

IMPLEMENTATION PLAN FOR THE REVITALIZATION OF THE GEODETIC FRAMEWORK FOR HONDURAS



(AS PROVIDED UNDER THE HURRICANE MITCH RECONSTRUCTION PROGRAM FOR CENTRAL AMERICA)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION NATIONAL OCEAN SERVICE



NATIONAL GEODETIC SURVEY
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HURRICANE MITCH RELIEF ACTIVITIES

As part of the Department of Commerce (DOC) "Implementation Plan for Reconstruction Work in Central America," dated July 1999, the National Geodetic Survey (NGS) is tasked to develop a modern geodetic reference system for Honduras. This system will provide the spatial framework for precision marine, air and land navigation, mapping and charting, resource management, disaster relief operations, engineering and cadastral surveys, and Geographic Information Systems (GIS). The design of this framework will include, to the extent possible, several elements of the U. S. National Spatial Reference System (NSRS), including Continuously Operating Reference Stations (CORS), a High Accuracy Reference Network (HARN), absolute gravity observations, and technology transfer to ensure a sustainable infrastructure. These data will become the framework for an Inter-American Geospatial Data Network (IGDN).

To ensure the successful completion of this plan, NGS must develop a close relationship with the national government agencies and academic institutions responsible for surveying, mapping and charting, and cadastral activities.

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In addition, a working relationship with other U.S. Federal agencies involved in "Mitch", as well as World Bank (WB) related activities in this region is essential. These include the Federal Aviation Administration (FAA), National Imagery and Mapping Agency (NIMA), U.S. Geological Survey (USGS), and the U.S. Department of Transportation Volpe Transportation Center (Volpe).

CONTINUOUSLY OPERATING REFERENCE STATIONS (CORS)

The core of any modern geodetic network must take advantage of the powerful capabilities of CORS. While this activity has been very successful in the United States, there are currently only 2 Central American CORS, located in Aguasalientes, Mexico (INEGI) and Moin, Costa Rica (MOIN), in coordination with the International GPS Service (IGS). To establish a strong framework, a network of 3 CORS will be installed

in Honduras (Figure 1), Two of these sites will be established in coordination with Volpe, IGN and the Ports Authority. Under the overall “Mitch” program, Volpe is funded to establish Differential GPS (DGPS) sites in Honduras. The station in Tegucigalpa will be established at the IGN offices. To the extent possible, all CORS will be established in accordance with similar stations in the United States National Spatial Reference System and will include:

- _ Dual-Frequency L1/L2 GPS receivers
- _ Choke ring style antennas
- _ High stability monumentation

CORS should achieve an accuracy of better than 2 cm horizontal and 4 cm ellipsoid height relative to the existing IGS stations at the 95% (2 sigma) confidence level.

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The station in Tegucigalpa will be designed to conform with the recommendations of NGS Process Action Team 20 “CORS SITE MONUMENTATION.”

	<u>Latitude (N)</u>	<u>Longitude (W)</u>
Puerto Cortez - w/Volpe	15° 50'	87° 55'
San Lorenzo - w/Volpe	??	??
Tegucigalpa – New site by NGS	14° 04'	87° 13'

All CORS data will be adjusted into the International Earth Rotation Service (IERS) Terrestrial Reference Frame (ITRF) currently defined as ITRF97. The resulting 3-dimensional coordinates X, Y, and Z will be converted into latitude, longitude, and ellipsoid height using the parameters for the Geodetic Reference System 1980 (GRS80) ellipsoid. These data should be compatible with the Department of Defense World Geodetic System 1984 (WGS 84) solution of GPS week 873, referred to as WGS 84 (G873), +/- less than 10 cm at the 95 % (2 sigma) confidence level.

NGS will train IGN employees to eventually take over the maintenance, analysis, operation and data distribution of CORS. CORS support training will be conducted both in the host country and at NGS Headquarters in Silver Spring. At the end of that time, NGS will evaluate the efficiency of each country’s capabilities, and determine an appropriate course which could include, but not be limited to: complete transfer of all operations to the host country, continued but limited NGS data analysis and distribution, transfer of the processing to IGS, or establishment of a regional processing center.

HIGH ACCURACY REFERENCE NETWORK (HARN)

To make the reference frame accessible for the many applications required of these data, a primary network of high accuracy control survey points must be established. Referred to as an High Accuracy Reference Network (HARN), these points will be monumented as conventional survey control points (e.g., a disk in bedrock or a concrete post) and will be spaced approximately 40-50 km apart. This network will support a wide range of surveying and mapping techniques, including conventional surveying measurements (e.g., leveling, traverse, trilateration, and triangulation), static and kinematic GPS, photogrammetry, and remote sensing. The implementation of a HARN in conjunction with CORS in the United States has proven to be an effective, efficient and economical basis for most surveying, mapping, charting, and GIS applications.

Honduras has a historical “classical” geodetic triangulation networks established in cooperation with the former InterAmerican Geodetic Survey (IAGS), and adjusted to the North American Datum of 1927 (NAD 27). IAGS was an international outreach effort of the Defense Mapping Agency (DMA), formerly the Army Map Service (AMS), currently NIMA. Some of these data were submitted to NGS by DMA for inclusion in the original adjustment of the North American Datum of 1983 (NAD 83). Unfortunately, NGS was never provided with descriptions of these control points and this data appears to be of minimal value today. Where possible and practical, the HARNs will attempt to incorporate these control points to determine a higher quality datum transformation from NAD 27 to WGS84 than is currently published by NIMA in their technical report TR8350.2 “*World Geodetic System of 1984, Its Definition and Relationship with Local Geodetic Systems.*” The 1994 GPS programs implemented by NIMA for Honduras indicated that very little of the IAGS networks still exist.

In an effort to reduce duplication of effort, this plan recommends that the 30 stations established by NIMA in Honduras be used as the basis for the HARN. As this networks was established prior to Mitch, it is uncertain as to the extent of damage or destruction of these control points in Honduras. NGS will provide technical support to perform the field reconnaissance of these control points, and will send a GPS field unit to perform the observations. NGS proposes to use the GPS field observation specifications currently used for the Federal Base Network Height Modernization activities in the United States.

These specifications should produce a network with accuracies of not worse than 1-2 cm horizontal and 2-3 cm ellipsoid height relative to CORS at the 95% (2 sigma) confidence level. These specifications include:

- _ Only dual-frequency, full-wavelength on L2 GPS receivers
- _ Fixed height poles
- _ Three - 5.5 hour sessions with one session offset by 4 hours
- _ CORS as fixed control
- _ Vector processing with NGS “PAGES” software

- Network adjustment with NGS "ADJUST" software
- IGS produced precise orbits

GRAVITY SURVEYS

Any significant improvements to a regional geoid model will require extensive airborne or relative gravity observations. Unfortunately there are insufficient resources in the "Mitch" budget to provide for these activities. NGS can implement a strategically designed network of "absolute" gravity stations in cooperation with NIMA which will provide a framework for future relative surveys.

AIRPORT SURVEYS

A very important element of any disaster relief plan is the capability of efficiently using both ground, water, and air navigation. A portion of this plan will be dedicated to providing surveys of airports selected in consultation with FAA, NIMA, and the national Civil Aviation Administration (CAA). To the extent possible, these surveys will be conducted in accordance with FAA 405 "Standards for Aeronautical Surveys." These standards will ensure compliance with requirements of the International Civil Aviation Organization (ICAO) as defined in Doc. 9674-AN/946 "World Geodetic System - 1984 (WGS-84) Manual." The surveys will be limited to establishment of Primary and Secondary Airport Stations (PACS/SACS), positioning runway end points, and runway centerline profiles. Obstacle/obstruction surveys will be conducted at approximately 9 airports as listed below. These surveys will be designed as pilot projects to provide training to contractors/national institutions to develop their own capabilities. Those activities will be left to the CAA to contract or perform on its own. The PACS will be included in the development of the national HARN. The airports to be considered include:

<u>AIRPORT</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>
AHUAS	15° 28.2'	84° 21.2'
CORONEL ENRIQUE SOTO CANO (O)	14° 22.9'	87° 37.3'
CUCUYAGUA	14° 37.6'	88° 52.6'
GUANAJA	16° 26.8'	85° 54.4'
ISLAS DEL CISNE	17° 24.5'	83° 55.9'
LA MESA INTERNATIONAL (O)	15° 27.1'	87° 55.5'
MOCORON DURZONA	14° 59.3'	84° 13.2'
PUERTO LEMPIRA	15° 15.7'	83° 46.9'
TELA	15° 46.6'	87° 28.5'
TONCONTIN INTERNATIONAL (O)	14° 03.7'	87° 13.0'
TRUJILLO	15° 55.6'	85° 56.3'

(O) - Obstruction surveys to be completed.

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WATER LEVEL NETWORK

The NOS Center for Operational Oceanographic Products and Services (CO-OPS), has designated the site at Puerto Cortes as the primary tide gauge site to be established in their Mitch related activities. NGS in cooperation with IGN will ensure that one or more of the bench marks associated with this site will be positioned in the HARN. An effort will also be made to include a connection to the site at Puerto Castilla.

<u>Station</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Years</u>
Puerto Cortes	15E 50.1'	87E 57.2'	19
Puerto Castilla	16E 01.0'	86E 02.0'	13

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DATA ADJUSTMENTS AND DISTRIBUTION

NGS will conduct a regional network adjustment of all the CORS and HARN stations. This solution will be provided using the ADJUST network software. Every effort will be made to include technical representatives of IGN to assist in the adjustment process at NGS Headquarters in Silver Spring, MD. Since it is likely that the HARN in Honduras will not be observed concurrently with other Central American countries, NGS will ensure the integration of this survey into a regional network solution. NGS will also pursue cooperative activities with Belize, Coast Rica, Mexico, and Panama to develop an integrated Central American reference frame connected to the South American Sistema

de Referência Geocêntrico para a América do Sul (SIRGAS) and United States National Spatial Reference System (NSRS).

For the duration of the “Mitch” program, NGS will provide storage of all original GPS observations in the NGS Data Base and distribution of all CORS/HARN data through the Internet. Eventually, these data should be stored and distributed either through IGN, or through a regional data support center.

METEROLOGICAL SENSORS

The use of GPS for the measurement of upper atmospheric water vapor content is a well established process. All CORS established in this program will also be provided with hydrometeorological sensors as part of the data collection network outlined in the Department of Commerce Implementation Plan. These activities will be coordinated with the National Weather Service (NWS).

REGIONAL MAPPING ACTIVITIES

USGS has the assigned responsibility to enhance the national mapping, GIS activities and development of national hydrological data bases for the region.. NGS will coordinate activities with USGS to ensure they are able to take full advantage of CORS/HARN data to support the variety of activities defined in their regional implementation plan.

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WORLD BANK COORDINATION

The World Bank is particularly interested in “Mitch” activities in Honduras where it has long-term land administration programs. Within these long-term programs, WB is financing geodetic activities that could be very complementary to NOS activities. Therefore, every effort will be made to ensure the compatibility, coordination, and enhancement of NGS activities with the current WB related programs.

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