall and levee.

The benefits of centrifuge modeling are that it provides accurate data that can be used to validate breaching mechanisms observed in the field and verify the results of numerical models. The models can be analyzed for possible breaching modes by recording several types of data. The data to be collected are an increase in pore pressure inside the levee which provides hydraulic gradient variations, horizontal and vertical displacements of the levee along multiple locations, video images of the structure before during and after the loading event, and post-test dissections of the model. The model can be constructed with internal markers (colored soil) to provide information related to internal stress and strain, available from the post-test dissection.

2.4.6 Geodetic Vertical Survey Datum Assessment – Task 6

To insure that the levee heights have remained relevant to sea level rise in the New Orleans area, all elevations should be measured relative to the latest Geodetic Vertical Datum as determined by an ongoing study being conducted by CEMVN and the NOAA. This should include the lake levels, the river levels, the projected protection levels, and the top of the levees. NOAA is progressing on an effort to determine subsidence in the entire Gulf Coast region and dramatic changes are being reported. The entire region is so dynamic that NOAA is no longer going to rely on local bench marks, but instead is proposing to use GPS surveying techniques to measure elevations relative to stable areas that are hundreds of miles away. NOAA is also proposing to have all elevations measured in this manner have time stamps on them so the values could be corrected on some regular interval.

2.4.7 Analysis of Floodwall and Levee Performance – Task 7

This model uses the hydrodynamic time history information from Task 5, Storm Surge and Waves Physical Models, to identify or confirm which mechanisms led to breaching of the floodwalls and levees during and after Hurricane Katrina. The model should be able to represent flexing and yielding of the embedded cantilever floodwalls, subsidence and slipping of the levee slopes, seepage through and under the levees, and the interaction between the levee and the embedded sheet piling as the levee is eroded along its sloping surface and at the vertical interface with the sheet piling. This two dimensional or three dimensional soil-structure interaction model will be used to estimate the degradation, damage, and breaching of the wall and levee system due to the dynamic loading applied by the pulsating and pounding of the storm surge and waves. The information about the cumulative damage to the components and features of the hurricane protection system will also be used in Task 10 below to estimate the risks associated with their performance during future hurricanes and tropical storms.

2.4.8 Pumping Station Performance Assessment – Task 8

This assessment should show how the pumping stations performed to evacuate the flooded areas. The assessment will determine if the state of inoperability of pumping stations was due to conditions that exceeded the original design/operating criteria, actual post-storm conditions, or lack of readiness. This information is needed to determine if the pumping station system performed as well as could have been expected considering the magnitude of the storm and its impact on nearby flood control features, or if the original design criteria needs to be revised. It should also determine if operation, maintenance, and inspection procedures are adequate, and if improvements, such as automation and remote control of equipment, should be considered.

A detailed evaluation of the pumping stations includes:

1. The state of equipment operability prior to and after the storm
2. Identification of the damaged equipment and the cause of the damage,
3. The causes of inoperability include
    a. The loss of primary power and the lack of a reserve power supply,
    b. Debris blocking the intakes,
    c. Flooding of main and auxiliary equipment,
4. Structural damage,
5. Availability of experienced operators,
6. Availability of fuel and spare parts,
7. Physical access to the facility,
8. Review operation and maintenance records,
9. Review periodic inspection records,
10. Review pump station design parameters that were exceeded,
11. Different types of short or long term improvements,
12. Layout, location and elevation of station equipment,
13. Type of equipment control (remote, automatic or manual).

2.4.9 Consequence Analysis of Hurricane Katrina – Task 9

This task will focus on the economics, human heath and safety, social and cultural, and environment consequences related to the performance hurricane protection and flood damage reduction system. The assessment will be by the type of event and geographic scale sufficient for the needs of Task 10. Additionally, consequences will be assessed at the local, regional and national level. The interior drainage modeling work (Tasks 2 and 3) will provide timelines, depths and areas for different levee, floodwall and pumps performance scenarios. It is anticipated that the Task 10 will need consequences for at least three scenarios: 1) as planned performance, 2) actual performance, and 3) post levee and floodwall reconstruction. Assessment of consequences for each scenario will be automated, to the extent practical, using a common set of underlying data and data from other tasks in the IPET scope. All data is to base centrally accessible through database and file system being developed as part of Task 1. Each consequence scenario must account for the mass and continued evacuation of Greater New Orleans population. Task 10 will be using the products of Task 9 so extensive coordination will be necessary.

Because of the different natures of the consequences, Task 9 is divided into 4 subtasks with a subtask leader for each. The subtasks are:

a. Economic Consequences

b. Social consequences and consequences to cultural and historical aspects

c. Environmental consequences

d. Human health, including psychological, and safety consequences

The approach and products for each subtask are detailed in the following sections.

2.4.9.1 Economic Consequences

The purpose of the subtask is to estimate and categorize the various damages caused by the recent occurrence of Hurricane Katrina and subsequent flooding in the Greater New Orleans system (GNO). As with similar catastrophic events, the economic consequences were not limited to the Greater New Orleans system alone, but through the subsequent out-migration of people and disruption of economic activity related events have impacted regional and national economic activities. But to fully evaluate the economics of hurricane activities, a baseline economic analysis of the GNO region is necessary. This will require an assessment of impacted economic activities, property and infrastructure in the related area, elements that are consistently estimated for any direct economic analysis of regional activity. A reasonably complete analysis of the impacts of Hurricane Katrina will require extension of investigation and analysis beyond the level of effort that would typically be required for evaluation of flood damages. As an example, traditional flood damage studies do not consider the consequences of wind damage, but wind damage bears a real cost on structures and may have implications for resulting debris removal and disposal. The various levee breaks can be estimated in a traditional flood analysis based on property valuation, but the models may not be adequate to estimate catastrophic economic disruptions. Because of the duration of flooding and other events, the need to examine non-traditional damages may be necessary, including the disruption to transportation activities, including commercial freight movement. In these contexts, economic analyses have been scoped to first determine the immediate and direct economic consequences of Katrina combined subsequent estimation of damages and economic costs in both an NED (National Economic Development) and Regional Developmental Impact (RED\DRI) perspective.

The primary geographical area for assessment of impacts will be limited to four (4) areas of the GNO region to Orleans, Jefferson, St. Bernard, and Plaquemines parishes. Two (2) general scenarios have been specified for study and these include

1. impact of conditions from Katrina assuming storm damage and flood control measures fully functioned as intended (without tentatively reported physical failure or compromise); and

2. impact of conditions from Katrina for climatic or storm conditions from Katrina assuming storm conditions and events as they transpired during and after onslaught of the storm with consideration of (tentatively reported) structural failure or physical compromise of civil works storm damage and flood control measures (as engineered, constructed, and maintained up until occurrence of the storm).

2.4.9.1.1 Work Tasks and Analytical Approach

a. Literature Review of Flood Assessments and Catastrophic Events. Due to the uncertainty concerning estimating widespread economic disruptions, some research on flood assessments and catastrophic events is necessary. With the availability of economic assessments from various academic and professional groups, it is important to categorize the methodologies and databases used in these respective analyses. The literature review will focus on collecting estimates of hurricane-related damage to the city, region and the nation to the extent as scope for studies, but also information on how assessments were conducted in response to the events.

b. Develop Baseline Geospatial Economic Database of the Greater New Orleans Region. The baseline economic database of the GNO region will be critical to expeditious assessment of the conditions that existed prior to arrival of Hurricane Katrina, but also for much of the work required for post-Katrina evaluations. The data collection efforts will primarily rely upon information from local sources collected from local Corps representatives but will also employ publicly available databases from other Federal Government Agencies. If necessary, databases will be supplemented by private databases developed by trade associations and related industries or data vendors. Geographic information system (GIS) work will be supported by various parts of USACE and will involve some coordination with other groups and governmental agencies to ensure economic and physical geographical information are sufficiently developed for Task 9 and Task 10 efforts.

c. Evaluate various models for assessing economic benefits and costs. There are various methodologies for estimating spatial economic activities and linkages across economic sectors. Traditional flood damage evaluation methods for actual occurrence (i.e., relating characteristics concerning flood height, speed and duration, etc.) will be combined with computerized simulation or modeling applications to develop or estimate data and information needed for analysis of both general scenarios. Engineering-based models can provide a good assessment of structural damages and damages in a geographical framework as well as for alternative assumptions for conditions. In addition, there were other activities in the region that were disrupted, even beyond direct structural loss. A number of private enterprise, public service, and transportation activities were significantly affected by Hurricane Katrina. Any assessment of economic impacts should consider significant interrelationships of other economic sectors, such as transportation and tourism, but also other second and third order effects, such as changing building capacities and land-use permitting changes. With particular to regard to RED\DRI studies, several models are under review for application with intent to apply at least two models as verification of estimates and reasonableness of findings.

d. Damage\Engineering event models and linkages to economic and engineering models for Initial Scenario-Based Geospatial Economic Assessments. Once the Economic and Flood Damage models are integrated and reconciled over the GNO geographic region, comparisons can be developed against base mapping to evaluate structural damage relative to locale, nature of occurrence, and extent. The base mapping developed in Task 2 when linked with the various engineering models will not only allow better estimation of direct costs to the Greater New Orleans region but can also be linked to national I/O models and other economic multiplier approaches for estimation of direct, indirect, and induced impacts at the local, regional and national level to the extent they apply. The task also requires additional datasets on other items, such as wind damage models, to be incorporated in the economic evaluation process.

e. Presentation of Study Findings; Identify and discuss differences between catastrophic and non-catastrophic system events and what are the issues associated with applied or adapted methodologies, models or procedures. Discussions of second and third order effects, such as business reestablishment or changing investment needs in a regional and multi-regional or national context; explain potential variance or range(s) in the values for estimation(s) and explain study limitations.

The report will discuss lessons learned concerning the development of studies for impact of Hurricane Katrina, and present in summary tabular form the valuations for economic impacts. There will be some discussion on the study’s limitations relative to time and data availability as well as interpretation of results.

2.4.9.1.2 Anticipated Products

A report outlining the economic consequences of various items related to the Hurricanes in the New Orleans area and the resultant economic damage to the local, regional and national economies.

1. A review of non-traditional flood damage assessments, including navigation and transportation disruptions, resulting from catastrophic failures
2. Clearly defined framework for data integration process related to developing project level enterprise GIS for economic analysis
3. Review of linking non-traditional elements in flood damage assessment studies to multiuse or multipurpose projects
4. Development of regional enterprise GIS datamart structure for planning and project review purposes

2.4.9.2 Social consequences and consequences to cultural and historical aspects

The purpose of this subtask is to describe the social, cultural and historic consequences of Katrina. The impacts upon the population of New Orleans, upon its communities, and upon its institutions will be described.

2.4.9.2.1 Approach

Demographic and community data will be used to describe New Orleans before Katrina. The changes in these characteristics of New Orleans attributable to Katrina will then be gathered and compared to the baseline. Immediate, short-term and long-term impacts will be assessed (within the time constraints of the study). The study will focus on New Orleans; however, the consequences of evacuated populations on key cities and towns in the region will be described. A small team of Corps social scientists will conduct the study and will take the fullest possible advantage of related research by other agencies and institutions.

2.4.9.2.2 Products

A report will be produced documenting the study methods and results. The results will be reported in narrative and with ample tabular and graphic displays to summarize the data. The report will contain an executive summary and an appendix of talking points. As an option, a slideshow will be prepared if there is a need at the study's completion

2.4.9.3 Environmental consequences

The purpose of this subtask is to investigate environmental impacts originating from the failure of the levee system to perform as designed around New Orleans and 4 nearby parishes during Hurricane Katrina. The subtask study is needed to determine the extent to which flooding of areas in New Orleans and its urban proximity resulting from demonstrated failure of the levee design may have had significant consequences for environmental resources and significant implications for environmental benefits. This subtask will require the combined efforts of ERDC and IWR with ERDC labor and facilities providing a large fraction of the total resource requirement.

2.4.9.3.1 Work Tasks

a. Data Consolidation and Analysis. The purpose of this step is to inform decisions about the need and specific nature of subsequent steps in this subtask. Existing data gathered from all credible sources and new data relevant to this task purpose will be gathered, consolidated, and analyzed for its environmental implications. The results of the data analysis and recommendations about pursuing subsequent steps will be reported within 30 days of subtask initiation. This subtask step will focus on environmental contaminants, shellfish status, wetland vegetation mortality, wildlife disease transmission and debris disposal. It includes data on water and sediment chemistry and ecological resource condition within the area potentially impacted by levee breaching including the New Orleans, Lake Pontchartrain, Lake Borgne, and St. Bernard Parish. The activities include search, acquisition, screening (for quality), and geographically linking data (with respect to impact sources and manifestation). Data will be limited to that pertaining to chemical and bacterial contamination in waters, suspended sediment, and living organisms and to other damages resulting in ecological resources from the need to pump floodwaters out of New Orleans (which includes purposeful breaching of levees protecting St Bernard Parish). Extent of freshwater wetland mortality from saltwater intrusion in St. Bernard Parish will be analyzed using existing remote sensing data. Any existing data also will be gathered and analyzed for possible transmission of disease and other safety concerns from urban wildlife or invasive non-urban wildlife (e.g., poisonous snakes). New sediment contamination data are crucial for habitats in the vicinity of pumped floodwater outfalls. Because of lags in contaminant transfer from habitat to living populations future contamination of resource populations is possible even if existing data show otherwise. Absence of sediment contamination in Lake Pontchartrain and other habitats in the vicinity of pumped water outfalls would indicate low probability for future contamination of important ecological resource populations. Site visitation to freshwater wetlands exposed to salt water provides needed "ground truth" data to complement aerial imagery and an opportunity to possibly verify water quality changes, if done quickly enough. Data useful for economic and health and safety analyses will be shared with those responsible for those subtasks.

b. Resource Impact Assessment: This step involves refinement of an assessment plan based on the results of Step 1, if it proves necessary to investigate environmental impacts further. It includes gathering additional data on contamination of sediments and associated small organisms, further analysis of data on St Bernard Parish wetlands, finfish and shellfish community contamination, endangered fish population status, and fish community health. All or some of these activities would be pursued only if the search for existing data and its analysis reveal a need to go further. Budget estimates are preliminary and based on the need to fully investigate each area as understood at this time. If existing data prove inadequate, new data collection on fish contamination is proposed for those metals and organics most likely to have originated from the pumped floodwaters of New Orleans. Evaluation of fish health consistent with anticipated impacts of contamination is proposed to estimate future population changes and resource utility changes (e.g., harvest closures). Information on shellfish and finfish meat contamination is relevant to future possible fisheries closures and fish health. Sampling of endangered pallid and gulf sturgeon in the vicinity must be limited to population status to avoid sacrifice of individuals. Sampling of non-endangered fishes with similar trophic position in the ecosystem would be used as an indicator of sturgeon contamination. There may be no need for endangered fish sampling if there is no indication of contamination in the sediment and other fish species.

c. Contaminant transport/fate model calibration and application. The purpose of calibrating and applying a contaminants transport and fate model is to link sources of contamination in the flooded area of New Orleans to resource contamination (determined in step 1 and 2) in ecosystems receiving pumped flood waters—primarily Lake Pontchartrain. There may be no need to apply the model without evidence of contamination of sediments in Lake Pontchartrain habitats and/or in resource species (subtask progress review will help with this decision). The three activities associated with the model include estimating model contaminant source terms, model application to the New Orleans floodwaters, and model application to Lake Pontchartrain. Source terms can be estimated using existing sediment and water quality data in the flood waters, if it is detailed enough, or by gathering data on contaminant/pathogen sources and estimating transfer to the flood waters based on oxidation-reduction and other existing environmental information (see step 4). These source terms are contaminant fluxes or concentrations that will be used as contaminant input boundary conditions in the model. Various techniques will be applied, including partitioning relationships, fugacity modeling, and application of a simplified contaminant fate model for inundated contaminated sediments.

A spatially explicit numeric model will be used to determine the transport and fate of contaminants and pathogens first in the flooded area and then in the waters receiving pumped floodwater. Calibration of the model will produce a tool that can be used to evaluate the location and amount of water and sediment contamination in relation to flood levels, levee repairs, and meteorological events. The model will be driven by a hydrodynamics model of appropriate dimensions and grid cell sizes for both the flooded area (one activity) and Lake Pontchartrain (a separate activity including linkage to the flood water model). The floodwater and lake models will be linked to ecological resource contaminant models to track fates into resource tissues (fish). The activities include confirmatory sampling and analysis to validate predicted mobility and deposition of contaminants and pathogens.

d. Determine mechanisms for contaminant release. The two activities proposed here assess the transfer of contaminants and pathogens from sources in the flooded zone to flood waters either in the absence of sufficient water and concentration data or in a separate evaluation of materials transport. Existing published data indicate that metal contamination was significant with respect to its impacts on fish resource populations once exposed. However, those data were not gathered to precisely assess distributions through time and space in the floodwaters and may not be representative of the actual contaminants and pathogen loads transported into receiving waters via the floodwater pumps. These additional analyses will aid evaluation of the adequacy of existing data and interpretation of model predictions. There is no need for these data and analyses if analysts can confidently conclude that there is no significant contamination of the resource populations or their sedimentary habitat/food sources.

e. IWR analysis of environmental benefits. This activity requires about four weeks to evaluate data and analyses of resource condition produced at ERDC and on other independently gathered information. It is the final step in environmental analysis. It will focus on the extent of environmental impact on scare ecological resources not amenable to economic valuation, such as the endangered fish and related impacts in wetlands damaged by salt intrusion following levee breaching.

f. IWR Coordination/administration. This step includes coordination of IWR with ERDC on all aspects of data gathering, analysis, and reporting, as well as coordination among subtask groups. This cost will vary somewhat in amount depending on the actual effort at and output from ERDC.

2.4.9.3.2 Anticipated Products

1. Reports/Appendices
    - *a.* Ecological resource summary of existing data (ERDC)
        - i. Contamination status if possible to determine
        - ii. Resource abundance status if possible to determine
        - iii. Recommendation to proceed or not to next steps
    - *b.* Levee failure impact on ecological resources (ERDC-if study proceeds)
    - *c.* Levee failure impact on environmental benefits (IWR)

2. Calibrated Contaminants Fate Model (if study proceeds that far)
3. Databases used for report determinations (in requested formats)

2.4.9.4 Human health, including psychological, and safety consequences

Objective and Scope of Work: Identify, characterize and quantify the most significant human health (physical and mental) and safety impacts and risks from Katrina flooding scenarios in greater New Orleans. The scenarios considered will include the actual flood event, the hypothetical flood event that would have occurred if the flood control infrastructure worked as planned, and possibly other hypothetical flood scenarios. Each scenario will need to reflect post-flood population evacuation, return and permanent displacement; repair and rebuilding; and living conditions that bear on human health and safety moving forward.

2.4.9.4.1 Analytical Approach

Identify and characterize major potential health and safety risks and impacts of flooding, and compile data on potentially exposed populations, observed impacts, and exposure and risk parameters. Incorporate the data into a database and software platform that can used to quantitatively estimate immediate, short and possibly long term impacts and elevated risks to exposed populations of Katrina flooding scenarios as measured against a "no flooding" reference condition.

2.4.9.4.2 Sub-Task Activities:

a. Risk-based screening & prioritization/Development of analytical framework. Identify and characterize health and safety impacts and risks potentially resulting directly (e.g., exposure to floodwaters) or indirectly (e.g., repair and rebuilding) from flooding scenarios. This will consider potential impacts and risks relating to 1) accidental injury and death, 2) individual mental health, and resulting health and safety consequences for others, 3) loss of health care resources, 4) biological risks, and 5) chemical risks. Develop and use a risk-based screening platform to prioritize the specific health and safety risks and impacts that will be the focus of assessment (e.g., develop and apply criteria on severity, duration and potential populations at risk). Once accomplished, develop an analytical framework & identify data needs and potential sources. This task is needed to determine the focus and scope of the study (e.g., determine whether study should focus only on immediate and short term impacts and risks), and inform database and model development.

b. Compile data on potentially affected populations. Identify and characterize various populations and different subgroups potentially exposed to the different health and safety risks and impacts, including their demographic and general health and safety profiles. This task is needed to determine the potentially many different population subgroups for which exposure, risk and impact assessments will be required to estimate incidence of different health and safety endpoints.

c. Compile data on baseline exposures, impacts and risks. Compile the data and information needed to estimate baseline (no flooding) public health and safety exposures, risks and incidence for each of the populations potentially exposed to and impacted by the different health and safety risks. This will rely on health surveillance data on baseline incidence, exposure and risk assessment combined with parameters (e.g., dose-response coefficients) from epidemiological and clinical studies. This task is needed to provide the data required to establish the reference condition from which the health and safety risks and impacts of flooding scenarios will be assessed.

d. Compile data on flood scenarios exposures, impacts and risks. Compile the data and information needed to estimate human health and safety exposures, risks and impacts in the flooding scenarios. This will rely on a combination of actual impact data from post-event health surveillance as well as human health exposure and risk assessments using parameters (e.g., dose-response coefficients) from epidemiological and other studies. This task is needed to provide the data required to establish health and safety risks and impacts corresponding to flooding scenarios

e. Develop database and software platform for estimating health impacts and risks. Using the data compiled in Tasks 2-4, develop a database and software platform that can be linked alternative flooding and evacuation scenarios (that depict flood timelines, depths and affected areas) and used to rapidly calculate increased incidence of human health and safety impacts resulting from those scenarios. This task is needed to estimate health and safety risks and impacts from the actual flood event and alternative flood scenarios.

2.4.9.4.3 Data Requirements

Include but not limited to:

a. Interior drainage models outputs (flooding when and where)

b. Census block data and demographic profiles

c. Clean-up and repair activities and workforce

d. Pre- and post-event evacuees and returnees by area

e. Biological and chemical contaminants in floodwaters, human exposure pathways and health endpoints

f. Baseline health and safety profiles; surveillance monitoring of observed health and safety impacts

g. Pre and post-flood health and safety resources (e.g., hospitals, health inspectors)

h. Residents facing and not facing permanent or long term displacement from homes, by area.

i. Infrastructure and materials damages and associated safety hazards

j. Epidemiological evidence on health and safety risks from past hurricanes, other events; exposure and risk parameters for health and safety risks and impacts.

2.4.9.4.4 Anticipated Products

a. A database and software platform that can be used in Task 10 to provide insight into potential human and health and safety risks before and after permanent repairs/improvements are made to NO hurricane protection system,

b. Documentation for the database and software platform that describes its development, operation, and use

c. Report providing estimates of health & safety impacts and risks under alternative flood scenarios.

2.4.10 Engineering and Operational Risk and Reliability Analysis – Task 10

This analysis is needed to assess the overall risk of the various floodwalls, levee, pumping station and other hurricane protection features working together as an integrated system. All engineered systems impose risks that result from humans using technology to create conditions or activities that are not produced by nature. For instance, the hurricane protection system in New Orleans controlled interior flooding and provided protection to the city from storm surges and waves beyond what occurs naturally. A safe hurricane protection project is one that performs its intended functions without imposing unacceptable risks to public safety, property and welfare.

For example, to assess the risks of having evacuees return to the city of New Orleans after Hurricane Katrina we need to make sound decisions about the integrity of the hurricane protection features, acting together as an integrated system, by answering the question,

- “What can go wrong?”

And the companion questions,

- “How likely is that to occur?”
- “What are the consequences?”

Using an engineering or operational standard we can only answer the question

- “What can go wrong?”

We need the unified framework of a reliability and risk analysis to fully evaluate performance during and after Hurricane Katrina.

This task will examine the risks to life and property posed by the New Orleans hurricane protection system prior to Katrina and by the system as it exists in its current condition. The risk analysis will consider the expected performance of the various elements of the system and the consequences associated with that performance. The condition of the system has been degraded by the effects of hurricane Katrina. The levees may have been overtopped, damaged by impacts from debris, saturated, submerged and/or breached. Flood walls have also been damaged by the storm. Emergency or permanent repairs on many of these elements have been accomplished since the hurricane. Some levee and flood wall repairs are temporary and some emergency equipment repairs were performed on older elements for which parts may not have been available. The pumping system was also damaged and shut down or submerged. The function of the pumping system during the storm, while not part of the protection system, is important to reduce flooding during and after a storm. The post Katrina reliability of the levees, flood walls and pumping stations will be considered in the risk assessment. The reliability of the various elements of the protection system will be determined using analytical and expert elicitation methods.

The effectiveness of the protection system is dependent upon how well the operational elements of the system performed. Elements such as road closure structures, gate operations and pumping plants, etc. that requires human operation and proper installation during a flood fight can dramatically impact flood levels. The lessons learned concerning the performance of these elements during Katrina will be considered in the analysis.

Another element that affects consequences, especially loss of life, is the effectiveness of the evacuation plans. The pre-Katrina risk will be calculated based on the evacuation plan that was in place before the hurricane struck. The residual risks associated with the post-Katrina protection system will also assume that the evacuation plan will be fully implemented.

The changed demographics of the local areas protected by the system will be considered when determining the consequences in Task 9. In some areas, many homes and much of the infrastructure were destroyed by the hurricane and some may not be rebuilt. Therefore the pre-Katrina populations and property values will be impacted and must be considered in the post-Katrina analysis. Another element that affects consequences, especially loss of life, is the effectiveness of the evacuation plans. The pre-Katrina risk will be calculated based on the evacuation plan that was in place before the hurricane struck. The residual risks associated with the post-Katrina protection system will also assume that the evacuation plan will be fully implemented.

The reliability and risk analysis will relate the performance of individual features (floodwalls, levees, pumps, etc.) located throughout the hurricane protection system to the overall performance of operating the integrated system. This will require analysis of three states that represents the condition of the hurricane protection system.

- Before the arrival of Hurricane Katrina. This state will be the baseline for estimating risk.
- After Hurricane Katrina
- During the interim recovery period after the hurricane protection features are repaired or improved to be more damage resistant.

The difference in relative risks among the three states will be a unified measure for fully evaluating the performance of the integrated system before Hurricane Katrina, after Hurricane Katrina, and during the interim recovery period.

2.5 Management and Reporting

This task involves the overall management of the performance evaluation and an independent review effort that will include consolidation of the reports and report preparation, project coordination, communications with the media and public, and other public affairs efforts.

2.6 Interrelation of Work Items

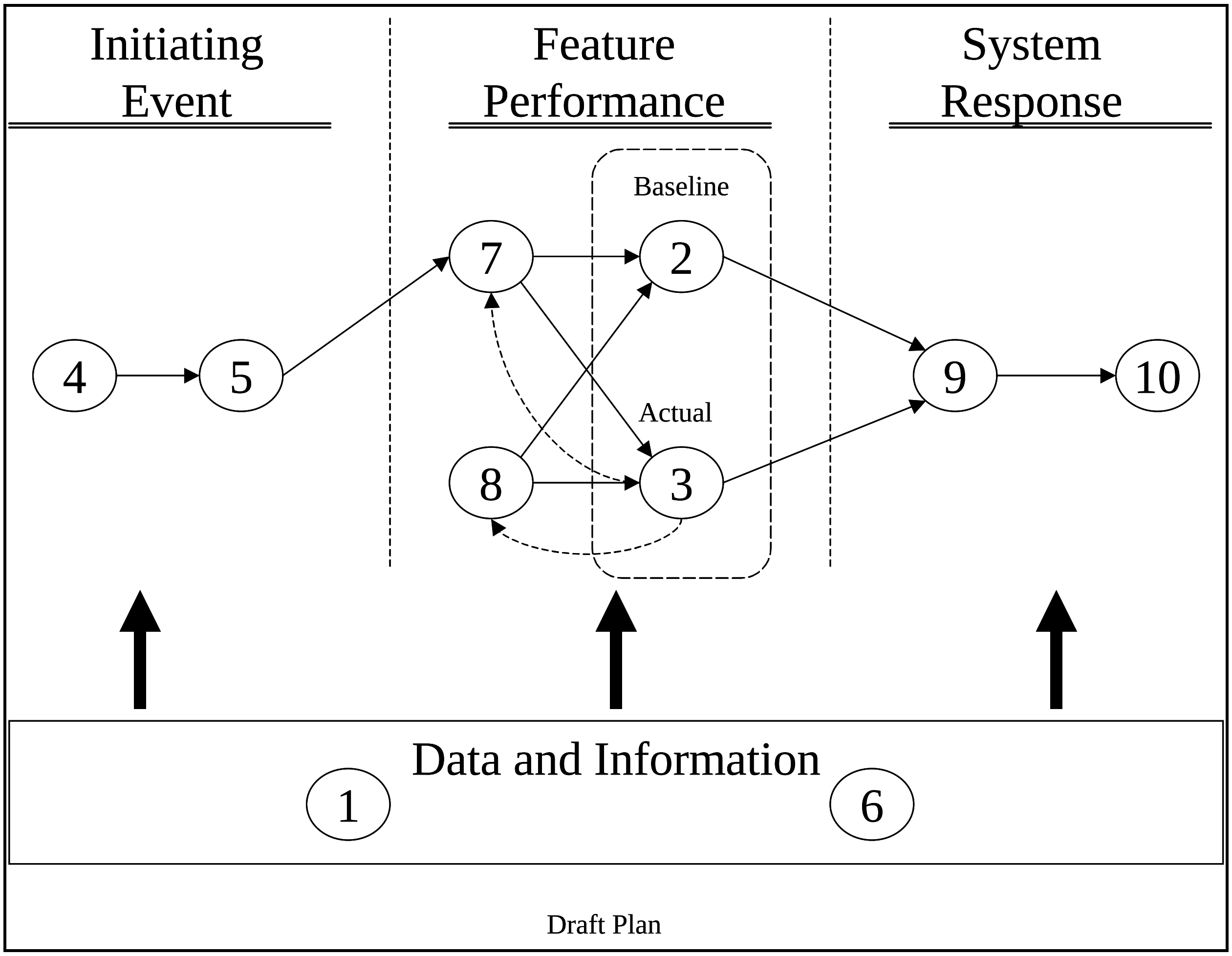


Figure C-1. Evaluation Framework

3 Team

3.1 Overview

The assembly of professionals to accomplish the IPET effort is both unusual and unprecedented. Only experts have been solicited in any particular field that is a part of IPET. The robust IPET team, which numbers some 150 scientists and engineering professionals, is in large part a "virtual" project delivery team (PDT)—that being a team whereby its personnel are geographically located across the United States, and in a few instances, located across the globe.

3.2 Participating Organizations

- United States Army Corps of Engineers
- American Society of Civil Engineers
- National Research Council
- National Oceanic & Atmospheric Administration
- United States Department of Agriculture
- United States Bureau of Reclamation
- Federal Emergency Management Administration
- Steedman & Associates, LTD
- Rensselaer Polytechnic Institute
- GeoDelft (the Netherlands)
- University of Florida
- Georgia Institute of Technology
- Utah State University
- Stanford University
- Harris County Flood Control District (Texas)
- Virginia Polytechnical Institute
- South Florida Water Management District
- University of Maryland
- Pennsylvania State University
- University of Notre Dame

3.3 IPET Team Hierarchy

Item	Task Force	Leader
	Project Director	Ed Link - HQUSACE
	Technical Director	John Jaeger - CELRH
	Project Manager	Jeremy Stevenson - CELRH
	Team	**Co-Leaders**
1a	Perishable Data	Reed Mosher - ERDC-GSL
1b	System Data	Denise Martin - ERDC-ITL
2	Baseline Interior Drainage Numerical Model	Jeff Harris - IWR-HEC & Steve Fitzgerald of the Harris County Flood Control District
3	Interior Drainage Numerical Model	Jeff Harris - IWR-HEC & Steve Fitzgerald of the Harris County Flood Control District
4	Numerical Model of Hurricane Katrina	Bruce Ebersole - ERC-CHL & Joannes Westerink - University of Notre Dame
5a	Storm Surge & Wave Physical Model - Hydrodynamic Forces	Don Resio - ORDC-CHL & Robert Dean - University of Florida
5b	Storm Surge & Wave Physical Model - Centrifuge Breaching	Mike Sharp - ERDC-CHL & Scott Steedman - Steedman & Associates, LTD
6	Geodetic Vertical Survey Assessment	Jim Garster - ERDC-TEC Bill Bergen - HQUSACE Dave Zilkoski - NOAA
7	Analysis of Floodwall and Levee Performance	Reed Mosher - ERDC-GSL & Michael Duncan - Virginia Polytechnic Institute
8	Pumping Station Performance	Brian Moentenich - CENWP-HDC & Bob Howard - South Florida Water Management District
9	Consequence Analysis of Hurricane Katrina	Dave Moser - IWR & Patrick Canning - USDA
10	Engineering and Operation Risk and Reliability Analysis	Jerry Foster - HQUSACE Bruce Muller - USBR
Note: Teams 2-10 have interagency co-leaders		

Interagency Performance Evaluation Task Force (IPET) Leaders

Project Director

Dr. Lewis E. (Ed) Link is a Senior Fellow in the R.H. Smith School of Business and Senior Research Engineer in the Department of Civil and Environmental Engineering, University of Maryland. He is also a senior consultant to Toffler Associates where he is engaged in strategic and future studies in government and industry. Dr. Link was a senior executive in various research and development positions in the U.S. Army Corps of Engineers from 1986 to 2002, rising to the position of Director of Research and Development. His varied engineering expertise includes emphasis on water resources. He received his B.S. in geological engineering from North Carolina State University, his M.S. in civil engineering from Mississippi State University, and his Ph.D. in civil engineering from Pennsylvania State University.

Technical Director

Dr. John Jaeger is Chief of the Engineering and Construction Services Division of the Huntington (WV) District, U.S. Army Corps of Engineers. He directs a staff of 225 and is the senior civilian responsible for design, construction, dam safety, water management, flood protection, and environmental enhancement and restoration projects in a 45,000-square-mile area. Dr. Jaeger has 25 years of experience in research, design, construction, review and evaluation of water resource and construction projects; he has also worked hurricane response and recovery missions. He received his B.S. and M.S. in civil engineering/structural engineering from the University of Missouri at Rolla, a M.B.A. from Nova Southeastern University, a M.A. in strategic studies from the Army War College, and his Ph.D. in engineering from The Ohio State University.

Project Manager

Jeremy Stevenson is a civil engineer in the Cost Engineering Section of the Huntington (WV) District, U. S. Army Corps of Engineers. His expertise is in cost engineering and project management for large civil works projects, including all phases of life cycle cost estimating, project scheduling and management. He has life cycle cost engineering expertise on navigational locks, dams, floodwalls, levees, and nonstructural flood proofing. Stevenson received his B.S. in civil engineering from the West Virginia Institute of Technology and his M.S. in engineering from Marshall University.

Task Team Co-leaders

Data Collection and Management Team

Denise Martin is a computer scientist at the U.S. Army Engineer Research and Development Center. Her research expertise is focused on the development of information sharing architectures involving key issues of information portability, modularity, scalability, and interoperability. She has been actively involved in requirements identification and analysis, development, enhancement, and implementation of Computer-Aided Drafting and Design (CADD), Geographic Information Systems (GIS), and relational database management as they apply to business, engineering, management and research and development projects within the Corps of Engineers and other federal, state, and local government organizations. Martin has a B.S. in mathematics and computer science and a M.S. in computer science, all from Mississippi State University.

Dr. Reed L. Mosher is a Senior Scientific Technical Manager at the U.S. Army Engineer Research and Development Center. He directs complex theoretical and applied research programs to develop advanced survivability and protective technologies for U.S. forces. He was involved in the assessment of bombing attacks at Oklahoma City, Khobar Towers (Saudi Arabia), and the U.S. embassies in East Africa. He has directed research and development related to the dynamic response of structures to blast and shock from conventional and nuclear weapons, seismic effects from earthquakes, and hydraulic loads from fluid flow. Dr. Mosher earned his B.S. in civil engineering from Worcester Polytechnic Institute, his M.S. in civil engineering from Mississippi State University, and his Ph.D. in civil engineering from Virginia Polytechnic Institute and State University.

Geodetic Vertical and Water Level Datum Assessment

James Garster is team leader in the Geospatial Applications Branch at the U.S. Army Engineer Research and Development Center. He is also coordinator for the U.S. Army Corps of Engineers

Surveying and Mapping Community of Practice. Garster assists Corps offices across the country with surveying and mapping support. As a member of the Federal Geodetic Control Subcommittee, Vertical Reference Systems Group, his is assisting with implementation of NAVD88 datum and is devising procedures to meet geodetic vertical requirements using the Global Positioning System. He earned his B.S. in mathematics from the University of Rhode Island and his M.S. in survey engineering from the University of Maine.

David Zilkoski is the Director of the National Geodetic Survey, National Ocean Service, National Oceanic and Atmospheric Administration (NOAA). He has been with NOAA since 1974. Zilkoski has overseen the development and technology transfer of new technologies, including the Shallow Water Positioning System, the incorporation of geodetic data and procedures to determine accurate elevation models, and the use of GPS, LIDAR and IFSAR to generate shoreline and other coastal information. He has authored numerous publications on coastal subsidence, surveying, and vertical datum issues. Zilkoski received a B.S. in forest engineering from Syracuse University and an M.S. in geodetic science from The Ohio State University.

Hurricane Surge and Wave Analysis

Bruce Ebersole is Chief of the Flood and Storm Protection Division at the .S. Army Engineer Research and Development Center. He directs basic and applied research and engineering studies in the areas of coastal and estuarine hydrodynamic and sedimentation processes, field data acquisition, and hydrology/surface water/groundwater interactions. Ebersole's personal research career has focused on tidal circulation, storm surge, nearshore wave transformation, and beach/inlet processes with a focus on numerical model development and application. He earned both his B.S. in civil engineering and his M.S. in civil engineering (with emphasis on coastal engineering) from the University of Delaware.

Dr. Joannes Westerink is an associate professor in Civil Engineering and Geological Sciences at the University of Norte Dame. He is the co-developer of the advanced circulation model, ADCIRC, and has extensive research and engineering expertise in hurricane storm surge prediction, tidal hydrodynamics, modeling of circulation and transport in coastal areas and oceans, finite element methods, and computational fluid mechanics. Dr. Westerink received his B.S. and M.S., both in civil engineering, from the State University of New York at Buffalo and his Ph.D. in civil engineering from the Massachusetts Institute of Technology.

Hydrodynamic Forces Analysis

Dr. Robert Dean is an Emeritus Graduate Research Professor in the Civil and Coastal Engineering Department at the University of Florida. He is a national expert on beach erosion problems, wave theories, tidal inlets and coastal structures. In 2005, Dr. Dean chaired the National Research Council Committee on the Restoration and Protection of Coastal Louisiana. He received his B.S. in civil engineering from the University of California at Berkeley, his M.S. in physical oceanography from Texas A&M University, and his Ph.D. in civil engineering from the Massachusetts Institute of Technology.

Dr. Don Resio is a Senior Technologist at the U.S. Army Engineer Research and Development Center. He has been involved with performing and directing engineering and oceanographic research for more than 30 years. Dr. Resio is the technical leader for the Coastal Military Engineering Program. He directs the Corps of Engineers MORPHOS project aimed at improving the predictive state of the art for winds, waves, currents, surges, and coastal evolution due to storms. He is the leader of the Risk Analysis team for the Louisiana Coastal Protection and Restoration program. Dr. Resio is also the biannual co-organizer of the International Workshop on Wave Prediction and Hindcasting. He earned his B.A., M.S. and Ph.D. from the University of Virginia.

Geotechnical Structure Performance Analysis

Dr. Michael Sharp is the Technical Director for Civil Works Infrastructure at the U.S. Army Engineer Research and Development Center (ERDC). He has over 20 years experience in earthquake engineering, soil dynamics, engineering geophysics and centrifuge modeling. Dr. Sharp was previously the Director of the Centrifuge Research Center at ERDC. He earned a B.S. in biology from the University of Mississippi, a B.S. in civil engineering from Texas A&M University, a M.S. in civil engineering from Mississippi State University, and his Ph.D. from Rensselaer Polytechnic Institute.

Dr. Scott Steedman is a civil engineer and consultant based in London and is an expert in physical scale modeling of geotechnical problems. He and his scientific and engineering staff at Steedman & Associates Ltd. specialize in risk and disasters, forensic investigations, and urban engineering and research. Formerly a Fellow of St. Catharine's College and lecturer at Cambridge University, he was director of engineering for Sir Alexander Gibb and Partners and latterly director of civil engineering for designers Whitby Bird and Partners. Dr. Steedman received his B.S. from Manchester University and his M.S. and Ph.D. from Cambridge University, England.

Floodwall and Levee Performance Analysis

Dr. J. Michael Duncan is a University Distinguished Professor and Director of the Center for Geotechnical Practice at Virginia Polytechnic Institute and State University. His research interests have focused on slope stability, soil-structure interaction, design and analysis of foundations, strength and deformation properties of soils, finite element analyses of stresses and deformations in earth masses, and seepage through soil. He has authored more than 200 publications in the area of geotechnical engineering. Dr. Duncan received his B.S. and his M.S. from the Georgia Institute of Technology and his Ph.D. from the University of California at Berkeley.

Dr. Reed L. Mosher is a Senior Scientific Technical Manager at the U.S. Army Engineer Research and Development Center. He directs complex theoretical and applied research programs to develop advanced survivability and protective technologies for U.S. forces. He was involved in the assessment of bombing attacks at Oklahoma City, Khobar Towers (Saudi Arabia), and the U.S. embassies in East Africa. He has directed research related to the dynamic response of structures to blast and shock from conventional and nuclear weapons, seismic effects from earthquakes, and hydraulic loads from fluid flow. Dr. Mosher earned his B.S. in civil engineering from Worcester Polytechnic Institute, his M.S. in civil engineering from Mississippi State University, and his Ph.D. in civil engineering from Virginia Polytechnic Institute and State University.

Pumping Station Performance Analysis

Robert Howard is Director of Operations for the South Florida Water Management District, which includes hurricane and flood protection for the Miami and Dade County area. He has been working in the water management field since 1988. Howard provides operational control and monitoring of water control structures and water bodies for flood control, water supply and environmental enhancement. He leads an operational planning team that investigates potential areas of operational flexibility as well as operation of the district's emergency Operations Control Center, meteorological analysis section, communications and computer control system, and a real-time decision support system. Howard earned his B.S. in civil engineering from the University of Florida and his M.S. in civil engineering from the Georgia Institute of Technology.

Brian L. Moentenich is the national mechanical design expert for hydroelectric and large pump houses for the U.S. Army Corps of Engineers. Working in the Hydroelectric Design Center at the Corps' Portland District, he has more than 31 years experience in design, acquisition, installation, testing and repair/rehabilitation of large hydro-turbines and pumps. Since the Corps owns and operates some of the largest pumps in the world to supply attraction water for salmon in the Pacific Northwest, Moentenich has been involved in the inspection, testing and repair of pumps that are rated at more than twice the capacity of the largest pump in the New Orleans/Southern Louisiana area. He received his B.S. in mechanical engineering and applied science from Portland State University and his M.S. in mechanical engineering from The Ohio State University.

Interior Drainage/Flooding Analysis

Steve Fitzgerald is the Chief Engineer for the Harris County Flood Control District, which encompasses the Houston, TX, metro area. He developed and updates the district's Policy, Criteria, and Procedure Manual and is currently managing the comprehensive district's Urban Stormwater Management Study. Fitzgerald also serves as the manager of the Harris County Flood Control District's flood watch and information program, which monitors and evaluates actual flood events. He received a B.S. in civil engineering from Stanford University and a M.S. in civil engineering from the University of Illinois at Urbana-Champaign.

Jeff Harris is the Chief of the U.S. Army Corps of Engineers' Hydrology and Hydraulics Technology Division, Institute for Water Resources, Hydrologic Engineering Center (HEC), at Davis, CA. He is responsible for overseeing the development, training and application of various HEC developed models, including HEC-RAS (one-dimensional steady and unsteady flow applications), HEC-HMS (event and continuous simulation rainfall-runoff), Geo-HMS (a GIS pre-processor for HMS), GeoRAS (GIS pre- and post-processor for RAS) and HEC-SSP (new frequency analysis application). Harris supervised the development of hydraulic models for studies of California's Central Valley after the January 1997 floods and has worked as the Corps liaison with the California Department of Water Resources in multiple flood events. He received his B.S. in atmospheric science from the University of California at Davis.

Consequence Analysis

Dr. Patrick Canning is a Senior Economist at the Economic Research Service, U.S. Department of Agriculture. His research emphasizes economic systems modeling with a recent focus on the geography of U.S. food distribution. Dr. Canning co-developed a multiregional applied general equilibrium model of the U.S. economy for analysis of food markets. His contributions in applied mathematical programming are being used to facilitate analysis that links multiregional economic flow accounts to physical process models, such as disease spread or freight routing models. He received B.S. and M.S. degrees in agricultural and resource economics at the University of Maryland and his Ph.D. in economics from George Washington University.

Dr. David A. Moser is the Chief Economist for the U.S. Army Corps of Engineers and Senior Team Leader—Economics at the Institute for Water Resources where he conducts research in economic methods related to benefit-cost analysis and risk analysis methods for water resources. Moser was instrumental in developing the risk analysis procedures for major rehabilitation, flood damage evaluation, and dam safety programs and led the development of such risk assessment computer models as IWR-Repair, a hydropower major rehabilitation model, and NavSym, a navigation traffic simulation model. He is currently working on the development of a risk analysis model to evaluate hurricane protection and storm damage reduction benefits (Beach-*fx*). Moser received a B.A. in economics from Wittenberg University, a M.A. degree in economics from the University of Toledo, and a Ph.D. in economics from the University of Cincinnati.

Risk and Reliability Analysis

Jerry Foster is with Headquarters, U.S. Army Corps of Engineers. He has more than 34 years of experience in a broad range of structural engineering issues including risk and reliability analysis of civil works structures; design, evaluation and construction of dams, navigation and flood control structures; structural reliability of aging structures; computer analysis of civil works structures and the design of buildings. His experience includes more than 30 years with the U.S. Army Corps of Engineers. Foster earned his B.S. from the University of Maryland.

Bruce C. Muller, Jr. is the Chief of the Dam Safety Office for the Bureau of Reclamation. He is a national leader in the development and implementation of risk-based analysis methods for evaluating the safety of dams. He is responsible for the safety of more than 350 dams throughout the 17 western states. Muller also has 21 years experience in the design of dams. He received his B.S. in civil engineering at Purdue University and his M.S. in water resources management from Colorado State University.

3.4 ERP Team Hierarchy

ERP Leadership	**ERP Role**
David Daniel	ERP Chair
Lawrence Roth	ASCE Deputy Executive Director
John Durrant	ASCE Managing Director, Engineering Programs
ERP Member	**ERP Role**
Christine Andersen	Public Agency Representative
Jurjen Battjes	Hydraulics
Billy Edge	Coastal Engineering
William Espey	Hydrology
Robert Gilbert	Risk Management
Thomas Jackson	Pump Stations
David Kennedy	Public Agency Representative
Dennis Mileti	Consequence Analysis
James Mitchell	Geotechnical
Peter Nicholson	Geotechnical
Clifford Pugh	Hydraulics
George Tamaro	Soil-Structure Interactions
Robert Traver	Urban Drainage

4 Schedule

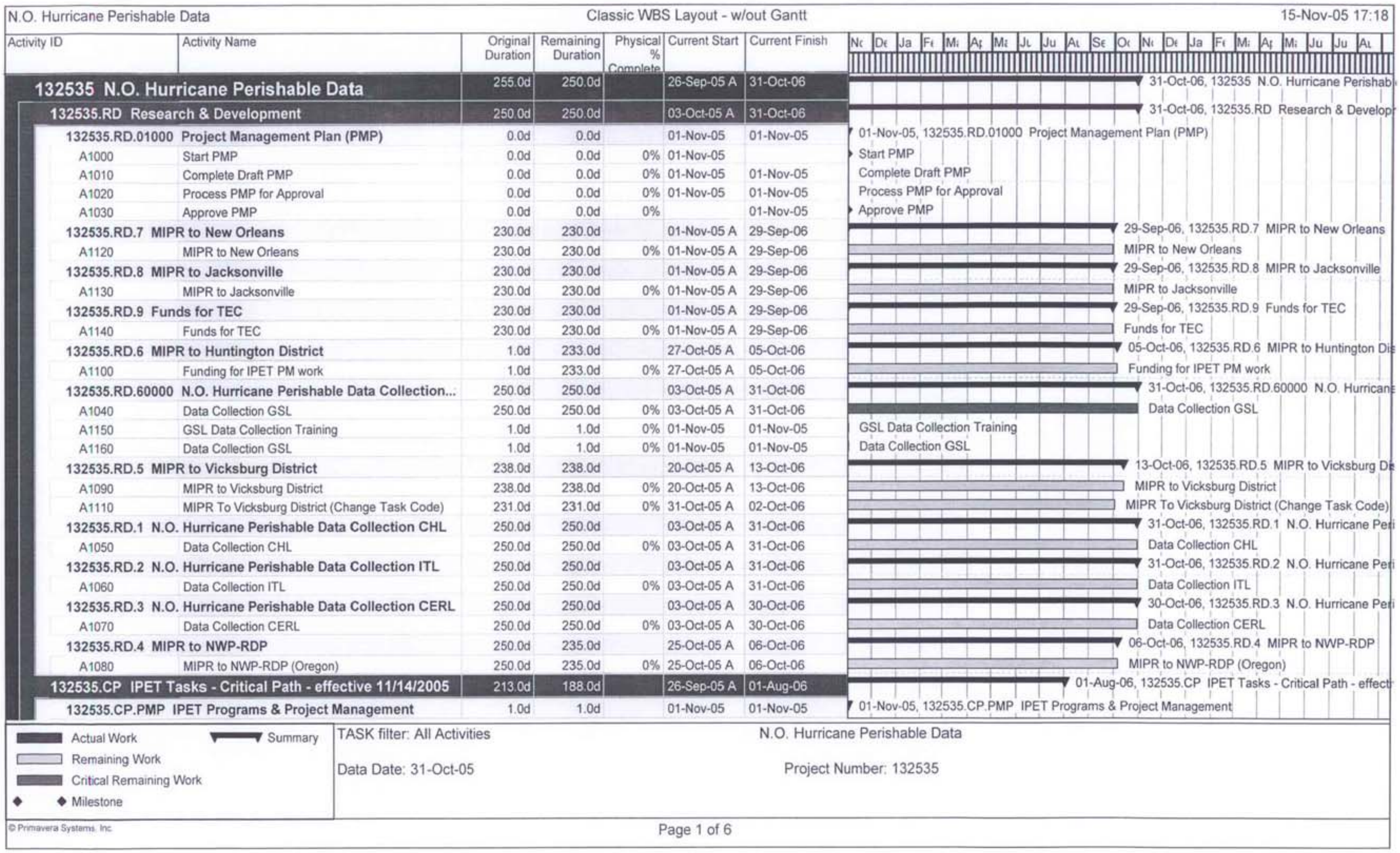
4.1 Schedule Development

The Primavera project schedule shown in Figure C-2 was developed to manage the very broad ranging scope of the Interagency Performance Evaluation Task Force (IPET). The schedule shall be used by the IPET management team in assessing the status of and maintaining progress for each of the IPET sub tasks and the IPET team's overall progress and goal of completing the Final IPET Report by June 1st, 2006. The IPET project schedule shall be maintained and managed by the IPET Project Manager and provided to the IPET Project Director, the IPET Technical Director and the IPET Co-Leads as updates are made on a bi-weekly basis or as directed. The Schedule was developed by the PM coordinating with all IPET Co-Leads for identification of their tasks' activities and inter-relationships to other tasks' activities. Activity durations and logic ties were made based on the input of the Co-Leads along with input by the Project and Technical Directors. It is important to note that the IPET schedule is fairly complex by the shear number of activities and ensuing logic ties and that a balance between developing the activities to a reasonable amount of detail should be achieved in order to most effectively manage the project.

4.2 Schedule Updating & Reporting

Protocol for Statusing IPET Schedule. In order to keep IPET schedule information current in P2, the IPET PM will generally employ a bi-monthly update cycle. The process will occur in the following manner:

- Every other week an email will be sent to the task leads and co-leads for Tasks 1-10 at the beginning of the scheduled update week.
- The email will contain a PDF of the full IPET schedule as well as a file containing activities specific only to the receiving tasker. Activities in the latter file which must be statused (i.e. anything scheduled to start or finish since the last update cycle) will be highlighted for quick visual reference.
- Task leads and co-leads should review and discuss the status of their activities.
- The project manager will contact each task lead (usually a few hours after emails are sent) to obtain the status of their activities. The call should take less than 15 minutes unless task leads have questions or wish to raise issues.



N.O. Hurricane Perishable Data — Classic WBS Layout - w/out Gantt — 15-Nov-05 17:18

Activity ID	Activity Name	Original Duration	Remaining Duration	Physical % Complete	Current Start	Current Finish
132535	**N.O. Hurricane Perishable Data**	255.0d	250.0d		26-Sep-05 A	31-Oct-06
132535.RD	**Research & Development**	250.0d	250.0d		03-Oct-05 A	31-Oct-06
132535.RD.01000	**Project Management Plan (PMP)**	0.0d	0.0d		01-Nov-05	01-Nov-05
A1000	Start PMP	0.0d	0.0d	0%	01-Nov-05	
A1010	Complete Draft PMP	0.0d	0.0d	0%	01-Nov-05	01-Nov-05
A1020	Process PMP for Approval	0.0d	0.0d	0%	01-Nov-05	01-Nov-05
A1030	Approve PMP	0.0d	0.0d	0%		01-Nov-05
132535.RD.7	**MIPR to New Orleans**	230.0d	230.0d		01-Nov-05 A	29-Sep-06
A1120	MIPR to New Orleans	230.0d	230.0d	0%	01-Nov-05 A	29-Sep-06
132535.RD.8	**MIPR to Jacksonville**	230.0d	230.0d		01-Nov-05 A	29-Sep-06
A1130	MIPR to Jacksonville	230.0d	230.0d	0%	01-Nov-05 A	29-Sep-06
132535.RD.9	**Funds for TEC**	230.0d	230.0d		01-Nov-05 A	29-Sep-06
A1140	Funds for TEC	230.0d	230.0d	0%	01-Nov-05 A	29-Sep-06
132535.RD.6	**MIPR to Huntington District**	1.0d	233.0d		27-Oct-05 A	05-Oct-06
A1100	Funding for IPET PM work	1.0d	233.0d	0%	27-Oct-05 A	05-Oct-06
132535.RD.60000	**N.O. Hurricane Perishable Data Collection...**	250.0d	250.0d		03-Oct-05 A	31-Oct-06
A1040	Data Collection GSL	250.0d	250.0d	0%	03-Oct-05 A	31-Oct-06
A1150	GSL Data Collection Training	1.0d	1.0d	0%	01-Nov-05	01-Nov-05
A1160	Data Collection GSL	1.0d	1.0d	0%	01-Nov-05	01-Nov-05
132535.RD.5	**MIPR to Vicksburg District**	238.0d	238.0d		20-Oct-05 A	13-Oct-06
A1090	MIPR to Vicksburg District	238.0d	238.0d	0%	20-Oct-05 A	13-Oct-06
A1110	MIPR To Vicksburg District (Change Task Code)	231.0d	231.0d	0%	31-Oct-05 A	02-Oct-06
132535.RD.1	**N.O. Hurricane Perishable Data Collection CHL**	250.0d	250.0d		03-Oct-05 A	31-Oct-06
A1050	Data Collection CHL	250.0d	250.0d	0%	03-Oct-05 A	31-Oct-06
132535.RD.2	**N.O. Hurricane Perishable Data Collection ITL**	250.0d	250.0d		03-Oct-05 A	31-Oct-06
A1060	Data Collection ITL	250.0d	250.0d	0%	03-Oct-05 A	31-Oct-06
132535.RD.3	**N.O. Hurricane Perishable Data Collection CERL**	250.0d	250.0d		03-Oct-05 A	30-Oct-06
A1070	Data Collection CERL	250.0d	250.0d	0%	03-Oct-05 A	30-Oct-06
132535.RD.4	**MIPR to NWP-RDP**	250.0d	235.0d		25-Oct-05 A	06-Oct-06
A1080	MIPR to NWP-RDP (Oregon)	250.0d	235.0d	0%	25-Oct-05 A	06-Oct-06
132535.CP	**IPET Tasks - Critical Path - effective 11/14/2005**	213.0d	188.0d		26-Sep-05 A	01-Aug-06
132535.CP.PMP	**IPET Programs & Project Management**	1.0d	1.0d		01-Nov-05	01-Nov-05

▬	Actual Work
▭	Remaining Work
▬	Critical Remaining Work
◆	Milestone
▼	Summary

TASK filter: All Activities

Data Date: 31-Oct-05

N.O. Hurricane Perishable Data

Project Number: 132535

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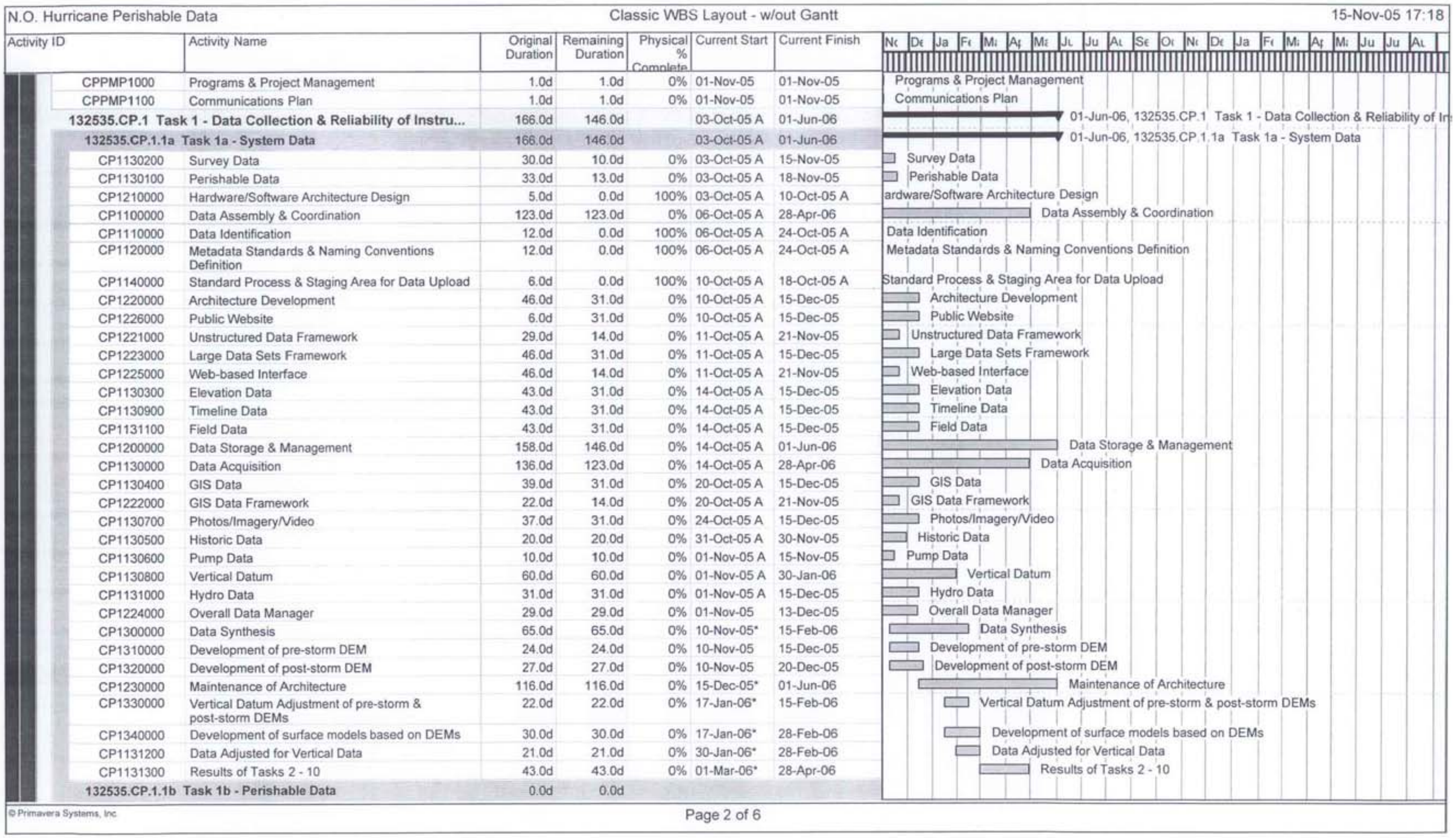
Figure C-2. Primavera Project Schedule (Sheet 1 of 6)



N.O. Hurricane Perishable Data — Classic WBS Layout - w/out Gantt — 15-Nov-05 17:18

Activity ID	Activity Name	Original Duration	Remaining Duration	Physical % Complete	Current Start	Current Finish
CPPMP1000	Programs & Project Management	1.0d	1.0d	0%	01-Nov-05	01-Nov-05
CPPMP1100	Communications Plan	1.0d	1.0d	0%	01-Nov-05	01-Nov-05
132535.CP.1	**Task 1 - Data Collection & Reliability of Instru...**	166.0d	146.0d		03-Oct-05 A	01-Jun-06
132535.CP.1.1a	**Task 1a - System Data**	166.0d	146.0d		03-Oct-05 A	01-Jun-06
CP1130200	Survey Data	30.0d	10.0d	0%	03-Oct-05 A	15-Nov-05
CP1130100	Perishable Data	33.0d	13.0d	0%	03-Oct-05 A	18-Nov-05
CP1210000	Hardware/Software Architecture Design	5.0d	0.0d	100%	03-Oct-05 A	10-Oct-05 A
CP1100000	Data Assembly & Coordination	123.0d	123.0d	0%	06-Oct-05 A	28-Apr-06
CP1110000	Data Identification	12.0d	0.0d	100%	06-Oct-05 A	24-Oct-05 A
CP1120000	Metadata Standards & Naming Conventions Definition	12.0d	0.0d	100%	06-Oct-05 A	24-Oct-05 A
CP1140000	Standard Process & Staging Area for Data Upload	6.0d	0.0d	100%	10-Oct-05 A	18-Oct-05 A
CP1220000	Architecture Development	46.0d	31.0d	0%	10-Oct-05 A	15-Dec-05
CP1226000	Public Website	6.0d	31.0d	0%	10-Oct-05 A	15-Dec-05
CP1221000	Unstructured Data Framework	29.0d	14.0d	0%	11-Oct-05 A	21-Nov-05
CP1223000	Large Data Sets Framework	46.0d	31.0d	0%	11-Oct-05 A	15-Dec-05
CP1225000	Web-based Interface	46.0d	14.0d	0%	11-Oct-05 A	21-Nov-05
CP1130300	Elevation Data	43.0d	31.0d	0%	14-Oct-05 A	15-Dec-05
CP1130900	Timeline Data	43.0d	31.0d	0%	14-Oct-05 A	15-Dec-05
CP1131100	Field Data	43.0d	31.0d	0%	14-Oct-05 A	15-Dec-05
CP1200000	Data Storage & Management	158.0d	146.0d	0%	14-Oct-05 A	01-Jun-06
CP1130000	Data Acquisition	136.0d	123.0d	0%	14-Oct-05 A	28-Apr-06
CP1130400	GIS Data	39.0d	31.0d	0%	20-Oct-05 A	15-Dec-05
CP1222000	GIS Data Framework	22.0d	14.0d	0%	20-Oct-05 A	21-Nov-05
CP1130700	Photos/Imagery/Video	37.0d	31.0d	0%	24-Oct-05 A	15-Dec-05
CP1130500	Historic Data	20.0d	20.0d	0%	31-Oct-05 A	30-Nov-05
CP1130600	Pump Data	10.0d	10.0d	0%	01-Nov-05 A	15-Nov-05
CP1130800	Vertical Datum	60.0d	60.0d	0%	01-Nov-05 A	30-Jan-06
CP1131000	Hydro Data	31.0d	31.0d	0%	01-Nov-05 A	15-Dec-05
CP1224000	Overall Data Manager	29.0d	29.0d	0%	01-Nov-05	13-Dec-05
CP1300000	Data Synthesis	65.0d	65.0d	0%	10-Nov-05*	15-Feb-06
CP1310000	Development of pre-storm DEM	24.0d	24.0d	0%	10-Nov-05	15-Dec-05
CP1320000	Development of post-storm DEM	27.0d	27.0d	0%	10-Nov-05	20-Dec-05
CP1230000	Maintenance of Architecture	116.0d	116.0d	0%	15-Dec-05*	01-Jun-06
CP1330000	Vertical Datum Adjustment of pre-storm & post-storm DEMs	22.0d	22.0d	0%	17-Jan-06*	15-Feb-06
CP1340000	Development of surface models based on DEMs	30.0d	30.0d	0%	17-Jan-06*	28-Feb-06
CP1131200	Data Adjusted for Vertical Data	21.0d	21.0d	0%	30-Jan-06*	28-Feb-06
CP1131300	Results of Tasks 2 - 10	43.0d	43.0d	0%	01-Mar-06*	28-Apr-06
132535.CP.1.1b	**Task 1b - Perishable Data**	0.0d	0.0d			

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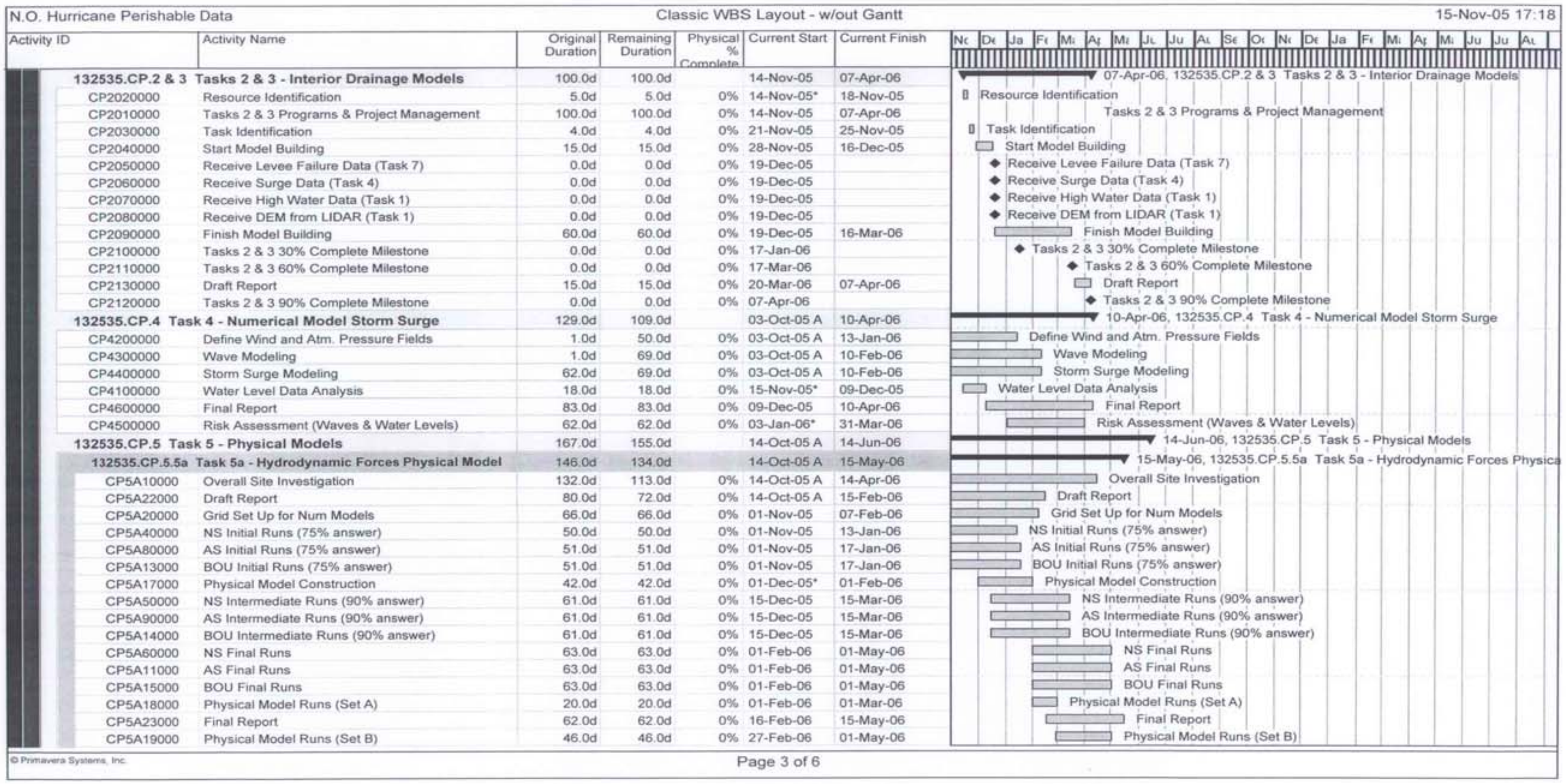
Figure C-2. (Sheet 2 of 6)



N.O. Hurricane Perishable Data

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Activity ID	Activity Name	Original Duration	Remaining Duration	Physical % Complete	Current Start	Current Finish
132535.CP.2 & 3	**Tasks 2 & 3 - Interior Drainage Models**	100.0d	100.0d		14-Nov-05	07-Apr-06
CP2020000	Resource Identification	5.0d	5.0d	0%	14-Nov-05*	18-Nov-05
CP2010000	Tasks 2 & 3 Programs & Project Management	100.0d	100.0d	0%	14-Nov-05	07-Apr-06
CP2030000	Task Identification	4.0d	4.0d	0%	21-Nov-05	25-Nov-05
CP2040000	Start Model Building	15.0d	15.0d	0%	28-Nov-05	16-Dec-05
CP2050000	Receive Levee Failure Data (Task 7)	0.0d	0.0d	0%	19-Dec-05	
CP2060000	Receive Surge Data (Task 4)	0.0d	0.0d	0%	19-Dec-05	
CP2070000	Receive High Water Data (Task 1)	0.0d	0.0d	0%	19-Dec-05	
CP2080000	Receive DEM from LIDAR (Task 1)	0.0d	0.0d	0%	19-Dec-05	
CP2090000	Finish Model Building	60.0d	60.0d	0%	19-Dec-05	16-Mar-06
CP2100000	Tasks 2 & 3 30% Complete Milestone	0.0d	0.0d	0%	17-Jan-06	
CP2110000	Tasks 2 & 3 60% Complete Milestone	0.0d	0.0d	0%	17-Mar-06	
CP2130000	Draft Report	15.0d	15.0d	0%	20-Mar-06	07-Apr-06
CP2120000	Tasks 2 & 3 90% Complete Milestone	0.0d	0.0d	0%	07-Apr-06	
132535.CP.4	**Task 4 - Numerical Model Storm Surge**	129.0d	109.0d		03-Oct-05 A	10-Apr-06
CP4200000	Define Wind and Atm. Pressure Fields	1.0d	50.0d	0%	03-Oct-05 A	13-Jan-06
CP4300000	Wave Modeling	1.0d	69.0d	0%	03-Oct-05 A	10-Feb-06
CP4400000	Storm Surge Modeling	62.0d	69.0d	0%	03-Oct-05 A	10-Feb-06
CP4100000	Water Level Data Analysis	18.0d	18.0d	0%	15-Nov-05*	09-Dec-05
CP4600000	Final Report	83.0d	83.0d	0%	09-Dec-05	10-Apr-06
CP4500000	Risk Assessment (Waves & Water Levels)	62.0d	62.0d	0%	03-Jan-06*	31-Mar-06
132535.CP.5	**Task 5 - Physical Models**	167.0d	155.0d		14-Oct-05 A	14-Jun-06
132535.CP.5.5a	**Task 5a - Hydrodynamic Forces Physical Model**	146.0d	134.0d		14-Oct-05 A	15-May-06
CP5A10000	Overall Site Investigation	132.0d	113.0d	0%	14-Oct-05 A	14-Apr-06
CP5A22000	Draft Report	80.0d	72.0d	0%	14-Oct-05 A	15-Feb-06
CP5A20000	Grid Set Up for Num Models	66.0d	66.0d	0%	01-Nov-05	07-Feb-06
CP5A40000	NS Initial Runs (75% answer)	50.0d	50.0d	0%	01-Nov-05	13-Jan-06
CP5A80000	AS Initial Runs (75% answer)	51.0d	51.0d	0%	01-Nov-05	17-Jan-06
CP5A13000	BOU Initial Runs (75% answer)	51.0d	51.0d	0%	01-Nov-05	17-Jan-06
CP5A17000	Physical Model Construction	42.0d	42.0d	0%	01-Dec-05*	01-Feb-06
CP5A50000	NS Intermediate Runs (90% answer)	61.0d	61.0d	0%	15-Dec-05	15-Mar-06
CP5A90000	AS Intermediate Runs (90% answer)	61.0d	61.0d	0%	15-Dec-05	15-Mar-06
CP5A14000	BOU Intermediate Runs (90% answer)	61.0d	61.0d	0%	15-Dec-05	15-Mar-06
CP5A60000	NS Final Runs	63.0d	63.0d	0%	01-Feb-06	01-May-06
CP5A11000	AS Final Runs	63.0d	63.0d	0%	01-Feb-06	01-May-06
CP5A15000	BOU Final Runs	63.0d	63.0d	0%	01-Feb-06	01-May-06
CP5A18000	Physical Model Runs (Set A)	20.0d	20.0d	0%	01-Feb-06	01-Mar-06
CP5A23000	Final Report	62.0d	62.0d	0%	16-Feb-06	15-May-06
CP5A19000	Physical Model Runs (Set B)	46.0d	46.0d	0%	27-Feb-06	01-May-06

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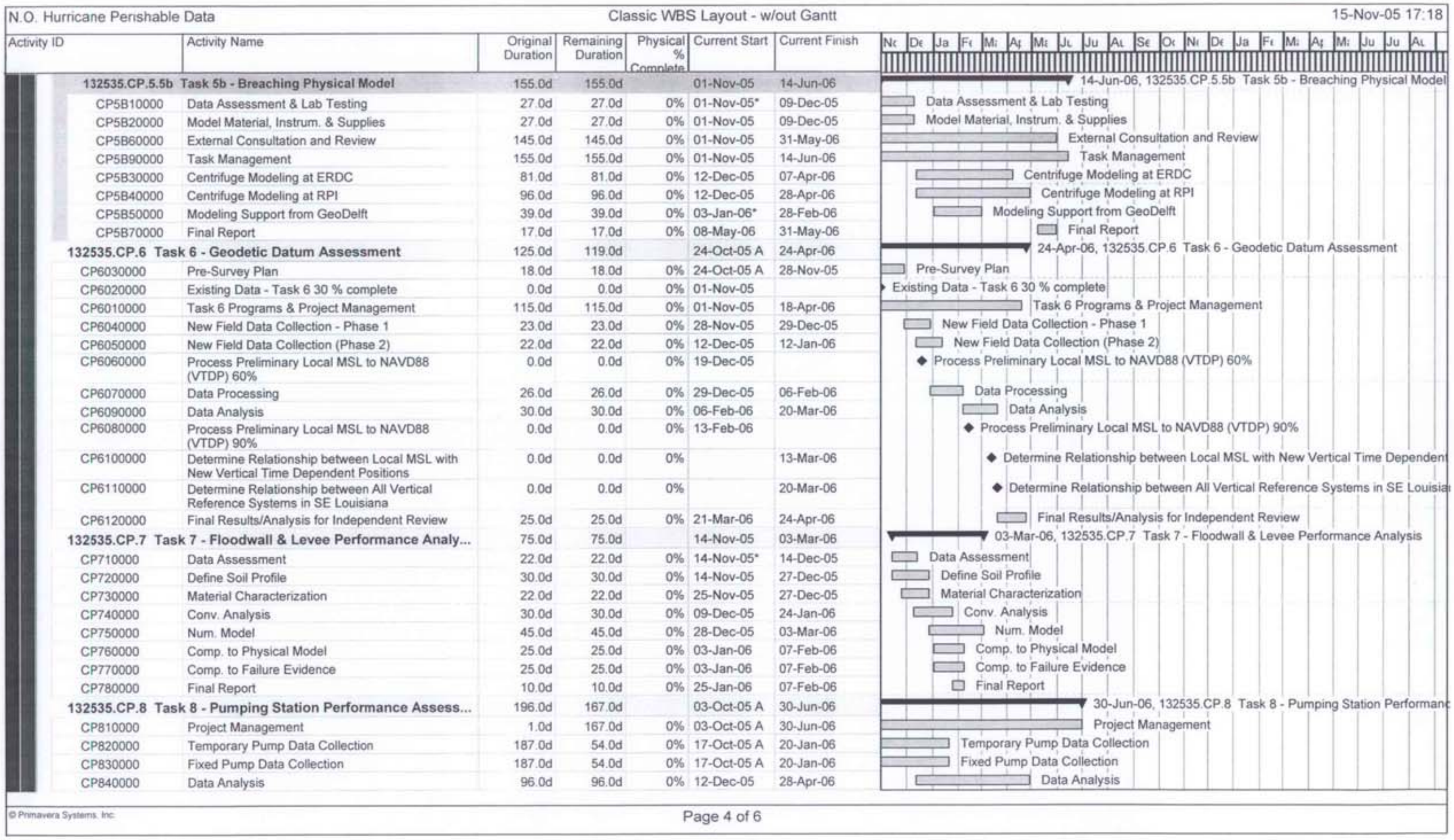

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Activity ID	Activity Name	Original Duration	Remaining Duration	Physical % Complete	Current Start	Current Finish
132535.CP.5.5b	**Task 5b - Breaching Physical Model**	155.0d	155.0d		01-Nov-05	14-Jun-06
CP5B10000	Data Assessment & Lab Testing	27.0d	27.0d	0%	01-Nov-05*	09-Dec-05
CP5B20000	Model Material, Instrum. & Supplies	27.0d	27.0d	0%	01-Nov-05	09-Dec-05
CP5B60000	External Consultation and Review	145.0d	145.0d	0%	01-Nov-05	31-May-06
CP5B90000	Task Management	155.0d	155.0d	0%	01-Nov-05	14-Jun-06
CP5B30000	Centrifuge Modeling at ERDC	81.0d	81.0d	0%	12-Dec-05	07-Apr-06
CP5B40000	Centrifuge Modeling at RPI	96.0d	96.0d	0%	12-Dec-05	28-Apr-06
CP5B50000	Modeling Support from GeoDelft	39.0d	39.0d	0%	03-Jan-06*	28-Feb-06
CP5B70000	Final Report	17.0d	17.0d	0%	08-May-06	31-May-06
132535.CP.6	**Task 6 - Geodetic Datum Assessment**	125.0d	119.0d		24-Oct-05 A	24-Apr-06
CP6030000	Pre-Survey Plan	18.0d	18.0d	0%	24-Oct-05 A	28-Nov-05
CP6020000	Existing Data - Task 6 30 % complete	0.0d	0.0d	0%	01-Nov-05	
CP6010000	Task 6 Programs & Project Management	115.0d	115.0d	0%	01-Nov-05	18-Apr-06
CP6040000	New Field Data Collection - Phase 1	23.0d	23.0d	0%	28-Nov-05	29-Dec-05
CP6050000	New Field Data Collection (Phase 2)	22.0d	22.0d	0%	12-Dec-05	12-Jan-06
CP6060000	Process Preliminary Local MSL to NAVD88 (VTDP) 60%	0.0d	0.0d	0%	19-Dec-05	
CP6070000	Data Processing	26.0d	26.0d	0%	29-Dec-05	06-Feb-06
CP6090000	Data Analysis	30.0d	30.0d	0%	06-Feb-06	20-Mar-06
CP6080000	Process Preliminary Local MSL to NAVD88 (VTDP) 90%	0.0d	0.0d	0%	13-Feb-06	
CP6100000	Determine Relationship between Local MSL with New Vertical Time Dependent Positions	0.0d	0.0d	0%		13-Mar-06
CP6110000	Determine Relationship between All Vertical Reference Systems in SE Louisiana	0.0d	0.0d	0%		20-Mar-06
CP6120000	Final Results/Analysis for Independent Review	25.0d	25.0d	0%	21-Mar-06	24-Apr-06
132535.CP.7	**Task 7 - Floodwall & Levee Performance Analy...**	75.0d	75.0d		14-Nov-05	03-Mar-06
CP710000	Data Assessment	22.0d	22.0d	0%	14-Nov-05*	14-Dec-05
CP720000	Define Soil Profile	30.0d	30.0d	0%	14-Nov-05	27-Dec-05
CP730000	Material Characterization	22.0d	22.0d	0%	25-Nov-05	27-Dec-05
CP740000	Conv. Analysis	30.0d	30.0d	0%	09-Dec-05	24-Jan-06
CP750000	Num. Model	45.0d	45.0d	0%	28-Dec-05	03-Mar-06
CP760000	Comp. to Physical Model	25.0d	25.0d	0%	03-Jan-06	07-Feb-06
CP770000	Comp. to Failure Evidence	25.0d	25.0d	0%	03-Jan-06	07-Feb-06
CP780000	Final Report	10.0d	10.0d	0%	25-Jan-06	07-Feb-06
132535.CP.8	**Task 8 - Pumping Station Performance Assess...**	196.0d	167.0d		03-Oct-05 A	30-Jun-06
CP810000	Project Management	1.0d	167.0d	0%	03-Oct-05 A	30-Jun-06
CP820000	Temporary Pump Data Collection	187.0d	54.0d	0%	17-Oct-05 A	20-Jan-06
CP830000	Fixed Pump Data Collection	187.0d	54.0d	0%	17-Oct-05 A	20-Jan-06
CP840000	Data Analysis	96.0d	96.0d	0%	12-Dec-05	28-Apr-06

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N.O. Hurricane Perishable Data | Classic WBS Layout - w/out Gantt | 15-Nov-05 17:18

Activity ID	Activity Name	Original Duration	Remaining Duration	Physical % Complete	Current Start	Current Finish
CP850000	Determine Improvements	79.0d	79.0d	0%	23-Jan-06	12-May-06
CP860000	Prepare Report	89.0d	89.0d	0%	23-Jan-06	26-May-06
132535.CP.9	**Task 9 - Consequence Analysis**	208.0d	188.0d		03-Oct-05 A	01-Aug-06
CP910000	Program Management & Oversight	1.0d	188.0d	0%	03-Oct-05 A	01-Aug-06
CP920000	Economic Consequences	208.0d	188.0d	0%	03-Oct-05 A	01-Aug-06
CP930000	Social, Cultural, & Historical Aspects	208.0d	188.0d	0%	03-Oct-05 A	01-Aug-06
CP940000	Environmental Consequences	208.0d	188.0d	0%	03-Oct-05 A	01-Aug-06
CP950000	Human Health & Safety Concerns	208.0d	188.0d	0%	03-Oct-05 A	01-Aug-06
132535.CP.10	**Task 10 - Risk & Reliability**	144.0d	119.0d		26-Sep-05 A	24-Apr-06
CP1010000	Develop Team 10 SOW	20.0d	0.0d	100%	26-Sep-05 A	24-Oct-05 A
CP1011000	Assemble Team Membership	20.0d	0.0d	100%	26-Sep-05 A	24-Oct-05 A
CP1020000	Develop Software for Risk Model	22.0d	19.0d	0%	28-Oct-05 A	29-Nov-05
CP1012000	Contracting for Team Members	12.0d	9.0d	0%	28-Oct-05 A	14-Nov-05
CP1016000	Develop Meeting 1 Read Ahead	11.0d	8.0d	0%	28-Oct-05 A	10-Nov-05
CP1019000	Develop Draft Risk Models	22.0d	19.0d	0%	28-Oct-05 A	29-Nov-05
CP1021000	Develop Draft Reliability Models	22.0d	19.0d	0%	28-Oct-05 A	29-Nov-05
CP1015000	Data Collection and Assembly for Team	10.0d	10.0d	0%	31-Oct-05 A	15-Nov-05
CP1022000	Provide IPET Team w/ Data Required for Models	12.0d	11.0d	0%	31-Oct-05 A	16-Nov-05
CP1040000	4th Team Mtg - Final Model Runs, finalize Team 10 Reports	3.0d	3.0d	0%	01-Nov-05	03-Nov-05
CP1041000	Develop Draft Report	60.0d	78.0d	0%	01-Nov-05 A	24-Feb-06
CP1013000	Leader/Co-leader Site Visit	2.0d	2.0d	0%	04-Nov-05*	07-Nov-05
CP1014000	Meet w/CEMVN & ASCE	2.0d	2.0d	0%	08-Nov-05	09-Nov-05
CP1017000	1st Tm Mtg: Dev. Risk Model Arch; Reliability Models; etc.	3.0d	3.0d	0%	14-Nov-05*	16-Nov-05
CP1018000	Meeting w/ Team 7, 8 & 9 Coordinate Reliability & Risk	2.0d	2.0d	0%	14-Nov-05	15-Nov-05
CP1023000	Dev. Workshop Read Ahead & Agenda	7.0d	7.0d	0%	14-Nov-05*	22-Nov-05
CP1024000	Conduct Workshopt to Solicit Expert Opinions, etc.	2.0d	2.0d	0%	29-Nov-05*	30-Nov-05
CP1025000	Revise Draft Risk Model	36.0d	36.0d	0%	30-Nov-05	23-Jan-06
CP1026000	Revise Draft Reliability Models	36.0d	36.0d	0%	30-Nov-05	23-Jan-06
CP1027000	Preliminary Input Data (60% Solution) from other teams.	13.0d	13.0d	0%	01-Dec-05	19-Dec-05
CP1028000	Provide IPET teams w/ Prelim. Results of Risk & ...	5.0d	5.0d	0%	03-Jan-06	09-Jan-06
CP1029000	ITR Review of Prelim. Results	9.0d	9.0d	0%	03-Jan-06	13-Jan-06
CP1030000	2nd Tm Mtg; Dev. Scenarios, refine risk model, etc.	4.0d	4.0d	0%	23-Jan-06*	26-Jan-06
CP1031000	Sensitivity Testig of Risk Model	22.0d	22.0d	0%	26-Jan-06	27-Feb-06
CP1032000	Develop Scenarios for Risk Model of N.O.	22.0d	22.0d	0%	26-Jan-06	27-Feb-06
CP1034000	Intermediate input data from other teams (75% S...	22.0d	22.0d	0%	26-Jan-06	27-Feb-06
CP1036000	Pre-Final (80-90%) input of data required from te...	9.0d	9.0d	0%	21-Feb-06	03-Mar-06
CP1037000	Final Risk Model Runs	9.0d	9.0d	0%	21-Feb-06	03-Mar-06

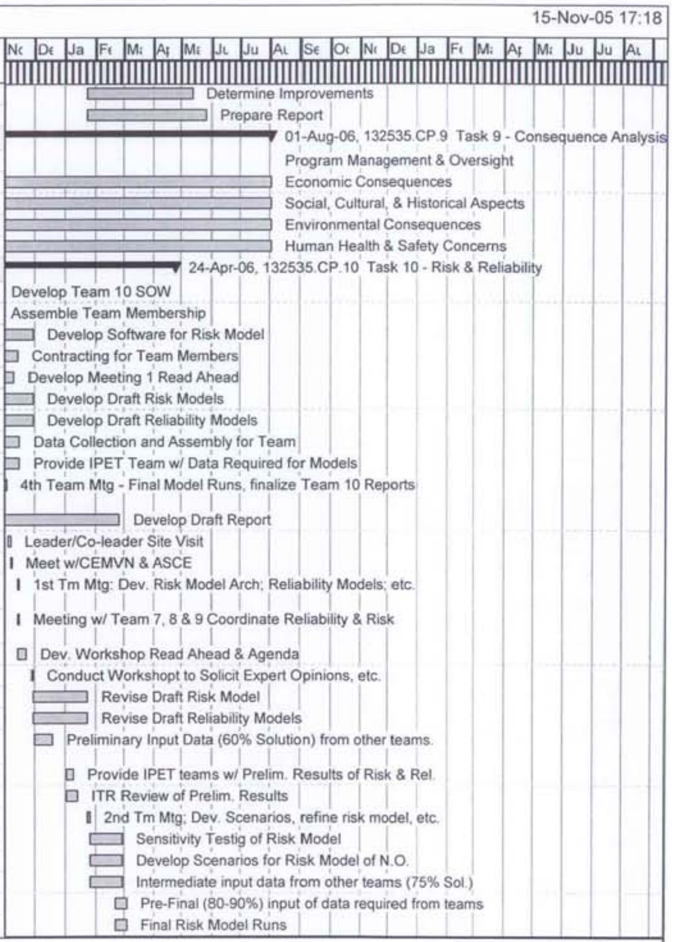

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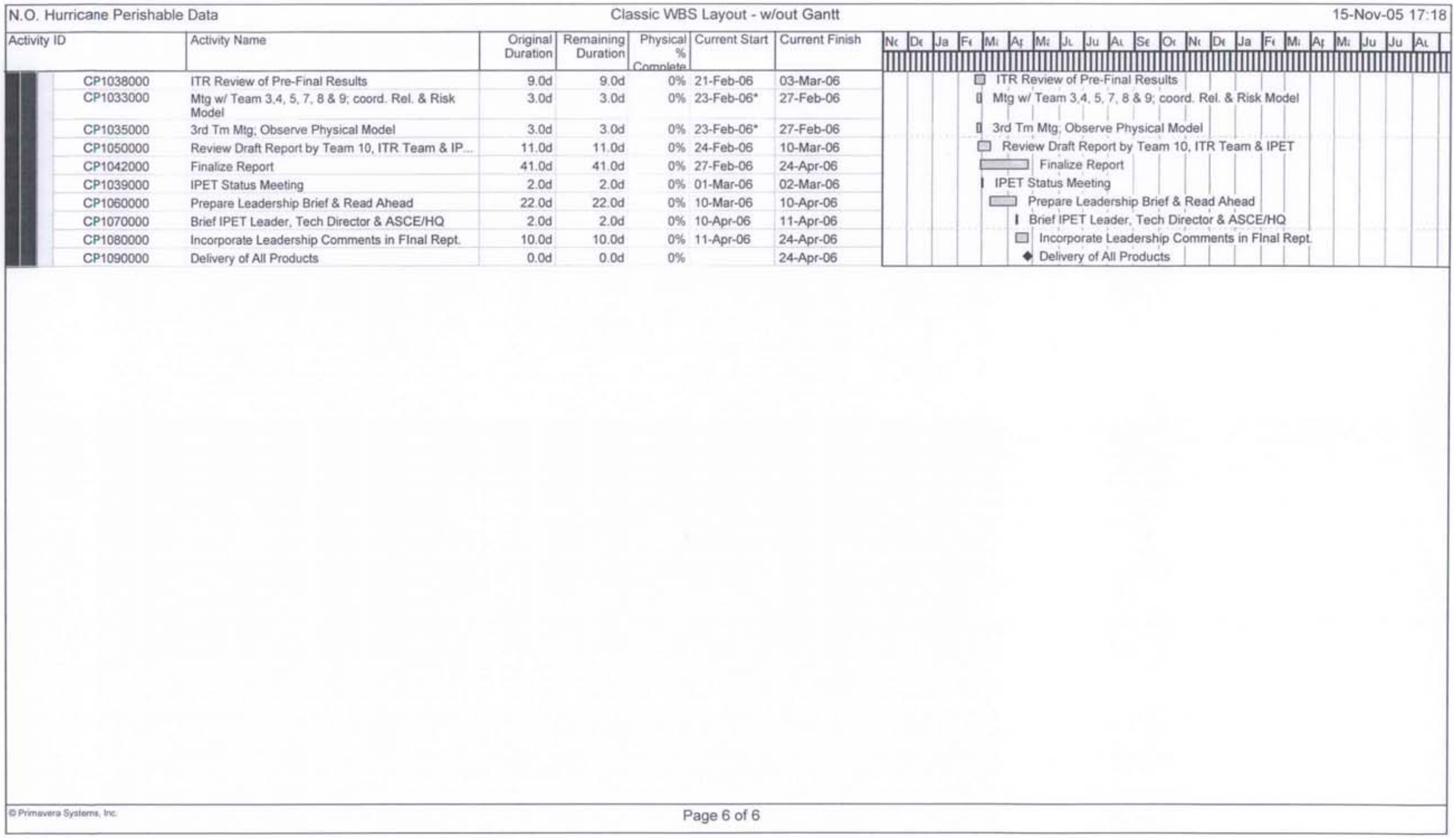
Figure C-2. (Sheet 5 of 6)



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Activity ID	Activity Name	Original Duration	Remaining Duration	Physical % Complete	Current Start	Current Finish
CP1038000	ITR Review of Pre-Final Results	9.0d	9.0d	0%	21-Feb-06	03-Mar-06
CP1033000	Mtg w/ Team 3,4, 5, 7, 8 & 9; coord. Rel. & Risk Model	3.0d	3.0d	0%	23-Feb-06*	27-Feb-06
CP1035000	3rd Tm Mtg; Observe Physical Model	3.0d	3.0d	0%	23-Feb-06*	27-Feb-06
CP1050000	Review Draft Report by Team 10, ITR Team & IP...	11.0d	11.0d	0%	24-Feb-06	10-Mar-06
CP1042000	Finalize Report	41.0d	41.0d	0%	27-Feb-06	24-Apr-06
CP1039000	IPET Status Meeting	2.0d	2.0d	0%	01-Mar-06	02-Mar-06
CP1060000	Prepare Leadership Brief & Read Ahead	22.0d	22.0d	0%	10-Mar-06	10-Apr-06
CP1070000	Brief IPET Leader, Tech Director & ASCE/HQ	2.0d	2.0d	0%	10-Apr-06	11-Apr-06
CP1080000	Incorporate Leadership Comments in Final Rept.	10.0d	10.0d	0%	11-Apr-06	24-Apr-06
CP1090000	Delivery of All Products	0.0d	0.0d	0%		24-Apr-06

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Figure C-2. (Sheet 6 of 6)

5 Quality Management Plan

5.1 Overview

5.1.1 Scope

This Quality Management Plan (QMP) documents project-specific quality assurance and quality control procedures deemed appropriate by and for the efforts of the Interagency Performance Evaluation Team (IPET). Quality improvements are also documented and may be included in the Lessons Learned. The QMP is an integral part of the Project Management Plan (PMP), along with the Risk Management Plan, the Communications Plan and the Safety and Occupational Health Plan. These plans are developed concurrently in the iterative Project Planning Phase.

5.1.2 Plan-Do-Check-Act

Quality is planned for and managed through the “Plan-Do-Check-Act” cycle for project execution.

Plan-Do-Check-Act, or PDCA, describes a philosophy for continuously improving an organization’s processes. Sometimes referred to as the Shewhart Cycle or the Deming Cycle, PDCA is accomplished by implementing the adage “think first, then do”. Figure C-3 illustrates the PDCA cycle.

“Plan, Do, Check, Act” *is a cycle of activities designed to drive continuous improvement. Initially implemented in manufacturing, it has broad applicability in business. First developed by Walter Shewhart, it was popularized by Edwards Deming in the 1950’s.*

The earliest application of the PDCA cycle involved starting a process in the “plan” phase and applying what had been learned from the previous phases or runs. The four phases of the PDCA cycle would continue sequentially over and over till the process had improved to the point of satisfaction.

This QMP embraces the PDCA philosophy by determining and monitoring quality objectives, measuring actual quality against the stated objectives, and taking corrective action when the quality does not meet the those objectives.

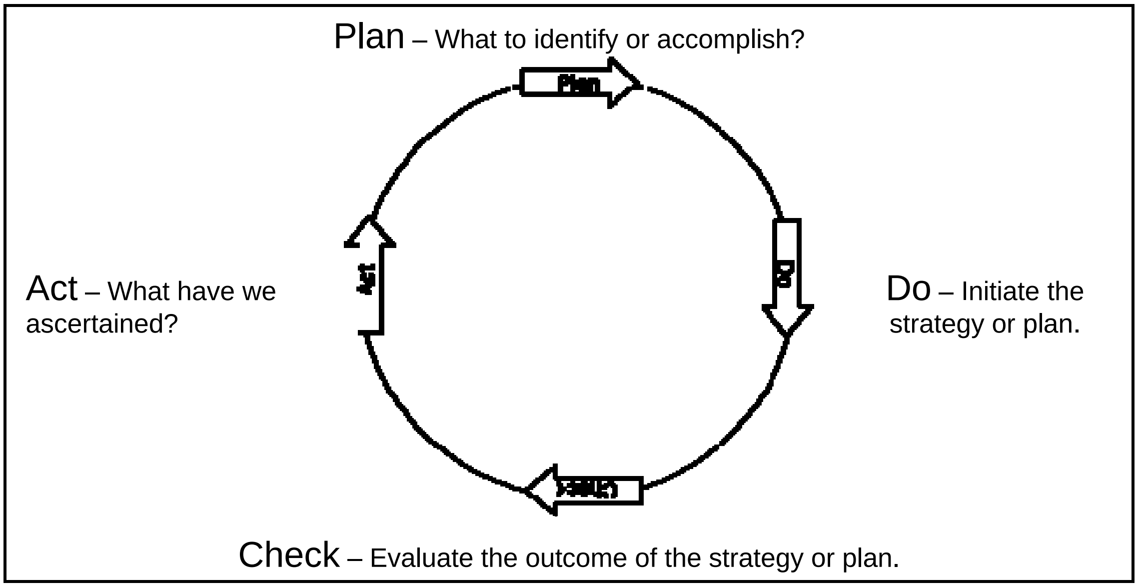

Figure C-3. Plan, Do, Check, Act Cycle

5.2 Customer Expectations

5.2.1 Customers Identified

The results and findings of the IPET effort are for a host of customers. As would be expected, the public interest generated by a catastrophe the magnitude of hurricane Katrina is enormous. The number of parties with a justified interest in an effort such as IPET is correspondingly high. The PMP describes ten tasks and four questions for IPET to deliberate. Some of IPET's customers have an interested vested in the entire IPET scope while other customers are concerned only with the first seven tasks. Table C-1 summarizes the customers, their interest in IPET, and whether they are internal or external.

Table C-1
Summary of Customers

Customer	**Perspective (Internal/External)**	**IPET Interest**
Donald Rumsfield	External	Tasks 1-7, Questions 1-3
Secretary of the Army	External	Tasks 1-7, Questions 1-3
Assistant Sec of the Army	External	Tasks 1-7, Questions 1-3
National Research Council	External	Tasks 1-7, Questions 1-3
General Strock	External	Tasks 1-10, Questions 1-4
External Review Panel	External	Tasks 1-10, Questions 1-4
General Public	External	Tasks 1-10, Questions 1-4
Task Force Guardian	External	Tasks 1-10, Questions 1-4
Task Force Hope	External	Tasks 1-10, Questions 1-4

5.3 Quality Plans

5.3.1 Data Collection & Management

QA/QC Process for Maintaining Consistent, Credible Data within the IPET Data Repository

IPET data residing within the data repository will be used in many different forms and for many different purposes. It will be essential to the IPET that an effective QA/QC procedure be developed to ensure that all IPET teams and members operate within a consistent operating framework and that all data residing within the repository undergo QA/QC before it is sanctioned for use in applications. It is recommended that for every major data type (elevations, high water marks, time series information, soil/substrate characteristics, etc), a team of experts, working in conjunction with Denise Martin, be designated to review data used in applications to establish appropriate standards for these data. It would also be the responsibility of this team to provide the "final" information to the appropriate application groups within a pre-defined schedule.

The concept as it might be applied to data used to form the Digital Elevation Model (DEM) is described below.

1. Data collected from many sources would come into the data repository after some level of screening and computer-based QA/QC is applied. These data would need to have the metadata necessary to link them back to time of survey and benchmarks referenced.
2. The proper treatment of different classes/sets of elevation data would be established. For example, some of the lidar elevations may be contaminated by vegetation, or some of the surveys may not yet be linked appropriately to established benchmarks.
3. Data would be extracted from the database and used to generate information for the DEM. The DEM grid would be reviewed by a team of experts (QA/QC group), ensuring that "line" features such levees are properly resolved and that the grid appropriately meets the need of the intended application(s). This team should consist of people who are recognized as being able to speak authoritatively in this field with regard to the data itself (someone with a surveying background), the data storage/retrieval (presumably Denise Martin), the intended data application (someone with modeling experience), and others as needed to perform required work.
4. This group would be responsible for providing the common DEM to be used by all applications for the IPET study.
5. All elements within the DEM would be linked back to source information in a fashion that would allow subsequent adjustments in the vertical to be applied to the grid.
6. The DEM would be stored within the data repository with appropriate annotations stating the purpose of the grid and any notes relative to limits of applicability.

The general concept in this QA/QC procedure is that data within a data repository may be of various levels of validity and/or accuracy. Given the multiple sources and types of data being collected/acquired for this study, computers can only provide a cursory level of QA/QC. Consequently, at least in important areas of common interest over several groups (DEM, high-water marks, soil characteristics, levee structures, etc.), a subject matter expert team will be required to ensure that the data is appropriate and consistent before it is be used in final applications. Initial runs may have to proceed before this team has completed its product; however, this effort should be given sufficient funds and priority to make sure that these QA/QC efforts provide their products within a time frame that is consistent with the needs for these products.

5.3.2 Interior Drainage Model

1. Summary - This document provides the Quality Control Plan for the development of the interior models for the Interagency Performance Evaluation Task Force (IPET). HEC-HMS and HEC-RAS models were developed for Jefferson Parish East and West Banks, Orleans East Bank, New Orleans East, St Bernard Parish and Plaquemines Parish.

2. Task Management – Each Task in the IPET study has a Corps of Engineers Co-lead and a Non-Corps of Engineers Co Lead. For tasks 2 and 3, Jeff Harris, Chief of Hydrology and Hydraulics Division at HEC was the Corps co-lead and Steve Fitzgerald, Head Engineer at Harris County Flood Control in Houston Texas is the Non-Corps co-lead. Each performed review of written documentation provided by the modeling teams.

3. Modeling Teams – Teams were assembled from personnel at the Hydrologic Engineering Center (HEC), Vicksburg District (MVK), New Orleans District (MVN) and an AE to be determined. These teams were assembled to build models for all areas. In some cases existing models were updated to fit needs. In areas where no models exist, new models were developed. The table below shows the modeling teams and areas worked on.

Modeling Teams		
Basin	Team	
	HEC-RAS	HEC-HMS
Jefferson East Bank	AE-TBD	AE-TBD
Jefferson West Bank	AE-TBD	AE-TBD
Orleans East Bank	MVK	MVK
New Orleans East	MVN	MVN
St. Bernard	MVN	HEC
Plaquemines	HEC	HEC
AE TBD MVK – Corps of Engineers, Vicksburg District MVN – Corps of Engineers, New Orleans District HEC – Corps of Engineers, Hydrologic Engineering Center, Davis, CA		

4. Internal QC – Each modeling team had an internal quality review. Each team performed in-progress review during model development process.

5.3.3 Numerical Model Storm Surge & Waves

1. Purpose. The purpose of this plan is to identify the quality-related objectives of Task 4, Regional Hydrodynamics, and to describe how achievement of these objectives will be measured, and to describe the quality-related processes that will be used to assure that the objectives are achieved.

2. Scope. The scope of the objectives, measures, and processes described herein pertain to the entire Regional Hydrodynamics study under IPET.

3. Quality Objectives. The Regional Hydrodynamic analysis work of the IPET team is important from an investigative perspective of what were the wave and water level conditions along the periphery of the hurricane protection system during the storm and how do they compare to values used in design. The work products will be carefully reviewed at multiple levels to assure that they comply with the latest accepted practices and appropriate model usage. Outputs from all models will be comprehensively compared to measured data in all facets of the work, and in some cases results from other models, to assess quality of information produced and minimize uncertainty in results.

4. Roles and Responsibilities.

4.1. Team Co-Leader (TC). The TC is accountable for delivering a study that meets the IPET leadership's quality expectation. Specific responsibilities include:

- Determining quality objectives
- Assigning specific team members responsible for the quality of each facet of the Regional Hydrodynamics study.
- Assigning quality objectives to the various modules and data input to the models.
- Periodically reviewing program performance against quality objectives
- Developing remediation plans when quality performance is not in line with objectives

4.2. Sub-Team Leader/Technical Reviewer (TR). A TR is assigned for each of the major sub-teams (modules) of the Regional Hydrodynamics team activities who are accountable for delivering a product to the TC that that meets the stated quality requirements herein. Specific responsibilities include:

- Review of work within the assigned module for technical and mathematical accuracy.
- Review of the assigned module for compliance with accepted practices and appropriate model usage.
- Responding to IPET review team comments and modifying the module as necessary to resolve comments.

- Developing remediation plans when technical performance is not in line with objectives.

5. Quality Processes.

5.1 Internal Review Team (IRT) Review will be conducted by the TRs and senior staff members working on each module, who have expertise in the specific area of study to which they are assigned. The IRT leader will collect all comments by other team members for review by the TC. The TC will also provide review for technical areas within their scope of expertise The IRT leader (the TR) will also assure that all comments are appropriately addressed and report modified as appropriate.

5.2 Team Technical Report Review will be conducted to insure the consistency of the findings. This review will be performed by the TC prior to final submittal of the report for editing and publishing in the IPET Final Report. General comments on the structure of the team's report will be forwarded to the TC for resolution. Comments on specific sections of the report will be forwarded to the IRT member assigned to that section. Team members assigned to develop specific sections of the report will resolve comments found pertinent to their section by the IRT member or TC and will make appropriate changes required by the IRT and the TC. Revised sections will be submitted to the TC for inclusion into the final technical report.

5.3 IPET External Technical Review (ETR) will be conducted by a group of experts who are external to the IPET team with expertise in the appropriate fields of study. Comments will be submitted to the TC for resolution and appropriate changes will be made in the report.

5.4 ERP review will be conducted by the ASCE. Comments will be submitted to the TC for resolution and appropriate changes will be made in the report.

6. Internal Review Team Members assigned to the major sections and overall report are:

- TC (Bruce Ebersole)
- Executive Summary – Bruce Ebersole
- High Water Mark and Hydrograph Analysis – TBD
- Winds and Atmospheric Pressures – TBD
- Wave Modeling and Analysis – TBD
- Storm Surge Modeling and Analysis– Joannes Westerink (TR)
- Overall Report Review and consistency cross-check – Bruce Ebersole (TC)

5.3.4 Hydrodynamic Forces Physical Model

1. Purpose. The purpose of this plan is to identify the quality-related objectives of Task 5a, High Resolution Hydrodynamic Analysis (HRHA), and to describe how achievement of these objectives will be measured, and to describe the quality-related processes that will be used to assure that the objectives are achieved.

2. Scope. The scope of the objectives, measures, and processes described herein pertain to the entire High Resolution Hydrodynamic Analysis study under IPET.

3. Quality Objectives. The High Resolution Hydrodynamic Analysis work of the IPET team is important from an investigative perspective of what were the forces on the various protection structures during the storm including at the time of failure, if appropriate. The work products of the HRHA team studies will be carefully reviewed at multiple levels to assure that they comply with the latest accepted practices and appropriate model usage. Outputs from all models will be compared and calibrated to measured data, information from time stamped photographs, and information from personal interviews.

4. Roles and Responsibilities.

4.1. Team Co-Leader (TC). The TC is accountable for delivering a study that meets the IPET leadership's quality expectation. Specific responsibilities include:

- Determining quality objectives
- Assigning specific team members responsible for the quality of each module of the study.
- Assigning quality objectives to the various modules and data input to the models.
- Periodically reviewing program performance against quality objectives
- Developing remediation plans when quality performance is not in line with objectives

4.2. Technical Reviewer (TR). A TR is assigned for each of the major aspects (modules) of the HRHA team activities who are accountable for delivering a product to the TC that that meets the stated quality requirements herein. Specific responsibilities include:

- Review of the assigned module for technical and mathematical accuracy.
- Review of the assigned module for compliance with accepted practices and appropriate model usage.
- Responding to IPET review team comments and modifing the module as necessary to resolve comments.
- Developing remediation plans when technical performance is not in line with objectives.

5. Quality Processes.

5.1 Internal Review Team (IRT) Review will be conducted by designated team members with expertise in the specific area of study to which they are assigned. The IRT leader will collect all comments by other team members for review by the TC. The IRT leader will also assure that all comments are appropriately addressed and report modified as appropriate.

5.2 Team Technical Report Review will be conducted to insure the consistency of the findings. This review will be performed by all Task 5a Team members prior to final submittal of the report for editing and publishing in the IPET Final Report. General comments on the structure of the team's report will be forwarded to the TC for resolution. Comments on specific sections of the report will be forwarded to the IRT member assigned to that section. Team members assigned to develop specific sections of the report will resolve comments found pertinent to their section by the IRT member and will make appropriate changes required by the IRT and the TC. Revised sections will be submitted to the TC for inclusion into the final technical report.

5.3 IPET External Technical Review (ETR) will be conducted by a group of experts who are external to the IPET team with expertise in the appropriate fields of study. Comments will be submitted to the TC for resolution and appropriate changes will be made in the report.

5.4 ERP review will be conducted by the ASCE. Comments will be submitted to the TC for resolution and appropriate changes will be made in the report.

6. Internal Review Team Members assigned to the major sections and overall report are:

- Executive Summary – Donald Resio
- ADCIRC Water Level Model – TBD
- Boussinseq Model – TBD
- Parametric Model – Bob Dean
- Engineering Analysis – TBD
- Barge Impact Analysis – Bob Dean
- Physical Model – TBD
- STWAVE Wave Model – Donald Resio
- Overall Report Review and consistency cross-check - TBD

5.3.5 Breaching Physical Centrifuge Model

In order to maintain the highest degree of control over the quality of the efforts related to Task 5b of the IPET analysis, the following actions will be employed.

1) All work will be initiated, overseen, and verified by both task co-leads. No work will be conducted until both co-leads have provided their concurrence with the action. All work once initiated will be under the general oversight of both co-leads. All data and analysis will be under the direction of both co-leads.
2) Several physical models will be constructed and tested as part of the Task 5b efforts. Each model will have at least one redundant model tested to provide verification and quality control.
3) Data and analysis of all models will be conducted by the co-leads and sent to all physical model team members for review and verification.
4) Prior to release of any final data, the external review panel will be informed and allowed time to review all information for correctness and completeness. Only after receiving their comments and approval will information be considered final.
5) Complete and thorough documentation of all testing procedures, methods, and data will be kept by the co-leads.

5.3.6 Geodetic Vertical and Water Level Datums

Geodetic Data Collection done to NGS Standards

The phase 1 survey data collection was designed and performed to meet or exceed the NGS standards for leveling and GPS observations. These standards were developed to establish GPS derived orthometric heights (elevations) and are recognized national standards used by the surveying and mapping profession.

All observation schemas were pre approved prior to all field observations and data collection. Survey instrumentation was calibrated in accordance with Department of Commerce standards prior to all field observations.

All field observations were submitted to NGS in the standard Blue Book format as required for inclusion into the National Spatial Reference System. All final verification, adjustments, and publication were performed by NGS.

Independent calculations of geodetic and tidal datum relationship

All calculations were independently performed by USACE and NOAA (CO-OPS and NGS). Periodic review meetings, every month, were held to discuss and verify results. All discrepancies in the results were resolved at these meetings.

Contractor Data Collection

The survey contractor was responsible for performing quality control over all work performed, in accordance with the Quality Control Plan submitted on award of the basic Indefinite Delivery Contract. Many of the specifications listed above provide forms of quality control by requiring specific observing schemes, redundant observations, connection checks between control points, closed loop level lines, periodic RTK calibration checks, level peg tests, etc. The contractor was expected to perform additional quality control checks during data processing and prior to submittal.

Quality assurance checks were performed by both the contractor and government (IPET Survey Team). GPS observations establishing supplemental vertical control points were checked by running independent solutions from NOAA CORS stations distant from the NAVD88 (2004.65) project network. This afforded a blunder check on all points. The government performed spot checks on data submittals, including reality checks by modelers receiving the data. A few isolated survey data errors or blunders were found by both the contractor and government, indicating a quality control/assurance process was in place. Corrections were made and resubmitted by the contractor.

5.3.7 Analysis of Floodwall and Levee Performance

The quality control procedures used in the stability analyses were applied to determination of strength parameters, development of cross sections for analysis, and calculation of factors of safety. Databases of laboratory shear strength parameters were developed by ERDC, and checked at Virginia Tech (VT). The cone penetration test raw data were reduced independently at ERDC and at VT, and the reduced data were compared for accuracy and consistency. After the laboratory and field data were analyzed both by VT and ERDC personnel, a common set of analysis parameters was determined by consensus. Hand and spreadsheet calculations used to determine lateral and vertical property evaluations were checked between groups.

The cross sections used for analysis were developed at ERDC and at VT. The cross sections were examined for accuracy, and a final master AUTOCAD file was developed and used for subsequent analysis.

The stability analyses were performed by three different groups using two different software packages. UTEXAS4 was used at ERDC and at Univ. of Texas, Austin. SLIDE was used by M. Duncan at VT. The same cross sections were analyzed by all parties; and the strength interpolation functions, slice shear strengths and boundary forces, and factors of safety were compared. Hand calculations were used to evaluate the output from the programs. It should be noted that during this process, errors were found in both programs, and these errors would not have been discovered without this quality control procedure. The errors have subsequently been corrected in both software packages. All differences in factor of safety values determined were satisfactorily resolved in every case.

5.3.8 Pump Station Performance Assessment

The objective of the Quality Control Plan is to insure the successful completion of the study and delivery of a high-quality product, within budget and on time. The Quality Control Plan consists of the following elements: Product Delivery Team, Independent Technical Review Team, periodic team meetings, study milestones and baseline estimate of time and costs.

Product Delivery Team. The PDT responsible for IPET Task 8 included co-leads: Brian Moentenich, Corps of Engineers, HDC and Bob Howard, South Florida Water Management District. An AE Firm was retained to collect the raw data. The fuel endurance calculations, pump, system and operational curves were developed by Corps of Engineers, HDC. The reverse flow curves were developed by Portland District EC-HD and by Portland District EC-HY. The report was jointly written by the team from the Corps of Engineers and Bob Howard.

Contractor: The AE contractor will be required to perform an internal quality review on all work products he provides. The PDT will perform QA on the work the AE contractor performs as well as reviewing all generated work products.

Independent Technical Review Team. The ITR was performed by senior engineers with significant experience in pump station design. The team’s purpose was to provide a technical review of all elements of the study and to insure that the study conforms to the requirements of the scope of work for the Interagency Performance Evaluation Task Force (IPET). The ITR Team consisted of Corps of Engineers, HDC and Portland District EC-HD.

Periodic Team Meetings. Meetings of the PDT will be conducted to coordinate the efforts of its members. Meetings are anticipated to be two hours in length or less. The meetings will be used to discuss the study process, issues, budget, and schedules. The project manager will be responsible for scheduling the meetings and providing minutes as needed.

Study Milestones. The study milestones consist of a listing of the significant elements or phases of the study and their projected completion dates. The project coordinator and Co-Leads will monitor and report progress on the study to insure that the milestones are accomplished. In the event that any of the milestones cannot be accomplished, the co-leads will discuss why milestones cannot be accomplished and work with the PDT to take appropriate actions.

Baseline Estimate of Time and Costs. The time and cost to compete each study task has been estimated and is included in the Project Management Plan. These estimates are subject to review and revision during the course of the study

5.3.9 Consequence Analysis

1. Purpose. The purpose of this plan is to identify the quality-related objectives of Task 9, Consequence Analysis, and to describe how achievement of these objectives will be measured, and to describe the quality-related processes that will be used to assure that the objectives are achieved.

2. Scope. The scope of the objectives, measures, and processes described herein pertain to the entire Consequence Analysis (CA) study under IPET.

3. Quality Objectives. The CA work of the IPET team is integral to understanding the dimensions of consequences such as loss of life, property, social and cultural institutions, and environmental quality, from the Hurricane Katrina event as well as from other possible hurricane and storm events. The work products of the CA studies will be carefully reviewed at multiple levels to assure that they comply with accepted CA theories and practices. Inputs and outputs from the multiple CA simulation models and study frameworks will be compared to historical and emerging measures from Katrina and relevant historical storms to measure the ability of the models and frameworks to inform the actual experience.

4. Roles and Responsibilities.

4.1. Team Co-Leaders (TC). The TC are accountable for delivering a consequence analysis study that meets the IPET leadership's quality expectation. Specific responsibilities include:

- Determining quality objectives
- Assigning specific team members responsible for the quality of each sub-task of consequences.
- Assigning quality objectives tailored to each sub-task team pertaining to data/information sources, analysis methodologies, and adherence to the project scope.
- Periodically reviewing program performance against quality objectives
- Developing remediation plans when quality performance is not in line with objectives

4.2. Sub-Task Leader (SL). A SL is assigned to each sub-task and is responsible for the quality of each sub-category of consequences.

4.3. Technical Reviewer (TR). A TR is assigned for each of the major aspects of the four CA sub-tasks who are accountable for providing informed interim and end of study guidance and recommendations to the SL and TC that meets the stated quality requirements herein. Specific responsibilities include:

- Review of the assigned module for technical accuracy and analytical relevance.
- Review of the assigned module for compliance with accepted practice.
- Developing remediation plans when technical performance is not in line with objectives

5. Quality Processes.

5.1 Internal Consequence Analysis Team (ICAT) Review will be conducted by designated team members with expertise in the specific area of study to which they are assigned. The ICAT reviewer will also have available comments by other team members and will evaluate and combine the appropriate comments into a single edited document for submittal to the TC for inclusion into the final QA report.

5.2 Team Technical Report Review will be conducted by all Task 9 Team members prior to final submittal of the report for editing and publishing in the IPET Final Report. General comments on the structure of the team's report will be forwarded to the TC for resolution. Comments on specific sections of the report will be forwarded to the ICAT member assigned to that section. Team members assigned to develop specific sections of the report will resolve comments found pertinent to their section by the ICAT member and will make appropriate changes required by the ICAT and the TC. Revised sections will be submitted to the TC for inclusion into the final technical report.

5.3 IPET Internal Technical Review (ITR) will be conducted by experts external to the IPET team with expertise in consequence analysis. Comments will be submitted to the TC for resolution.

5.4 ERP review will be conducted by the ASCE. Comments will be submitted to the TC for resolution.

6. Reports Produced. A final Quality Assurance report will be prepared which documents the review processes and results of the activities required by this plan. Interim Reports will be prepared at each level of review that will include critical comments, their resolution and any changes made to the CA studies in response to the comments. The review levels are:

a) Team Technical Report review will be conducted by all Consequences Team members prior to final submittal. Team members will prepare individual write-ups for the major technical sections of the report. Each section shall be reviewed for mathematical, theoretical and scoping adequacy before submittal for inclusion in the final report. Members assigned to the major sections are:
   - Executive Summary – Dr. Dave Moser and Dr. Patrick Canning
   - Economics – Moser/Canning
   - Human Health & Safety – TBD
   - Social & Cultural – TBD
   - Environmental – TBD

b) Internal Consequence Analysis Team review by designated team members for each major sub-task. These sub-tasks and the responsible reviewers are:
   - Economics – TBD

    - Human Health & Safety – TBD
    - Social & Cultural – Dr. JoAnne Nigg
    - Environmental – TBD

c) IPET ITR will be conducted by the ITR team described in Section 6.5 - Independent Technical Review

d) ERP review will be conducted by Dr. Dennis Mileti

5.3.10 Risk & Reliability

1. Purpose. The purpose of this plan is to identify the quality-related objectives of Task 10, Engineering and Operational Risk and Reliability Analysis, and to describe how achievement of these objectives will be measured, and to describe the quality-related processes that will be used to assure that the objectives are achieved.

2. Scope. The scope of the objectives, measures, and processes described herein pertain to the entire Engineering and Operational Risk and Reliability (R&R) study under IPET.

3. Quality Objectives. The Risk and Reliability (R&R) work of the IPET team is an important step in explaining how the New Orleans Hurricane Protection System (HPS) performed during Katrina and in describing the risks to life and property that the system poses in the future. The work products of the R&R studies will be carefully reviewed at multiple levels to assure that they comply with accepted R&R theories and practices. Outputs from the risk model will be compared to the actual performance of the HPS during historical storms to measure the ability of the model to predict actual experience.

4. Roles and Responsibilities.

4.1. Team Co-Leader (TC). The TC is accountable for delivering a risk study that meets the IPET leadership's quality expectation. Specific responsibilities include:

- Determining quality objectives
- Assigning specific team members responsible for the quality of each module of the risk model.
- Assigning quality objectives to the risk model modules and data input to the model.
- Periodically reviewing program performance against quality objectives
- Developing remediation plans when quality performance is not in line with objectives

4.2. Technical Reviewer (TR). A TR is assigned for each of the major aspects (modules) of the R&R who is accountable for delivering a product to the TC that that meets the stated quality requirements herein. Specific responsibilities include:

- Review of the assigned module for technical and mathematical accuracy.
- Review of the assigned module for compliance with accepted practice.
- Responding to IPET review team comments and modify the module as necessary to resolve comments
- Developing remediation plans when technical performance is not in line with objectives

5. Quality Processes.

5.1 Internal Risk Team (IRT) Review will be conducted by designated team members with expertise in the specific area of study to which they are assigned. The IRT reviewer will also collect all comments by other team members and will evaluate and combine appropriate the comments into a single edited document for submittal to the TC for inclusion into the final QA report.

5.2 Team Technical Report Review will be conducted by all Task 10 Team members prior to final submittal of the report for editing and publishing in the IPET Final Report. General comments on the structure of the team's report will be forwarded to the TC for resolution. Comments on specific sections of the report will be forwarded to the IRT member assigned to that section. Team members assigned to develop specific sections of the report will resolve comments found pertinent to their section by the IRT member and will make appropriate changes required by the IRT and the TC. Revised sections will be submitted to the TC for inclusion into the final technical report.

5.3 IPET Internal Technical Review (ITR) will be conducted by experts external to the IPET team with expertise in Risk and Reliability. Comments will be submitted to the TC for resolution.

5.4 ERP review will be conducted by the ASCE. Comments will be submitted to the TC for resolution.

6. Reports Produced. A final Quality Assurance report will be prepared which documents the review processes and results of the activities required by this plan. Interim Reports will be prepared at each level of review that will include critical comments, their resolution and any changes made to the R&R studies in response to the comments. The review levels are:

a) Team Technical Report review will be conducted by all Risk Team members prior to final submittal. Team members will prepare individual write-ups for the major technical sections of the report. Each section shall be reviewed for mathematical and theoretical adequacy before submittal for inclusion in the final report. Members assigned to the major sections are:
    - Executive Summary – Jerry Foster
    - Risk model – TBD
    - Uncertainty – TBD
    - Hurricane model – TBD/Bob Dean (waves)
    - Reliability Model – TBD
    - Consequences – TBD
    - Risk Communication – TBD

b) Internal Risk Team review by designated team members for each major study module. These modules and the responsible reviewers are:
    - Risk Module – TBD
    - Reliability Module – TBD
    - Hurricane Module – TBD
    - Uncertainty Module – TBD

- Consequences Module – Bruce Muller
- Risk Communication – HQUSACE

c) IPET ITR will be conducted by team TBD

d) ERP review will be conducted by Dr. Robert Gilbert at the University of Texas.

5.4 Independent Review Panel

The work required for the independent review panel should be led by an independent, objective third-party organization such as the American Society of Civil Engineers (ASCE). The ASCE will be fully reimbursed for all their costs associated with coordinating, facilitating and administratively supporting all of the work of the independent review panel.

The independent review panel should consist of five to ten members who are recognized authorities in their field(s) of expertise. The labor and expenses of the panel members associated with the independent review will be fully reimbursed.

The independent review panel should include experts from some of the suggested areas of expertise described below

a. A coastal engineer with expertise in modeling storm surges

b. A mechanical engineer with expertise in low head, large volume pump technology

c. A geotechnical engineer with expertise in the performance of embankments and levees founded on soft sediments.

d. A structural engineer with expertise in modeling dynamic soil structure interaction behavior

e. A civil engineer with expertise in modeling risk and reliability of water resource projects

f. An economist or a social scientist with expertise in modeling consequences of catastrophic natural events.

g. An emergency manager or meteorologist with expertise in disasters resulting from tropical hurricanes.

h. A geospatial engineer or a land surveyor with expertise in referencing to the vertical survey datum along the Gulf Coast.

i. A civil engineer with expertise in planning and designing storm surge and wave protection systems for major cities

j. A senior engineering executive from a coastal state or federal water resource agency.

k. A hydrologic engineer with expertise in planning and design of interior drainage systems.

5.5 Independent Technical Review

5.5.1 Organizational Quality System Requirements

An Independent Technical Review of the Interagency Performance Evaluation Taskforce (IPET) draft Final Report shall be performed.

Independent Technical Review (ITR) is intended to provide a structured approach to examine in detail the technical results and recommendations of a given product – in this case the IPET draft Final Report – Phase 2. The purpose is to enhance the quality by bringing additional independent, high-caliber expertise to examine the product. It is a separate, structured, comprehensive, and thorough fact-finding process by senior professionals who are separate and independent from the project team. An ITR is not a critique of the writer's competence and it should not reflect the reviewer's preferences. It goes beyond the normal checks (including spelling, grammar, line-by-line mathematical checks, etc.) that are part of standard processes.

The comment resolution process should be such that the comment is made, the response to the comment is then addressed directly following the comment, and the agreement statement from the reviewer should follow the response. All responses including "concur" should include a short statement indicating what will be done as a result of the agreement.

While the ITR process is intended to enhance the quality of the product with the input and advice of a second party, it is important to note that the responsibility for the report remains with the IPET team. Therefore, in the event that resolution of comments cannot be achieved, the ultimate decision lies with the IPET Team.

All participants see ITR as an endeavor that demands special attention and procedures. It is addressed to a specific scope, format and duration.

The schedule and a brief discussion of the work involved is as follows.

Volume I - Executive Summary and Introduction (12 May initial submittal)

Ed Link / John Jaeger / Joan Pope

Volume II - Geodetic Vertical and Water Level Datum (24 April initial submittal)

Jim Garster / Bill Bergen / Dave Zilkoski

Volume III - The Hurricane Protection System (30 April initial submittal)

John Jaeger

Volume IV - The Storm (10 May initial submittal Regional Hydrodynamics and 15 May High Resolution Hydrodynamics)

Regional Hydrodynamics [Bruce Ebersole/ Joannes Westerink]

High Resolution Hydrodynamics [Don Resio / Bob Dean]

Volume V - The Performance (10 May initial submittal)

All except Physical Centrifuge model [Reed Mosher / Mike Duncan]

Physical Centrifuge Model [Mike Sharp) / Scott Steedman

Volume VI - The Consequences (28 April initial submittal Interior Drainage and Pumps and 5 May Losses Analysis)

Interior Drainage [David “Jeff” Harris / Steve Fitzgerald]

Pump Stations [Brian Moentenich / Bob Howard]

Losses Analysis [David Moser/ Pat Canning]

Volume VII - The Risk (10 May initial submittal)

Jerry Foster / Bruce Muller

Volume VIII - General Appendices (10 May initial submittal)

(Glossary and Definition of Terms, Information Management, Project Management Plan)

Jeremy Stevenson / Denise Martin

5.6 Final — Cover-to-cover review of the final report. 18-24 May 06

The ITR is intended to produce results. Therefore, the recommendations should be disseminated as necessary to bring about implementation, especially to the persons who wrote the report. In order to accomplish this review and resolution of comments will be done through Groove software. Each Volume will be assigned their respective workspace. The review and resolution will be accomplished within the established workspace and there will be a lead author/co-author from the IPET assigned for each workspace (for response and resolution of comments). A folder will be created in the workspace for comments. Reviewers will provide their comments on a separate *word document* within the comment folder. It will be the reviewer’s responsibility to read existing review files to ensure comments are not duplicated. Likewise, the final document and comment folder will also reside in a workspace for final comment and resolution.

The recommended file naming convention should include the volume, and the reviewer’s name such as *Vol II Comments.doc*

The suggested format of word document should be as follows:

Independent Technical Review
of the
Interagency Performance Evaluation Taskforce (IPET) Report
Volume II – Geodetic Vertical and Water Level Datums

Page xx	Comment 1. (made by reviewer)
	Response (from co-author)
	Resolution (documents agreement)
Page xx	Comment 2. (made by reviewer)
	Response (from co-author)
	Resolution (documents agreement)

Chapter-by-Chapter Review. This review will be accomplished as the chapters are provided. The review comments will be made electronically, writers of the IPET Report will respond to the comments as they are received and the ITR team and writer will resolve the comments and document the resolution.

Task 2. Final Cover-to-Cover Review. This review and resolution will also be done electronically as stated in Task 1. In addition, provide feedback on suggestions for revised, enhanced, or new criteria, policy, and procedures for USACE consideration. Some of this, along with lessons learned, will likely come out of ITR comments on Volume I “Executive Summary and introduction”. A document with the consolidated comments from all reviewers along with responses and resolution will then be prepared by the ITR Team Leader and distributed to the ITR team for final signatures. Upon agreement with the consolidated document, the ITR team shall affix their signature.

6 Acquisition Strategy

The IPET team shall use a diverse and robust acquisition strategy in order to secure all AE contracted resources required to complete and deliver the final IPET Report by the June 1st, 2006 deadline. The IPET team Co-Leads will each determine and utilize the appropriate and most timely contracting resources within USACE in order to gain AE services rapidly. The team will comply with all Federal Government contracting laws as well as the Federal Acquisition Regulations or FARs and Engineering FARS or EFARS while procuring AE resources through viable and current AE contracts. Each Co-Lead and their respective USACE contracting resource shall be responsible for developing scopes of work, independent government cost estimates for such, negotiating with the contractors to agreeable amounts, maintaining a contracting file documenting all AE procurement for IPET, and the like in order to maintain a legal and traceable record for all IPET government procured services.

7 Risk Analysis

7.1 Risk Identification

Risk will be managed by the implementation of the Risk Management Plan Business Process and through periodic IPET assessments and reviews that address schedule, cost, and any special project concern.

7.2 Risk Evaluation

The IPET will review and identify risk issues that could potentially impact successful program execution and develop risk control procedures to mitigate them. On-going risk analyses will be performed for five categories of project risk: health and safety, scope, quality, schedule, and cost. Regular reviews will be conducted to monitor high-risk issues and to identify additional risks that could negatively impact the program.

Following are potential high-risk issues that the Project Manager and the IPET will monitor:

- Significant cost and schedule changes for individual projects and the overall IPET scope of work.
- Timely completion and sharing of data and results among tasks.
- Sufficient contracting capacity to achieve IPET scope and schedule.

Regular reviews will assess problems of this nature and establish alternative methods for problem resolution.

7.3 IPET Task-by-Task Risk Identification Matrices

7.3.1 Task 1b – System Data

Date Identified	Area of Risk	Description	Probability of Occurrence	Strategy for Mitigation
12/2005	Schedule	The likelihood that the project will be completed within the schedule specified.	High	A very regimented time schedule will be enforced and actively managed.
12/2006	Technology	Comprehensive testing of the system may be insufficient due to time constraints	Basic	The system will be based on 3 primary components. Each component will be sufficiently tested during development. The entire system will also be tested for basic functionality.
12/2005	Technology	Interoperability of software components required to build the Data Repository	Medium	Selection of industry standard software development technology (C, Java, Web-enabled) and frequent communication with software vendors, developers, and system administrators will ensure that components interoperate properly
12/2005	Technical obsolescence	The ability to adequately maintain the system after deployment.	Basic	Funding to maintain the IPET Data Repository will be requested after the IPET study is completed.
12/2005	Data/Info	Requirements for data content/type and the mechanisms for users to access the data may change.	Medium	A data requirements matrix will be compiled and strictly managed.
12/2005	Reliability of Systems	How well the system produced operates.	Basic	Use of DoD-approved USACE computing facilities and corporately-endorsed software will maximize the reliability of developed systems.
12/2005	Technology	Use of web-based technology to deliver large datasets could result in network performance and security risks.	Medium	Access control based on the USACE UPASS system will be embraced. Network performance will be monitored and additional requirements will be communicated to the USACE network team. Additionally, a DITSCAP accreditation will be performed on the system.

7.3.2 Task 2/3 Interior Drainage Modeling

Date Identified	Area of Risk	Description	Probability of Occurrence	Strategy for Mitigation
12/2005	Schedule	The likelihood that the project will be completed within the schedule specified.	High	A very regimented time schedule will be enforced and actively managed.
12/2005	Data/Info	Receipt of data necessary to fully develop interior models. Includes surveys, high water marks, observed data, etc	Medium	Model development will continue to meet deadlines. If data is not available when needed, modeling teams will make decisions on how to continue without data and have contingency to add data when it becomes available.
12/2005	Calibration	Running models using data from additional events besides Katrina	Low	In lieu of model calibration with other events, a sensitivity analysis of various model parameters will be performed to determine impact on results. This analysis will be documented in report.
12/2005	Communication	The ability to keep modeling teams adequately informed of entire IPET interior modeling status and any developments that will impact development	Low	Weekly modeling team conference calls will occur.
12/2005	Technology	The ability of existing software to adequately model system	High	Software developers are incorporated within the study team and are available to perform immediate updates.
12/2005	Manpower	Having enough people to perform the work	High	Employ additional Corps District personnel or A/E firms.

7.3.3 Task 4 - Numerical Model Storm Surge & Waves

Date Identified	Area of Risk for Task 4	Description	Probability of Occurrence	Strategy for Mitigation
10/2005	Schedule	The likelihood that the project will be not completed within the schedule specified.	Medium	A much-regimented time schedule will be enforced and actively managed. Team status meetings will be held on a regular basis. Spiral development process will be adopted.
10/2005	Technology	Problems with models selected for use in water level and wave analysis. Models have never before been applied in such and interactive, comprehensive manner for this large of a domain	Low	Subject appropriate models will be selected by their applicability and acceptability as the latest standard of practice for hurricane processes simulation. Model developers will be engaged in each facet of the work, including the recognized expert(s) for each technology being applied.
10/2005	Data/Info	Delays in receipt of the necessary data will cause delays in completing model runs. Untimely receipt of data will stack work up later in the project and reduce quality of results at various stages in the spiral development process	High	Data requirements will be requested as soon as identified, from the group responsible for data collection and management. If not available in a timely manner, attempts will be made to obtain this required data through other means or develop best work-around solution.
10/2005	Reliability of Systems	Computer facilities incapable of supporting time requirements for modeling efforts. Possible problems associated with migration of MSRC to new Cray XT3 high performance computer (hardware and software test and evaluation period)	Low	Use of DoD-approved USACE computing facilities and corporately-endorsed software will maximize the reliability of the system. Dedicated high performance computing resources from MSRC will be sought on available resources within the MSRC network of computing assets
10/2005	Team	Experts not available for Product Delivery Team.	Low	Appropriate subject matter experts will be recruited for the Product Delivery Team. Contracts and MIPRs will be used to obtain services from experts outside of the USACE.

7.3.4 Task 5a - Hydrodynamic Forces Physical Model

Date Identified	Area of Risk for Task 5a	Description	Probability of Occurrence	Strategy for Mitigation
12/2005	Schedule	The likelihood that the project will be not completed within the schedule specified.	High	A much-regimented time schedule will be enforced and actively managed. Team status meeting will be held on a regular basis.
12/2005	Technology	Problems with models selected for use in water level and wave analysis.	Low	Subject appropriate models will be selected by their applicability and acceptability as the latest standard of practice.
12/2005	Data/Info	Delays in receipt of the necessary data will cause delays in completing model runs.	High	Data requirements will be requested, as soon as identified, from the group responsible for data collection and management. If not available in a timely way, attempts will be made to obtain this required data through other means.
12/2005	Reliability of Systems	Computer facilities incapable of supporting time requirements for modeling efforts.	Low	Use of DoD-approved USACE computing facilities and corporately-endorsed software will maximize the reliability of the system.
12/2005	Team	Experts not available for Product Delivery Team.	Medium	Appropriate subject matter experts will be recruited for the Product Delivery Team. Contracts will be used to obtain services from experts outside of the USACE.

7.3.5 Task 5b – Centrifuge Modeling of Floodwall & Levee Performance

Date Identified	Area of Risk	Description	Probability of Occurrence	Strategy for Mitigation
12/2005	Schedule	The likelihood that the project will be completed within the schedule specified.	High	A very regimented time schedule will be enforced and actively managed.
12/2005	Equipment	Necessary equipment that has to be designed and constructed for completion of testing	Medium	Multiple locations for equipment will be identified to minimize the risk of non-availability.
12/2005	Contracts	Completion of contracts with external partners.	Medium	Aggressively pursue the contracting office to complete contracts in a timely manner.
12/2005	Data/Info	Requirements for data from other task groups and external groups.	Medium	A data requirements matrix will be compiled and strictly managed.
12/2005	Technology	Use of web-based technology to deliver large datasets could result in network performance and security risks.	Medium	Access control based on the USACE UPASS system will be embraced. Network performance will be monitored and additional requirements will be communicated to the USACE network team. Additionally, a DITSCAP accreditation will be performed on the system.

7.3.6 Task 6 - Geodetic Vertical and Water Level Datums

Date Identified	Area of Risk	Description	Probability of Occurrence	Strategy for Mitigation
11/2005	Schedule	The likelihood that the project will be completed within the schedule specified.	High	A very regimented time schedule will be enforced and actively managed.
11/2006	Technology	Installation of new tide gages for measuring water levels (local mean sea level) across project area	High	If installation of new gages is not feasible and practical, then we will use existing and historical gages to determine local mean sea level relationship
11/2005	Schedule/Funding	Lack of funding in a timely manner to get task order in place for data collection	High	Break data collection into two separate task orders
12/2005	Historical Tide Stations	Historical tide station benchmarks may have been disturbed or destroyed	High	Need to research additional tide stations and have the descriptions available for field coordinator

12/2005	Data Processing	Volume of data being collected might slow down the data processing. Some results might rely on previous surveys.	Medium	Data needs to be processed as it is collected
12/2005	Data Analysis	Review of data and determination of local mean sea level relationship to the geodetic datum	Medium	Data will be analyzed by NOAA CO-OPS and USACE ERDC independently and then compared.
12/2005	Data for other tasks	Data requirements from other task might not be known until well into the project	Medium	Make other tasks aware of need to provide survey group with data requirements as soon as they arise.
12/2005	Contractor / Data collection oversight	Review of Data collected from various field survey crews.	Medium	The contractor collecting the data has established a QA plan. Task 6 has a field coordinator reviewing and spot-checking field data collection files. Data being collected to NOAA NGS standards and will be independently checked.

7.3.7 Task 7 - Analysis of Floodwall and Levee Performance

Date Identified	Area of Risk	Description	Probability of Occurrence	Strategy for Mitigation
12/2005	Schedule	The likelihood that the project will be completed within the schedule specified.	High	A very regimented time schedule will be enforced and actively managed.
12/2006	Software	Suitable computer programs for slope stability analysis and soil-structure interaction analysis must by found and validated.	Basic	Commercially available and widely used computer programs will be evaluated and tested against one another for quality control.
12/2005	Ability to locate needed records	Much data will have to be located in old documents and organized	Medium	Begin early, stay well-organized, and assign as many people as possible to the task.

12/2005	Availability of surge and wave data	The surge and wave data are needed to define the loads on the structures	Basic	Inform the groups that must supply this information what is needed and when it is needed
12/2005	Sampling, field testing, and laboratory testing	Requirements for sampling and testing may overwhelm available resources	Medium	As many labs and groups of engineers as possible will be brought to the task
12/2005	Analysis	Need to perform extensive analyses of many breach locations, and to perform independent checks on the results	Basic	Several analysis teams will operate in parallel and check each others' work
12/2005	Report writing	Need to write clear, complete and concise reports describing the investigation and explaining the results and their significance	Medium	Several report-writing teams will work in parallel, reviewing and revising each others' work

8 Safety and Occupational Health Plan

IPET will follow all USACE Safety Policies for site visits and project implementation. Team members will receive safety briefings on all projects that they visit.

9 Communications Plan

Interagency Performance Evaluation Task Force Communications Plan

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Part 1: Background and Purpose

Background: The Interagency Performance Evaluation Task Force (IPET) was established by the Chief of Engineers Hurricane Katrina caused the nation considerable concern with regard to our approaches and capabilities to protect Americans from land falling hurricanes, as well as our general emergency response readiness. This concern is shared by the professionals involved with planning, designing, constructing, sustaining and operating many of the flood protection and damage reduction measures. The Katrina Interagency Performance Evaluation Task Force was established by the Chief of Engineers to learn what happened with regard to flood protection and damage reduction capabilities in New Orleans during hurricane Katrina and to use that knowledge to shape the reconstitution of flood protection for the New Orleans area.

The mission of the task force is to provide credible and objective scientific and engineering answers to fundamental questions about the performance of the hurricane protection and damage reduction system in the New Orleans metropolitan area. These facts will be used to assist in the reconstitution of hurricane protection in New Orleans. The Task Force is comprised of experts from government (federal, state and local), industry and academia, working together as teams to accomplish a comprehensive analysis before the start of the next hurricane season. It will be modeled after the practice of the National Academy of Engineering with an independent review component as well as broad participation by experts from across government and academia. They will use the most appropriate tools and available data to better understand what forces the storm placed on the New Orleans flood protection structures and why the performed as they did. It is not enough to know that a structure or measure failed, it is essential to examine the observed evidence of performance in the context of the forces applied and the resulting response to build back the desired capability without inherent vulnerabilities that may have previously existed.

The Task Force will partner with other organizations conducting related studies and analyses to maximize their effectiveness within the short time frame of the study. While specific attention will be given to the components of the system that experienced failure, understanding where and why other components may have been degraded in their ability to provide protection and where they performed successfully is equally important to providing more reliable protection in the future. An external panel of experts under the leadership of the American Society of Civil Engineers will provide constant review of the Task Force assumptions, analyses and findings. A National Research Council Panel will provide independent strategic oversight and synthesize the results of this work, particularly with regard to the physical performance of the flood control structures. As such there will be a two tier review of the quality and applicability of the findings of the Task Force.

Purpose: This document provides a single assembly of the communications protocols and plans for the Interagency Performance Evaluation Task Force. It is intended to cover all aspects of communications from the assurance of data and information, interaction with external and independent review groups, interfaces with the media and external organizations as well as communications internal to the Corps of Engineers. A special section is provided on the interface with Task Force Guardian because of the high priority placed on providing insights and findings to them as they are developed to influence as much as possible the reconstitution of hurricane protection in the New Orleans area.

Part 2: Data and Information Assurance

Objective: To provide an information repository that can be used as an effective and efficient source of information for the work of the IPET, Task Force Guardian, the ASCE External Review Team and to provide effective information transfer in response to external requests. It is essential for all of these purposes that the information within the IPET repository is examined and validated for authenticity, accuracy and sensitivity (legal and security). The meta-data is also an essential part of entering the data and information into the repository to allow efficient management, access and distribution of the information as it is needed.

Process: IPET data residing within the data repository will be used in many different forms and for many different purposes. It will be essential to the IPET that an effective QA/QC procedure be developed to ensure that all IPET teams and members operate within a consistent operating framework and that all data residing within the repository undergo QA/QC before it is sanctioned for use in applications. It is recommended that for every major data type (elevations, high water marks, time series information, soil/substrate characteristics, etc), a team of experts, working in conjunction with Denise Martin, be designated to review data used in applications to establish appropriate standards for these data. It would also be the responsibility of this team to provide the "final" information to the appropriate application groups within a pre-defined schedule.

Data QA/QC: The concept as it might be applied to data used to form the Digital Elevation Model (DEM) is described below.

1. Data collected from many sources would come into the data repository after some level of screening and computer-based QA/QC is applied. These data would need to have the metadata necessary to link them back to time of survey and benchmarks referenced.
2. The proper treatment of different classes/sets of elevation data would be established. For example, some of the LIDAR elevations may be contaminated by vegetation, or some of the surveys may not yet be linked appropriately to established benchmarks.
3. Data would be extracted from the database and used to generate information for the DEM. The DEM grid would be reviewed by a team of experts (QA/QC group), ensuring that "line" features such levees are properly resolved and that the grid appropriately meets the need of the intended application(s). This team should consist of people who are recognized as being able to speak authoritatively in this field with regard to the data itself (someone with a surveying background), the data storage/retrieval (presumably Denise Martin), the intended data application (someone with modeling experience), and others as needed to perform required work.
4. This group would be responsible for providing the common DEM to be used by all applications for the IPET study.
5. All elements within the DEM would be linked back to source information in a fashion that would allow subsequent adjustments in the vertical to be applied to the grid.
6. The DEM would be stored within the data repository with appropriate annotations stating the purpose of the grid and any notes relative to limits of applicability.

The general concept in this QA/QC procedure is that data within a data repository may be of various levels of validity and/or accuracy. Given the multiple sources and types of data being collected or acquired for this study, computers can only provide a cursory level of QA/QC. Consequently, at least in important areas of common interest over several groups (DEM, high-water marks, soil characteristics, levee structures, etc.). A subject matter expert team will be required to ensure that the data is appropriate and consistent before it is be used in final applications. Initial runs may have to proceed before this team has completed its product; however, this effort should be given sufficient funds and priority to make sure that these QA/QC efforts provide their products within a time frame that is consistent with the needs for these products. Point of Contact for information QA/QC is Denise Martin, ERDC/ITL.

Legal and Security QA/QC: The evaluation of information for legal or security sensitivity is an important step in the process of proving information to requestors in a reasonable time frame. The IPET mechanism chosen for provision of information is setting up a web site on which all releasable information is placed and can be accessed by the public. That web site, http://ipet.wes.army.mil, became active on 29 Oct, 2005 and will have increasing amounts of information available as it is screened and deemed releasable. While the ultimate release authority remains at this time the DoD HKTF, the USACE process for screening and releasing information for inclusion on the IPET web site is as follows:

1. If information has been widely available or released in the past, it can be immediately placed on the IPET Web site, making it available to the public.
2. If information has not been released or in the public domain previously it will be first checked for prior legal or security designations. If designated as protected information, that designation will evaluated for current appropriateness by legal council and a subject matter expert. If no longer considered sensitive, it will be reevaluated for release using current privacy and security criteria.
3. If information is not previously designated as sensitive from a legal or security perspective, it will be evaluated by a subject matter expert and legal council to determine if it can be released. If deemed non-sensitive, it will be presented to the DoD HKTF for consideration for release. Given approval from the HKTF, it the information will be immediately placed on the IPET Web Site.

If a request for information relevant to Hurricane Katrina is received by the IPET, the requestor will be directed to the IPET Web Site, the repository for all released information. If they can not find what they want, they will be instructed to submit a more focused request, which will be examined for potential response based on the near term availability of the information..

Part 3: IPET and Task Force Guardian Plan

Objective: The primary purpose of this plan is to facilitate timely support to Task Force Guardian (TFG) from the Interagency Performance Evaluation Team (IPET). Incorporation of lessons learned by the IPET is critical to TFG's design and construction to restore the Federal hurricane protection system in New Orleans and southeast Louisiana to withstand the Standard Project Hurricane. This level of protection, which was authorized by Congress, is equivalent to a fast moving Category 3 hurricane. TFG has been tasked to complete restoration of the hurricane protection system to this level by June 1, 2006, the start of hurricane season along the Gulf coast.

This plan establishes roles and responsibilities to:

- Efficiently transfer and coordinate the flow of information from the New Orleans District (MVN) to the IPET;

- Coordinate and expedite the flow of information between the IPET and TFG during design; and
- Document IPET input to TFG during the design and construction processes.

Process: Three people from MVN are assigned to the IPET to participate at varying levels of engagement on the surge and wave, geodetic assessment, flood wall and levee performance, consequence, and risk and reliability task teams. Due to their comprehensive understanding of the MVN organization, the hurricane protection system and the performance evaluation project objectives, they have a primary responsibility for facilitating the prompt transfer of information from the MVN to the IPET

The following organization chart for TFG includes telephone numbers and email addresses for the TFG Project and Technical Managers. TFG LiaisonThis chart is intended to encourage non-documented telephone conversations between respective counterparts on the IPET and TFG teams to facilitate free and open discussion on technical issues. However, all formal input from the IPET to TFG shall be documented in an email correspondence to provide a prompt means of conveyance and a record to substantiate the input. The email shall be addressed to the relevant TFG Technical Manager with a receipt confirmation request. TFG LiaisonTFG LiaisonIn the cases where there is a disagreement between the respective technical leaders on the IPET and TFG teams, the TFG Project Manager is responsible for coordinating and documenting the resolution. The TFG shall not be bound to implement IPET input or recommendations; however, the TFG Project Manager shall document the rationale for not concurring with the comment in a brief memorandum for the record.

Whenever the IPET, or subsets of the IPET, plan to be on site they are required to contact TFG LiaisonTFG liaisona minimum of three days in advance, so that their TFG counterparts have the opportunity to participate in the on-site observations and data collection efforts. Additionally, the IPET shall provide an out brief to discuss all notable observations at existing infrastructure sites and at reconstruction sites with the TFG Project Managers. The TFG Project Managers are responsible for assembling the appropriate members of their Project Delivery Teams (PDTs) to participate in the out briefs. In addition to the out brief, the IPET will provide a trip report that documents significant observations that should be considered in the designs for restoring the hurricane protection project. The trip report will be furnished to TFG liaisonTFG Liaison for dissemination to the TFG Project Managers.

The TFG Program Manager and John Jaeger (co-IPET leader) have the lead responsibilities for communicating IPET and TFG progress and for maintaining situational awareness among the corresponding disciplines on each team. The IPET conducts a weekly conference call to coordinate their internal activities. The final topic of discussion at each weekly teleconference is, "What have we learned that would benefit the reconstruction effort currently underway in New Orleans." Jeremy Stevenson will provide minutes of these meetings to TFG Liaisonthe TFG Liaison as another way to share information. TFG Liaisonwill be responsible for disseminating these minutes to the TFG Project Managers.

To assure the hurricane protection system performance evaluation is initiated as quickly as possible, the entire IPET has scheduled a site visit for November 7-8, 2005. The leaders of the

IPET will meet with the Commanders of the Mississippi Valley Division, the New Orleans District, Task Force Guardian and their senior leaders on November 6, 2005 to assure that project needs and priorities are clearly understood. Upon completion of the IPET site visit, the IPET will provide an out brief to the TFG Project Managers and Technical Managers. The TFG Project Managers will provide a layout of the Project Management Plan for restoration of the hurricane protection system with special emphasis on key milestones and dates. The IPET will submit the trip report to TFG LiaisonTFG Liaison by November 15, 2005.

The IPET shall be offered the opportunity to participate in the Independent Technical Review (ITR) process for construction plans and specifications. The TFG Project Manager shall contact the IPET Project Manager a minimum of 7 days prior to completion of the draft documents. The IPET Project Manager shall determine the appropriate reviewers within the IPET and provide the TFG project Manager with the list of persons to forward the documents. The respective IPET members shall have 5 days to submit comments. The TFG shall not be bound to implement IPET recommendations; however, the appropriate TFG Technical Manager shall document the rationale for not concurring with the comment in a brief response to comment record.

Due to the critical schedule constraints, the design process must be completed on a very fast track. This will require the TFG design team to make reasonable assumptions regarding such critical design parameters as soil shear strength and permeability. When a substantial difference between expected and actual conditions is observed during construction, it is critical that the best technical experts participate in any decisions to modify the plans or specifications during construction. Therefore, IPET participation in the Engineering During Construction (EDC) process is critical to project success. The IPET shall plan for prompt response to all EDC requests. The IPET and TFG Project Managers shall promptly arrange for the most appropriate technical experts to respond to these requests, and the results shall be documented within the contract modification documents.

Part 4: IPET and ASCE External Review Panel Terms of Reference

Objective: The Objective of the ASCE External Review Panel is to provide for an external, expert, and constructive technical review of the activities and products of the Interagency Performance Evaluation Task Force to provide:

a. Validated and credible answers to fundamental questions concerning the performance of the flood protection system in New Orleans during Hurricane Katrina, and

b. Insights for the reconstitution of authorized flood protection for New Orleans

Process: The primary point of contact for the ASCE in this relationship will be Mr. Larry Roth, Deputy Executive Director, ASCE. The IPET points of contact will be Dr. Lewis E. Link, IPET Project Director, University of Maryland, or Dr. John Jaeger, IPET Technical Director, Chief of Engineering and Construction, Huntington District, USACE.

The external review panel will operate in accordance with three overarching principles:

a. Independence
  - The External Review Panel will comprise experts with limited or no current ties to the Corps of Engineers or major stakeholders in the New Orleans flood protection process.
  - The activities of the ERP will be separate and independent from the activities of the Task Force.

b. Periodic
  - The ERP will provide review and feedback throughout the conduct of the schedule of activities of the task force to expedite completion of the task force efforts, as well as providing a final overall review.

c. Comprehensive
  - The ERP will have membership with recognized expertise in the major technical areas in which the Task Force will be conducting analysis.

The scope of the ERP activities will provide balanced, objective, expert technical review that includes:

a. At the start of the Task Force - The overall scope of work and composition of efforts planned by the IPET

b. At specified points and as required during the IPET work effort - The key assumptions, technical analysis and products generated by each of 10 major technical teams

c. At the end of the IPET effort – The overall findings and conclusions of the teams and the task force, specifically whether the interpretations of analysis and the conclusions based on the analysis are reasonable

The ERP has no approval authority on the findings of the Task Force, nor are ERP’s recommendations to the Task Force binding, but the Task Force will give serious consideration to each and respond in writing to the ERP with a summary of actions taken and the rationale for such actions. Given any significant disagreement between the IPET and ERP, a dispute resolution process will be used to reach consensus.

The following Rules of Engagement will govern the interaction of the IPET and ERP:

The IPET will:

- *a.* Will provide information requested by ERP in timely manner to facilitate expedient review.
- *b.* Will assign Team Leaders as primary POC to ERP for specific topical areas.
- *c.* Will provide ERP actions to be taken in response to specific feedback / recommendations provided to the Task Force.
- *d.* Leadership to meet monthly (or more frequently as needed) with ASCE leadership to assess effectiveness of independent review process.
- *e.* Will participate with ASCE leadership to provide an efficient issue resolution process for the effort.
- *f.* Will handle release and dissemination of all information concerning the activities, analyses and products of the IPET using the communications protocols included herein and by the USACE.
- *g.* Will handle all media inquiries concerning the activities, analyses and products of the IPET using the communications protocols included herein and by the USACE.
- *h.* Will refer all media inquiries concerning the ERP activities, analyses and products to the ERP.

The ERP will:

- *a.* Will provide a principle point of contact to the Task Force and to each Task Force Team.
- *b.* Principle Points of Contact will not participate in Task Force Team activities or discussions.
- *c.* Will provide expedient review to facilitate the continued progress by the Task Force.
- *d.* ASCE leadership will meet monthly (or more frequently as needed) with Task Force leadership to assess effectiveness of Independent review process.
- *e.* Will participate with Task Force leadership to provide an efficient issue resolution process for the effort.
- *f.* Will refer to the task Force all inquiries and requests for data, information, analyses or products generated by the Task Force.
- *g.* Will handle information dissemination and disclosure for all analyses and products generated by the ERP using ASCE communications protocols.
- *h.* Will handle all media inquiries concerning the activities, analysis and products of the ERP using accepted ASCE communications protocols.
- *i.* Will refer all media inquiries and requests concerning the Task Force activities, analyses or products to the Task Force.

Part 5: National Research Council Independent Review Panel Terms of Reference

TO BE DEVELOPED with OASA(CW) and NRC

Part 6: IPET External Communications Plan

Objective: IPET information and analysis is intended to be distributed as widely as possible. While the first priority will be to assist Task Force Guardian and officials involved in the New Orleans flood protection reconstruction, validated information and validated analyses will also be provide to the public as appropriate. This protocol is to provide clear guidelines for the preparation and release of information concerning IPET activities and findings.

Process: DOD Hurricane Katrina Task Force: The Department of Defense (DoD) has created a Hurricane Katrina Task Force (HCTF) that will act as a clearinghouse and denial authority for all information released pursuant to requests for information relating to Hurricane Katrina from inside and outside the DoD. The HKTF is lead by COL Rhodes. They are the ultimate release authority for Katrina related information requests. The Current guidance from the HCTF is as follows:

a. The Corps can post previously released information – such as general design memoranda – on its websites even when the purpose of posting such information was to respond to numerous public information requests relating to Hurricane Katrina. The Corps does not need to clear such information or documents to be posted with the HCTF prior to posting. The HCTF is only interested in reviewing the release of previously unreleased information pursuant to a Hurricane Katrina related request. The HKTF will accept packages for review by Action Officers. Those action officers identified below will separately provide documents to the Task Force for review prior to release, based on the following procedures.

b. Packages sent electronically will be sent to McHale-Mauldin.tf.osd-policy@osd.mil.

c. We will attempt to send information in the most expeditious manner. Paper packages will be coordinated through the same e-mail address. Small amounts of information should be sent via e-mail. For large amounts provide the HKTF with access to an .ftp or internal website, or send CD/DVDs or coordinate with the HKTF on other methods.

d. Only completed packages will be sent to the Task Force for review. Packages will not be sent to the Task Force until they have gone through the normal Corps coordination procedures.

e. Each Corps Team member mentioned below will be responsible for providing information to the Task Force from their own area, or asking others to provide it.

TBD, Congressional Committee Requests

TBD, Public Affairs
TBD, Homeland Security
TBD, Legislative Affairs
TBD, Engineering/Investigation teams
TBD, FOIA requests/Website/Litigation
TBD, FOIA/Investigation Team Issues
TBD, HQ FOIA Requests
John Jaeger, Investigation Teams (internal and external)
Office of Chief Counsel, HQUSACETBD, FOIA/Miscellaneous

E-mail messages transmitting Packages to the HKTF by the Corps representatives should be copied to the other members of the Corps Team to ensure that we are not duplicating efforts. Additional procedures will be provided by the HKTF as their processes become more refined and the IPET interface is more comprehensively defined.

The U.S. Army Corps of Engineers on Oct. 29, 2005 began publicly releasing available data relevant to the performance of the hurricane and storm protection system around New Orleans during Hurricane Katrina. The current releasable data will be posted on a publicly accessible web site, https://ipet.wes.army.mil. Additional data will be added to the web site as it becomes available. See Part 2, Data and Information Assurance for the process used to screen and release information.

Media Interaction: All media requests for information will be forwarded to the USACE Public Affairs person assigned to support IPET. Reponses will be coordinated with the appropriate Team leaders and team members as well as the Project Director and/or the Technical Director.

a. Releases will be based on validated and factual information.

b. Releases on new, previously unpublished or distributed information will be cleared as appropriate through the DoD HKTF.

c. Releases will be coordinated with the Office of Public Affairs, HQ USACE and where appropriate with the Public Affairs offices in MVD and MVN.

d. The Project Director or Technical Director or a designated individual will provide verbal public feedback on specific questions.

e. The IPET will conduct frequent media updates on its work and specific releases to announce findings considered significant to the study and the reconstitution of flood protection in New Orleans.

f. The IPET will coordinate any releases or responses that involve or mention the ERP with the ASCE Communications staff.

Part 7: IPET Internal Communications Plan

IPET Virtual Office: IPET internal communications will be supported by Groove Virtual Office. Groove Virtual Office is a product that effectively facilitates file sharing, meetings and project management, data and process tracking for groups of geographically distributed co-workers, such as our IPET teams. Groove makes it easier for teams to bring relevant information together in one place – data, files, messages, edits, forms, meetings, calendars, etc. Instead of using email to transfer files among team members, files can be transferred to a folder within a Groove Workspace and immediately available to the entire membership of the workspace. A Groove workspace has been created for the IPET team with separate folders for each Task. In order to participate within this workspace, the Groove software must be installed on each participant's desktop computer. The USACE Knowledge Management Environment (KME) manages the Groove software licenses. The following protocol has been established to manage internal communications via Groove for the IPET study.

Acquiring and Installing Groove software:

USACE users: USACE employees may request a Groove license by completing the request form at http://kme.usace.army.mil/groove. Within 24-48 hours an email will be sent with the license keys and installation instructions. Once Groove is installed on a user's computer, an invitation must be sent by the IPET workspace manager to participate in the workspace. Upon acceptance of the invitation, the workspace will be loaded on the user's computer and available for opening from the Groove Launchbar.

Non-USACE users: Non-USACE users may request a Groove license as an external partner through a USACE sponsor. The USACE sponsor provides the external partner's Full name, Company Name, Company address, and email address to the USACE KME Groove manager (Hortense Frank). The instructions for installing Groove and the activation key are then sent via email to the external partner. Once Groove is installed on a user's computer, the user must send their VCard to the workspace manager.

To send your VCard (External Partner):

1) On your Launchbar, click Options-->Preferences

2) Under the Identities tab, click on the link that says "email this contact"

3) Enter the workspace manager's email address in the To: field and click send

The workspace manager will then send an invitation to the external partner to participate in the workspace. Upon acceptance of the invitation, the workspace will be loaded on the user's computer and available for opening from the Groove Launchbar.

Foreign National users: Foreign Nationals may not participate in the Groove workspace.

IPET Workspaces

To facilitate internal communications for the large team involved in this study, several Groove workspaces have been created:

- IPET Study – Management
- IPET Study – Task 1 Data Collection and Mgmt
- IPET Study – Task 2 Baseline Hydro Response
- IPET Study – Task 3 Actual Hydro Response
- IPET Study – Task 4 Numerical Model for Storm Surge and Wave
- IPET Study – Task 5 Storm Surge Wave Breaching Physical Model
- IPET Study – Task 6 Geodetic Vertical Survey Datum Assessment
- IPET Study – Task 7 Analysis of Floodwall and Levee Performance
- IPET Study – Task 8 Pumping Station Performance Assessment
- IPET Study – Task 9 Consequence Analysis
- IPET Study – Task 10 Eng and Operational Risk and Reliability Analysis

Task Leads will manage their respective workspace. With the exception of Task 1, members of the workspaces for individual Tasks will include only those involved in that specific task. Members of the Task 1 workspace will include individuals from all the tasks, since Data activities apply to all of the IPET team. Members of the IPET Study – Management workspace include Ed Link, John Jaeger, Jeremy Stevenson, and the Task Leads, with Jeremy Stevenson as the manager.

IPET Data Repository

In addition to the Groove workspace, a data repository will support IPET internal communications. The data repository will provide the hardware and software framework required to store, organize, manage, and deliver the data associated with this study to both USACE users and non-USACE partners. A USACE enterprise approach based on existing corporate frameworks and standards will be employed to manage the heterogeneous data required for this study. Data sets will be stored and managed according to the component that best fits the type of data. For example, scanned documents will be stored and managed within the corporate framework for unstructured data, while GIS layers will be stored and managed within the corporate framework for geospatial data, and model data will be stored and managed within the appropriate corporate framework. An overall data manager will manage the metadata for all datasets. A web-based interface will be developed to support user access to the data. A QA/QC Group of subject matter experts will be established to authorize each data set that is stored in the repository. The base data will reside in a common repository in a format suitable for archival and active use.

Weekly Virtual Conferences: IPET will hold at least weekly virtual conferences to facilitate communications within the Task Force. The conference will be arranged through the Jeremy Stevenson, IPET Project Manager, who will provide information concerning call in phone numbers and access codes to the IPET participants. The agenda for the conference will be set by the Technical Director in consultation with the Project Director and posted to the participants at least 2 hours prior to the call. All information or documents needed for the conference will be placed in the Virtual Office space prior to the conference. The conferences will be held, unless circumstances cause a change, at 1000 to 1200 hours, Eastern Time. Each conference will include a strategic overview by the Project Director, a status of key activities by the Team Leaders, a discussion of major issues and summary of actions. One fixed item on the agenda will be to summarize contacts with Task Force Guardian and identify what has been generated or learned during the week that can assist Task Force Guardian in their efforts to rebuild hurricane protection in New Orleans. The Project Manager will be responsible for preparing and distributing minutes for the conference, placing them in the Virtual Office space.

Part 8: Appendices

Appendix 1 : ASCE Media Communications Protocol

Issue: Uncoordinated contact with the media often results in incomplete, inappropriate or inaccurate information being disseminated to important audiences. It also can result in missed opportunities to effectively achieve communication goals, and hinder efforts to develop and nurture effective relationships with key media. This policy ensures that team members and staff are properly informed on the best way to meet the needs of both media and the team; enables the communications staff to track media contacts; and ensures media receive quick response to requests.

Communications Objectives: Our communications goals are to reassure the public that qualified and credible engineers are studying the levee performance to determine whether there are lessons for the future, to support the panel's work by minimizing disruptions and distractions, and to establish the role of ASCE and panel members as independent, highly credible, and authoritative technical experts.

Policy: ERP members must coordinate all contact with the media through the ASCE Communications Department. If a staff member of the Communications Department asks you to respond to a media request for information or comment, you should attempt to do so promptly and within the reporter’s deadline.

Media are defined as: newspapers, radio and TV stations, magazines, on-line publications or media sites, and trade magazines (like *ENR* or *Professional Builder*), including those published by universities, government agencies and private corporations or organizations.

Procedure: All media calls/e-mails/or personal requests must be forwarded promptly to the communications staff *prior* to responding to any questions, sending information or referring calls to another panel member. Do not provide background material, answer questions, or refer them to another panel member, staff person, or outside expert until asked to do so by a member of the communications staff. All news releases, advisories, letters and pitch calls to the media must be coordinated *first* through the Communications Department. This department is the only Society entity authorized to issue news releases on behalf of the panel.

Speaking Invitations: You may be asked to speak before professional organizations. Keep in mind that these presentations, especially when open to the public or media, are covered by the same limitations as media interviews. Please ask that the individuals handling promotion or publicity for these speaking engagements contact communications staff to coordinate. We will also be happy to facilitate review of any part of your presentation that you may have questions about in order to allow you to have, as much as possible, an open exchange of information with your professional colleagues.

Communications Department Hours: Communications staff has staggered schedules so there is generally someone available in the office between 8:00 a.m. and 6:30 p.m. The senior manager, external relations and the director of communications are on-call on evenings and weekends.

Media calls should be referred in the following order:

Sr. Manager, External Relations:
Director of Communications:
Manager, Communications
ASCE Central: 1-800-548-2723
After hours: TBD

Appendix 2: ASCE External Review Panel Membership

Ms. Christine F. Andersen, P.E., M.ASCE (Public Agency Representative)
Director of Public Works
City of Long Beach

Dr. David E. Daniel, Ph.D, P.E., M.ASCE (Chair)
President, University of TX at Dallas

Dr. Billy Edge, P.E., F.ASCE (Coastal Engineering)
Professor
Texas A&M University

Mr. Joseph Louis Ehasz, Jr., P.E., F.ASCE (Construction/Maintenance)
Vice President
Washington Group International

Mr. William Howard Espey, Jr., P.E., M.ASCE (Hydrology)
President
Espey Consultants, Inc.

Mr. Thomas L. Jackson, P.E., F.ASCE (Pump Stations)
DMJM Harris

Mr. David Kennedy, F.ASCE (Public Agency Representative)
Consultant

Dennis S. Mileti (Consequence Analysis)

Dr. James K. Mitchell, Ph.D., P.E., Hon.M.ASCE (Geotechnical)
Professor Emeritus, Virginia Tech

Mr. Clifford A. Pugh, P.E., M.ASCE (Hydraulics)
Manager
U.S. Bureau of Reclamation

Mr. George Tamaro, Jr., P.E., Hon.M.ASCE (Soil-structure Interaction)
Partner
Mueser Rutledge Consulting Engineers

Mr. Robert Traver, P.E., M.ASCE (Urban Drainage)
Associate Professor
Villanova University
Dept of Civil and Environmental Engineering

STAFF

Lawrence H. Roth, P.E., G.E., F.ASCE
Deputy Executive Director
ASCE

John E. Durrant. P.E., M.ASCE
Managing Director, Engineering Programs
ASCE

Appendix 3: IPET Teams Protocol for Release of Public information

MEMORANDUM FOR MISSISSIPPI RIVER VALLEY DIVISION
ENGINEER RESEARCH AND DEVELOPMENT CENTER

SUBJECT: Protocol for releasing documents associated with Hurricane Katrina

1. Background: On 24-Oct-05, the Department of Defense established the Hurricane Katrina Comprehensive Review Task Force (DoD TF). The Task Force is the sole release approval authority for DoD responses to Hurricane Katrina inquiries from non-DoD entities. In response to the massive inquiries for information on the New Orleans levee system, the DoD TF has authorized the Army Corps of Engineers to release any documents that had been previously made available to the general public. In order to answer the numerous information requests as well as to make these documents available to the general public, the Engineer Research and Development Center (ERDC) created the "New Orleans Hurricane Protection Projects Data" website (Website).

2. Purpose: The purpose of this memorandum is to establish the necessary protocol and points of contact for reviewing the releasability of information in response to Hurricane Katrina inquiries.

3. Documents available to the public prior to Hurricane Katrina: The DoD TF and the Assistant United States Attorney have approved the release of any documents that were available to the public prior to Hurricane Katrina. Consequently, the protocol outlined in sections 4 and 5 does not apply to these documents. Once either New Orleans District Counsel or Assistant ERDC Counsel determines that a subject document was available to the public prior to Hurricane Katrina, then the document can be posted on the Website.

   If it is difficult to ascertain whether a specific document was in the public domain prior to Hurricane Katrina, then that document must be sent through the protocol outlined in sections 4 and 5.

4. Information not available to the general public in response to 9-11: This information includes any information that was made available to the general public prior to 9-11 but “pulled” from the public domain due to the global war on terrorism (GWOT). Before this information is placed on the Website, a subject matter expert must conclude that the release of such information will not adversely affect the GWOT.

   New Orleans District Counsel and Assistant ERDC Counsel will conduct the initial legal review of any documents that were pulled from the public domain in response to 9-11. New Orleans District Counsel and Assistant ERDC Counsel will forward the documents to Dr. Reed Mosher (Technical Director, Survivability and Protective Structures, ERDC-GSL) and MVD for GWOT review. If neither Dr. Mosher nor MVD representative TBD is the appropriate subject matter expert for a given document, then they will forward the document to the appropriate subject matter expert for his/her review and so notify New Orleans District Counsel and Assistant ERDC Counsel. Upon completion of his/her review, the subject matter expert will return the document to New Orleans District Counsel, Assistant ERDC Counsel as appropriate, along with a written determination as to whether the document is releasable.

   Documents that are recommended for release will be forwarded to either MVD Counsel or ERDC Counsel. All documents under the Mississippi Valley Division’s (MVD) jurisdiction will be forwarded to MVD Counsel. All ERDC documents will be forwarded to ERDC Counsel and MVD Counsel. MVD Counsel and ERDC Counsel will then forward the documents to the DoD Task Force for release approval and copy furnish Office of Chief Counsel, HQUSACE.

New Orleans District Counsel will also coordinate with the Department of Justice (DoJ) for review of any documents that are the subject of litigation. Before these documents are released, New Orleans District Counsel will obtain DoJ approval. Such coordination will take place concurrent with submission to the DoD TF.

Upon receipt of approval from the DoD TF and DoJ (where appropriate), either MVD Counsel or ERDC Counsel will forward the approved documents to Denise Martin (ERDC-ITL) for placement on the Website. Ms. Martin will oversee any scanning and placement of documents on the Website. Ms. Martin will also maintain an index of all documents placed on the Website, to include the date each document was so posted. Ms. Martin will notify Assistant ERDC Counsel of all documents placed on the website, to include the date of posting. Assistant ERDC Counsel will in turn notify ERDC Counsel, MVD and New Orleans District Counsel.

5. Documents not available to the general public prior to Hurricane Katrina shall not be placed on the Website until the DoD TF approves their release. Typically, DoD TF approval requires the following steps:

   a. New Orleans District Counsel and Assistant ERDC Counsel will initially review the document;

   b. New Orleans District Counsel and/or Assistant ERDC Counsel will forward the document to Dr. Mosher and MVD for GWOT review;

   c. After GWOT review, Dr. Mosher and/or appropriate subject matter expert will return the document to either New Orleans District Counsel and/or Assistant ERDC Counsel;

   d. New Orleans District Counsel and/or Assistant ERDC Counsel will forward the document to MVD Counsel or ERDC Counsel, as appropriate;

   e. MVD Counsel and/or ERDC Counsel will submit the document to the DoD TF for approval and copy furnish Office of Chief Counsel, USACEHQ.

   f. DoD TF will notify either MVD Counsel or ERDC Counsel whether it is permissible to place the document on the website;

   g. If DoD TF approval is received, then either MVD Counsel or ERDC Counsel will direct Ms. Martin to place the document on the website.

   To ensure the proper steps have been taken, Ms. Martin will need the attached routing slip completed before the subject document is placed on the Website.

6. Contract documents: New Orleans District Counsel and Assistant ERDC Counsel will review all contract documents in accordance with current Procurement Integrity Act and Freedom of Information Act guidelines. Documents recommended for release by New Orleans District Counsel and Assistant ERDC Counsel will be forwarded to either MVD Counsel or ERDC Counsel. All MVD and New Orleans District documents will be forwarded to MVD Counsel. All ERDC documents will be forwarded to ERDC Counsel. MVD Counsel and ERDC Counsel will then forward the documents to the DoD TF for release approval. (Note: This paragraph pertains to contract documents in the custody of ERDC and the New Orleans District. Any contracts administered by other Corps commands will be reviewed by those commands and coordinated with MVD Counsel.

7. Documents from non-Corps entities: Before a document owned by a state, local, or non-Corps federal agency can be posted to the Website, New Orleans District Counsel or Assistant ERDC Counsel will coordinate with the subject agency to obtain the quickest possible release of their documents in our possession.

8. Freedom of Information Act Requests: As documents are posted to the Website, FOIA Officers will notify those requestors whose requests relate to the documents recently posted. It is the FOIA Officer of the office that has custody of the original records who is responsible for responding to the requestor. After the FOIA Officer determines that the search for documents has been concluded, a final letter will be mailed to the requestor, so notifying them that the search

and release are complete. Withholdings must be identified therein.

The POC for this memorandum is Assistant ERDC Counsel.

Chief, Business Technical Division, MVD

Assistant Chief Counsel/
Division Counsel, MVD

Attachment

Dr. Reed L. Mosher
ERDC-GSL Technical Director,
Survivability and Protective
Structures

ERDC Counsel

Routing Slip for Requests to Post Katrina Documents to the New Orleans Hurricane Protection Projects Data Website

1. Legal Review	Initials	Date
New Orleans District Counsel		
OR		
Assistant ERDC Counsel		
2. Litigation Review		
New Orleans District Counsel		
3. GWOT Review		
Reed Mosher		
OR		
MVD Personnel TBD		
OR		
*____________________ Subject Matter Expert		
4. MVD/ERDC Review		
MVD Counsel		
OR		
ERDC Counsel		

5. Dod TF Approval

NAME:

Approval Date:

6. Posted to Website

NAME:

Date:

7. <u>Notification Sent</u>

NAME:

Date:

* If neither Dr. Mosher nor MVD is the subject matter expert for this particular document, then the GWOT reviewer must sign here.

Appendix 4: IPET and ERP Issue Resolution Process

The intent for resolving technical issues is at the lowest level possible. When a technical issue develops at the working level those involved should seek to resolve the issue at there level within 2 days keeping the appropriate IPET Task Co-Leaders (see below) and ERP Task Reviewers (see below) informed of the situation. When the technical issue can not be resolved within 2 days those involved at the working level should engage the support of the appropriate IPET Task Co-Leaders and ERP Task Reviewers to resolve the technical issue. The appropriate IPET Task Co-Leaders and ERP Task Reviewers involved seek to resolve the issue at there level within 1 day keeping the IPET and ERP Final Issue Resolution Team (see below) informed of the situation. If the appropriate IPET Task Co-Leaders and ERP Task Reviewers are unable to resolve the technical issue in 1 day they should engage the IPET and ERP Final Issue Resolution Team where the technical issue will be resolved in 1 day. All discussions and resolutions on technical issues shall be documented through the level in which resolution was made and the documentation shall be maintain in the Groove IPET All-Task workspace and ERP workspace

All non technical issues should be brought to the appropriate IPET and ERP Final Issue Resolution Team Members where the non technical issue will be resolved.

IPET Task Co-Leaders

Task 1 – Data Collection and Management – Denise Martin and Reed Mosher

Task 2 and 3 – Interior Drainage Interior Models – Jeff Harris and Steve Fitzgerald

Task 4 – Numerical Model of Hurricane Katrina Surge and Wave environment – Bruce Ebersole and Joannes Westerkink

Task 5a – Storm Surge and Wave Physical and Numerical Models Hydrodynamic Forces Don Resio and Bob Dean

Task 5b – Storm Surge and Wave Physical Model – Centrifuge Breaching – Mike Sharp and Scott Steedman

Task 6 – Geodetic Vertical Survey Assessment – Jim Garster and Dave Zilkowski

Task 7 – Analysis of Floodwall and Levee Performance – Reed Mosher and Mike Duncan

Task 8 – Pumping Station Performance – Brian Moentenich and Bob Howard

Task 9 – Consequence Analysis of Hurricane Katrina – Dave Moser and Pat Canning

Task 10 – Engineering and Operation Risk and Reliability Analysis – Jerry Foster and Bruce Muller

ERP Task Reviewers

David E. Daniel - Task 7 Analysis of Floodwall and Levee Performance

Christine F. Andersen - Task 6 Geodetic Vertical Survey Assessment

Billy Edge - Task 5a - Storm surge & wave Physical model - Hydrodynamic Forces
Task 5b - Storm surge & wave Physical model - Centrifuge Breaching
Task 4 - Numerical model of Hurricane Katrina surge and wave environment

Joseph L. Ehasz - Task 7 - Analysis of Floodwall and Levee Performance
Task 8 - Pumping Station Performance

William H. Espey - Task 2 and 3 - Interior Drainage Numerical Models

Thomas L. Jackson - Task 8 - Pumping Station Performance

David F. Kennedy - Task 1 - Data Collection and Management - Perishable, system data

Dennis S. Mileti - Task 9 - Consequence Analysis of Hurricane Katrina

James K. Mitchell - Task 7 - Analysis of Floodwall and Levee Performance

Clifford A. Pugh - Task 5a - Storm surge & wave Physical model - Hydrodynamic Forces
Task 5b - Storm surge & wave Physical model - Centrifuge Breaching
Task 4 - Numerical model of Hurricane Katrina surge and wave environment

George Tamaro - Task 7 - Analysis of Floodwall and Levee Performance

Robert Traver - Task 2 and 3 - Interior Drainage Numerical Models

Robert Gilbert - Task 10 - Engineering and Operation Risk and Reliability Analysis

Jurjen Battjes - Delft - Foreign representative

IPET and ERP Final Issue Resolution Team

David Daniel – Chairman ERP

Larry Roth – Technical Director ERP

Ed Link – Project Director IPET

John Jaeger – Technical Director IPET

10 Closeout Plan

The IPET project will be closed out by ERDC-GSL once each funded IPET task and their respective activities have been coordinated to be complete with the IPET Project Management team and respective IPET Task Co-Leads. The closeout process for each project begins once the scope for the IPET task is complete, and involves the following areas:

10.1 Verification of Project Completeness and Suitability

- Ensure that the final IPET Report has been completed in compliance with customer project requirements to answer all question related to the performance of the system in wake of Hurricane Katrina.
- Ensure that all ITR, ERP and NRC comments have been answered and addressed in the final IPET Report.

10.2 Physical/Electronic Turnover of Final Products

- Assemble and transfer the final IPET report to customers as required.
- Perform appropriate transfer of results and data to Task Force Hope, Task Force Guardian, and the New Orleans District.
- Finalize posting of IPET Final Report and all related data on the IPET Data Repository and IPET Public Website.

10.3 Financial closeout

- Transfer all assets to the proper asset work items
- Review unliquidated obligations and commitments, and clear them out of project accounts. Close completed work items

10.4 Miscellaneous closeout

- Complete “Lessons Learned”
- Prepare and send project personnel a memorandum closing project
- Organize records and store/archive properly

Appendix D
Task Force Guardian Inputs

IPET Products Provided to Task Force Guardian and Task Force Hope

a. **Data Repository – 25 October 2005.** The IPET Data Repository was established as an entry point for collecting information pertaining to the New Orleans and Southeast Louisiana Hurricane Protection Projects that needs to be validated as factual. This repository supports both the IPET and TFH/TFG efforts by providing a database where information can be reviewed for accuracy and quality prior to posting the information on the IPET public website.

b. **Establishment of the IPET Public Website – 2 November 2005.** The IPET public website was established as a way to be fully transparent in effectively sharing factual information pertaining to the New Orleans and Southeast Louisiana Hurricane Protection Projects. The website provides a way to proactively communicate information that might otherwise require the public and TFG to process Freedom of Information Acts.

c. **Establishment of On-Line Team Workspace using Groove – 22 September 2005.** To enable IPET, ERP, and members of TFH/TFG with on-line workspaces to communicate and share information virtually, Groove software and technical support was provided by IPET. Through these virtual workspaces information can be effectively and efficiently shared. Groove is a primary tool used to bring the IPET, ERP, and TFH/TFG teams together in sharing knowledge and information required to accomplish their missions.

d. **Integration of the IPET Public Website and the TFH/TFG Electronic Bid Solicitation Websites – 15 November 2005.** As a way to more effectively enable public benefit from the historic and performance-related information on the IPET public website and the reconstruction plans and specifications on the TFH/TFG electronic bid solicitation website, electronic linkage was provided to facilitate integration of the two sites.

e. **"Summary of Field Observations Relevant to Flood Protection in New Orleans, LA" – 5 December 2005**. This IPET review provided Task Force Guardian with a simple statement of concurrence or nonconcurrence from the IPET floodwall and levee sub team and additional relevant discussion for each of the major findings in the ASCE/NSF report's chapter eight, "Summary of Observations and Findings." The additional discussion relates to the analysis being conducted by the IPET or others that would assist in applying the ASCE/NSF findings to the reconstruction of hurricane protection in New Orleans.

f. **"Preliminary Wave and Water Level Results for Hurricane Katrina" – 23 November 2005.** This IPET report to TFH/TFG included observations from the IPET surge and wave sub team from a field trip and overflight of New Orleans and Southeast Louisiana.

g. **"Summary of IPET Numerical Model of Hurricane Katrina Surge and Wave Plans, Approach and Methods" – 19 December 2005.** This PowerPoint presentation by the IPET surge and wave sub team provided TFH/TFG with an update on wave and water level results for Hurricane Katrina. Wave and water level results from fast-track simulations of upper Category 3 type storms on various storm tracks and a Standard Project Hurricane event were also provided.

h. **Review of Proposal to Float In and Sink a Barge to Close Canals by June 2006 – 28 December 2005.** The proposal included the use of existing large ship tunnel thrusters mounted on a barge with huge pumping capacities. Review determined that the closure plan does not have enough pumping capacity to match existing pumps during a hurricane.

i. **Technical Support to TFG on the Analysis and Design of the Reconstruction Plans and Specifications for the Breaches – Continuous Support as Needed.** Technical support continues to be provided to TFG on an as-needed basis. As a minimum, monthly face-to-face meetings take place in New Orleans. This support includes geotechnical and structural consultations. These discussions also include reviews of plans and specifications for reconstruction features such as T-walls, L-walls, I-walls, levees, and foundation investigations.

j. **Evaluation of Existing and As-Built Conditions at Canals.** This evaluation includes concrete and steel material properties for reinforcement and sheet piles on the I-walls, as-built length of sheet piles, surveys, and foundation material properties and boring logs.

k. **Life-cycle Documentation of the Hurricane Protection System.** This documentation includes a review of the design, construction, and operation and maintenance of the hurricane system.

l. **Verification of Current and Reconstructed Floodwall Elevations – November 2005.** Established a tidal gage in November 2005 at the 17th Street Canal to monitor current sea level relationships to the newest NAVD88 datum epoch (2004.65). Verified floodwall elevations on Lakefront outfall canals and IHNC relative to this latest tidal and vertical epoch.

m. **LIDAR Ground Truthing – December 2005 - June 2006.** Performed ground-truthing surveys throughout the region to calibrate various LIDAR-based elevation models used by Task Force Guardian.

n. **Densification of Control Benchmarks – 31 December 2005.** IPET has established approximately 75 vertical benchmarks throughout the region. These control points are being used for Task Force Guardian construction activities.

o. **Establishment of GIS Team – 2 February 2006.** The "GIS Team" was established to maximize the effectiveness and efficiency of the GIS resources within IPET, Task Force Guardian, Task Force Hope, and the New Orleans District. The GIS Team consists of members from each of the four teams and provides a way to integrate efforts and share information pertaining to the HPS. The GIS Team will also provide for a way to assure a smooth transition of IPET generated GIS information to the New Orleans District upon disbanding of IPET once its performance evaluation is completed. Significant IPET data sets shared with TFG in January and February 2006 include the digital elevation models, vertical datum survey data, geotechnical data, and photographs.

p. **Insight into probable cause of breaching at 17th Street Canal – March 2006.** Information was shared with TFG on the probable cause of breaching at the 17th Street Canal. Recommendations were provided on considering the formation of a gap at the base of cantilever I-walls and shear strength variations between the centerline and inboard toe of levees used in combination with I-walls.

q. **Storm Surge and Wave analysis results for Katrina and historical storms – December 2005.** Information pertaining to modeled Katrina storm surge and wave heights and periods for various locations along the HPS was provided to TFG. In addition, modeled surge and wave results from other historical storms were also provided.

r. **Review comments on canal closure structures – December 2005 and January 2006.** IPET review comments for the outfall canal closure structures were provided to aid in development of high quality P&S for the closure structures.

s. **Provided comments in IPET Report 2 regarding comparison of Hurricane Katrina wave and period conditions with design values – March 2006.** Design wave conditions, particularly wave period, should be re-evaluated for the east-facing levees in east Orleans, St. Bernard and Plaquemines Parishes.

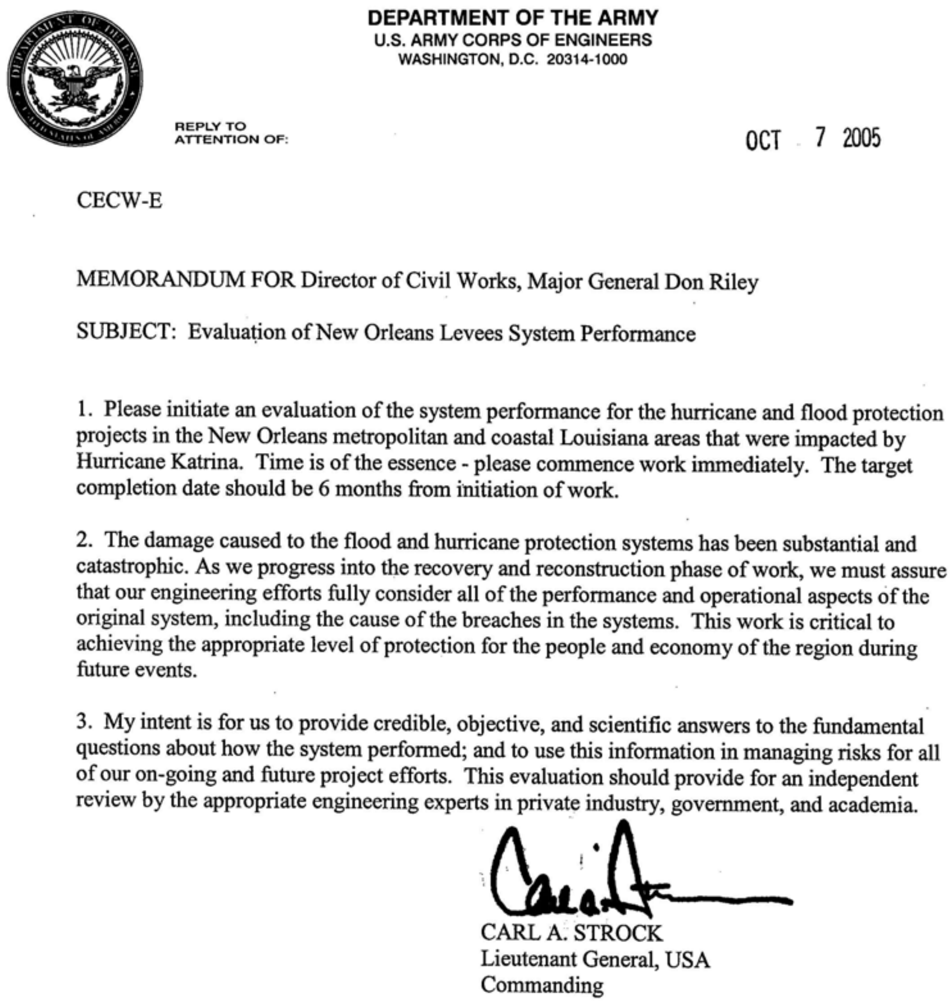
t. **Closure Structures Modeling – January – February 2006.** IPET members at MVN performed modeling analysis of the closure structures on 17th Street, Orleans and London Ave Canals.

u. **Closure Structures Interim Operations Plan – March 2006.** IPET members review and comment on operations of the gates and pumps. This includes criteria for closing & opening, and coordination with local jurisdictions.

v. **MRGO White Paper – March 2006**. Input on analysis of MRGO effect on storm propagation into metropolitan New Orleans and vicinity.

w. **ITR on Heat Straightening Repairs at Empire Floodgate.** IPET team members visited the Empire Floodgate and reviewed the proposed repair plan approving of the corrective action plan and making further clarifying recommendations. IPET suggested requiring in the specs that the project supervisor be an experienced heat straightener possibly added to section 5 of the specs and that NDT be performed prior to and following the heat straightening. The initial NDT would benefit general initial assessment of the floodgate and provide a base line in the event you get an inexperienced contractor that does more harm then good. TFG will know if heat straightening caused cracking if you have a base line. TFG may want to consider the simultaneous application of V heat on both sides of the flange considering its thickness this could be added in section 3.5 of Avent's spec. IPET believes section 3.5.3 pertains to simultaneous vee heats on the same side of the flange.

Appendix E
IPET Official Documents



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

OCT 7 2005

CECW-E

MEMORANDUM FOR Director of Civil Works, Major General Don Riley

SUBJECT: Evaluation of New Orleans Levees System Performance

1. Please initiate an evaluation of the system performance for the hurricane and flood protection projects in the New Orleans metropolitan and coastal Louisiana areas that were impacted by Hurricane Katrina. Time is of the essence - please commence work immediately. The target completion date should be 6 months from initiation of work.

2. The damage caused to the flood and hurricane protection systems has been substantial and catastrophic. As we progress into the recovery and reconstruction phase of work, we must assure that our engineering efforts fully consider all of the performance and operational aspects of the original system, including the cause of the breaches in the systems. This work is critical to achieving the appropriate level of protection for the people and economy of the region during future events.

3. My intent is for us to provide credible, objective, and scientific answers to the fundamental questions about how the system performed; and to use this information in managing risks for all of our on-going and future project efforts. This evaluation should provide for an independent review by the appropriate engineering experts in private industry, government, and academia.

CARL A. STROCK
Lieutenant General, USA
Commanding

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

24 OCT 2005

REPLY TO
ATTENTION OF

Dr. William A. Wulf
President
National Academy of Engineering
2100 Constitution Avenue NW
Washington, DC 20418

Dear Dr. Wulf:

The Army is initiating a performance evaluation to provide credible, objective engineering and scientific answers to fundamental questions about the operation and performance of the hurricane protection projects in New Orleans and Southeastern Louisiana. Due to the immediacy of the task, the evaluation is to be completed by June 2006, so that the Army and others have the information required to begin a permanent rebuilding of the hurricane protection system in New Orleans.

We envision a focused effort designed to answer the following questions related to the performance of the hurricane protection system:

a) What was the design capacity (surges, waves, water levels, winds, category storm, etc.) of the hurricane protection system for New Orleans and vicinity?

b) What forces were exerted against the hurricane protection system (storm surges and waves generated by Hurricane Katrina) and now did the system respond in the face of these forces?

c) What levees and/or floodwalls were overtopped, breached or failed during hurricane Katrina, and what caused these results?

Detailed technical data and analysis relevant to the three principal questions will be provided by an Interagency Performance Evaluation Task Force, with in-depth external technical review provided by experts from the American Society of Civil Engineers (ASCE).

This study is on the protection system, with its main focus on existing levees and/or floodwalls that were overtopped, breached, failed, or severely stressed during Hurricane Katrina, and whether such situations were the result of design, construction, or operation and maintenance issues, soil and geo-technical conditions, changed assumptions upon which the design or construction were based, or as the result of the severity of Hurricane Katrina.

I request that the National Academy of Engineering, through the Board on Infrastructure and the Constructed Environment, assemble a multidisciplinary, independent, panel of acknowledged national and international experts to provide a

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high-level independent review and to issue findings and recommendations based on the work of the Interagency Performance Evaluation Task Force (IPET) and the ASCE External Review Panel and other information deemed relevant to answering the three key questions. Thus, it is anticipated that the National Academy of Engineering would,

a) Interact as needed with the IPET, ASCE External Review Panel , State of Louisiana, City of New Orleans, Parish officials, the public and other organizations, as determined appropriate,

b) Review the overall activities and analyses procedures being undertaken by the IPET, and the feedback of the ASCE External Review Panel and, if appropriate, recommend additional efforts to the extent possible, to enhance the value of their efforts,

c) Synthesize the findings and conclusions of the IPET and recommendations of the ASCE External Review Panel and information gathered from public hearings, as appropriate,

d) Issue interim, draft and/or final findings and recommendations, as appropriate, regarding the performance of the hurricane protection systems for the New Orleans metropolitan area, lessons learned, and ways to potentially improve the performance of the existing hurricane protection system performance and possible approaches to improve performance for the future at the authorized level of projection.

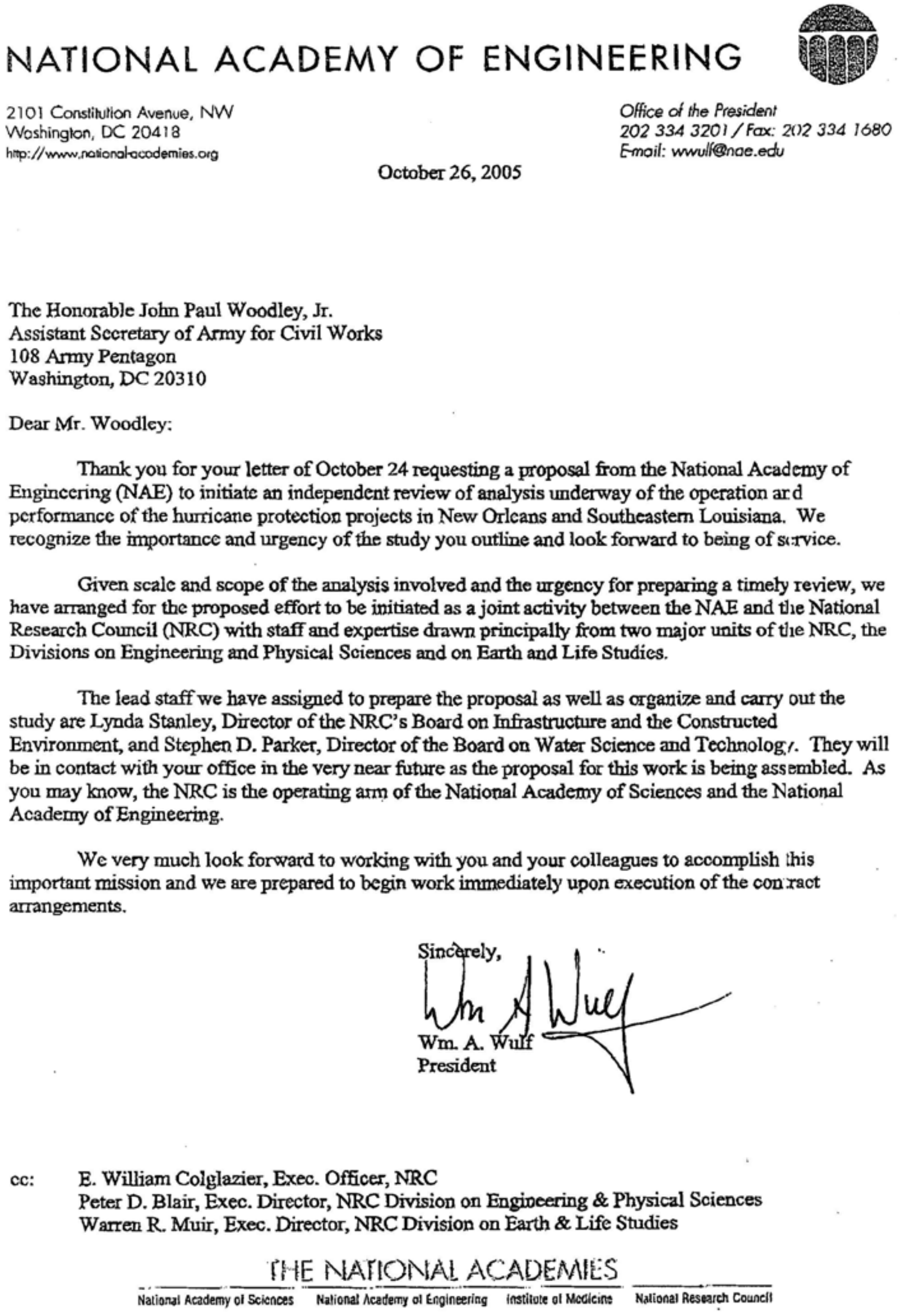
I would appreciate your help in arranging to have a proposal prepared for consideration by the Army that describes how the National Academy of Engineering would provide the requested assistance and the costs associated therewith. Please feel free to contact my office if you have any questions whatsoever. I look forward to working with you in order to accomplish this critical mission.

Very truly yours,

John Paul Woodley, Jr.

John Paul Woodley, Jr.
Assistant Secretary of the Army
(Civil Works)

Cc:
USACE, Chief of Engineers
Lynda L. Stanley, Director, Board on Infrastructure and the Constructed Environment, National Research Council



NATIONAL ACADEMY OF ENGINEERING

2101 Constitution Avenue, NW
Washington, DC 20418
http://www.national-academies.org

Office of the President
202 334 3201 / Fax: 202 334 1680
E-mail: wwulf@nae.edu

October 26, 2005

The Honorable John Paul Woodley, Jr.
Assistant Secretary of Army for Civil Works
108 Army Pentagon
Washington, DC 20310

Dear Mr. Woodley:

Thank you for your letter of October 24 requesting a proposal from the National Academy of Engineering (NAE) to initiate an independent review of analysis underway of the operation and performance of the hurricane protection projects in New Orleans and Southeastern Louisiana. We recognize the importance and urgency of the study you outline and look forward to being of service.

Given scale and scope of the analysis involved and the urgency for preparing a timely review, we have arranged for the proposed effort to be initiated as a joint activity between the NAE and the National Research Council (NRC) with staff and expertise drawn principally from two major units of the NRC, the Divisions on Engineering and Physical Sciences and on Earth and Life Studies.

The lead staff we have assigned to prepare the proposal as well as organize and carry out the study are Lynda Stanley, Director of the NRC's Board on Infrastructure and the Constructed Environment, and Stephen D. Parker, Director of the Board on Water Science and Technology. They will be in contact with your office in the very near future as the proposal for this work is being assembled. As you may know, the NRC is the operating arm of the National Academy of Sciences and the National Academy of Engineering.

We very much look forward to working with you and your colleagues to accomplish this important mission and we are prepared to begin work immediately upon execution of the contract arrangements.

Sincerely,

Wm A Wulf

Wm. A. Wulf
President

cc: E. William Colglazier, Exec. Officer, NRC
Peter D. Blair, Exec. Director, NRC Division on Engineering & Physical Sciences
Warren R. Muir, Exec. Director, NRC Division on Earth & Life Studies

THE NATIONAL ACADEMIES
National Academy of Sciences · National Academy of Engineering · Institute of Medicine · National Research Council

Hurricane Katrina Lessons Learned Issue Paper

Subject: Critical Infrastructure and Impact Assessment

Conclusion: The Department of Homeland Security (DHS) should organize the Federal departments and agencies that support critical infrastructure restoration in the aftermath of a disaster. Reorganization should include the revision of the National Response Plan (NRP), the National Infrastructure Protection Plan (NIPP), and DHS should identify ways to address gaps in information related to critical infrastructure.

Discussion:
The Nation relies on interdependent systems known as "critical infrastructure" to maintain its defense, continuity of government, economic prosperity, and quality of life. The term critical infrastructure means "systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters."[1] Transportation, electricity, banking, telecommunications, food supply, and clean water are examples of critical infrastructure services that have become basic aspects of our daily lives. These services are often only noticed when they are disrupted, and the American public expects speedy restoration of them.

Private sector companies own and operate 85 percent of our Nation's infrastructure and are responsible for protecting their facilities and restoring operations following an incident. Response planning must also recognize the unique Federal responsibility to support private sector efforts and assist in the restoration of critical infrastructures imperative to the National economy or integral to larger cascading systems or supply chains.

In the post 9/11 environment, the government's efforts have focused on the protection of critical infrastructure to avoid the impact of a natural disaster or terrorist attack because the private sector had shown the ability to adequately address restoration of services. In fact, the National Strategy for the Physical Protection of Critical Infrastructures and Key Assets points out the robust and resilient nature of critical infrastructure due to decades of experience of successfully recovering from natural disasters.[2] However, Hurricane Katrina has shown that there are times when the Federal government must be prepared to help the private sector with restoration efforts.

In the Homeland Security Act of 2002, Congress assigned the Department of Homeland Security (DHS) the mission of coordinating the overall protection of the Nation's critical infrastructure.[3] On December 17, 2003, The President affirmed this mission in Homeland Security Presidential Directive 7 (HSPD-7), which established a National policy for Federal departments and agencies to identify and prioritize the Nation's critical infrastructure and key resources. HSPD-7 required DHS to develop the National Infrastructure Protection Plan (NIPP) by December 17, 2004, to identify, prioritize, and coordinate the protection of critical infrastructure and key resources; and to provide the unifying structure for the integration of critical infrastructure protection efforts into a single national program. Currently in draft,[4] the NIPP will when final also identify how homeland security partners will develop and implement a national effort to protect critical infrastructure, as well as how they their efforts will be coordinated and integrated with emergency management and preparedness activities.[5]

Hurricane Katrina had a significant impact on the region's critical infrastructure across many sectors. The Hurricane temporarily caused the shutdown of most crude oil and natural gas production in the Gulf of Mexico as well as a great deal of the refining capacity in Louisiana, Mississippi and Alabama. Eleven petroleum refineries, or one-sixth of the Nation's refining capacity, were shut down.[6] Additionally, "[m]ore than ten percent of the Nation's imported crude oil enters through the Louisiana Offshore Oil Port[7]" adding to the impact on the energy sector. Across the region over 2.7 million customers suffered power outages across Louisiana, Mississippi, and Alabama.[8] In addition, approximately 75 percent of the Nation's corn and soybean crops travel through Louisiana ports.[9]

In light of this, there were many success stories for both the Federal government and the private sector where Federal actions mitigated the impact to the Nation. For example:

- The Department of Homeland Security temporarily waived Jones' Act restrictions which prevent foreign vessels from delivering products to more than one U.S. port without traveling to a foreign country between deliveries.[10] This action provided fuel companies an alternative to the incapacitated refinery and pipeline system, thereby averting a critical shortage of fuel throughout the Nation and minimizing the impact of fuel shortages on the economy.[11]

- The Environmental Protection Agency (EPA) waived national sulfur emissions standards for diesel fuel so that highway vehicles could use otherwise prohibited high-sulfur fuel produced for non-road uses.[12]

- The Department of Energy (DOE) removed Federal restrictions impeding restoration efforts and sent representatives to Gulf Coast energy facilities to assist with restoration.[13]

- Federal departments worked together to restore two facilities providing 60% of U.S. liquid hydrogen production. Other Federal officials further minimized the disruption by locating alternate sources while Federal responders worked to quickly restore the damaged facilities. As liquid hydrogen is critical to power generation and the production of steel, aluminum, and integrated circuits, these actions averted a potentially severe impact to the national economy and saved thousands of jobs.[14]

Because of advanced planning, many businesses anticipated and swiftly counteracted forces that impeded the delivery of their products or services and maintained excellent situational awareness of their own resources and markets. Some of the best examples of critical infrastructure planning and restoration include:

- Norfolk Southern Railroad recognized the potential impact that the loss of certain key bridges would cause and positioned repair barges just outside the hurricane impact area. After the hurricane passed, they used the barges to quickly repair the bridges, minimizing the impact on regional business.[15]

- Because Wal-Mart significantly invested in operations centers and contingency planning, they were able to open 83% of their 171 stores in the impact area within six days after landfall in spite of damage incurred by 63% of the total.[16]

While there were successes, the Federal response to Hurricane Katrina with respect to critical infrastructure protection and restoration can be improved. There was no clear Federal guidance regarding prioritization of the provision of limited government resources to critical infrastructure. Consequently, businesses that had not effectively planned or anticipated the Hurricane's effects had to compete for limited government resources.

The Government's ability to protect and restore the operation of priority national critical infrastructure was hindered by five interconnected problems: (1) a fractured response structure; (2) lack of coordination among the Federal departments and agencies, as well as among the private sector, and State and local officials; (3) lack of a prioritized policy and plan to address the protection and restoration of critical infrastructure during times of limited resources and competing demands; (4) a lack of situational awareness to decision makers; and (5) lack of understanding between the private sector and the Federal government regarding roles and the appropriate use of Federal resources to support restoration.

Fractured Response Structure

The response structure guided by the National Response Plan (NRP) did not operationally account for the need to coordinate critical infrastructure protection and restoration efforts across the Emergency Support Functions (ESF) functions. The NRP designates the protection and restoration of critical infrastructure as essential objectives of five ESFs: Transportation, Communications, Public Works and Engineering, Agriculture, and Energy.[17] Although these critical infrastructures are necessary to assist in all other response and restoration efforts, there are seventeen critical infrastructure and key resource sectors whose needs must be coordinated during response and recovery.[18] The needs and activities of all seventeen critical infrastructure sectors must be integrated and synchronized into a single effort in order to recognize the inherent interdependencies between them.

The Interim NIPP provides strategic-level doctrine for all Federal, State, and local entities to use in prioritizing infrastructure for protection. However, there is no supporting implementation plan and the application of this doctrine during a natural disaster has no standard operating procedure or operational policy. Federal, State and local officials need a unified operational policy and implementation plan that can be shared across the relevant ESFs to provide them with the necessary background to make informed operational decisions related to limited resources.

The NRP calls for an "Infrastructure Liaison" in the Joint Field Office (JFO) to serve as the principal advisor for all critical infrastructure issues.[19] However, for Katrina there was no senior level individual focused on the prioritization of Federal support to restoration efforts, knowledgeable about the interdependencies between sectors, or capable of providing recommended courses of action to senior interagency leadership. The lack of such an official advocating for critical infrastructure protection and restoration within the Joint Field Office limited the integration of protection and restoration priorities into overall response objectives.

The Lack of Coordination across the Federal Government, State and Local Officials and the Private Sector

The Federal government did not adequately coordinate its actions with State and local protection and restoration efforts, and, in fact, the Federal government created confusion by responding to individualized requests in an inconsistent manner. For example, the Federal government provided assets to assist in response to some requests from the private sector for security forces while unilaterally denying others.[20] The Federal Bureau of Investigation sent agents to temporarily protect a critical AT&T telephone network node. In contrast, FEMA denied requests to protect petroleum refineries along the Gulf Coast.[21]

Governments at all levels generally failed to identify critical infrastructure and prioritize in advance the need to restore it. Federal representatives were unaware until notified by a private energy company that the loss of electric power in one of the affected Gulf Coast States would shut down a crucial pumping station. This lack of: identifying critical infrastructure; understanding of interdependencies; and the importance of restoring critical infrastructure was in part caused by the separation of the traditional Federal role in the protection of infrastructure from its role in restoration activities.[22] The separation of these two related activities among Federal agencies has created a gap in our ability to respond.

In addition, the protection and restoration of critical infrastructure is a shared responsibility that can not be accomplished by the Federal government alone. State and local governments and the private sector must all be involved in the prioritization and protection of critical infrastructure. The lack of coordination was not only between the Federal, State and local governments, but also with the private sector. Industries with critical infrastructure contacted various Federal departments and agencies and requested assistance to protect or to restore their facilities. These requests were inconsistently coordinated across sectors and responded to in an ad hoc fashion.[23]

Because the private sector owns most of our Nation’s infrastructure, the Federal government cannot identify or prioritize what is critical without their assistance. To date, the private sector has not fully participated in this effort to prioritize critical infrastructure in part because the government has not made an effective “business case”[24] to clearly articulate how it is in the private sector’s best interest to provide the government with detailed information about their facilities.[25] Although DHS has begun developing a public-private sector partnership architecture to share information, businesses generally do not believe they will receive a return on their investment in assisting the government.[26] Our private sector partners are often concerned with the significant liability and proprietary concerns attached with sharing such information with government officials.[27] However, this information is essential for the government to have a full understanding of the protection, contingency, and restoration plans in order to be able to better coordinate with Federal emergency response efforts.

Lack of a Policy to Address the Prioritization of Protection and Restoration of Critical Infrastructures

Federal, State, and local officials responded to Hurricane Katrina without a comprehensive understanding of the interdependencies of the critical infrastructure sectors in each geographic area and the potential national impact of their decisions. For example, an energy company arranged to have generators shipped to facilities where they were needed to restore the flow of oil to the entire southeast United States. However, FEMA Region IV representatives diverted these generators to hospitals.[28] While lifesaving efforts are always the first priority, there was no overall awareness of the competing important needs of the two requests. It is not difficult to imagine inadvertently diverting equipment from one lifesaving mission to another unawares.

The assets, systems, and functions that comprise our infrastructure sectors are not uniformly "critical" and vary in a local, state, regional, or national context. Decisions affecting and supporting the restoration of critical infrastructure must be informed and prioritized based on national impact.

The National Strategy for Homeland Security and subsequent policy documents such as the interim NIPP provide a sector-based organizational scheme for protecting critical infrastructures with identified lead Federal agencies. This facilitates a detailed knowledge of critical assets within a sector, but limits the ability to map systems of infrastructure interdependency. Part of the difficulty in identifying and prioritizing critical infrastructure recovery efforts was that this sector-based approach in protection can only initially assess the criticality of each asset and only takes into account the impact of its individual loss without a full regard to sector or system degradation.

Critical infrastructure restoration efforts must estimate the consequence of the loss of an individual asset based on an understanding of the impact not just on that facility or resource, but on the entire system used to distribute an essential good or service. The systems used to distribute goods and services such as electric power, fuel, grain, containers, and people are networks. Understanding the impact of the loss of a facility or node on the network and on interdependent networks requires a systems approach.

Although some limited progress has been made in determining these cross sector dependencies, there is still much work that needs to be done. To date, there is no agreed upon plan for prioritization of restoration of critical infrastructures based on a study of interdependences.

That being said, the prioritization for protection and restoration are closely linked. Prioritization of protection is based on risk that combines an assessment of threat, vulnerability and consequence. Prioritization of restoration is based on the consequence of the loss of infrastructure and on the need for the infrastructure to support the immediate response. The Federal government should develop priorities for restoring critical infrastructure using much of the same information used to prioritize protecting it. Having restoration priorities will allow the Federal government to make decisions during disaster response that are informed by established restoration priorities.

Under the Stafford Act mission assignment process, local requests for assistance in restoration and protection of infrastructure are filled by the State, and are relayed for Federal support only when the State's capabilities are exceeded. State and local requests are based on their local priorities, and do not recognize Federal priorities. Had the Nation's critical infrastructure priorities been provided, it is unclear how the State and Local officials would have handled these critical infrastructure priorities against other State needs. During Hurricane Katrina, when critical infrastructure protection requirements were identified, local and state authorities occasionally appeared confused by the seeming Federal intrusion on their priorities.

Lack of Situational Awareness to Decision Makers

Conflicting information was provided to decision makers, and as noted in other issue papers, the Federal government lacked timely, accurate and relevant ground-truth information necessary to evaluate which critical infrastructures were damaged and/or inoperative. The rapid needs assessment teams did not focus on National critical infrastructure, and did not have had the expertise necessary to evaluate protection and restoration needs.[29]

Beginning on August 28, the day before landfall, the National Infrastructure Simulation and Analysis Center (NISAC) submitted impact assessment reports to DHS Headquarters.[30] The first report forecasted the disruption of electrical power, natural gas, and petroleum, and also mapped infrastructure throughout the Gulf Coast region. In addition, it provided an analysis of the hurricane's impact, based primarily on the predicted loss of power. Subsequent reports submitted soon after landfall included an economic impact assessment of the damage to infrastructure based in part on statistics from the Department of Commerce. However, the analysis did not include recommendations for courses of action for senior leadership to aid them in making decisions on how best to mitigate the impact of the hurricane.

Since Hurricane Katrina, NISAC has significantly improved their capability to provide reports detailing the cascading impact of major disasters on the Nation's infrastructure. Yet they do not have the best expertise to assess economic impact or a comprehensive understanding of the authorities held by each department and agency to take action to mitigate the impact of major disasters. The economic modeling expertise resident in the Department of Commerce and Treasury Department would have greatly aided in the preparation for and the response to the hurricane. This information should be incorporated in the NISAC modeling.

Adding to the lack of situational awareness was the fact that the Federal government currently lacks the capability to rapidly integrate damage reports, then identify and prioritize critical infrastructure for protection and restoration. A rapidly provided, prioritized list of national critical infrastructure damaged or inoperative following Katrina would have allowed the Joint Field Office's Infrastructure Support Branch to expedite and sequence protection and restoration.

Lack of Understanding between the Private Sector and the Federal Government

There was a lack of understanding between the private sector and the Federal government over the use of Federal resources to address critical infrastructure restoration. Private companies could not locate lodging for employees needed to restore operations because Federal, State, and local governments had occupied the limited available lodging.[31] State law enforcement officials prevented private sector employees from entering the disaster area to protect or restore their facilities because they did not have the proper credentials.[32] In addition there was confusion over what resources the Federal government would provide to the private sector for protection and restoration.

Because the private sector owns most critical infrastructures, the Federal government cannot identify nor prioritize private sector infrastructure needs without their assistance. However, the private sector has not fully participated in the Federal effort to understand critical infrastructure interdependences. DHS has developed and continues to build a public-private sector partnership architecture described in the NIPP to share information with the private sector, but a greater exchange is still needed. In addition, this information exchange must be reinforced by collaborative contingency planning and exercises.

Recommendations

Structure

1. DHS should revise the National Response Plan to:

a. Provide for a stronger Infrastructure Support Branch in the National Operations Center.[33] This entity will coordinate with critical infrastructure sectors, provide senior leaders with a summary of reports and modeling, and develop recommended preemptive and responsive actions to remediate or mitigate the impact of the loss of critical infrastructure. These optional actions will be based on reports from the Impact Assessment Working Group,[34] the NISAC, Sector Coordinating Councils, and consultation with DHS/IP.

b. Establish a new ESF focused on national and regional infrastructure restoration efforts. The new ESF would take the current critical infrastructure restoration responsibilities from the Emergency Support Functions for Transportation (ESF-1), Communications (ESF-2), Public Works and Engineering (ESF-3), Energy (ESF-12), and Long-Term Community Recovery and Mitigation (ESF-14) and combine their expertise with representatives from all 17 critical infrastructure sectors to address issues of infrastructure restoration.

c. Strengthen the role and responsibility of the Infrastructure Liaison. Currently, the Infrastructure Liaison is designated by DHS/IP, to serve as the principal advisor to the JFO Coordination Group regarding all national and regional level critical infrastructure and key resource incident-related issues.[35] This role should be more clearly defined, and have greater responsibility which should include a designated group of trained and knowledgeable critical infrastructure staff that are available for immediate deployment to the JFO to fill the role of the expanded Infrastructure Liaison group.[36] This expanded Infrastructure Liaison will incorporate the Private Sector Liaisons to ensure unity of effort.

Policy and Planning

2. DHS should revise the National Preparedness Goal to require the collaborative development of regional disaster plans (such as those required by the DHS Urban Area Security Initiative) with the private sector. This activity will not only prepare the Federal government to respond, but will set private sector expectations of specific actions the government will take in response to a disaster.

3. Set basic criteria for private sector preparedness against which these regional plans can be measured. There is a lack of a clear and agreed upon prioritized implementation plan to address the coordinated restoration and protection of critical infrastructure during times of limited resources and competing demands. Basic levels of private sector preparation similar to those outlined in the National Preparedness Goal should be set and used to measure progress in restoration planning.

4. DHS should review, revise, and finalize the Interim NIPP within 90 days to:

a. **Standardize Federal government policy to link the prioritization of both protection and restoration.** Linking prioritization for protection to prioritization for restoration will motivate private sector participation in the effort to prioritize critical infrastructure and to develop disaster response plans.

b. **Require the use of a systems and resiliency approach to determine the global consequence of the loss of each asset.** Using a systems approach will clearly identify the assets in each region whose loss has the greatest potential to cause a national impact.

c. **Address cross sector dependencies in the systems approach.** As outlined in the National Strategy for the Physical Protection of Critical Infrastructures and Key Assets, critical infrastructure restoration and protection efforts should take into account the five cross-sector security priorities.[37]

d. **Add an annex to the NIPP to describe how those policy considerations that are learned in the prioritization for protection will be used to develop restoration priorities.** The Federal government can develop priorities for restoring critical infrastructure using much of the same information used to prioritize protecting it. Having restoration priorities will allow the Federal government to make crisis decisions informed by clearly established restoration priorities.

Information

5. DHS should expand the National Infrastructure Simulation and Analysis Center's (NISAC) Modeling and Analysis capability to allow more robust and accurate systems modeling. Sector specific agencies should provide the NISAC with any modeling available to their department for their assigned sector. In addition, as directed in HSPD-7 the Department of Homeland Security will work with other appropriate Federal Departments and Agencies to geospatially map, image and analyze critical infrastructure.

6. The Departments of Homeland Security, Treasury, and Commerce, as well as the President's Council of Economic Advisors, and the National Economic Council should form an Impact Assessment Working Group to provide an overall economic impact assessment of major disasters. Since Hurricane Katrina, NISAC has significantly improved their capability to provide reports detailing the cascading impact of major disasters on the Nation's infrastructure but it does not include a robust assessment of the economic impacts. The various economic modeling expertise of the members of the Impact Assessment Working Group should be incorporated into the NISAC models.

7. The Department of Commerce should lead, in cooperation with the Department of Treasury and Homeland Security, the development and implementation of incentives to motivate private sector cooperation and participation in the effort to prioritize infrastructure. This review of incentives should include a review of the Defense Production Act, The Protected Critical Infrastructure Information Act, as well as tax and insurance incentives. These incentives should then be incorporated into the articulation of a business case for private sector participation in infrastructure protection. This business case should discuss protection and prioritized restoration as well as encourage private sector infrastructure resiliency and redundancy.

8. DHS should share the Plans and Policy for Federal response and delineated roles and responsibilities with the private sector. The National Response Plan urges businesses to develop disaster contingency plans.[38] Businesses have been unable to develop completely effective contingency plans without understanding the actions Federal, State, and local governments will take in response to a disaster. Furthermore, the Federal government has been unable to develop agreed upon response plans for prioritized restoration. The first step to establishing a collaborative planning and exercise program with the private sector is to, with appropriate protections, share relevant sections of the NRP with key private sector partners.

[1] USA Patriot Act

[2] The White House, *National Strategy for the Physical Protection of Critical Infrastructures and Key Assets*, February 2003 at 9, "Our Nation's critical infrastructures are generally robust and resilient. These attributes result from decades of experience gained from responding to natural disasters, such as hurricanes and floods, and the deliberate acts of malicious individuals. The critical infrastructure sectors have learned from each disruption and applied those lessons to improve their protection, response, and recovery operations.".

[3] The Homeland Security Act of 2002

[4] DHS issued the "Interim NIPP" in February 2005. The NIPP is still incomplete and in draft and does not incorporate private sector and sector specific agency input.

[5] Homeland Security Presidential Directive 7 (HSPD-7)

[6] Department of Energy, statement by Secretary Samuel W. Bodman before the Senate Energy and Natural Resources Committee on October 27, 2005. Can be found at: http://www.energy.gov/news/2405.htm

[7] "More than ten percent of the nation's imported crude oil enters through the Louisiana Offshore Oil Port." Energy Information Administration, *Special Report, Hurricane Katrina's Impact on the U.S. Oil and Natural Gas Markets*, September 6, 2005. For example, approximately 75 percent of the nation's corn and soybeans coming from as far

away as Indiana and Wisconsin and shipped through ports travels through Louisiana. Purdue University News, *Economists: Katrina's Impact Could Reach Harvest-Ready Crops*, September 9, 2005.

National Infrastructure Protection Plan, November 2, 2005 (observing that private sector companies own and operate more than 85 percent of the Nation's infrastructure).

[8] Hurricane Katrina Situation Report #10, Office of Electricity Delivery and Energy Reliability (OE), U.S. Department of Energy. August 30, 2005 (10:00 AM EDT)

[9] The White House, Statement of Ben Bernanke, Chairman of the Council of Economic Advisors, October 20, 2006. "The economic impact of the hurricanes included significant damage to the country's energy infrastructure. As you know, Katrina shuttered a substantial portion of U.S. refining and pipeline capacity, which led to a spike in gasoline prices in the weeks after that storm. Rita caused further damage. The federal government has assisted, in among other ways, by lending or selling oil from the Strategic Petroleum Reserve, arranging for additional shipments of oil and refined products from abroad to the United States, and providing appropriate regulatory waivers to increase the flexibility of the energy supply chain. In part because of these efforts and a vigorous private-sector response,, oil prices have returned to roughly their pre-Katrina levels. Wholesale gasoline prices have also retreated to levels of mid-August, suggesting that the recent decline in prices at the pump is likely to continue. Natural gas prices may remain elevated somewhat longer, however, because of lost production in the Gulf, the difficulty of increasing natural gas imports, and damage to plants that process natural gas for final use." More info at: http://www.whitehouse.gov/cea/econ-outlook20051020.html, and; Purdue University News, *Economists: Katrina's Impact Could Reach Harvest-Ready Crops*, September 9, 2005.

[10] DHS summary timeline of events states," Secretary Chertoff signed a waiver of the Jones Act allowing foreign flagged vessels to transport petroleum and petroleum products between U.S ports," and, the Department of Energy Chronology, and, the White House, "After Hurricane Katrina, Secretary Chertoff waived the Jones Act, allowing foreign-flagged ships to temporarily transport fuel from one U.S. port to another. Following Hurricane Rita, the President has directed Secretary Chertoff to again waive these restrictions. This increases the flexibility of our energy distribution system, allowing fuel to be delivered more rapidly to areas that need it, " more info at: http://www.whitehouse.gov/news/releases/2005/09/20050926-1.html

[11] Department of Energy Timeline, October 13, 2005, "Concerning refined product (gasoline), the Jones Act requires that ships moving fuels between US ports be US. With Colonial/Plantation down, not only are there potential shortages up the East Coast, but there are going to refinery cutbacks in Houston due to inability to move product. There will be excess product in Houston only a few days sailing from required demand areas and no ships to move the product. Temporarily relieving the Jones Act would allow foreign ships to temporarily fill this transportation bottleneck and help balance the system," and; Congressional Research Service Report– *Oil and Gas Disruption from Hurricanes Katrina and Rita.* October 21, 2005**, "**Hurricanes Katrina and Rita shut down oil and gas production from the Outer Continental Shelf in the Gulf of Mexico, the source for 25% of U.S. crude oil production and 20% of natural gas output. Katrina, which made landfall on August 29, resulted in the shutdown of most crude oil and natural gas production in the Gulf of Mexico, as well as a great deal of refining capacity in Louisiana and Alabama, 554,000 barrels per day of which was still closed as of late October, 2005. Offshore oil and gas production was resuming when Hurricane Rita made landfall on September 24, and an additional 4.8 million barrels per day (mbd) of refining capacity in Texas and nearby Louisiana was closed. Combining the effects of both storms, 1.3 mbd of refining — about 8% of national capability — is shut down, reducing the supply of domestically refined fuels commensurately." See info at: http://fpc.state.gov/documents/organization/55824.pdf

[12] Environmental Protection Agency, "EPA, working with the Department of Energy, has responded quickly and decisively after recent hurricanes to address fuel supply disruptions that are due to refinery and pipeline infrastructure damage in the Gulf Region by issuing emergency waivers of certain fuel standards in areas around the country. These temporary waivers have been necessary to help ensure that an adequate supply of fuel is available, particularly for emergency vehicle needs." at: http://www.epa.gov/compliance/katrina/waiver/index.html , and; Congressional Research Service Report– *Oil and Gas Disruption from Hurricanes Katrina and Rita.* October 21, 2005

[13] Department of Energy lessons learned submission in response to Frances Fragos Townsend memo of October 3, 2005

[14] Department of Homeland Security Request For Information responses and November 21, 2005 interview of Mr. Frederic Nichols of the National Manufacturer's Association. The Department of Homeland Security and the National Aeronautics Space administration joined to provide alternative hydrogen sources.

[15] White House, meeting with private sector CEOs hosted by Frances Fragos Townsend on November 3, 2005.

[16] Wal-Mart, Testimony by Jason Jackson, Director, Business Continuity Global Security given on November 16, 2005 before the Senate Homeland Security and Government Affairs Committee, “As previously stated, we feel an obligation to reopen our facilities as quickly as possible to support our communities. During Hurricane Katrina**,** 63 percent of our 171 impacted facilities were damaged or suffered some type of loss. Our restoration, energy, systems, security, and management teams worked around the clock to recover operations and mitigate further loss. Our pre-staged generators provided power to facilities in areas that did not have power for days, our security teams worked with law enforcement and the National Guard to ensure safety, and our management teams reopened facilities (often metering operating hours or the customer traffic due to limited Associate staffing). Our information systems teams established network and voice connectivity by setting up temporary satellite systems. We utilized mobile and regional command posts to guide local operations and ensure Associate and response team accountability. We talked with the Center for Disease Control and state health agencies to develop strategies to best prepare our Associates for the potential of a health threat. Through hard work, good pre-planning, a coordinated response and Associates who are dedicated to serve their communities, we were able to recover and reopen 83 percent of our facilities in the Gulf area within six days before we moved into a status quo that required time to repair facilities. Sixty-six percent of our recovery occurred within 48 hours of the storm making landfall. While we are steadily returning to "operations as normal," we still have eight facilities that are closed due to damages caused by the storm - two in western Mississippi and six in the New Orleans metro market.”

[17] Department of Homeland Security, *National Response Plan*, December 2004, Page 12.

[18] Agriculture and Food, Banking and Finance, Chemical, Commercial Facilities, Dams, Defense Industrial Base, Emergency Services, Energy, Government Facilities, Information Technology, National Monuments and Icons, Nuclear Reactors, Material and Waste, Postal and Shipping, Public Health and Healthcare, Telecommunications, Transportation, Water.

[19] Ibid, Page 36. The NRP requires DHS’s Information Analysis and Infrastructure Protection Directorate to designate this person. Ibid, Page 36.

[20] Depending on the circumstances and the facility, private companies or local law enforcement normally provide security for private facilities. In this circumstance, however, many local law enforcement and privately contracted security personnel were victims or evacuees, leaving a vacuum of security.

[21] Department of Homeland Security, November 18, 2005 response to Homeland Security Council November 3 request for information, “Unresolved issue: Requests to provide security forces (e.g., National Guard and others) to petroleum refineries along the Gulf Coast, were, for the most part, denied by FEMA General Counsel on the basis that unless the National Guard or NORTHCOM forces had been in place at the refineries prior to the emergency; the companies would need to use private security forces, if available.”

[22] The Department of Homeland Security is responsible for the coordination of critical infrastructure protection and restoration; however various sector specific agencies also have a responsibility for protection and restoration efforts among their respective sectors. These roles and responsibilities will be outlined in the Sector Specific Plans that will be released 180 days after the final National Infrastructure Protection Plan NIPP is released.

[23] Secretary Bodman (Department of Energy) interview by Frances Fragos Townsend on December 3, 2006. In this interview the Secretary found his staff working the same issue because energy companies had called Federal representatives at multiple levels. He called the senior people in each organization, clarified request, and expedited their processing.

[24] A “Business Case” addresses, at a high level, the business need that the project seeks to resolve. It includes the reasons for the project, the expected business benefits, the options considered (with reasons for rejecting or carrying forward each option), the expected costs of the project, a gap analysis, and the expected risks.

[25] General Accounting Office, letter GAO-04-300R, *Posthearing Questions from the September 17, 2003, Hearing on “Implications of Power Blackouts for the Nation’s Cybersecurity and Critical Infrastructure Protection: The Electric Grid, Critical Interdependencies, Vulnerabilities, and Readiness,* dated December 8, 2003. at http://www.gao.gov/new.items/d04300r.pdf

[26] Ibid.

[27] Ibid.

[28] Department of Energy chronology – event on August 31, 2005

[29] Department of Homeland Security, *National Response Plan* at 51, "The Regional Response Coordination Center (RRCC) initially deploys a DHS/Emergency Preparedness & Response (EPR)/FEMA-led Emergency Response Team Advance (ERT-A), including rapid needs assessment personnel and appropriate ESF representatives, to State operating facilities and incident sites to assess the impact of the situation, collect damage information, gauge immediate Federal support requirements, and make preliminary arrangements to set up Federal field facilities." FEMA Rapid Needs Assessment form, "Infrastructure Specialist (representing ESF #3)-assesses the status of transportation." In addition, they did not have expertise in the nationally critical infrastructures in the region.

[30] NISAC provides advanced modeling and simulation capabilities for the analysis of critical infrastructures and their interdependencies, vulnerabilities, and complexities. These capabilities help improve the robustness of our nation's critical infrastructures by aiding decision makers in the areas of policy analysis, investment and mitigation planning, education and training, and near real-time assistance to crisis response organizations.
The Department of Homeland Security's (DHS) Information Analysis and Infrastructure Protection (IAIP) Directorate is the program office for NISAC. The program's two prime contractors are Los Alamos National Laboratory (LANL) and Sandia National Laboratories (SNL) . NISAC integrates the two laboratories' existing expertise in modeling and simulation to address the nation's potential vulnerabilities and the consequences of disruption among our critical infrastructures. For more information, see http://www.lanl.gov/orgs/d/nisac/

[31] White House, meeting with private sector CEOs hosted by Frances Fragos Townsend on November 3, 2005.

[32] DOT Sitrep 11, September 1, 2005, "*Generally* railroads are having some problems getting their personnel past police patrols and into the affected area after curfews." Additionally: Department of Homeland Security. Event on August 30, 2005. Hurricane Katrina Timeline , "New Orleans police directing evacuation of T-Mobile employees from commerce building."

[33] As described in the National Response Plan page ESF-ii.

[34] The impact assessment working group is set forth as a later recommendation.

[35] The Infrastructure Liaison is to expressly, 1.) Coordinate CI/KR and ESF issues between the JFO Coordination Group and IAIP representatives located at the IIMG and NRCC, 2.) Communicate information to the IAIP representative at the IIMG, NRCC, and NICC. 3.) Act as liaison between the national and regional level CI/KR, the private sector, and JFO activities, 4.) Coordinate CI/KR and ESF issues between the JFO Coordination Group and IAIP representatives located at the IIMG and NRCC, 5.) Provide situational awareness concerning the affected CI/KR and provide periodic updates to the JFO Coordination Group, and 6.) Communicate information to the IAIP representative at the IIMG, NRCC, and NICC.

[36] There was no designated Infrastructure Liaison for days after Katrina. The liaison did not have an adequate support staff and was not adequately built into the ESF structure to appropriately coordinate restoration efforts and provide input on decisions involving competing needs, gain situational awareness, or receive information vital to restoration efforts, or to adequately communicate that information to the IIMG, NRCC, and NICC. The NRP sets forth a typical staffing requirement to include an Infrastructure Liaison. One official to address critical infrastructure is inadequate. The lack of a dedicated group advocating for critical infrastructure protection and restoration within the Joint Field Office Coordination Group (a NIMS unified-command entity at the coordination level) limited the integration of protection and restoration priorities into overall objectives.

[37] The National Strategy for the Protection of Critical Infrastructures and Key Assets lists five cross-sector security priorities. These are planning and resources allocation; information sharing and indications and warnings; personal surety, building human capital and awareness; technology and research and development (R&D); and modeling simulation and analysis

[38] Department of Homeland Security, *National Response Plan*, Page 2, December 2004.

[28] Department of Energy chronology – event on August 31, 2005

[29] Department of Homeland Security, *National Response Plan* at 51, "The Regional Response Coordination Center (RRCC) initially deploys a DHS/Emergency Preparedness & Response (EPR)/FEMA-led Emergency Response Team Advance (ERT-A), including rapid needs assessment personnel and appropriate ESF representatives, to State operating facilities and incident sites to assess the impact of the situation, collect damage information, gauge immediate Federal support requirements, and make preliminary arrangements to set up Federal field facilities." FEMA Rapid Needs Assessment form, "Infrastructure Specialist (representing ESF #3)-assesses the status of transportation." In addition, they did not have expertise in the nationally critical infrastructures in the region.

[30] NISAC provides advanced modeling and simulation capabilities for the analysis of critical infrastructures and their interdependencies, vulnerabilities, and complexities. These capabilities help improve the robustness of our nation's critical infrastructures by aiding decision makers in the areas of policy analysis, investment and mitigation planning, education and training, and near real-time assistance to crisis response organizations.
The Department of Homeland Security's (DHS) Information Analysis and Infrastructure Protection (IAIP) Directorate is the program office for NISAC. The program's two prime contractors are Los Alamos National Laboratory (LANL) and Sandia National Laboratories (SNL) . NISAC integrates the two laboratories' existing expertise in modeling and simulation to address the nation's potential vulnerabilities and the consequences of disruption among our critical infrastructures. For more information, see http://www.lanl.gov/orgs/d/nisac/

[31] White House, meeting with private sector CEOs hosted by Frances Fragos Townsend on November 3, 2005.

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[38] Department of Homeland Security, *National Response Plan*, Page 2, December 2004.

"Hurricane Katrina Lessons Learned Issue Paper; Subject: Critical Infrastructure and Impact Assessment" was summarized from the White House, Homeland Security Council's Report "The Federal Response to Hurricane Katrina, Lessons Learned," February 2006. http://www.whitehouse.gov/reports/katrina-lessons-learned/

Appendix F
IPET Communications Efforts

The IPET communications efforts have followed the IPET charge to forward information to the public as quickly as possible through various methods. In all aspects, IPET has responded as quickly as possible, truthfully, and accurately to media requests and has proactively sought out media opportunities at all levels.

IPET media interaction has been on-going since the earliest data collection efforts immediately following Hurricane Katrina. To date, IPET has interacted with more than 100 media contacts, including national media such as the New York Times, Wall Street Journal, Los Angeles Times, National Public Radio, NBC News, CBS News, ABC News, CNN, etc. Special attention has been made to inform citizens in New Orleans and Southeast Louisiana who have a vested interest in IPET activities. Our communications efforts have included numerous repetitive contacts with the leading newspapers, radio stations and television stations in Louisiana.

IPET communication staff is also coordinating with the External Review Panel communications staff at the American Society of Civil Engineers (ASCE) and with the communications staff at the National Research Council (NRC) to effectively inform the public of our interaction and our responsibilities to our citizens. A news conference was held in conjunction with ASCE at the IPET Report 1 release on Jan. 10, 2006, and IPET supported media interviews at the NRC meeting in New Orleans on Jan. 18, 2006. Media opportunities will be scheduled for subsequent IPET report releases to ensure maximum dissemination of information to the public.

As a team, all IPET members have been made available for media interaction. This has included both Corps of Engineers and non-Corps members. Media support from both IPET team members, such as the Harris County Flood Control District, and IPET contractors, such as Rensselaer Polytechnic Institute, have been instrumental in informing the public of the activities of IPET.

IPET has also worked closely with other Corps of Engineers organizations in the affected areas of Southeast Louisiana, such as Task Force Guardian, the New Orleans District, and the Mississippi Valley Division to provide accurate and useful information to the public.

IPET information products (news releases, bios, etc.) have been posted on both the IPET public web site (https://ipet.wes.army.mil) and the Corps of Engineers public web site (www.usace.army.mil).

Communications efforts have also included professional videotaping of IPET modeling activities to share with documentary production companies, news crews and for historical purposes.

A USACE news release requesting relocated residents of the greater New Orleans area who stayed during Hurricane Katrina and personally witnessed flooding due to levee overtopping or floodwall breaching before relocating to provide information, photos, and any other related data to IPET was published on 16 February, 2006. Anyone with information may contact the IPET through the IPET web site (hhttps://ipet.wes.army.mil. Information can also be e-mailed to *Katrina.Accounts@usace.army.mil* or eyewitnesses can call toll free 1-866-502-2570, extension 5004.