Natural Disaster Survey Report

Puerto Rico Flash Floods
January 5-6, 1992

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service, Silver Spring, Maryland

Front Cover: A destroyed bridge crossing the Rio de la Plata at Comerio.
Photograph courtesy of Alcides Dreumont.

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Barbara H. Franklin, Secretary

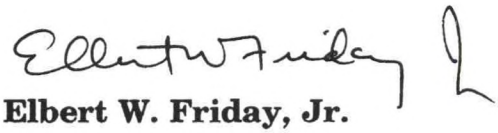
National Oceanic and Atmospheric Administration
Dr. John A. Knauss, Administrator

National Weather Service
Dr. Elbert W. Friday, Jr., Assistant Administrator

PREFACE

Flash floods are one of the many destructive forces of nature. It is always a humbling experience to view the devastation first hand and a difficult experience to interview individuals that have lived through such a tragedy. Unfortunately, it is only through disasters such as this that the National Weather Service and the hazards community can fully assess its warning procedures and capabilities.

I would like to express my gratitude to the Disaster Survey Team for their objectivity in producing this survey report on the performance of the National Weather Service during this tragic event.



Elbert W. Friday, Jr.

July 1992

FOREWORD

This report on the Puerto Rico flash floods was prepared by the Disaster Survey Team after a week of interviews and visits to damaged areas with Federal, Commonwealth, and local officials in Puerto Rico, and citizens who survived the flood's devastation.

The team is grateful to the many Federal, Commonwealth, and local officials who took time from urgent duties to share their impressions of events before and during the flood's onslaught. We appreciate the understanding and courtesy of the many citizens who consented to interviews while still trying to comprehend and deal with the disaster that struck their communities.

While this document is not intended to chronicle the entire history of the flash floods and the aftermath, it attempts to accurately assess the National Weather Service's performance to determine what further improvements are possible in forecasting and warning for flash floods.

The Disaster Survey Team

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ACRONYMS

ALERT	Automated Local Evaluation in Real Time
AST	Atlantic Standard Time
CD	Civil Defense
CDC	Centers for Disease Control
CPCS-1	Common Program Control Station
DCP	Data Collection Platform
DNR	Department of Natural Resources
EBS	Emergency Broadcast System
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
GOES	Geostationary Operational Environmental Satellite
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NWR	NOAA Weather Radio
NWS	National Weather Service
NWWS	NOAA Weather Wire Service
POP	Probability of Precipitation
USGS	U.S. Geological Survey
WPM	Warning Preparedness Meteorologist
WSFO	Weather Service Forecast Office
WSR-74S	Weather Surveillance Radar-1974 S-Band
WSR-88D	Weather Surveillance Radar-1988 Doppler

THE PUERTO RICO FLASH FLOOD DISASTER SURVEY TEAM

After a severe weather event such as a flash flood, a disaster survey team may be assigned by the National Oceanic and Atmospheric Administration (NOAA) to evaluate the role played by the National Weather Service (NWS), provide an objective appraisal, and make findings and recommendations.

Team Members

Leader, **Jennifer Joy Wilson**, Assistant Secretary and Deputy Administrator, NOAA

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EXECUTIVE SUMMARY

Thunderstorms associated with a quasi-stationary cold front northwest of Puerto Rico, and an extensive area of low pressure at the surface and aloft, resulted in substantial amounts of rain over the island on the afternoon and evening of January 5, 1992. Rainfall amounts over the interior and south portions of the island were in the 8- to 12-inch range with up to 20 inches reported at several locations. This intense rainfall resulted in severe flash floods and river flooding across Puerto Rico except the northwest portion.

The flooding resulted in 23 fatalities, 20 of which involved motor vehicles. Many lost their lives at the onset of the event when caught in heavy downpours while traveling on narrow twisting mountain roads and along fast flowing mountain streams. Several of the 23 deaths occurred when residents drove past police and civil defense barricades in an attempt to return home for Three Kings Eve--Puerto Rico's most celebrated holiday. Total damage was placed at 88 million dollars. Most of the damage was to bridges and roads.

A NOAA Disaster Survey Team was dispatched to Puerto Rico from January 12-18 to assess how the integrated warning program functioned prior to and during the flooding. The integrated warning program includes the detection and warning of the flash flood event, the communication of this critical information to the community, and the public response.

In this flood event, a series of factors contributed to the breakdown of the warning dissemination component of the integrated warning program. Some of these factors are a function of the unfortunate timing of the event. Others raise questions about the ability of the overall warning system to rapidly and effectively disseminate warnings for such rapid onset events. The catastrophic flash floods and river flooding which occurred in the Commonwealth of Puerto Rico on January 5 and 6 presented Federal, Commonwealth, and local officials with a worst-case scenario in which all aspects of the integrated warning program were severely tested.

CHAPTER 1

HYDROMETEOROLOGICAL SETTING

Brief, locally heavy, convective events are not uncommon in the tropics. Mountainous topography further enhances and localizes convection. The January 5-6, 1992, Puerto Rico flash floods and river flooding were caused by this type of convective activity. Occurrence was in a normally dry month during a dry season that usually extends through March.

On Saturday, January 4, at 8:00 p.m. Atlantic Standard Time (AST)[1], an extensive area of low pressure at the surface and aloft was located off the east coast of the United States. An associated cold front extended from the middle latitudes of the western Atlantic Ocean southwest to Hispaniola (see appendix A).

At 8:00 a.m., Sunday, January 5, the front was positioned northeast to southwest across the Dominican Republic. As the day progressed, convection ahead of the front became more active. By 2:00 p.m., a surface trough had developed over Puerto Rico ahead of the nearly stationary front. A weak surface low also developed near the Gulf of Venezuela reinforcing the moist southwest flow. Isolated showers and thunderstorms had now reached the interior mountains. Between 4:00 p.m. and 5:00 p.m., the convective activity slowed its rapid northeast movement as the front stalled. The nearly stationary thunderstorms further intensified due to orographic effects. Until this time, all convective activity was moving northeast at 15 to 20 knots--normally too fast to produce flash flooding.

At 5:33 p.m., Sunday, the lead forecaster issued the first flash flood watch for the north, east, and interior sections of Puerto Rico. At 6:45 p.m., the first flash flood warning was issued, and Emergency Broadcast System (EBS) activation was requested. By 8:00 p.m., Sunday, Puerto Rico remained between a stationary front to the west and a surface trough to the east. A weak surface low persisted over the coast of Venezuela. Although showers and isolated thunderstorms had overspread the island, most of the convective activity remained north of Puerto Rico.

By 8:00 a.m., Monday, a stationary front remained across Hispaniola. The surface trough ahead of the front and the weak low pressure system to the south had dissipated. Although scattered showers and thunderstorms persisted, the heavy rains had abated.

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[1] All times reported are Atlantic Standard Time.

Rainfall totals over the interior and south portions of the island were generally in the 8- to 12-inch range with 19.5 inches reported from Cayey and 20.3 inches reported from Toro Negro. This intense rainfall resulted in severe flash floods and river flooding across Puerto Rico except the northwest portion.

Finding 1.1

The Puerto Rico flash floods and river flooding of January 5-6, 1992, were produced by locally intense rainfall from slow moving showers and thunderstorms over the mountainous interior.

CHAPTER 2

PROVISION OF WARNINGS, FORECASTS, AND WSFO ACTIONS

The aforementioned meteorological pattern is a well-documented, rain-producing pattern for Puerto Rico. The forecast problem of the day--scattered showers and thunderstorms--was not expected to exceed flash flood guidance.

WSFO San Juan's station duty manual provides flash flood forecast guidelines and depicts flood-prone areas island wide. Flash flood guidance, listed in table 1, indicated that generally 4 to 8 inches of rain were required in a 3-hour period in order to produce flash flooding across most of the island. Corresponding soil moisture divisions based upon climate and geography appear in figures 1 and 2, respectively. Flash flood guidance, updated weekly at the San Juan Weather Service Forecast Office (WSFO), is empirically derived using an adjusted Palmer Drought Index model. Rainfall and temperature data are input via computer link with Puerto Rico's U.S. Geological Survey (USGS) office. This is the only flash flood guidance routinely available to forecasters at WSFO San Juan.

TABLE 1

Flash Flood Guidance for Puerto Rico

Climatological Divisions		Geographical Divisions			
1	8.69	1	6.07	19	4.02
2	8.98	3	5.00	21	5.16
3	6.46	5	7.60	23	8.96
4	9.10	7	3.01	25	4.55
5	3.00	9	5.52	27	6.99
6	4.15	11	6.51	29	7.26
		13	8.98	31	8.11
		17	3.00	39	5.52

The National Meteorological Center (NMC) prepares flash flood guidance--including graphical quantitative precipitation frequency analyses, precipitation forecast discussions, and excessive rainfall discussions--for the conterminous United States, several times daily. These flash flood guidance products are not prepared for Puerto Rico. The availability of these products would have enabled forecasters at WSFO San Juan to focus on the potential for flash flooding 12 to 24 hours prior to the event.

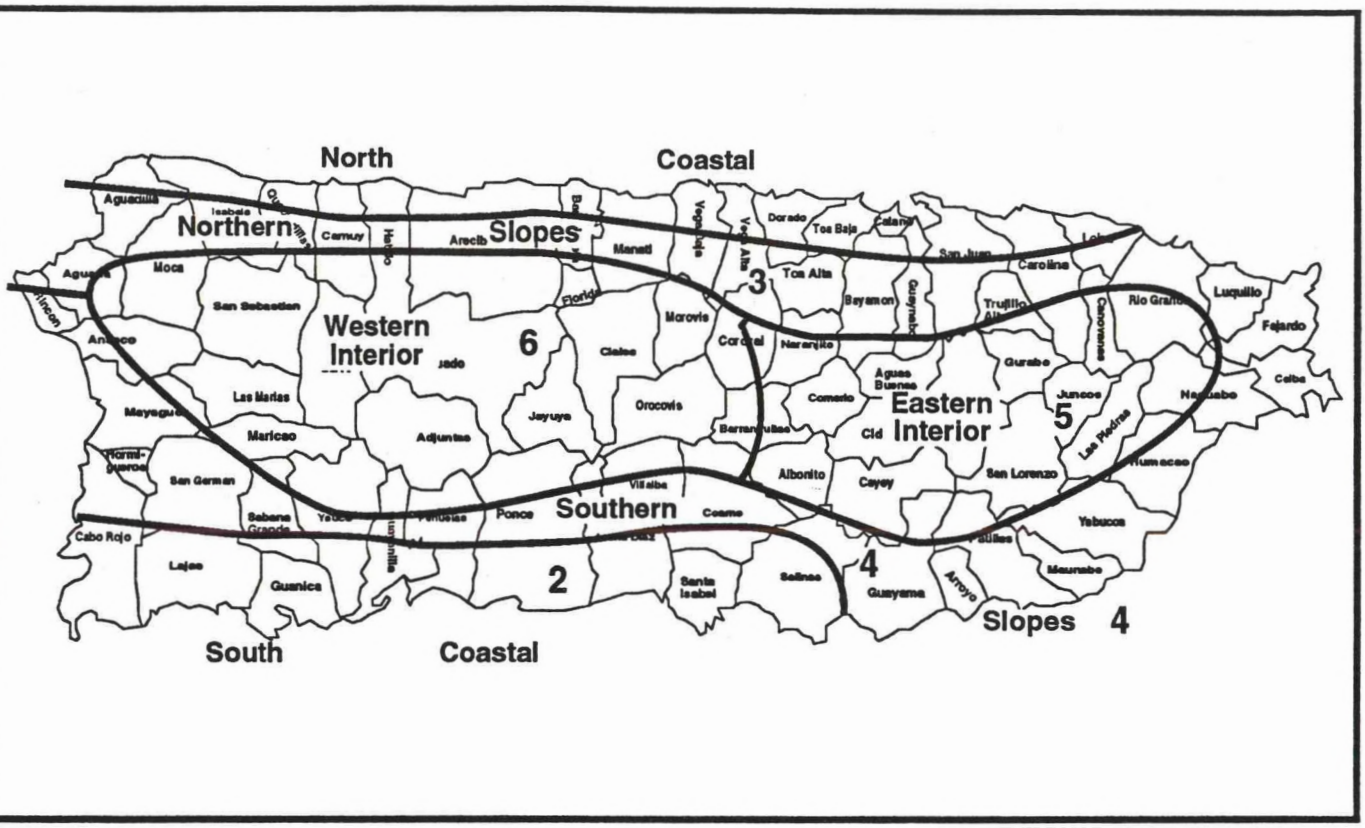

Figure 1. Climatological Divisions for Flash Flood Guidance

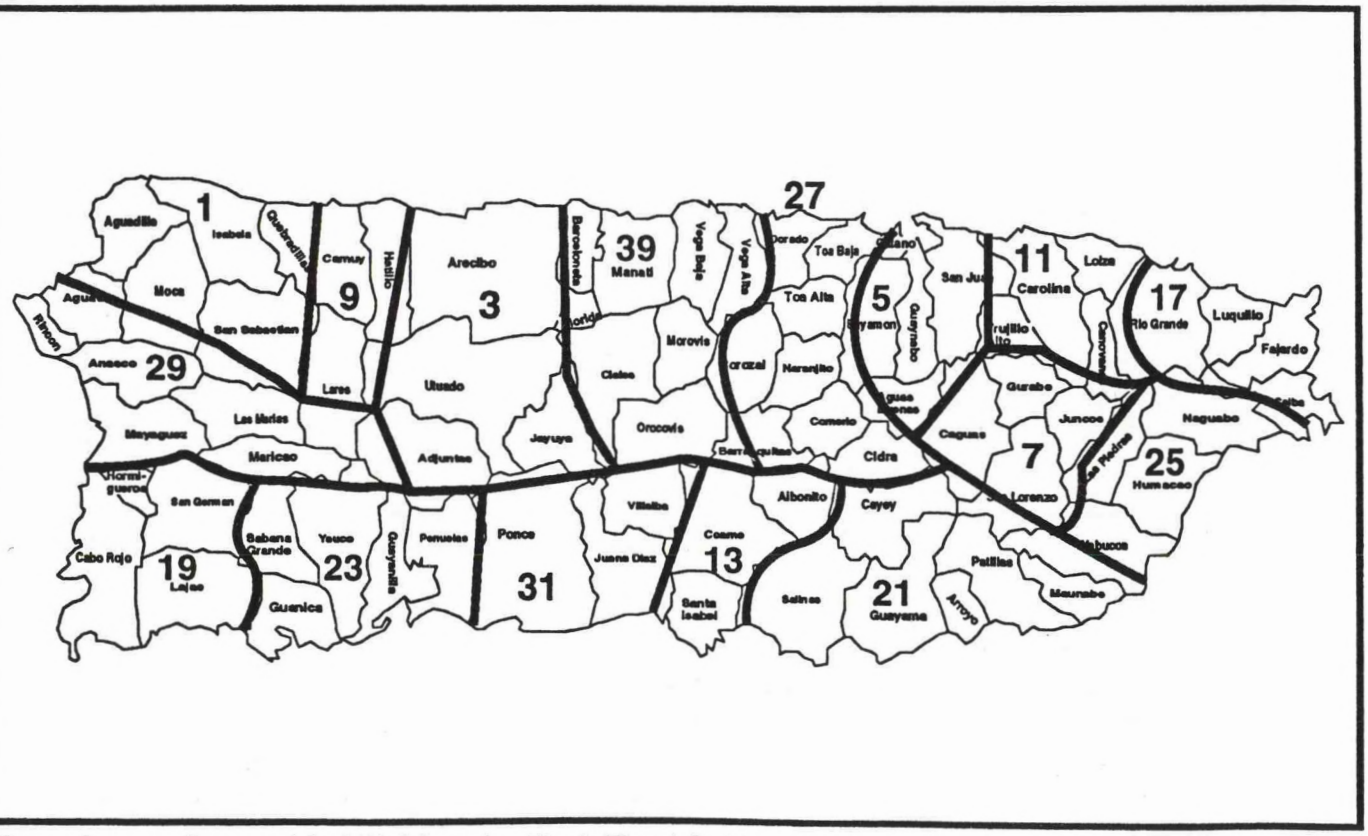

Figure 2. Geographical Divisions for Flash Flood Guidance

The meteorological pattern for widespread showers and thunderstorms was recognized by forecasters early Sunday morning, January 5. The Zone Forecasts issued by the WSFO San Juan at 5:30 a.m. called for scattered showers and thunderstorms with conditions expected to continue during the day across the western, interior, northern, and eastern sections of Puerto Rico. All warnings, watches, statements, forecasts, and weather summaries issued by WSFO San Juan, and discussed herein, appear in appendix B. A summary of warnings and watches appears in appendix C.

At 7:00 a.m., Sunday, January 5, the Zone and the State Forecasts were updated to indicate that scattered showers and isolated thunderstorms were to become more numerous across the western and interior sections. The probability of precipitation (POP) was increased to 60 percent for the western and interior sections of Puerto Rico and to 40 percent for the northern, eastern, and southern sections. The 7:15 a.m., Sunday, January 5, Puerto Rico and Virgin Islands Weather Summary succinctly described the increasing chance of rain extending into Three Kings Day.

The 11:30 a.m., Sunday, January 5, Zone Forecasts continued the high POPs. The forecasts indicated a 40 percent chance of showers for the northern, eastern, and southern sections of Puerto Rico with a 60 percent chance of showers and possible thunderstorms for the western and interior sections. The State Weather Summary issued at 11:30 a.m. also indicated an increase in shower and thunderstorm activity through Sunday afternoon and into Sunday night.

At 1:00 p.m., an Automated Local Evaluation in Real Time (ALERT) gage over the interior mountains near Barranquitas reported 0.51 inch of rain in a 10-minute period. It is not unusual to experience such rainfall rates in the tropics. Radar observations indicated that the responsible thunderstorm was isolated and moving rapidly northeast. By 1:30 p.m., forecasters noticed that the area of precipitation that was earlier expected to pass to the north of Puerto Rico developed a more southerly component as indicated by radar. The individual thunderstorms within the area, however, continued to progress northeast. Nonetheless, a forecaster contacted a representative of the Commonwealth Water and Sewer Authority at 1:50 p.m. and provided a briefing indicating that rain was overspreading the northern basin. The Water and Sewer Authority agreed to keep the WSFO staff informed of any significant developments.

At 2:30 p.m., additional ALERT gages started to alarm after reaching a predetermined threshold of one-half inch of rain in 30 minutes. The WSFO staff contacted the Commonwealth Civil Defense (CD) agency for flooding reports. The CD responded that although some areas were receiving heavy rain, no flooding had been reported. At 3:10 p.m., the Commonwealth CD contacted WSFO San Juan to report that in the municipality of Toa Alta, a tributary to the Rio de la Plata was near bankfull at a bridge along Route 861. The lead forecaster logged this information. However, since scattered thunderstorms within the area of precipitation continued

to move northeast, the lead forecaster decided to continue monitoring the situation. The lack of adequate flash flood guidance for Puerto Rico kept forecasters at WSFO San Juan from anticipating the potential magnitude of the event.

The 4:00 p.m., Sunday, January 5, issuance of the Zone Forecasts upgraded the POP to 80 percent for Sunday night with scattered showers and isolated thunderstorms--some locally heavy--across the northern, eastern, western, and interior sections. A 60 percent POP was forecast for the southern section of Puerto Rico. The 4:00 p.m. State Weather Summary reported the occurrence of scattered, brief, heavy showers and isolated thunderstorms moving across the island.

Between 4:00 p.m. and 5:00 p.m., Sunday, January 5, the convective activity slowed its rapid northeast movement and began to intensify. Radar indicated numerous heavy cells. The ALERT systems became more active, and CD radio traffic increased with reports of high water over numerous rivers and tributaries. The Disaster Survey Team found that radar observations were not taken between 2:35 p.m., Sunday, January 5, and 2:35 a.m., Monday, January 6. Forecasters at WSFO San Juan did not anticipate the rapid development of the convective activity nor the potential for it to stall over the interior of the island. When it became apparent that a significant event was unfolding, the lead forecaster reassigned the meteorologist technician on the radar shift to monitor the incoming Spanish-only CD broadcasts. The lead forecaster did not speak Spanish, and the incoming CD information was necessary in the preparation of watches, warnings, forecasts, and statements. According to WSFO San Juan's station duty manual, radar observations may be suspended to perform duties of a higher priority. The Disaster Survey Team believes that this reassignment provided the best use of resources. Three radar monitors are strategically located in the operations area, and there is ample evidence to confirm that the staff fully utilized the radar in the performance of their duties. With the heavy workload involved in coordination and issuance of watches, warnings, forecasts, and statements--and inaccessible staff due to the holiday--no additional personnel were called in to augment the staff. The staffing level at WSFO San Juan is currently below the model staffing level due to budgetary constraints.

At 5:33 p.m., Sunday, January 5, the lead forecaster issued the first flash flood watch for the north, east, and interior sections of Puerto Rico. According to a Centers for Disease Control (CDC) report (1992) on the Puerto Rico flash floods of January 5-6, 1992, the earliest fatalities occurred in the central mountain region at approximately the time of the first flash flood watch issuance.

At 6:45 p.m., Sunday, January 5, the first flash flood warning was issued for Barranquitas, Caguas, Aibonito, and Coamo municipalities, and EBS activation was requested. Unfortunately, fatalities had already occurred in Caguas, Coamo, and other municipalities not covered by the warning. However, as indicated in the CDC report, "Not one person interviewed--including CD officials, surviving companions, or family members--recalled hearing an official warning over the radio or television

during the evening of January 5 or early January 6." The CDC report continues, "...even if warnings had been broadcast, the warning system was not sensitive enough to send alerts before the impact of flash floods."

This may be explained by the fact that EBS activation as requested by the San Juan WSFO was ineffective. The Commonwealth CD Emergency Operations Center (EOC) activated the EBS at 9:05 p.m.--2 hours and 20 minutes after the warning was issued. In addition, the EBS tone was activated for less than the prescribed length of time, thus precluding any recipient from recording the message for retransmission. The EBS tone was considered too short by the media and was essentially ignored.

During the event, a total of ten flash flood warnings (EBS activation requested), six flash flood watches, and four flash flood statements were issued in response to information received from the CD EOC and others. The WSFO staff responded to this event in a professional manner. WSFO San Juan's flash flood watches and warnings were well-written, descriptive, and contained the proper call-to-action statements. EBS was activated only once by the Commonwealth CD, despite the fact that WSFO San Juan requested EBS activation on ten separate occasions. The EBS is detailed in Chapter 4.

Finding 2.1
The lack of adequate flash flood guidance for Puerto Rico--including graphical quantitative precipitation frequency analyses, precipitation forecast discussions, and excessive rainfall discussions--kept forecasters at WSFO San Juan from anticipating the potential magnitude of the event.

Finding 2.2
Forecasters at WSFO San Juan did not envision the rapid development of the convective activity nor the potential for it to stall over the interior of the island.

Finding 2.3
With the heavy workload involved in coordination and issuance of watches, warnings, forecasts, and statements--and inaccessible staff due to the holiday--no additional personnel were called in to augment the WSFO staff as the event unfolded.

Finding 2.4
Reassignment of the radar operator to a warning coordination role--the best use of staffing resources at the time--precluded radar observations between 2:35 p.m., Sunday, January 5, and 2:35 a.m., Monday, January 6.

Finding 2.5
The staffing level at WSFO San Juan is currently below the model staffing level due to budgetary constraints.

Finding 2.6
Fatalities occurred prior to the issuance of the first flash flood warning. The earliest fatalities occurred in the central mountain communities under the intense thunderstorms at approximately the time of the first flash flood watch issuance.

Finding 2.7
Although warning lead time was nil at the onset of the event in the central mountain communities under the intense thunderstorms, warning lead time improved further down stream.

Finding 2.8
WSFO San Juan's flash flood watches, warnings, and statements received virtually no media dissemination...except for the Weather Channel.

CHAPTER 3

DATA COLLECTION

Satellite imagery, land-based radar, surface weather observations, observations from the ALERT system, and other networks across the island provide the bulk of information for warnings and forecasts.

SATELLITE IMAGERY

WSFO San Juan receives routine Geostationary Operational Environmental Satellite (GOES) imagery via the Satellite Weather Information System. GOES imagery was used in the formulation of watches, warnings, forecasts, and statements throughout the event.

RADAR OBSERVATIONS

WSFO San Juan's Weather Surveillance Radar-1974 S-band (WSR-74S), a local warning radar, is located at the Luis Munoz Marin International Airport.

At 12:30 p.m., Sunday, January 5, the WSR-74S was logged as operating below performance standards. This was an opinion of the radar operator who believed that the radar reflectivity levels were too high. Radar maintenance records indicated that the WSR-74S was calibrated on January 2 and again January 8. According to these records, the radar was functioning normally. After a review of radar data, the Disaster Survey Team also concluded that the radar functioned normally during the event.

In the modernized NWS, the San Juan office will be equipped with a new Weather Surveillance Radar-1988 Doppler (WSR-88D) and advanced computer technology. Doppler radar capabilities will greatly increase the volume of available hydrometeorological data, including rainfall amounts, which would have been extremely valuable during this event. In direct support of the NWS modernization, a significant amount of activities are underway to capitalize on the new data collection and analysis technologies. Significantly more emphasis will be placed on the interrelationships between hydrology and meteorology. Additionally, the new NWS emphasis on improved warnings and forecasts for mesoscale events highlights the need to develop and implement hydrologic forecasting tools for smaller areas such as flash flood prone watersheds. Delivery of the San Juan WSR-88D is scheduled for June 1994 with commissioning in March 1995. New technological capabilities for observing and analyzing the atmosphere will enhance NWS operations in Puerto Rico.

SURFACE WEATHER OBSERVATIONS

Official surface weather observations throughout the Caribbean are sparse. WSFO San Juan takes hourly surface weather observations at the Luis Munoz Marin International Airport. The office also receives hourly observations from four additional sites on the island--Aguadilla, Mayaguez, Ponce, and the Roosevelt Roads Naval Air Station at Ceiba.

A supplemental network of volunteer amateur weather observers (KP4) collects data routinely. Members forward reports to a central coordinator who then relays these observations to WSFO San Juan. The KP4 rainfall observations for January 5 and 6 are depicted in table 2. Total rainfall through Sunday morning, January 5, was insignificant. However, by Sunday evening, rainfall was significant enough at several locations that observations should have been relayed to WSFO San Juan. There was no recollection by the WSFO staff of receiving near real-time observations from the KP4 network. Nonetheless, this network is geographically well distributed and the information is of value to meteorologists and hydrologists.

NWS cooperative weather observers also provide rainfall observations. However, these observations are forwarded to WSFO San Juan on a weekly basis and are unavailable for real-time operations. These observations are used as input into the preparation of flash flood guidance. Table 3 lists the NWS cooperative network rainfall totals for the 2-day event. An isohyetal analysis of these data appears in figure 3. Municipalities flooded and municipalities with fatalities are shown in figure 4.

ALERT SYSTEM

The hydrology of Puerto Rico is unique due to topography. In the mountains, slopes are steep and the soil is thin. Very little water infiltrates the soil surface, so runoff quickly turns creeks and streams into raging torrents. Since Puerto Rico's 70 drainage basins are small, rivers rise quickly downstream and inundate the coastal plains. In effect, almost all of these floods can be considered flash floods since crest occurs within 6 hours following heavy rainfall. This quickness to crest essentially eliminates conventional river forecasting procedures. It is precisely because of Puerto Rico's topography and climatology that the ALERT system has been implemented through a joint effort between the DNR, CD, and the NWS.

TABLE 2

Amateur Radio Network Rainfall Reports

	January 5		January 6	
	AM	PM	AM	PM
Aguadilla	0.00 0.00 0.00	1.40 0.64 0.66	M 0.23 0.31	M 0.00 0.10
Arecibo	0.00 0.00	0.94 1.05	0.54 0.20	0.03 T
Cabo Rojo	0.00	T	3.91	0.15
Caguas	0.00 0.00 0.00	6.40 5.80 4.59	2.40 2.37 2.50	0.14 0.20 0.11
Carolina	0.00	2.93	M	M
Ciales	0.10	2.00	15.00	0.05
Cupey	0.00	2.27	M	M
Guayama	0.03	0.11	4.42	0.48
Guaynabo	0.00	0.34	0.25	0.00
Gurabo	0.00	3.0	M	M
Isabela	4.0	2.56	M	M
Jayuya	0.15	M	2.10	M
Juncos	0.08	4.67	2.10	T
Levittown	0.00	1.85	0.67	0.00
Mayaguez	T 0.00	0.06 0.08	1.52 1.50	0.02 0.10
Moca	T	1.30	1.00	0.02
Orocovis	0.03	7.11	3.34	0.14
Rio Piedras	T	2.52	1.15	M
San Sebastian	0.00 0.00	0.08 0.28	1.61 2.00	0.02 0.00
Villalba	1.27	4.80	M	M

TABLE 3
Climatological Station Rainfall Reports

January	5	6	Total
Western Interior			
Adjuntas	0.31	6.63	6.94
Toro Negro	0.75	20.30	21.05
Arecibo	0.00	1.70	1.70
Cerro Maravilla	2.00	12.00	14.00
Coloso	0.00	1.40	1.40
Corozal	0.00	6.10	6.10
Dos Bocas	0.00	1.22	1.22
Jayuya	0.14	7.20	7.34
Maricao			6.40
Morovis	0.00	2.96	2.96
Negro-Corozal	0.00	8.00	8.00
San Sebastian	0.00	1.37	1.37
Utuado	3.55	0.02	3.57
Las Marias	0.02	1.14	1.16
Eastern Interior			
Aibonito	0.30	5.00	5.30
Caguas	0.05	6.95	7.00
Cayey	0.10	19.56	19.66
Cidra 1 E	0.05	10.36	10.41
Gurabo	0.07	7.11	7.18
Juncos	0.00	6.57	6.57
La Muda-Caguas	0.00	4.93	4.93
Pico del Este-Luquillo	1.60	10.10	11.70
Rio Blanco Lower	0.00	7.25	7.25
Paraiso	0.40	8.20	8.60
San Lorenzo	0.54	5.60	6.14
Northern Slopes			
Canovanas	0.15	4.95	5.10
Fajardo	0.00	8.00	8.00
Isabela	0.02	1.92	1.94
Manati	0.00	1.43	1.43
Rincon			2.25
Trujillo Alto	0.05	4.01	4.06

January	5	6	Total
Southern Slopes			
Benavente-Hormigueros	0.00	3.05	3.05
Corral Viejo	0.32	12.15	12.47
Guayama	0.00	4.82	4.82
Humacao	0.00	12.00	12.00
Juana Diaz Camp			10.15
Maunabo 2 SE	0.00	7.60	7.60
Puerto Real	0.00	4.80	4.80
Roosevelt Roads N.S.			6.29
Sabana Grande	0.00	5.00	5.00
Yabucoa	0.00	10.90	10.90
Patillas	0.00	2.10	2.10
North Coastal			
Arecibo			
Borinquen Airport	0.36	0.36	
Rio Piedras Heights	0.00	4.60	4.60
Rio Piedras Ag Ex			
Substation	0.05	2.00	2.05
Quebradillas		3.66	
San Juan WSFO	0.00	2.24	2.24
Toa Baja	0.00	3.30	3.30
South Coastal			
Aguirre Central	0.00	2.05	2.05
Central San Francisco	0.02	2.92	2.94
Coamo 4 S	0.00	9.00	9.00
Ensenada	0.05	4.16	4.21
Lajas	0.01	10.00	10.01
Ponce 4 E	0.20	8.30	8.50
Santa Isabel		5.00	5.00
Ponce City	1.66	5.49	7.15

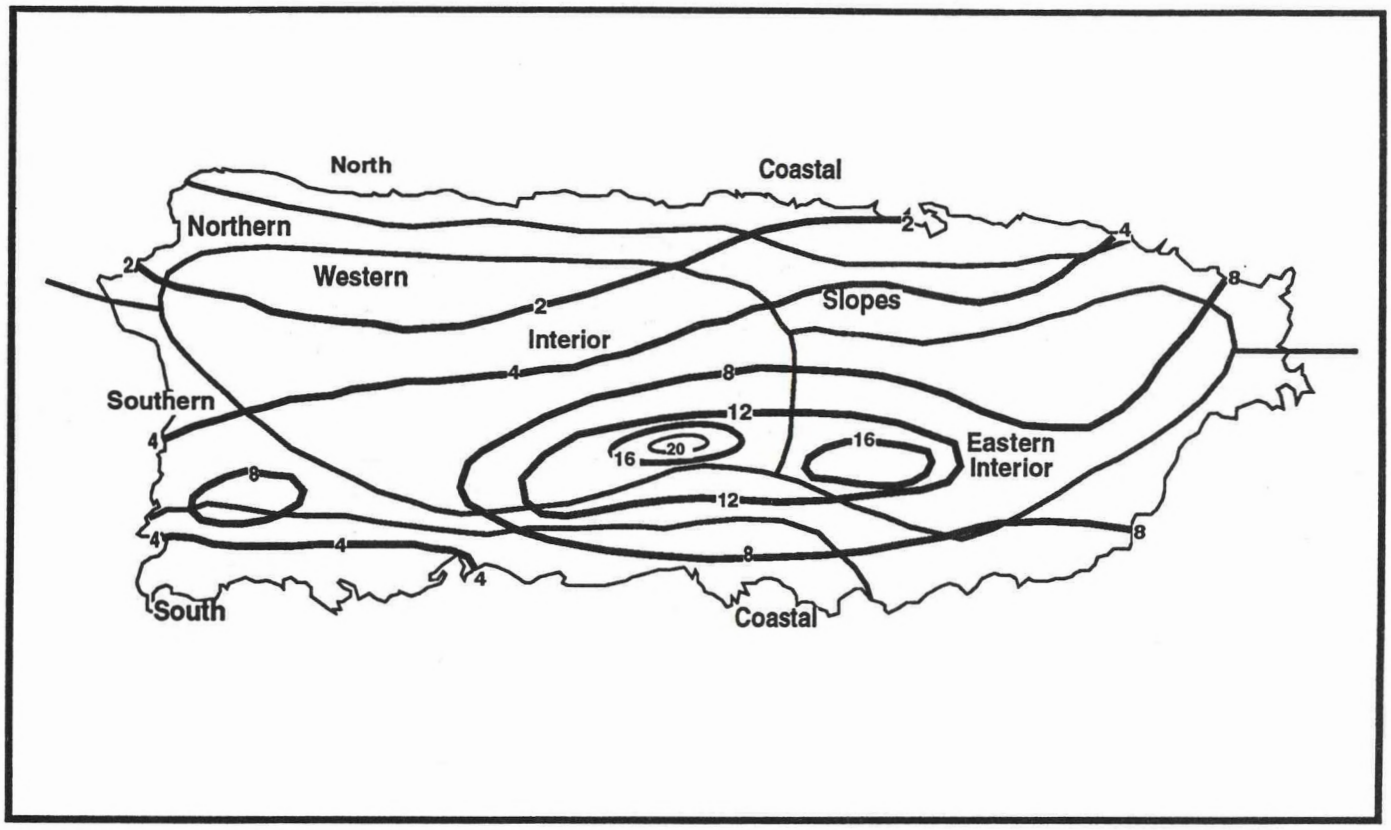

Figure 3. Isohyetal Analysis of Storm Total Precipitation Based on NWS Cooperative Network Reports

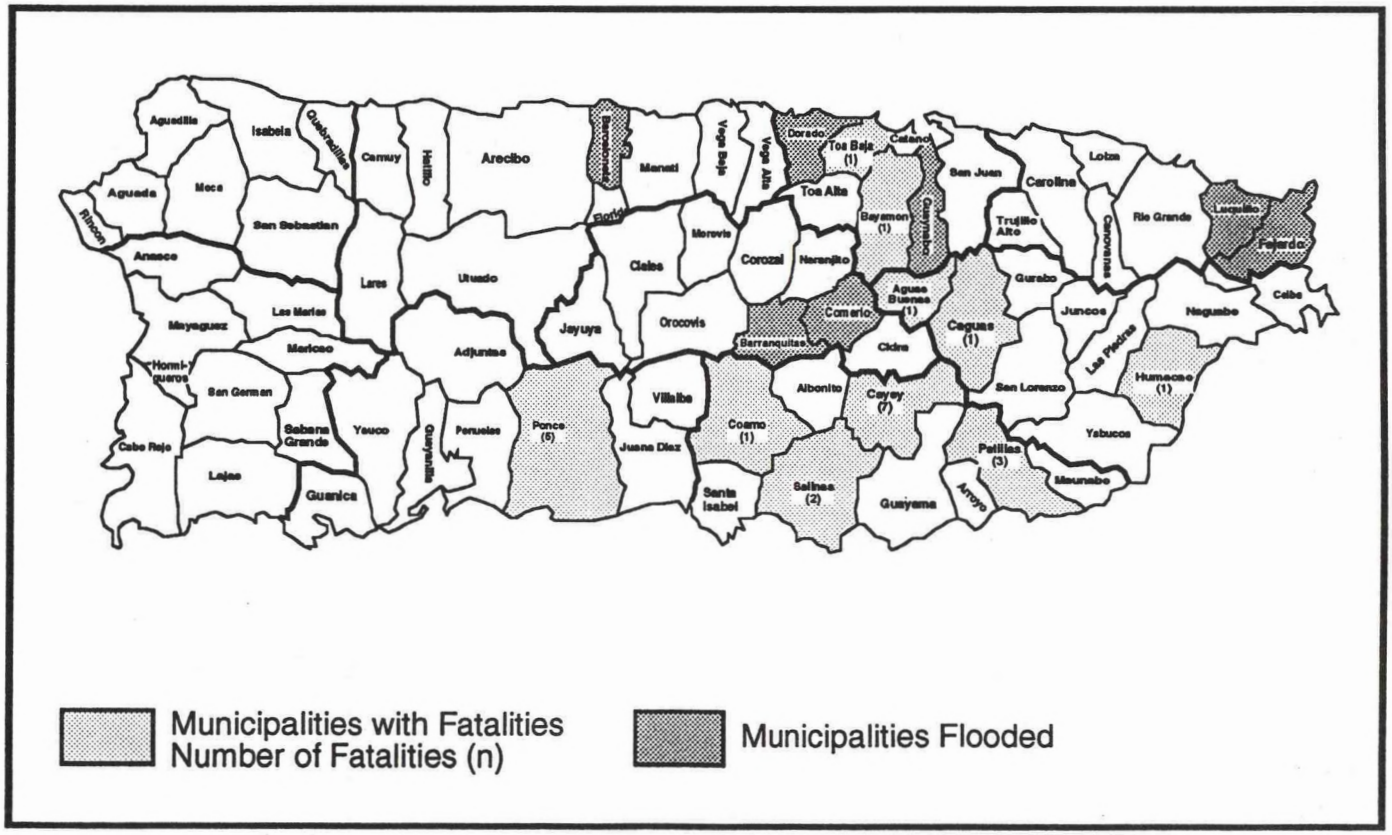

Figure 4. Municipalities Flooded and Municipalities with Fatalities

The key to maximizing the warning lead time necessary for quick response to a developing flood is real-time knowledge of storm conditions and the immediate evaluation of potential streamflow to follow. ALERT has been designed to accomplish much of this task. In Puerto Rico, the first element of this system was installed in the Rio Grande de Loiza basin in 1985. It consisted of six automatic rain gages, one repeater, and two base stations. Rain gages transmit rainfall amounts via battery-operated very high frequency transmissions for each millimeter of rainfall. Each base station receives, processes, and continuously displays the incoming field sensor data. Audio and video alarm capabilities are generated at predetermined levels. The initial system became functional in the spring of 1985, and subsequent expansions have covered additional basins as shown in figure 5. There are now 33 gages and four base stations located at WSFO San Juan, USGS, DNR, and Commonwealth CD.

On January 5, only two base stations were operating--WSFO San Juan and Commonwealth CD. The unit operating at Commonwealth CD actually belonged to the DNR. It was moved from the DNR office to Commonwealth CD since the CD base station was malfunctioning. The USGS unit was functional, but the office only operates on weekdays during normal business hours. The DNR is in the process of requesting funding for the installation of 15 additional automatic reporting rain gages and an additional base station for the central office of the DNR's Water and Sewer Authority.

As early as 1:00 p.m. Sunday, January 5, an ALERT gage in the interior of Puerto Rico was alarming. Within the next 3 hours, additional gages began to alarm. This system was functional throughout the event, audibly notifying the personnel as threshold rainfall values were exceeded. Data collected by the ALERT system for the 48 hours of significant rainfall and flooding are depicted in appendix D. Hourly precipitation reports from selected ALERT gages and cumulative rainfall totals appear in appendix E.

In addition to the ALERT system, the Water Resources Division of the USGS collects real-time hydrologic information from data collection platforms (DCP) and other gage sites across the island as shown in figure 6. Data include rainfall, streamflow, ground-water levels, and water quality. *These data are archived on the USGS computer but were unavailable to the forecasters during this event.* A compilation of USGS-collected rainfall totals and discharge maximums are depicted in table 4. Individual hydrograph depictions for selected stations appear in appendix F. Although most streams crested around 10:00 p.m., Sunday, January 5, the period of peak discharge ranged from 7:00 p.m., Sunday, January 5, to 3:00 a.m., Monday, January 6.

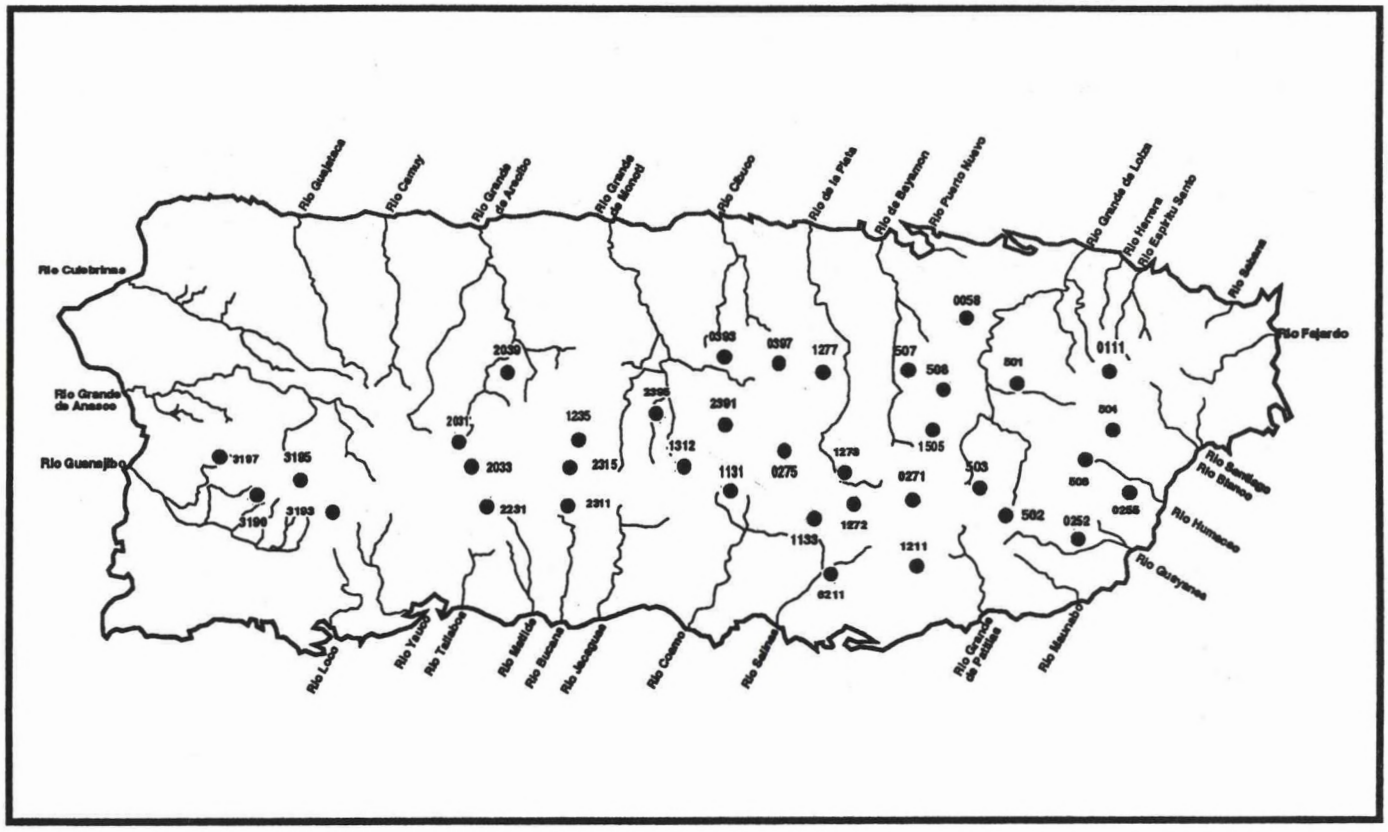

Figure 5. ALERT System

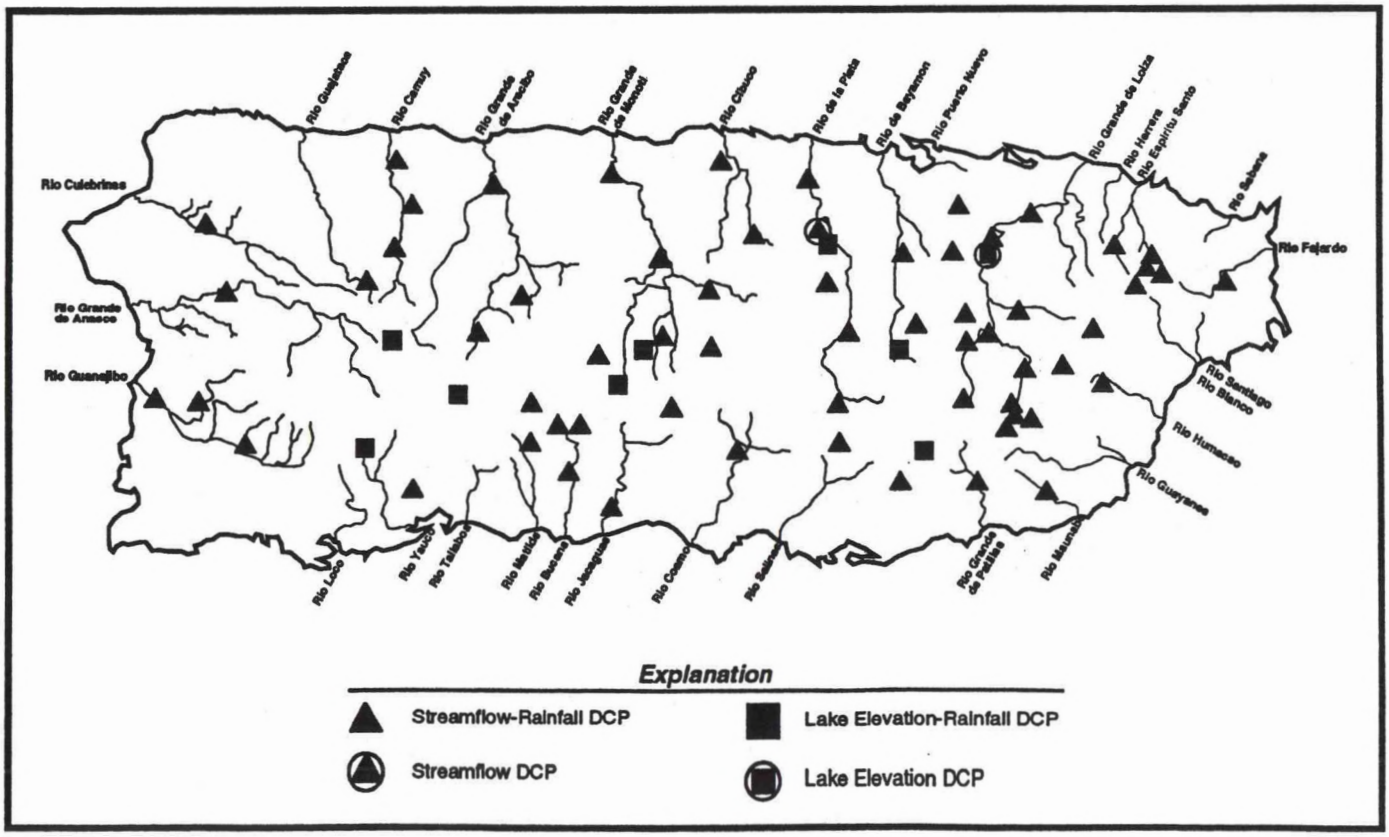

Figure 6. Data Collection Platforms

TABLE 4

USGS Station Reports

Station Number	Name	January 5	January 6	QMAX	CFS	Date of QMAX	Return Interval	Previous QMAX CFS	Previous QMAX	Previous QMAX Date	Basin Drainage Sq. Mile
50014800	Rio Camuy near Bayaney	0.94	0.45								
50015700	Rio Camuy near Hatillo	1.69	0.17								
50030460	Rio Orocovis near Orocovis	9.43	1.72								
50031200	Rio Grande De Manati near Morovis	4.70	0.88								
50035000	Rio Grande De Manati at Ciales	2.41	0.71								
50038320	Rio Cibuco below Corozal	5.41	0.43	11900	19.3	5	7	13600	19.80	11-07-74	15.1
50039990	Lago Carite at Gate Tower	10.08	1.11								
50043000	Rio De La Plata at Proyecto	10.20	1.90	75600	36.9	5	30	59600	32.21	8-27-61	63.0
50043800	Rio De La Plata at Comerio	9.56	1.75	127000	29.2	5		32000	17.36	4-18-89	109
50045010	Rio De La Plata below La Plata			127000	34.8	5		48800	22.98	4-18-89	173
50046000	Rio De La Plata at Hwy 2 near Toa Alta	3.47	0.25	110000	26.39	5	25	120000	37.4	9-13-28	208
50051150	Quebrada Blanca at Jagual	8.94	2.13								
50051180	Quebrada Salvatierra near San Lorenzo	6.72	2.04								
50051310	Rio Cayaguas at Cerro Gordo	7.06	1.38								
50051800	Rio Grnd Loiza at Hwy 183 San Lorenzo	0.45	0.45								
50053025	Rio Turabo above Borinquen	11.37	1.64								
50055000	Rio Grande De Loiza at Caguas	6.29	1.38								
50057000	Rio Gurabo at Gurabo	4.36	0.91								
50065500	Rio Mameyes near Sabana	5.97	0.58								
50067000	Rio Sabana at Sabana	7.64	0.40	95700	19.74	5	15	9010	19.35	4-21-83	3.96
50071000	Rio Fajardo near Fajardo	6.06	out	23200	19.88	5	25	23500	20.00	9-18-89	14.9
50081000	Rio Humacao at Las Piedras	5.83	1.64								
50090500	Rio Manuabo at Lizas	6.48	1.39								
50092000	Rio Grande De Patillas near Patillas	4.65	0.06	71000	26.0	5		14800	12.45	9-16-75	18.3
50106100	Rio Coamo at Coamo	10.20	2.48								
50111500	Rio Jacaguas at Juana Diaz	5.95	3.56	20690	22.81	5	20	40000	29.42	10-07-85	49.8
50112500	Rio Inabon at Real Abajo	4.71	5.99	5650	23.13	5	15	19000	25.3	10-07-85	9.7
50113800	Rio Cerrillos above Lago Cerrillos	11.59	7.10	7980	9.64	5		2500		9-25-90	15.4
50114000	Rio Cerrillos near Ponce	3.77	7.56								
50114390	Rio Bucana at Hwy 14 Bridge near Ponce	3.01	7.44	9830	12.46	5		17400	13.48	10-07-85	24.9
50115000	Rio Portugues near Ponce	7.42	7.30	6790	14.03	5	7	21000	20.20	10-07-85	8.82
50124200	Rio Guayanilla near Guayanilla	1.43	2.66	2210	11.77	5	2	14700	20.4	9-12-82	18.9
50138000	Rio Guanajibo near Hormigueros	0.57	0.86								

Finding 3.1
Due to the holiday, the KP4 network of volunteer amateur weather observers did not relay critical real-time rainfall observations to WSFO San Juan during the event.

Finding 3.2
The ALERT and DCP networks portrayed an accurate picture of the event. The ALERT alarms performed as designed, alerting WSFO San Juan and Commonwealth CD.

Finding 3.3
USGS hydrologic information was not available to forecasters in real time.

CHAPTER 4

DISSEMINATION AND COMMUNICATION

The warning process involves a series of interactive, mutually dependent actions in order to achieve its goal--to maximize the number of people who take timely and appropriate protective behavior. This warning process can be viewed as an integrated warning system comprised of three functional components. These include a scientific or detection component, an emergency management or warning component, and a public response component. If any one these components fails, the entire system can fail. In the case of severe weather and flooding, the NWS performs both scientific functions of detection and prediction and emergency management functions of issuing formal warnings through a variety of communications channels. All warnings were transmitted in Spanish and English via the NOAA Weather Wire Service (NWWS) and broadcast via NOAA Weather Radio (NWR). NWR's tone alert was used in all cases.

DISSEMINATION

WSFO San Juan was aware of the increase in shower and thunderstorm activity over the interior and eastern portions of the island during the morning of January 5. Records indicate that as convective activity continued into the early afternoon, forecasts were updated to indicate the increased likelihood of heavy rainfall. By midafternoon, communication on the CD radio network began to significantly increase. The WSFO staff monitored the CD radio network throughout the event. At 5:30 p.m., reports of 2- to 4-inches of rainfall and mudslides were relayed to the WSFO by Commonwealth CD prompting the issuance of the first flash flood watch. By 6:45 p.m., additional information supported the initial flash flood warning. The warning met all call-to-action requirements, including the request for immediate activation of the EBS.

Commonwealth CD had one person working at the EOC communications section on the afternoon of January 5. The Commonwealth CD EOC is staffed 24 hours a day, daily. Routine forecasts are normally rebroadcast at 8:00 a.m., 10:00 a.m., and 4:30 p.m., daily, over CD radio. All warnings and watches were communicated from Commonwealth CD to the nine Commonwealth CD zones and those municipalities monitoring the radio. The CD zone agencies are responsible for relaying severe weather information to the municipalities. At 4:00 p.m., Sunday, January 5, the decision was made to activate and fully staff the Commonwealth CD EOC. Additional staff arrived by 6:00 p.m. Personnel monitored the ALERT gages, CD radio, and NWS watches, warnings, forecasts, and statements. All information was relayed to Commonwealth CD zone officials and those local CD officials that could be reached.

EMERGENCY BROADCAST SYSTEM

The first flood warning was issued at 6:45 p.m. with a request for activation of the EBS. The EBS was not activated until 9:05 p.m. The delay of 2 hours and 20 minutes is a function of how the EBS is set up in Puerto Rico. According to the most recent Puerto Rico EBS Operational Plan, WSFO San Juan is not authorized to request--directly to the media--EBS activation for the Commonwealth or for the eight EBS operational areas within the Commonwealth. According to the EBS plan, only the Commonwealth CD is authorized to activate the EBS for the entire Commonwealth on behalf of the NWS. The request to the primary Common Program Control Station (CPCS-1) originates from Commonwealth CD. Once the Commonwealth CD decides upon EBS activation, it alerts the Commonwealth CPCS-1 (WKAQ-AM; KQ105-FM) to activate the EBS. The CPCS-1 broadcasts audio tones and alerts listeners on other EBS stations to stand by for an emergency message. The Commonwealth CD then broadcasts the message live, on the air, via the radio stations.

According to the Natural Disaster Survey Report (1990) on Hurricane Hugo, September 10-22, 1989, this EBS procedure worked well. In this case, there was ample lead time, and the Governor of Puerto Rico spoke live to the public on the EBS. The EBS was activated eight times prior to landfall. Regular briefings were held, and a constant stream of information was available. All components of the warning system had time to prepare and respond.

For this flood event, the 6:45 p.m. warning was received immediately at the 24-hour emergency communications section of the Commonwealth CD's EOC on both the NWWS and NWR. The CD director and staff were subsequently notified of the warning. Station logs at WKAQ-AM indicated that the Commonwealth CD contacted the station at 8:30 p.m. to alert them that an EBS activation would occur shortly. At 9:02 p.m., the first EBS tone was activated followed by a message to listeners that an emergency message was to follow. At 9:05 p.m., the tone was activated and the EBS emergency message was relayed by the Commonwealth CD director via telephone as a live, on-the-air broadcast. During this event, EBS was activated only once for the ten warnings that were issued.

Very few radio stations retransmitted the EBS message from the Commonwealth CPCS-1. Only two of five television stations activated their EBS and relayed the warning. A number of reasons were given for the low level of EBS activation by other radio and television stations. It was Three Kings Eve and the stations were short staffed with the least experienced personnel. Some radio stations were broadcasting prerecorded programs and were not staffed. Some stations' personnel described the EBS activation as being too short, precluding them from activating their EBS equipment and rebroadcasting the warning. Others viewed the EBS activation as a test rather than a real emergency despite the fact that most stations routinely conduct EBS tests and drills on weekdays during normal business hours. Part-time

personnel staffing stations at night or on weekends are not properly trained for emergency situations. In addition, television stations seldom use crawlers to air emergency information due to the lack of trained personnel, complex equipment, or union requirements. Finally, there are no NWWS subscribers since most radio and television stations find the NWWS pricing structure too expensive. Warnings are normally carried by the news wire services, but they too were closed.

The Federal Emergency Management Agency (FEMA) sent a team to review the EBS activation from a systems' technology standpoint. FEMA found that the current technology worked as planned. The memorandum also noted the several-hour delay in activating the EBS after NWS issued the warning. EBS activation problems during short-fused events are not new. Communication problems were well documented in the NOAA Natural Disaster Survey Report (1986) on the Puerto Rico flash flood event of October 6-7, 1985, as well as in the NOAA Natural Disaster Survey Report (1980) on Hurricanes David and Frederic as they concerned Puerto Rico and the U.S. Virgin Islands. These problems result from an organizational structure that does not allow for rapid access to the warning system by the local NWS office. While government-to-government components of the warning system work within the emergency management community, the warning of the public through the EBS took hours longer than planned.

COMMUNICATION

WSFO San Juan transmitted all watches, warnings, statements, and forecasts using various communications systems. Internally, forecast products were transmitted via the Automation of Field Operations and Services which links all NWS offices. All issuances were also transmitted via NWWS. However, there is only one NWWS drop in Puerto Rico--provided by the NWS and located at Commonwealth CD.

One communications issue encountered by the Disaster Survey Team was that the EBS CPCS-1 has no way to directly receive warnings from WSFO San Juan. In the past, radio and television stations had a teletype circuit direct from the NWS. With the only NWWS drop on the island located at the Commonwealth CD, the entire warning process is jeopardized if there is a communications failure at this agency.

Forecast products were broadcast via NWR. There are two NWR transmitters that cover most of the island. All warnings were preceded by an emergency tone alert. However, this warning dissemination system is vastly underutilized by local emergency officials, the news media, and the public. While the Commonwealth CD EOC did receive every tone-alerted warning via NWR, very few citizens in the areas devastated by flash floods had access to NWR broadcasts.

While warnings can be disseminated to local CD officials via the CD radio network or telephone, direct communication by the WSFO is discouraged. All radio communications are designed to go through the centralized communications center

operated by Commonwealth CD. Since the island does not have a National Warning System, the only link to local officials is through the Commonwealth CD. In fact, the only link to the EBS is through the Commonwealth CD. Some radio stations routinely contact the WSFO for weather information and forecasts which they record for news broadcasts. Many expressed a desire to see the responsibility for EBS activation given to WSFO San Juan.

Finding 4.1
Commonwealth CD activated the EBS 2 hours and 20 minutes after the warning was issued by WSFO San Juan.

Finding 4.2
The EBS tone was activated for less than the prescribed length of time precluding the media from activating their EBS equipment and rebroadcasting the warning.

Finding 4.3
EBS was activated only once for the ten warnings that were issued.

Finding 4.4
There was considerable confusion among the radio and television stations in the EBS network when the EBS was activated. Part-time personnel staffing stations at night or on weekends are not properly trained for emergency situations.

Finding 4.5
The eight EBS operational area CPCS-1 stations, including the Commonwealth CPCS-1, do not receive warnings in real-time from the NWS. Except for the NWWS drop at the Commonwealth CD EOC provided by the NWS, there are no NWWS subscribers in Puerto Rico. Most radio and television stations find the NWWS pricing structure too expensive. As a result, the media has no rapid, direct access to NWS warnings.

Finding 4.6
NWR is underutilized in Puerto Rico and thus ineffective in reaching emergency officials and citizens at risk.

CHAPTER 5

PREPAREDNESS

The San Juan WSFO has had a full-time Warning Preparedness Meteorologist (WPM) on staff since April 1991. The WPM has aggressively pursued preparedness activities at all levels. Meetings, seminars, and conferences with the media and CD agencies have been conducted throughout the Commonwealth and are considered major achievements. Work has also progressed on the Spanish translation of preparedness materials--a critical component of the preparedness program. Table 5 details the annual preparedness activities conducted by the WSFO staff from October 1, 1990, through September 30, 1991. A total of 216 separate severe weather preparedness activities were undertaken during this period. Almost half of the activities were awareness or safety presentations.

TABLE 5

Preparedness Activities of WSFO San Juan
October 1, 1990, through September 30, 1991

Coordination Meetings or Conferences	
Local Government	15
State Agencies	2
Federal Agencies	1
Statewide Organizations	28
TV/CATV Stations	1
Radio Stations	1
Newspapers	1
Total Coordination Meetings	49
Live or Taped Media Interviews	
TV/CATV	5
Radio	10
Newspapers	1
Total Media Interviews	16
Awareness or Safety Presentations	104
School Presentations	29
Severe Weather Training Sessions	16
Emergency Plans Helped Revise	2
	216

Most significant were the training sessions held for Commonwealth CD radio operators. The training has had a positive impact as indicated by the increased number of local flood reports relayed to the WSFO during this event. The WPM has also undertaken steps to bring the preparedness message to the citizens by staffing display and information booths at shopping malls and marinas island-wide. A major part of this effort is the provision of meaningful preparedness material translated into Spanish. The WPM has actively pursued the possibility of having several NWS preparedness pamphlets translated into Spanish. Some of these materials are awaiting sponsorship to defray printing costs. In addition, WSFO San Juan continues to promote NWR. Although NWR has always been on the agenda at meetings and conferences, the service continues to be greatly underutilized.

Finding 5.1

The new full-time WPM, along with the service hydrologist, are taking the preparedness message to all levels of the community. These efforts have produced positive results.

Finding 5.2

Preparedness materials distributed by the NWS are not always available in Spanish.

CHAPTER 6

PUBLIC RESPONSE

Cayey

Cayey is located in the mountains approximately 50 miles south of San Juan. This picturesque mountain town was severely impacted by flood waters. Cayey received 19.5 inches of rain. Seven people lost their lives. The Rio de la Plata, which runs through the center of town, flooded dozens of buildings. Damage to the town was placed at over a million dollars. On Sunday afternoon, January 5, many of the town's children were gathered at the town hall to celebrate Three Kings Eve. They were in the auditorium when light rain began to fall at 1:00 p.m. The children were sent home at 4:00 p.m. as the public celebration ended. At that time, the Mayor became concerned about the relentless rain. By 5:00 p.m., the river and creeks were near bankfull, and localized flooding had already started. The Mayor assembled the town's emergency committee. By 6:00 p.m., the flooding was getting worse. Many vehicles were swept away by the floods. The downtown area near the river was flooding. The Mayor indicated that prior to and during the flooding, the town received no warning of the heavy rain or potential flooding from emergency management officials. The town had no mechanism to receive the warnings directly from the NWS.

Comerio

Comerio is located on the Rio de la Plata downstream from Cayey, approximately 35 miles south-southwest of San Juan. Just upstream, the Rio Hondo joins with the Rio de la Plata. This town is in a valley surrounded by steep mountains. Comerio received 11 inches of rain. Not long after the flooding in Cayey, the flood waters reached Comerio. Eye witnesses stated they first knew of the danger when flood waters were flowing down the street that runs along the river. While NWR broadcasts can be received in town, no officials or citizens interviewed had access to a receiver. Officials indicated they received no flood warning prior to impact. The Mayor of Comerio was actively involved in the warning and rescue efforts. Emergency teams, many of them neighbors, went through the town to provide warning, evacuation, and rescue. As in Cayey, the entire community was involved in the emergency response. At 7:00 p.m., one bridge over the Rio de la Plata was overtopped. The public transportation company next to the river lost many buses to the rising water. The bridge was soon demolished by the flood. Between 8:30 p.m. and 9:00 p.m., the river downstream from the bridge began to flood that section of town. Residents indicated that the water rose so rapidly that they had no time to save personal property. Fortunately, no lives were lost in Comerio.

Toa Baja

Toa Baja is on the Rio de la Plata near the coast, approximately 20 miles west of San Juan. The Rio de la Plata flows from the mountains and broadens just south of town. The river forks at this point, with one fork next to Toa Baja and the other east of town through marshlands. At 3:00 p.m., the local CD director became concerned about the rain and contacted Commonwealth CD and other officials. He also contacted the upstream dam operator to obtain the current river levels. Commonwealth CD relayed this information to WSFO San Juan at 3:10 p.m. At 5:30 p.m., Commonwealth CD called to inform local CD officials of the flood watch issued by the NWS. Officials continued to actively monitor the weather and flood conditions. Spotters were placed at the river to monitor a river gage upstream from Toa Baja. At 9:00 p.m., the CD director received notification of the flood warning from Commonwealth CD. They continued to monitor the river level as it rose rapidly. According to local officials, the Rio de la Plata had reached the critical stage at 11:30 p.m. The outdoor warning sirens were sounded. Emergency personnel drove through the streets alerting residents of the impending flood. Residents knew to drive out of the area to higher ground or to one of the two emergency shelters. Those without vehicles went to preassigned street corners where vans and buses picked them up to take them to shelters. Officials estimated that about 50 percent of the residents heeded the call to evacuate. The others felt they could safely ride out the flood in their homes. At 11:50 p.m., the river overtopped its banks. The flood waters reached town and flooded most homes. Those who stayed had to escape to roofs or second stories. The currents of the flood waters prevented any normal evacuation by boat. There were five individuals trapped and in need of medical attention that were evacuated by helicopter. Several stranded motorists were also evacuated by helicopter. Throughout the event, no local radio or television station carried NWS watches or warnings. All flood warning information received in Toa Baja was from the Commonwealth CD, dam operators, or local officials upstream. This lead time allowed local CD officials to activate their response teams prior to the flooding. The lead time also allowed officials to safely evacuate those who chose to heed the warnings. As a result, there was little loss of life in Toa Baja.

Barceloneta

Barceloneta is located near the coast, approximately 40 miles east of Toa Baja, on the Rio Grande de Manati. Barceloneta experienced flooding despite the fact that there was little rain in the immediate area. Between 7:00 p.m. and 8:00 p.m., Sunday, January 5, local officials received a telephone call from police upstream warning them of the approaching flood. Local CD officials activated their emergency response teams. Although they had radio contact with Commonwealth CD, they did not recall receiving any official warning messages for their town from Commonwealth CD. They did remember monitoring their scanner radio for NWR updates on the flooding after the first contact with upstream officials. The local radio station did not broadcast any NWS warning information. Local officials issued door-to-door warnings

to low-lying neighborhoods. Flooding began around 11:00 p.m., Sunday. One neighborhood of seven families had to be evacuated. Two hours later, another four families had to be evacuated to higher ground. Due to the lead time provided by upstream officials, residents were evacuated prior to the flooding. There were no injuries or fatalities.

San Juan

Although San Juan did not experience any flooding, local CD officials did prepare for potential flooding. At 12:30 p.m., Sunday, January 5, the director of San Juan CD partially activated his EOC to monitor weather conditions. The EOC was fully staffed by 2:00 p.m. The San Juan CD EOC is equipped with state-of-the-art weather monitoring equipment. They contract to receive NWS warning and forecast products, real-time color radar, and GOES imagery from a private meteorological consulting firm. San Juan CD also monitored the Weather Channel for additional severe weather information for the duration of the event. All NWS watches and warnings were received via their communications equipment and CD radio. San Juan CD was prepared to evacuate low lying areas in the city if flooding occurred.

Finding 6.1
Local officials at the headwaters did not have direct access to NWS watches, warnings, forecasts, or statements.

Finding 6.2
Of those individuals who heard the warning, almost half elected to remain in vulnerable areas.

CHAPTER 7

FINDINGS AND RECOMMENDATIONS

The following summary of findings and recommendations recognizes the areas for improvement in the complete warning process from preparedness to public response.

Finding 1.1
The Puerto Rico flash floods and river flooding of January 5-6, 1992, were produced by locally intense rainfall and slow moving showers and thunderstorms over the mountainous interior.

Finding 2.1
The lack of adequate flash flood guidance for Puerto Rico--including graphical quantitative precipitation frequency analyses, precipitation forecast discussions, and excessive rainfall discussions--kept forecasters at WSFO San Juan from anticipating the potential magnitude of the event.

Recommendation 2.1
NMC should consider the technical feasibility of preparing routine flash flood guidance for Puerto Rico. The availability of these products would have enabled forecasters at WSFO San Juan to focus on the potential for flash flooding 12 to 24 hours prior to the event resulting in a more effective flash flood watch.

Finding 2.2
Forecasters at WSFO San Juan did not envision the rapid development of the convective activity nor the potential for it to stall over the interior of the island.

Recommendation 2.2
In the modernized NWS, the San Juan office will be equipped with a new Doppler weather surveillance radar and advanced computer technology. Doppler radar capabilities will greatly increase the volume of available hydrometeorological data, including rainfall amounts, which would have been extremely valuable during this event. Delivery of the San Juan Doppler radar is scheduled for June 1994 with commissioning in March 1995. In the meantime, forecasters at WSFO San Juan should develop an objective operational technique for the recognition of flash flood potential. This technique should incorporate meteorological pattern recognition, flash flood guidance, ALERT data, and other precursors to flash flooding.

Finding 2.3
With the heavy workload involved in coordination and issuance of watches, warnings, forecasts, and statements--and inaccessible staff due to the holiday--no additional personnel were called in to augment the WSFO staff as the event unfolded.
Finding 2.4
Reassignment of the radar operator to a warning coordination role--the best use of staffing resources at the time--precluded radar observations between 2:35 p.m., Sunday, January 5, and 2:35 a.m., Monday, January 6.
Recommendation 2.3, 2.4
WSFO staffing utilization should be reassessed during significant weather events. Standby staffing should be considered during holiday periods.

Finding 2.5
The staffing level at WSFO San Juan is currently below the model staffing level due to budgetary constraints.
Recommendation 2.5
The NWS should make every effort to fully staff WSFO San Juan.

Finding 2.6
Fatalities occurred prior to the issuance of the first flash flood warning. The earliest fatalities occurred in the central mountain communities under the intense thunderstorms at approximately the time of the first flash flood watch issuance.

Finding 2.7
Although warning lead time was nil at the onset of the event in the central mountain communities under the intense thunderstorms, warning lead time improved further down stream.

Finding 2.8
WSFO San Juan's flash flood watches, warnings, and statements received virtually no media dissemination...except for the Weather Channel.
Recommendation 2.8
The NWS should expand their media coordination efforts to ensure that watch/ warning products are recognized, understood, and properly communicated to the public.

Finding 3.1
Due to the holiday, the KP4 network of volunteer amateur weather observers did not relay critical real-time rainfall observations to WSFO San Juan during the event.
Recommendation 3.1
People networks are as important as automated networks for a guaranteed data collection. WSFO San Juan should seek further opportunities to expand the spotter network and to provide guidance for the KP4 volunteers to follow during significant weather events. To ensure the relay of timely observations, WSFO San Juan should work with the KP4 organization to establish a base station at the WSFO to be operated by KP4 volunteers during such events.

Finding 3.2
The ALERT and DCP networks portrayed an accurate picture of the event. The ALERT alarms performed as designed, alerting WSFO San Juan and Commonwealth CD.

Finding 3.3
USGS hydrologic information was not available to forecasters in real time.
Recommendation 3.3
WSFO San Juan should work with the USGS to develop methods of accessing hydrologic information in real time.

Finding 4.1
Commonwealth CD activated the EBS 2 hours and 20 minutes after the warning was issued by WSFO San Juan.
Finding 4.2
The EBS tone was activated for less than the prescribed length of time precluding the media from activating their EBS equipment and rebroadcasting the warning.
Finding 4.3
EBS was activated only once for the ten warnings that were issued.
Recommendation 4.1, 4.2, 4.3
The organizational structure for the operation of the EBS in Puerto Rico should be revised to authorize WSFO San Juan to directly request that the media activate the EBS. This would allow the NWS and media to react instantly to weather emergencies.

Finding 4.4

There was considerable confusion among the radio and television stations in the EBS network when the EBS was activated. Part-time personnel staffing stations at night or on weekends are not properly trained for emergency situations.

Recommendation 4.4

Although many stations routinely conduct EBS tests and drills, they are conducted on weekdays during normal business hours with full staffing. There should be an aggressive effort by the NWS--in conjunction with the local media, Commonwealth CD, FEMA, the Federal Communications Commission, and local CD officials--to design and conduct EBS drills for worst-case scenarios similar to that which occurred during this disaster.

Finding 4.5

The eight EBS operational area CPCS-1 stations, including the Commonwealth CPCS-1, do not receive warnings in real-time from the NWS. Except for the NWWS drop at the Commonwealth CD EOC provided by the NWS, there are no NWWS subscribers in Puerto Rico. Most radio and television stations find the NWWS pricing structure too expensive. As a result, the media has no rapid, direct access to NWS warnings.

Recommendation 4.5

The NWS, in conjunction with Commonwealth and local CD officials and the local media (especially CPCS-1 stations), should investigate other mechanisms for the rapid distribution of crucial warning information.

Finding 4.6

NWR is underutilized in Puerto Rico and thus ineffective in reaching emergency officials and citizens at risk.

Recommendation 4.6

A renewed effort should be undertaken to promote NWR via the media and other outlets. The NWS should vigorously encourage Commonwealth authorities to equip their sector and municipality CD offices with NWR receivers. While not a factor in this event, entities such as hospitals and schools should also be strongly encouraged to secure access to NWR broadcasts.

Finding 5.1

The new full-time WPM, along with the service hydrologist, are taking the preparedness message to all levels of the community. These efforts have produced positive results.

Finding 5.2

Preparedness materials distributed by the NWS are not always available in Spanish.

Recommendation 5.2

The NWS should investigate other mechanisms for providing preparedness materials to the Spanish speaking population.

Finding 6.1
Local officials at the headwaters did not have direct access to NWS watches, warnings, forecasts, or statements.

Recommendation 6.1
The NWS should educate local political, emergency response, and CD officials as to the coverage, availability, and cost of tone-activated NWR receivers with backup power.

Finding 6.2
Of those individuals who heard the warning, almost half elected to remain in vulnerable areas.

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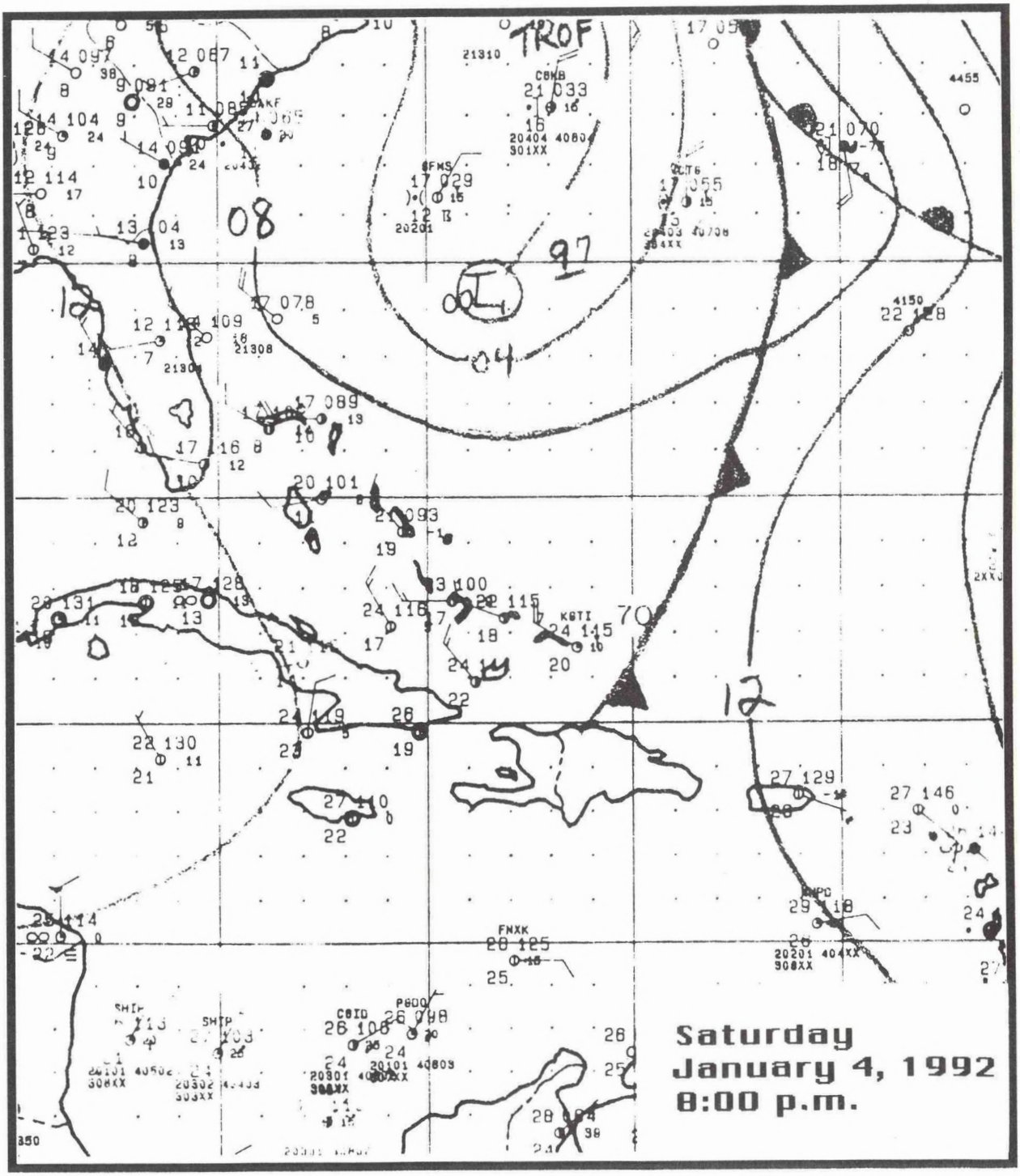
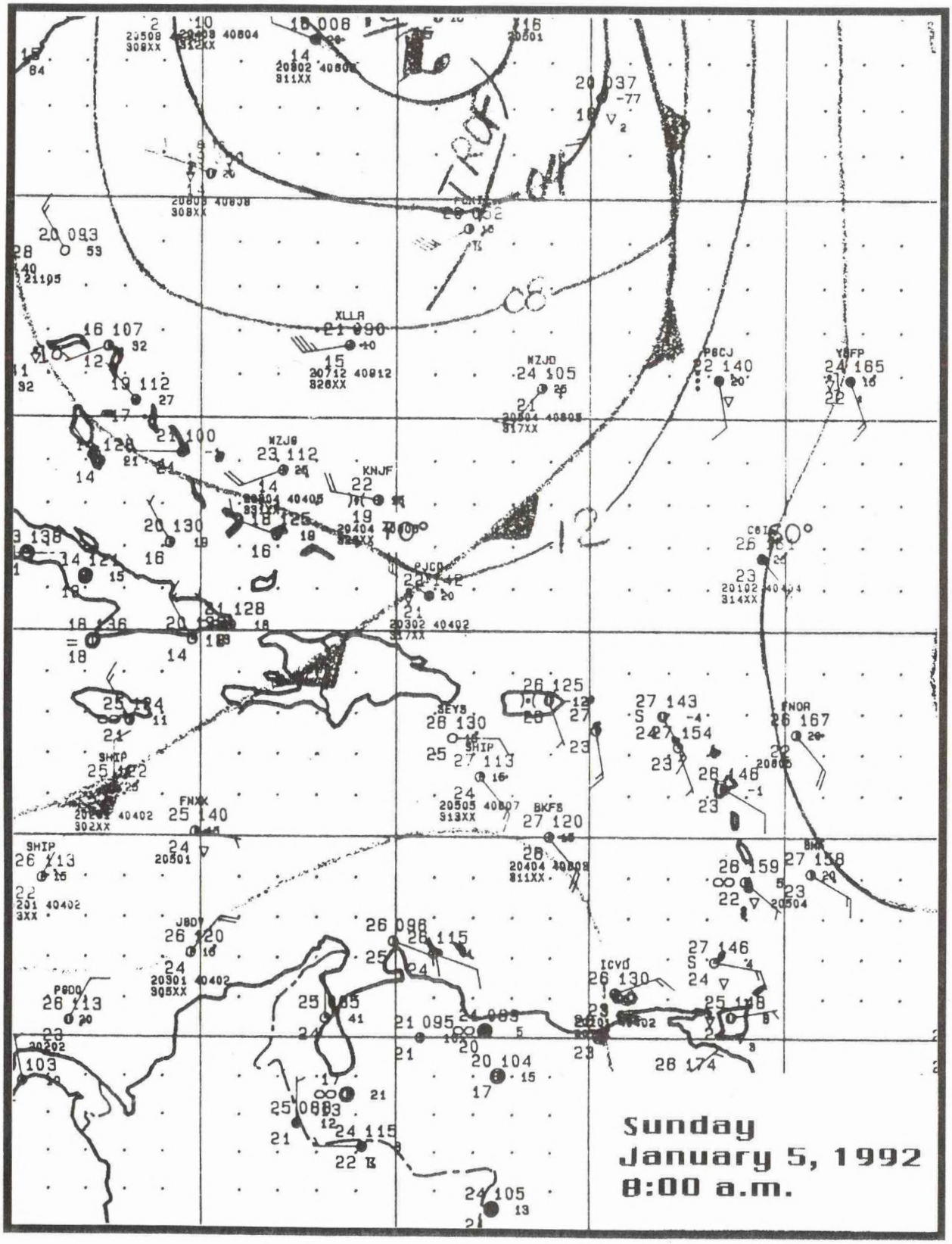
Staes, C., 1992: Epi-Aid Trip Report: Deaths Due to Flash Floods in Puerto Rico, January 5, 1992, Epi-92-29-2, Draft, Centers for Disease Control, Public Health Service, Department of Health and Human Services, Atlanta, Georgia, 10 pp.

APPENDIX A

HYDROMETEOROLOGICAL ASPECTS OF THE PUERTO RICO FLASH FLOODS

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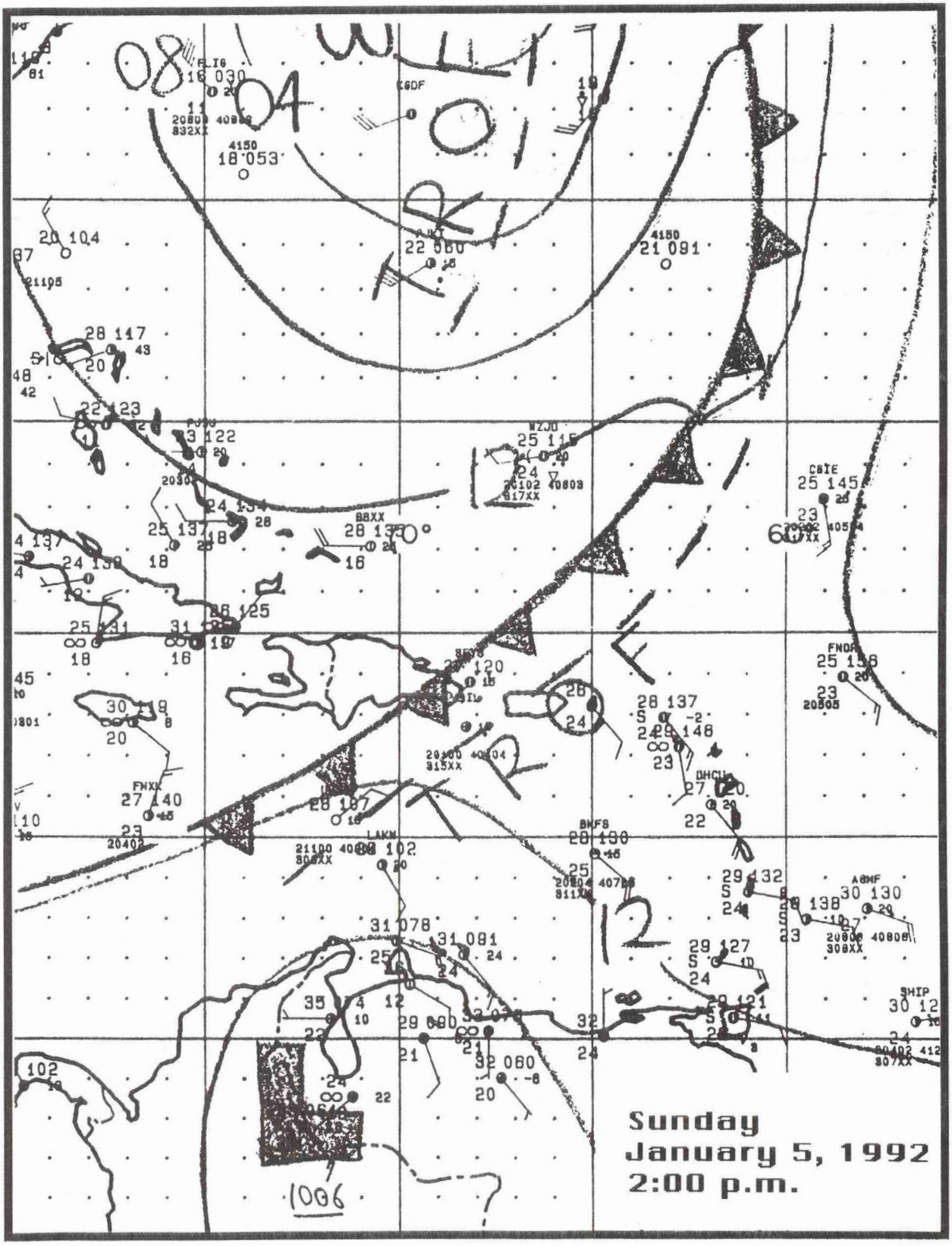
8:00 a.m.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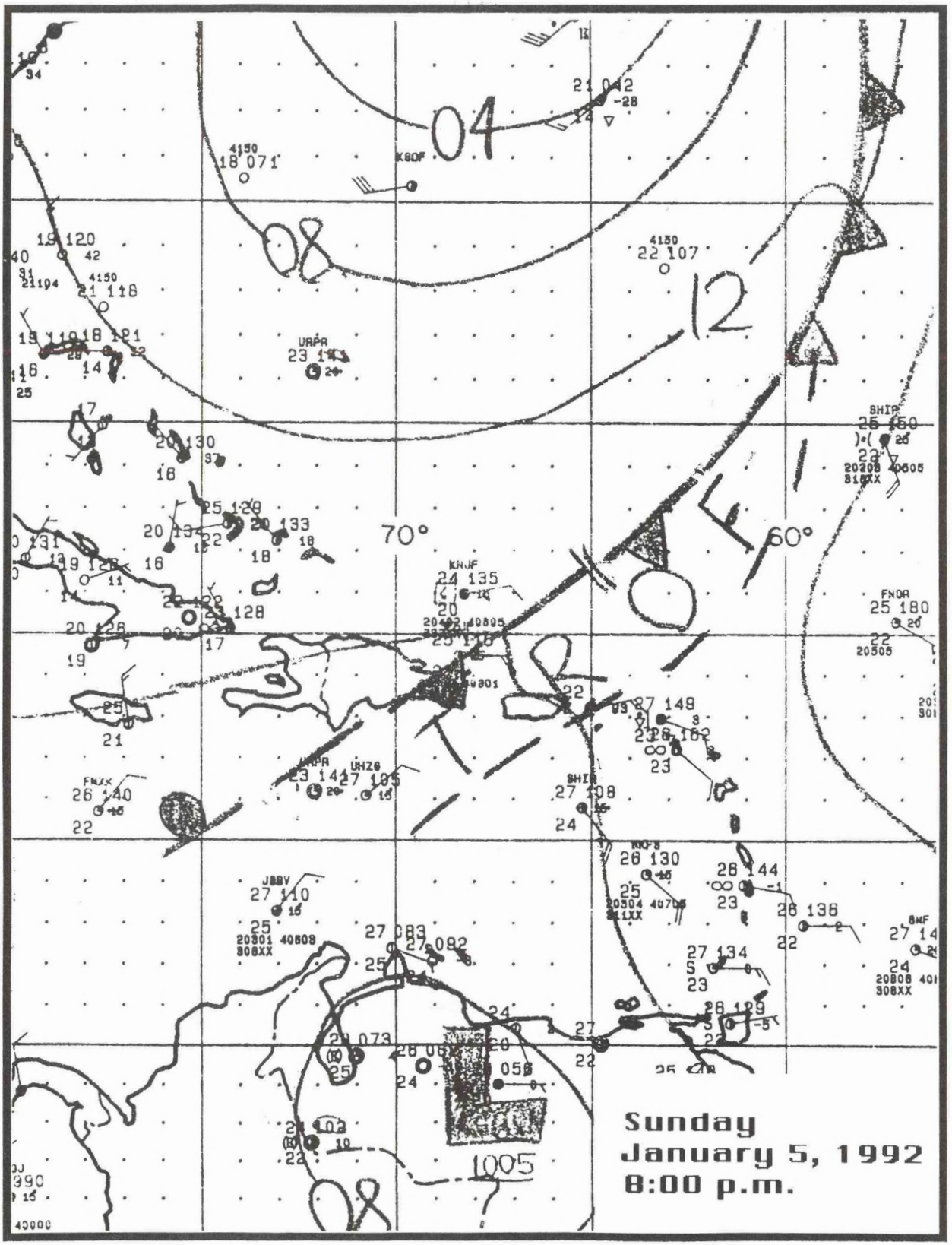
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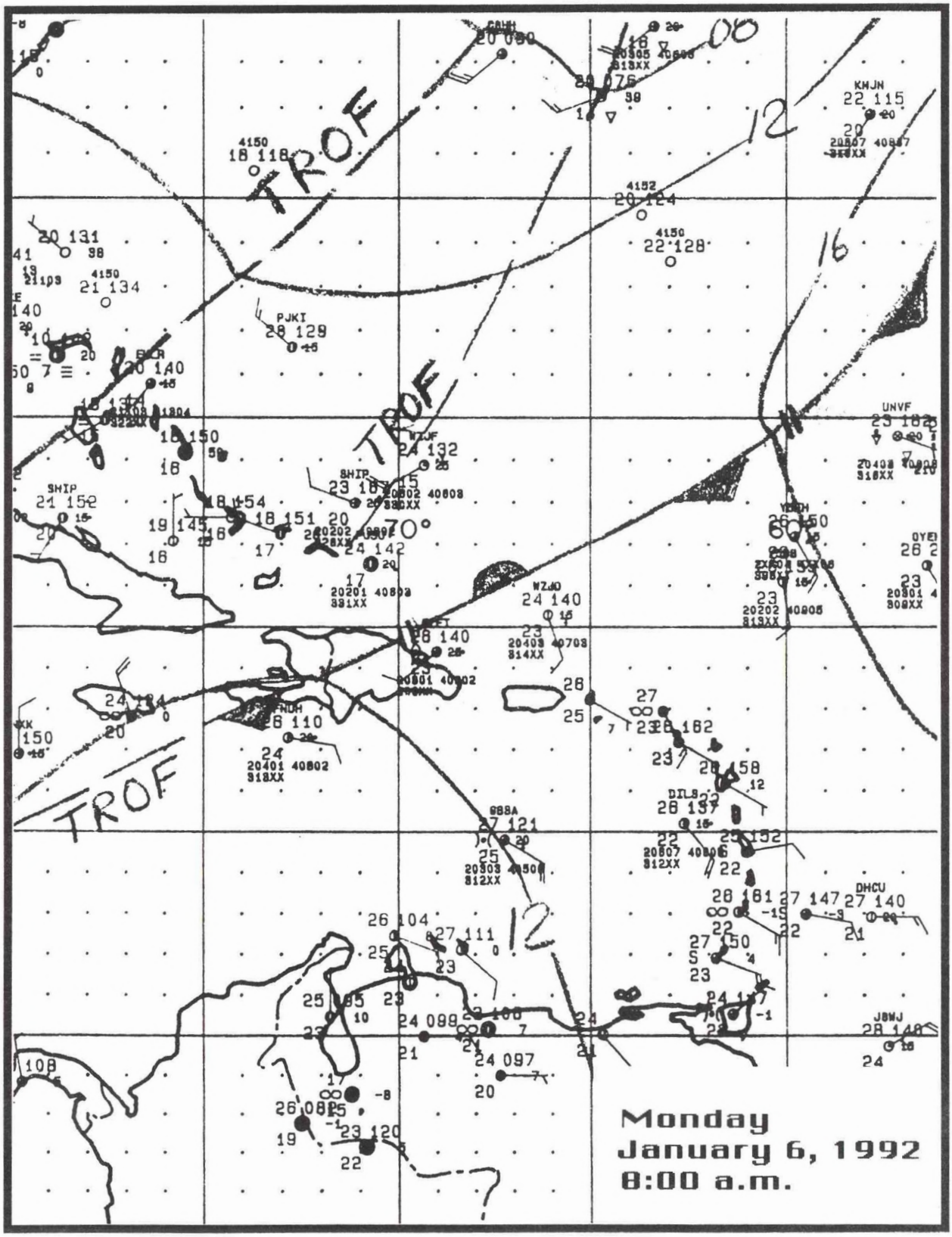
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Monday
January 6, 1992
8:00 a.m.

APPENDIX B

PRODUCTS ISSUED BY WSFO SAN JUAN, PUERTO RICO

SJUZFPPR
TTAA00 KSJU 051108 AMD

PUERTO RICO/U.S. VIRGIN ISLANDS ZONE FORECASTS...UPDATED
NATIONAL WEATHER SERVICE SAN JUAN PR
700 AM AST SUN JAN 5 1992

PRZ001-002-051530-
NORTH SECTIONS OF PUERTO RICO-EAST SECTIONS OF PUERTO RICO-
700 AM AST SUN JAN 5 1992

.TODAY...CONSIDERABLE CLOUDINESS WITH A 40 PERCENT CHANCE OF SHOWERS OR POSSIBLE THUNDERSTORMS. HIGH AROUND 85. WIND SOUTH TO SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 50 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75. WIND LIGHT AND VARIABLE.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85. WIND SOUTHEAST AROUND 10 MPH.

PRZ003-051530-
PONCE AND SOUTH SECTIONS OF PUERTO RICO-
700 AM AST SUN JAN 5 1992

.TODAY...CONSIDERABLE CLOUDINESS WITH A 40 PERCENT CHANCE OF SHOWERS. HIGH 85 TO 90. WIND SOUTH TO SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75. WIND LIGHT AND VARIABLE.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH 85 TO 90. WIND SOUTHEAST 10 TO 15 MPH.

PRZ004-005-051530-
MAYAGUEZ AND WEST SECTIONS OF PUERTO RICO-
INTERIOR SECTIONS OF PUERTO RICO-
700 AM AST SUN JAN 5 1992

.TODAY...CONSIDERABLE CLOUDINESS WITH A 60 PERCENT CHANCE OF SHOWERS OR POSSIBLE THUNDERSTORMS. HIGH FROM 70 MOUNTAINS TO NEAR 85 COAST. WIND SOUTH TO SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. LOW FROM NEAR 50 MOUNTAINS TO AROUND 70 COAST. WIND LIGHT AND VARIABLE.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH FROM NEAR 70 MOUNTAINS TO NEAR 85 COAST. WIND SOUTHEAST 10 TO 15 MPH.

PRZ006-007-051530-
ST THOMAS ST JOHN AND ADJACENT ISLANDS-ST CROIX-
700 AM AST SUN JAN 5 1992

.TODAY...CONSIDERABLE CLOUDINESS WITH A 50 PERCENT CHANCE OF SHOWERS OR A POSSIBLE THUNDERSTORM. HIGH NEAR 85. WIND SOUTH TO SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75. WIND SOUTHEAST 10 MPH.
.MONDAY...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85. WIND SOUTHEAST 10 TO 15 MPH.

SJUSWSPR
TTAA00 KSJU 051125

WEATHER SUMMARY FOR PUERTO RICO AND U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
715 AM AST SUN JAN 5 1992

AN INCREASE IN CLOUDINESS WAS OBSERVED ACROSS PUERTO RICO AND THE U.S. VIRGIN ISLANDS EARLIER THIS MORNING. SCATTERED SHOWERS AND ISOLATED THUNDERSTORMS WERE DETECTED BY THE NATIONAL WEATHER SERVICE RADAR OVER THE MONA CHANNEL AND OVER THE OFFSHORE NORTHERN WATERS. MOST OF THE SHOWERS AND THUNDERSTORMS WERE MOVING TOWARD THE NORTHEAST.

A COLD FRONT LOCATED OVER HISPANIOLA IN COMBINATION WITH AN UPPER LEVEL LOW NORTH OF THE BAHAMAS ARE RESPONSIBLE FOR THIS CHANGE IN THE WEATHER PATTERN. SCATTERED SHOWERS AND ISOLATED THUNDERSTORMS ARE TO BE EXPECTED ACROSS THE LOCAL AREA TODAY IN ADVANCE OF THE COLD FRONT THAT SHOULD CONTINUE TO APPROACH PUERTO RICO AND THE U.S. VIRGIN ISLANDS. WEATHER CONDITIONS WILL CONTINUE WITH ABOVE NORMAL CLOUDINESS AND SCATTERED SHOWERS INTO THE THREE KINGS DAY. A MARKED CHANGE FROM THE GENERALLY DRY PATTERN THAT PREVAILED UNTIL LAST NIGHT.

SJUZFPPR
TTAA00 KSJU 051501

PUERTO RICO/U.S. VIRGIN ISLANDS ZONE FORECASTS
NATIONAL WEATHER SERVICE SAN JUAN PR
1130 AM AST SUN JAN 5 1992

PRZ001-002-052000-
NORTH SECTIONS OF PUERTO RICO-EAST SECTIONS OF PUERTO RICO-
1130 AM AST SUN JAN 5 1992

.THIS AFTERNOON...CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85. WIND SOUTHEAST 10 TO 15 MPH.
.TONIGHT...CONTINUED CLOUDY WITH A 50 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75. WIND SOUTHEAST 5 TO 10 MPH.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85. WIND SOUTHEAST AROUND 10 MPH.

PRZ003-052000-
PONCE AND SOUTH SECTIONS OF PUERTO RICO-
1130 AM AST SUN JAN 5 1992

.THIS AFTERNOON...CONSIDERABLE CLOUDINESS WITH A 40 PERCENT CHANCE OF SHOWERS. HIGH 85 TO 90. WIND SOUTH TO SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75. WIND LIGHT AND VARIABLE.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH 85 TO 90. WIND SOUTHEAST 10 TO 15 MPH.

PRZ004-005-052000-
MAYAGUEZ AND WEST SECTIONS OF PUERTO RICO-
INTERIOR SECTIONS OF PUERTO RICO-
1130 AM AST SUN JAN 5 1992

.THIS AFTERNOON...CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS AND POSSIBLE THUNDERSTORMS. HIGH FROM 70 MOUNTAINS TO NEAR 85 COAST. WIND SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. LOW FROM NEAR 50 MOUNTAINS TO AROUND 7 COAST. WIND LIGHT AND VARIABLE.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH FROM NEAR 70 MOUNTAINS TO NEAR 85 COAST. WIND SOUTHEAST 10 TO 15 MPH.

PRZ006-007-052000-
ST THOMAS ST JOHN AND ADJACENT ISLANDS-SAINT CROIX-
1130 AM AST SUN JAN 5 1992

.THIS AFTERNOON...CONSIDERABLE CLOUDINESS WITH A 50 PERCENT CHANCE OF SHOWERS OR A POSSIBLE THUNDERSTORM. HIGH NEAR 85. WIND SOUTH TO SOUTHEAST 10 TO 15 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75. WIND SOUTHEAST 10 MPH.
.MONDAY...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85. WIND SOUTHEAST 10 TO 15 MPH.

SJUSWSPR
TTAA00 KSJ1 051502

WEATHER SUMMARY FOR PUERTO RICO AND U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
1130 AM AST SUN JAN 5 1992

SATELLITE PICTURES THIS MORNING INDICATED WIDESPREAD CLOUDINESS OVER MOST OF THE NORTHEAST CARIBBEAN WHILE WEATHER SERVICE RADAR SHOWED NUMEROUS SHOWERS AND ISOLATED THUNDERSTORMS NORTH OF PUERTO RICO AND SAINT JOHN MOVING TOWARDS THE NORTHEAST AT 15 MPH. THIS AREA OF CLOUDINESS AND RAIN DEVELOPED AS A RESULT OF A COMBINATION OF AN APPROACHING COLD FRONT AND AN UPPER LEVEL LOW.

SO FAR THIS MORNING A FEW SHOWERS WERE OBSERVED OVER INTERIOR SECTIONS OF PUERTO RICO AND OVER THE NORTHERN VIRGIN ISLANDS. EVEN THOUGH MOST OF THE RAIN WILL REMAIN OVER WATERS WELL NORTH OF OUR ISLANDS...THERE WILL BE AN INCREASE IN SHOWERS IN MOST LOCATIONS LATER THIS AFTERNOON AND TONIGHT AS THE FRONT CONTINUES TO MOVE SOUTHEASTWARD.

CONDITIONS WILL GRADUALLY RETURN TO NORMAL ON MONDAY WHEN MOST OF THIS ACTIVITY HAS MOVED NORTHEAST OF OUR AREA.

COASTAL SEA CONDITIONS WILL DETERIORATE IN THE VICINITY OF HEAVIER SHOWERS AND THUNDERSTORM...ESPECIALLY OVER NORTHERN WATERS THIS AFTERNOON AND TONIGHT THEREFORE MARINERS SHOULD EXERCISE CAUTION.

SJUZFPPR
TTAAOO KSJ1 051955

PUERTO RICO/U.S. VIRGIN ISLANDS ZONE FORECASTS
NATIONAL WEATHER SERVICE SAN JUAN PR
400 PM AST SUN JAN 5 1992

PRZ001-002-060200-
NORTH SECTIONS OF PUERTO RICO-EAST SECTIONS OF PUERTO RICO-
400 PM AST SUN JAN 5 1992

.TONIGHT...CLOUDY WITH OCCASIONAL SHOWERS AND POSSIBLE THUNDERSTORMS... SOME LOCALLY HEAVY. LOW 70 TO 75. WIND SOUTHEAST 5 TO 10 MPH. CHANCE OF RAIN 80 PERCENT.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS AND POSSIBLE THUNDERSTORMS. HIGH NEAR 85. WIND NORTHEAST AROUND 10 MPH.
.MONDAY NIGHT...PARTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75.
.TUESDAY...PARTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85.

PRZ003-060200-
PONCE AND SOUTHERN SECTIONS OF PUERTO RICO-

.TONIGHT...CLOUDY WITH A 60 PERCENT CHANCE OF SHOWERS AND POSSIBLE THUNDERSTORMS. LOW 70 TO 75. WIND LIGHT SOUTHEAST.
.MONDAY...MOSTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS AND POSSIBLE THUNDERSTORMS. HIGH NEAR 85. WIND NORTHEAST 10 TO 15 MPH.
.MONDAY NIGHT...PARTLY CLOUDY WITH 20 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75.
.TUESDAY...PARTLY CLOUDY WITH A 20 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85.

PRZ004-005-060200-
MAYAGUEZ AND WEST SECTIONS OF PUERTO RICO-
INTERIOR SECTIONS OF PUERTO RICO-
400 PM AST SUN JAN 5 1992

.TONIGHT...CLOUDY WITH OCCASIONAL SHOWERS AND POSSIBLE THUNDERSTORMS...SOME LOCALLY HEAVY. LOW FROM 50 MOUNTAINS TO 70 COAST. WIND SOUTHEAST 5 TO 10 MPH.
.MONDAY...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS AND POSSIBLE THUNDERSTORMS. HIGH FROM 70 MOUNTAINS TO NEAR 85 COAST.
.MONDAY NIGHT...PARTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. LOW FROM 50 MOUNTAINS TO NEAR 70 COAST.
.TUESDAY...PARTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. HIGH FROM 70 INTERIOR TO NEAR 85 COAST.

PRZ006-007-060200-
ST THOMAS ST JOHN AND ADJACENT ISLANDS-SAINT CROIX
400 PM AST SUN JAN 5 1992

.TONIGHT...CLOUDY WITH A 60 PERCENT CHANCE OF SHOWERS AND POSSIBLE THUNDERSTORMS. LOW 70 TO 75. WIND SOUTHEAST TO 10 MPH.
.MONDAY...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85. WIND SOUTHEAST 10 TO 15 MPH.
.MONDAY NIGHT...PARTLY CLOUDY WITH A 30 PERCENT CHANCE OF SHOWERS. LOW 70 TO 75.
.TUESDAY...PARTLY SUNNY WITH A 20 PERCENT CHANCE OF SHOWERS. HIGH NEAR 85.

SJUSWSPR
TTAA00 KSJ1 051956

WEATHER SUMMARY FOR PUERTO RICO AND U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
400 PM AST SUN JAN 5 1992

THE COMBINATION OF AN APPROACHING COLD FRONT AND AN UPPER LEVEL LOW PRODUCED WIDESPREAD CLOUDINESS OVER THE NORTHEAST CARIBBEAN ALONG WITH NUMEROUS SHOWERS AND ISOLATED THUNDERSTORMS. ALTHOUGH THESE SHOWERS AND THUNDERSTORMS WERE MOVING RAPIDLY TOWARDS THE NORTHEAST...SOME AREAS REPORTED BRIEF BUT HEAVY RAIN AS THEY PASSED. ONE MUNICIPALITY IN BARRANQUITAS REPORTED A DOWNPOUR OF ONE-HALF INCH IN 10 MINUTES. CIVIL DEFENSE ALSO REPORTED THAT ONE RIVER ALONG ROAD 861 IN TOA ALTA WAS AT BANKFULL.

WIDESPREAD FLOODING IS NOT EXPECTED SINCE THESE SHOWERS ARE MOVING RAPIDLY AND THE ENTIRE AREA HAS BEEN RELATIVELY DRY LATELY.

SHOWERS AND THUNDERSTORMS WILL DIMINISH LATER TONIGHT AND ON MONDAY WITH A GRADUAL RETURN TO MORE NORMAL CONDITIONS MONDAY NIGHT AND TUESDAY AS THE FRONT PASSES THROUGH.

COASTAL CONDITIONS WILL DETERIORATE IN THE VICINITY OF HEAVIER SHOWERS AND THUNDERSTORMS TONIGHT AND MONDAY...ESPECIALLY ALONG THE NORTH COAST. MARINERS SHOULD AVOID THREATENING WEATHER.

SJUFFASJU
TTAAOO KSJU 052133
PRZ005-001-002-060200-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE SAN JUAN PR
530 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH EFFECTIVE UNTIL 1000 PM AST THIS SUNDAY EVENING FOR THE INTERIOR AND NORTHEAST SECTIONS OF PUERTO RICO.

AN UPPER LEVEL LOW PRESSURE SYSTEM ALONG WITH A SURFACE TROUGH WERE PRODUCING WIDESPREAD SHOWERS WITH EMBEDDED THUNDERSTORMS ACROSS MUCH OF PUERTO RICO THIS AFTERNOON. ALTHOUGH MUCH OF THE HEAVIER SHOWERS AND STRONGER THUNDERSTORMS HAVE MOVED OFF TO THE EAST DUE TO THE STRONG UPPER LEVEL WINDS...ADDITIONAL SHOWERS AND A FEW THUNDERSTORMS ARE EXPECTED TO FORM TONIGHT OVER PUERTO RICO. HEAVY RAINS OF 2 TO 4 INCHES HAVE ALREADY CAUSED RIVER BANKS TO OVERFLOW ALONG PORTIONS OF THE LOIZA, FLANBOYAN AND MAGNOLIA RIVERS.

CIVIL DEFENSE OFFICIALS ALSO REPORTED MUDSLIDES AND LANDSLIDES OCCURRING AS A RESULT OF THE LOCALLY HEAVY RAINS IN THE AREA.

MOTORISTS SHOULD BE ALERT FOR FLOODING AND SHOULD NOT ATTEMPT TO CROSS FAST FLOWING OR RISING WATERS. RISING WATERS CAN EASILY SWEEP MOTOR VEHICLES DOWNSTREAM. IN MOUNTAINOUS AREAS AND STEEP TERRAIN...MUD SLIDES WILL ALSO BE A THREAT. IF FLASH FLOODING IS ENCOUNTERED OR A WARNING IS ISSUED...SEEK HIGHER GROUND IMMEDIATELY.

STAY TUNED TO THE NOAA WEATHER RADIO OR YOUR LOCAL RADIO/TV STATIONS FOR FURTHER INFORMATION.

SJUFFWSJU
TTAAOO KSJU DDHHMM
PRC027-007-013-060045-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
642 PM AST SAT JAN 5 1991

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR HAS ISSUED A FLASH FLOOD WARNING EFFECTIVE UNTIL 845 PM AST FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN CENTRAL PUERTO RICO

...BARRANQUITAS MUNICIPALITY

IN EAST CENTRAL PUERTO RICO

...CAGUAS MUNICIPALITY

IN SOUTH CENTRAL PUERTO RICO

...AIBONITO...COAMO MUNICIPALITY

NUMEROUS SHOWERS AND THUNDERSTORMS CONTINUED TO DEVELOP ACROSS THE INTERIOR AND NORTHEAST SECTIONS OF PUERTO RICO THIS AFTERNOON AND EVENING. HEAVY RAINS OF 3 TO 4 INCHES HAVE CAUSED RIVERS TO OVERFLOW. HIGH WATERS HAVE BEEN REPORTED ESPECIALLY IN CAGUAS WHERE FLOODING OF ROADS AND SOME HOMES HAVE OCCURRED. ADDITIONAL SHOWERS AND THUNDERSTORMS ARE EXPECTED TO FORM THROUGHOUT THE NIGHT.

BE ESPECIALLY CAUTIOUS AT NIGHT WHEN IT IS HARDER TO RECOGNIZE THE DANGERS OF FLOODS AND FLASH FLOODS. IF FLASH FLOODING IS OBSERVED...ACT QUICKLY. MOVE UP TO ESCAPE FLOOD WATERS. DO NOT STAY IN AREAS SUBJECT TO FLOODING WHEN WATER BEGINS RISING.

SJUFFWSJU
TTAAOO KSJU 052250 COR
PRC027-007-013-060045-

BULLETIN - EBS ACTIVATION REQUESTED...CORRECTED FOR DATE
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
642 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR HAS ISSUED A FLASH FLOOD WARNING EFFECTIVE UNTIL 845 PM AST FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN CENTRAL PUERTO RICO

...BARRANQUITAS MUNICIPALITY

IN EAST CENTRAL PUERTO RICO

...CAGUAS MUNICIPALITY

IN SOUTH CENTRAL PUERTO RICO

...AIBONITO...COAMO MUNICIPALITY

NUMEROUS SHOWERS AND THUNDERSTORMS CONTINUED TO DEVELOP ACROSS THE INTERIOR AND NORTHEAST SECTIONS OF PUERTO RICO THIS AFTERNOON AND EVENING. HEAVY RAINS OF 3 TO 4 INCHES HAVE CAUSED RIVERS TO OVERFLOW. HIGH WATERS HAVE BEEN REPORTED ESPECIALLY IN CAGUAS WHERE FLOODING OF ROADS AND SOME HOMES HAVE OCCURRED. ADDITIONAL SHOWERS AND THUNDERSTORMS ARE EXPECTED TO FORM THROUGHOUT THE NIGHT.

BE ESPECIALLY CAUTIOUS AT NIGHT WHEN IT IS HARDER TO RECOGNIZE THE DANGERS OF FLOODS AND FLASH FLOODS. IF FLASH FLOODING IS OBSERVED...ACT QUICKLY. MOVE UP TO ESCAPE FLOOD WATERS. DO NOT STAY IN AREAS SUBJECT TO FLOODING WHEN WATER BEGINS RISING.

SJUFFWSJU
TTAA00 KSJU DDHHMM
VIC035-037-060100-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
656 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR
HAS ISSUED A FLASH FLOOD WARNING
EFFECTIVE UNTIL 900 PM AST
FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN VIRGIN ISLANDS

...ST JOHN COUNTY...ST THOMAS COUNTY

A LARGE AREA OF SHOWERS AND SCATTERED THUNDERSTORMS CONTINUED TO MOVE ACROSS THE ST. THOMAS AND ST. JOHN AREAS LATE THIS AFTERNOON AND EVENING. HEAVY RAINS FROM THESE SHOWERS AND THUNDERSTORMS HAVE ALREADY PRODUCED FLOODING IN THE AREA. FAA OFFICIALS REPORTED THAT THE ST. THOMAS AIRPORT HAS BEEN CLOSED AS A RESULT OF FLOODING. THESE HEAVY RAINS AND THUNDERSTORMS ARE EXPECTED TO CONTINUE THROUGH THE NIGHT SO ADDITIONAL FLOODING IS POSSIBLE.

BE ESPECIALLY CAUTIOUS AT NIGHT WHEN IT IS HARDER TO RECOGNIZE THE DANGERS OF FLOODS AND FLASH FLOODS. IF FLASH FLOODING IS OBSERVED...ACT QUICKLY. MOVE UP TO ESCAPE FLOOD WATERS. DO NOT STAY IN AREAS SUBJECT TO FLOODING WHEN WATER BEGINS RISING.

SJUFFWSJU
TTAA00 KSJU DDHHMM
PRC027-025-021-007-060115-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
707 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR
HAS ISSUED A FLASH FLOOD WARNING
EFFECTIVE UNTIL 915 PM AST
FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN CENTRAL PUERTO RICO

...CIDRA...COMERIO MUNICIPALITY

IN EAST PUERTO RICO

...LAS PIEDRAS MUNICIPALITY

IN EAST CENTRAL PUERTO RICO

...CAYEY MUNICIPALITY...GURABO...SAN LORENZO MUNICIPALITY

NUMEROUS SHOWERS AND THUNDERSTORMS CONTINUED TO MOVE ACROSS THE EASTERN HALF OF PUERTO RICO THIS AFTERNOON AND EVENING. HEAVY RAINS OF 3 TO 5 INCHES HAS ALREADY FALLEN IS PARTS OF THE WARNING AREA SO FAR WITH MORE RAIN EXPECTED TONIGHT.

CIVIL DEFENSE OFFICIALS HAVE REPORTED RIVERS OVERFLOWING AND LANDSLIDES RESULTING FROM THE HEAVY RAINS.

A FLASH FLOOD WARNING MEANS THAT FLOODING IS OCCURRING OR IS IMMINENT. MOST FLASH FLOOD DEATHS OCCUR IN AUTOMOBILES. DO NOT ATTEMPT TO CROSS BRIDGES...DIPS...OR LOW SPOTS IF WATER COVERS THE ROADWAY. NEVER TRY TO CROSS A FLOWING STREAM...EVEN A SMALL ONE...ON FOOT. TO ESCAPE RISING WATER MOVE UP TO HIGHER GROUND.

SJUFFWSJU
TTAA00 KSJU DDHHMM
PRC021-060130-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
733 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR
HAS ISSUED A FLASH FLOOD WARNING
EFFECTIVE UNTIL 930 PM AST
FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN SOUTH PUERTO RICO

...GUAYAMA...SALINAS MUNICIPALITY

NUMEROUS SHOWERS AND THUNDERSTORMS CONTINUED TO FORM ACROSS THE WARNING AREA SINCE LATE THIS AFTERNOON. HEAVY RAINS HAVE DUMPED OVER 4.30 INCHES OF RAIN THE GUAYAMA AREA IN THE PAST ONE HOUR. THIS LARGE AMOUNT OF RAINFALL IN SUCH A SHORT TIME PERIOD MAY LIKELY CAUSE RIVERS TO OVERFLOW AND POSSIBLY CAUSE LANDSLIDES ALONG STEEP TERRAIN.

DO NOT DRIVE YOUR VEHICLE INTO AREAS WHERE THE WATER COVERS THE ROADWAY. THE WATER DEPTH MAY BE TOO GREAT TO ALLOW YOUR CAR TO CROSS SAFELY. VEHICLES CAUGHT IN RISING WATER SHOULD BE ABANDONED QUICKLY. MOVE TO HIGHER GROUND.

SJUFFASJU
TTAA00 KSJU 060005
PRZ003-060600-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE SAN JUAN PR
803 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH EFFECTIVE UNTIL 200 AM AST THIS MONDAY MORNING FOR THE SOUTHERN SECTIONS OF PUERTO RICO.

AN UPPER LEVEL LOW PRESSURE SYSTEM MOVING ACROSS A SURFACE TROUGH WAS PRODUCING NUMEROUS SHOWERS AND SCATTERED THUNDERSTORMS ACROSS MUCH OF PUERTO RICO SINCE THIS AFTERNOON. HEAVY RAINS CONTINUED TO FALL MAINLY ACROSS THE EASTERN HALF OF PUERTO RICO PRODUCING 3 TO 5 INCHES OF RAIN LOCALLY OVER A SHORT PERIOD OF TIME THIS EVENING.

NUMEROUS REPORTS OF RIVERS OVERFLOWING AND FLOODING OF LOW-LYING AREAS HAVE BEEN RECEIVED BY THIS OFFICE. SOME LANDSLIDES AND FLOODING OF HOMES HAVE ALSO OCCURRED SINCE LATE THIS AFTERNOON AS A RESULT OF THE HEAVY RAINS. ADDITIONAL SHOWERS AND THUNDERSTORMS WILL LIKELY OCCUR THROUGH THE NIGHT.

A FLASH FLOOD WATCH MEANS THAT THE THREAT OF FLASH FLOODING EXISTS IN THE WATCH AREA. PEOPLE IN THE WATCH AREA REMAIN ALERT AND BE PREPARED TO TAKE QUICK ACTION IF FLOODING IS OBSERVED OR A WARNING IS ISSUED.

MOTORISTS SHOULD BE ALERT FOR FLOODING AND SHOULD NOT ATTEMPT TO CROSS FAST FLOWING OR RISING WATERS. RISING WATERS CAN EASILY SWEEP MOTOR VEHICLES DOWNSTREAM. IN MOUNTAINOUS AREAS AND STEEP TERRAIN...MUD SLIDES WILL ALSO BE A THREAT. IF FLASH FLOODING IS ENCOUNTERED OR A WARNING IS ISSUED...SEEK HIGHER GROUND IMMEDIATELY.

STAY TUNED TO THE NOAA WEATHER RADIO OR YOUR LOCAL RADIO/TV STATIONS FOR FURTHER INFORMATION.

SJUFFWSJU
TTAA00 KSJU DDHHMM
PRC005-011-005-027-027-060245-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
850 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR
HAS ISSUED A FLASH FLOOD WARNING
EFFECTIVE UNTIL 1045 PM AST
FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN EAST CENTRAL PUERTO RICO

...AGUAS BUENAS MUNICIPALITY

IN NORTH PUERTO RICO

...CANOVANAS...CAROLINA MUNICIPALITY...CATANO MUNICIPALITY
...DORADO...TOA BAJA MUNICIPALITY...TOA ALTA MUNICIPALITY

NUMEROUS SHOWERS AND SCATTERED THUNDERSTORMS CONTINUED TO PRODUCE HEAVY RAINS OVER MUCH OF PUERTO RICO THIS EVENING. MANY RIVERS WERE FLOWING OUT OF BANKS AND NUMEROUS INCIDENTS AS A RESULT OF FLOODING HAS BEEN REPORTED BY CIVIL DEFENSE OFFICIALS. MORE RAIN IS EXPECTED THROUGHOUT THE NIGHT AS SHOWERS AND SCATTERED THUNDERSTORMS CONTINUE TO DEVELOP ACROSS THE AREA.

DUE TO THE HEAVY RAINS...SEVERAL DAMS WERE OVERFLOWING AND FLOOD GATES HAVE BEEN OPENED TO RELEASE THE BACKLOG OF WATER. THEREFORE...IN ADDITION TO THE RAIN...WATER BEING RELEASED FROM DAMS WILL LIKELY CAUSE FLOODING OF LOW-LYING AND FLOOD PRONE AREAS.

BE ESPECIALLY CAUTIOUS AT NIGHT WHEN IT IS HARDER TO RECOGNIZE THE DANGERS OF FLOODS AND FLASH FLOODS. IF FLASH FLOODING IS OBSERVED...ACT QUICKLY. MOVE UP TO ESCAPE FLOOD WATERS. DO NOT STAY IN AREAS SUBJECT TO FLOODING WHEN WATER BEGINS RISING.

SJUFFWSJU
TTAA00 KSJU 060143
PRC027-027-025-025-005-007-021-007-005-011-005-027-021-013-021-060745-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WETHER SERVICE SAN JUAN PR
940 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR
HAS ISSUED A FLASH FLOOD WARNING
EFFECTIVE UNTIL 345 AM AST
FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN CENTRAL PUERTO RICO

...BARRANQUITAS MUNICIPALITY...CIDRA...COMERIO MUNICIPALITY

IN EAST PUERTO RICO

...HUMACAO...YABUCOA MUNICIPALITY...LAS PIEDRAS MUNICIPALITY

IN EAST CENTRAL PUERTO RICO

...AGUAS BWENAS MUNICIPALITY...CAGUAS MUNICIPALITY
...CAYEY MUNICIPALITY...GURABO...SAN LORENZO MUNICIPALITY

IN NORTH PUERTO RICO

...BAYAMON...GUAYNABO MUNICIPALITY
...CANOVANAS...CAROLINA MUNICIPALITY...CATANO MUNICIPALITY
...DORADO...TOA BAJA MUNICIPALITY

IN SOUTH PUERTO RICO

...GUAYAMA...SALINAS MUNICIPALITY

IN SOUTH CENTRAL PUERTO RICO

...AIBONITO...COAMO MUNICIPALITY

IN SOUTHEAST PUERTO RICO

...PATILLAS MUNICIPALITY

HEAVY RAINS HAVE CAUSED FLOODING OVER MUCH OF THE WARNING AREA AND MORE RAIN IS EXPECTED OVERNIGHT AS SHOWERS AND THUNDERSTORMS CONTINUE TO DEVELOP OVER PUERTO RICO.

BE ESPECIALLY CAUTIOUS AT NIGHT WHEN IT IS HARDER TO RECOGNIZE THE DANGERS OF FLOODS AND FLASH FLOODS. IF FLASH FLOODING IS OBSERVED...ACT QUICKLY. MOVE UP TO ESCAPE FLOOD WATERS. DO NOT STAY IN AREAS SUBJECT TO FLOODING WHEN WATER BEGINS RISING.

SJUFFWSJU
TTAA00 KSJU 060152
PRC027-011-039-039-031-060745

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
950 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PR
HAS ISSUED A FLASH FLOOD WARNING
EFFECTIVE UNTIL 345 AM AST
FOR PEOPLE IN THE FOLLOWING LOCATIONS...

IN NORTH PUERTO RICO

...TOA ALTA MUNICIPALITY...TRUJILLO ALTO MUNICIPALITY
...VEGA ALTA MUNICIPALITY...VEGA BAJA MUNICIPALITY

IN SOUTH CENTRAL PUERTO RICO

...VILLALBA MUNICIPALITY

SHOWERS AND THUNDERSTORMS HAVE PRODUCED HEAVY RAINS OVER THE WARNING AREA SINCE SUNDAY AFTERNOON AND CAUSED FLOODING PROBLEMS AS A RESULT. MANY RIVERS HAVE ALREADY OVERFLOWED AND FLOODING OF LOW-LYING AREAS HAS OCCURRED. WITH MORE SHOWERS AND THUNDERSTORMS EXPECTED TO FORM OVER THE ISLAND TONIGHT...ADDITIONAL FLOODING IS LIKELY.

BE ESPECIALLY CAUTIOUS AT NIGHT WHEN IT IS HARDER TO RECOGNIZE THE DANGERS OF FLOODS AND FLASH FLOODS. IF FLASH FLOODING IS OBSERVED...ACT QUICKLY. MOVE UP TO ESCAPE FLOOD WATERS. DO NOT STAY IN AREAS SUBJECT TO FLOODING WHEN WATER BEGINS RISING.

SJUFFASJU
TTAA00 KSJU 060206
PRZ001-003-005-006-061200-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE SAN JUAN PR
1000 PM AST SUN JAN 5 1992

THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH EFFECTIVE UNTIL 800 AM AST MONDAY MORNING FOR THE INTERIOR...NORTH...EAST AND SOUTH SECTIONS OF PUERTO RICO AS WELL AS ST. THOMAS AND ST. JOHN IN THE U.S. VIRGIN ISLANDS.

A STRONG UPPER LEVEL LOW PRESSURE SYSTEM MOVING OVER A SURFACE TROUGH IN THE NORTHEAST CARIBBEAN CONTINUED TO PRODUCE NUMEROUS SHOWERS AND SCATTERED THUNDERSTORMS OVER MUCH OF THE WATCH AREA SUNDAY AFTERNOON AND EVENING. LOCALLY HEAVY RAINS OF 3 TO 5 INCHES WERE COMMON OVER MUCH OF THE WATCH AREA. ADDITIONAL RAINS OVER ALREADY SATURATED GROUND WILL LIKELY LEAD TO MORE FLOODING TONIGHT. PARTS OF EASTERN PUERTO RICO RECEIVED ABOUT 6.50 INCHES OF RAIN SINCE THIS AFTERNOON. CIDRA ALSO GOT ABOUT 6 INCHES OF RAIN TODAY.

A FLASH FLOOD WATCH MEANS THAT THE THREAT OF FLASH FLOODING EXISTS IN THE INDICATED AREA. PEOPLE IN THE WATCH AREA SHOULD REMAIN ALERT AND BE PREPARED TO TAKE QUICK ACTION IF FLOODING IS OBSERVED OR A WARNING IS ISSUED.

MOTORISTS SHOULD BE ALERT FOR FLOODING AND SHOULD NOT ATTEMPT TO CROSS FAST FLOWING OR RISING WATERS. RISING WATERS CAN EASILY SWEEP MOTOR VEHICLES DOWNSTREAM. IN MOUNTAINOUS AREAS AND STEEP TERRAIN...MUD AND LAND SLIDES WILL ALSO BE THREAT.

STAY TUNED TO THE NOAA WEATHER RADIO OR YOUR LOCAL RADIO/TV STATIONS FOR FURTHER INFORMATION.

SJUFFWSJU
TTAA00 KSJU 060523
PRC005-007-011-013-017-021-023-025--027-031-061100-

BULLETIN - EBS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
100 AM AST MON JAN 6 1992

THE NATIONAL WEATHER SERVICE IN SAN JUAN PUERTO RICO HAS EXTENDED AND EXPANDED THE FLASH FLOOD WARNING EFFECTIVE UNTIL 700 AM FOR PEOPLE IN THE FLOWING MUNICIPALITIES...

THE WARNING AREA HAS BEEN EXPANDED TO COVER ALL THE MUNICIPALITIES EAST OF A LINE FROM ARECIBO TO PENUELAS EXTENDING EASTWARD ACROSS THE REMAINDER OF PUERTO RICO.

MODERATE TO HEAVY RAINS CONTINUE ACROSS MOST SECTIONS OF PUERTO RICO. DURING THE LAST HALF HOUR SCATTERED THUNDERSTORMS HAVE BEGUN TO PRODUCE HEAVY RAINFALL OVER THE INTERIOR SECTIONS AND THIS RAIN IS EXPECTED TO SPREAD NORTHEASTWARD ACROSS THE REST OF THE NORTH AND CENTRAL INTERIOR SECTIONS DURING THE NEXT TWO HOURS. RAINFALL AMOUNTS ACCUMULATED DURING THE PAST 24 HOURS INDICATE THAT BETWEEN SEVEN AND NINE INCHES OF RAIN HAVE FALLEN IN SOME MUNICIPALITIES LIKE SAN LORENZO...GUAYAMA...CIDRA... BARRANQUITAS...VILLALBA...PONCE...PENUELAS...AIBONITO...JAYUYA AND UTUADO.

GROUND CONDITIONS ARE TOTALLY SATURATED AND THIS ADDITIONAL RAINFALL WILL CAUSE FLASH FLOODING...LANDSLIDES AND POSSIBLE MUDSLIDES. RIVER LEVELS MUST BE NEAR BANKFUL AT SEVERAL LOCATIONS MAINLY ALONG THE INTERIOR SECTIONS.

A FLASH FLOOD WARNING MEANS THAT FLOODING IS IMMINENT OR THAT IT HAS BEEN REPORTED. BE PREPARED TO EVACUATE AND TAKE NECESSARY PRECAUTIONS AS REQUIRED. MOTORISTS AND PEDESTRIANS ARE URGED NOT TO ATTEMPT TO CROSS FLOODED AREAS. PERSONS IN LOW LYING AREAS SHOULD SEEK HIGHER GROUND AND FOLLOW INSTRUCTIONS FROM THE CIVIL DEFENSE OR LAW OFFICIALS.

ADDITIONAL BULLETINS WILL BE ISSUED BY THIS OFFICE AROUND 4 AM OR SOONER IF CONDITIONS WARRANT. KEEP TUNED TO NOAA WEATHER RADIO OR ANY OTHER NEWS MEDIA FOR FURTHER INFORMATION.

SJUFFASJU
TTAA00 KSJU 060608
PRZ002-004-005-006-007-061200-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE SAN JUAN PR
200 AM AST MON JAN 6 1992

THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH EFFECTIVE UNTIL 800 AM AST MONDAY MORNING FOR THE INTERIOR AND WEST SECTIONS OF PUERTO RICO WEST OF A LINE FROM ARECIBO TO PENUELAS. THE FLASH FLOOD WATCH IS ALSO BEING EXTENDED TO COVER THE MUNICIPALITIES OF VIEQUES AND CULELBRA AND THE ISLAND OF ST CROIX. THE FLASH FLOOD WATCH CONTINUES IN EFFECT FOR ST THOMAS AND ST JOHN.

MODERATE TO HEAVY RAINS CONTINUE ACROSS MOST SECTIONS OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS. SCATTERED THUNDERSTORMS HAVE DEVELOPED DURING THE PAST HOUR OVER THE WEST SOUTHWEST SECTIONS OF PUERTO RICO. THIS ACTIVITY WAS MOVING TOWARD THE NORTHEAST AT 15 MPH. ALTHOUGH THE WEST SECTIONS OF PUERTO RICO DID NOT RECEIVE EXTENSIVE RAIN ON SUNDAY...THE INCREASE IN SHOWERS AND THUNDERSTORMS NOTED DURING THE PAST HOUR COULD PRODUCE FLASH FLOODING...LANDSLIDES AND POSSIBLE MUDSLIDES. ELSEWHERE...THE REST OF THE AREA REMAINS UNDER AN EXTENSIVE AREA OF CONTINUOUS RAINS.

A FLASH FLOOD WATCH MEANS THAT THE THREAT OF FLASH FLOODING EXISTS IN THE INDICATED AREA. PEOPLE IN THE WATCH AREA SHOULD REMAIN ALERT AND BE PREPARED TO TAKE QUICK ACTION IF FLOODING IS OBSERVED OR A WARNING IS ISSUED.

MOTORISTS SHOULD BE ALERT FOR FLOODING AND SHOULD NOT ATTEMPT TO CROSS FAST FLOWING OR RISING WATERS. RISING WATERS CAN EASILY SWEEP MOTOR VEHICLES DOWNSTREAM. IN MOUNTAINOUS AREAS AND STEEP TERRAIN...MUD AND LANDSLIDES WILL ALSO BE A THREAT.

STAY TUNED TO THE NOAA WEATHER RADIO OR YOUR LOCAL RADIO/TV STATIONS FOR FURTHER INFORMATION.

SJUFFSSJU
TTAA00 SKJU 060818
PRZALL-061000-

FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PUERTO RICO
415 AM AST MON JAN 6 1992

...A FLASH FLOOD WARNING REMAINS IN EFFECT UNTIL 7 AM FOR ALL THE MUNICIPALITIES EAST OF A LINE FROM ARECIBO TO PENUELAS.
...A FLASH FLOOD WATCH REMAINS IN EFFECT UNTIL 8 AM FOR ALL THE MUNICIPALITIES WEST OF A LINE FROM ARECIBO TO PENUELAS.
...A FLASH FLOOD WATCH REMAINS IN EFFECT UNTIL 8 AM FOR THE MUNICIPALITIES OF VIEQUES...CULEBRA AND ST THOMAS ST JOHN AND ST CROIX IN THE U.S. VIRGIN ISLANDS.

AN EXTENSIVE AREA OF LIGHT RAIN CONTINUES TO COVER MOST OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS. THERE ARE SOME SECTORS ALONG THE SOUTH WEST...EASTERN INTERIOR AND THE SOUTHEAST SECTIONS OF PUERTO RICO WHERE RAINS OF MODERATE INTENSITY ARE OCCURRING AND A FEW MINOR AREAS WHERE ISOLATED BUT LOCALLY HEAVY RAINS ARE STILL TAKING PLACE. MOST OF THE ACTIVITY IS MOVING TOWARD THE NORTHEAST AROUND 15 MPH HOWEVER...ADDITIONAL RAINS KEEP MOVING FROM THE MONA PASSAGE INTO PUERTO RICO.

RAINFALL AMOUNTS DURING THE LAST 24 HOURS ENDING AT 4 AM INDICATED THAT OVER TEN INCHES OF RAIN FELL ALONG THE SOUTHERN SLOPES IN THE MUNICIPALITY OF PENUELAS...VILLALBA AND PONCE AND ALONG THE CENTRAL INTERIOR IN THE MUNICIPALITY OF OROCOVIS.

GROUND CONDITIONS ARE TOTALLY SATURATED. ALTHOUGH THE THREAT OF HEAVY PRECIPITATION HAS DECREASED...THE PERSISTENT AND CONTINUOUS RAINS WILL KEEP A HIGH POTENTIAL FOR FLASH FLOODING ACROSS THE ENTIRE REGION THROUGH MONDAY MORNING. RIVER LEVELS ALONG THE COASTAL SECTIONS WILL REMAIN NEAR BANKFUL DUE TO THE CONSIDERABLE RUNOFF COMING FORM THE MOUNTAINS.

COMMONWEALTH CIVIL DEFENSE HAS REPORTED NEIGHBORHOODS THAT HAVE BECOME INCOMMUNICATED DUE TO FLOODING AND LANDSLIDES. SEVERAL MAIN ROADS ARE IMPASSABLE AND FLOOD WATERS HAVE AFFECTED PROPERTIES IN MANY SECTORS.

ALL RESIDENTS OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS SHOULD BE AWARE OF THE POTENTIAL FOR FLOODING DURING THE REMAINDER OF THIS MORNING. ADDITIONAL BULLETINS WILL BE ISSUED BY THIS OFFICE AS CONDITIONS WARRANT.

SJUFLWSJU
TTAA00 KSJU 061005
PRC003-039-061500-

BULLETIN-EBS ACTIVATION REQUESTED
FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
600 AM AST MON JAN 6 1992

THE NATIONAL WEATHER SERVICE HAS ISSUED A FLOOD WARNING FOR THE MUNICIPALITIES OF BARCELONETA IN NORTHERN PUERTO RICO UNTIL 1100 AM THIS MORNING.

THIS WARNING APPLIES MAINLY TO THE RIO GRANDE DE MANATI RIVER BASIN.

HEAVY RAINFALL WAS REPORTED OVER THE CENTRAL INTERIOR SECTIONS OF PUERTO RICO DURING LAST NIGHT. OVER TEN INCHES OF RAIN WERE RECORDED IN THE MOUNTAINS UNTIL 6 AM THIS MORNING...AND ADDITIONAL LIGHT RAIN CONTINUES TO FALL IN THE AREA WHICH FEEDS THE MAJOR TRIBUTARIES OF THE RIO GRANDE DE MANATI RIVER.

EXTENSIVE FLOODING IS OCCURRING IN BACELONETA WHERE THE COMMONWEALTH CIVIL DEFENSE HAS REPORTED THAT THE EVACUATION OF TOWN RESIDENTS IN PROGRESS. THE RIVER RIO GRANDE DE MANATI HAS OVERFLOWED ITS BANKS AND WITH ADDITIONAL RUNOFF FEEDING NORTHWARD FROM THE UPPER WATERSHEDS THE FLOODING ALONG THIS COASTAL TOWN WILL CONTINUE AND MAY DETERIORATE EVEN MORE.

A FLOOD STATEMENT WILL BE ISSUED AROUND 930 AM THIS MORNING.

SJUFFASJU
TTAA00 KSJU 061102
PRZALL-061600-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE SAN JUAN PR
700 AM AST MON JAN 6 1992

THE NATIONAL WEATHER SERVICE HAS EXTENDED THE FLASH FLOOD WATCH FOR ALL OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS UNTIL 12 NOON TODAY.

LIGHT TO MODERATE RAINS CONTINUE ACROSS PUERTO RICO AND THE U.S. VIRGIN ISLANDS. ALTHOUGH THE RAINS HAVE SHOWN A PERSISTENT MOTION TOWARD THE NORTHEAST DURING THE NIGHT...ADDITIONAL RAINS KEEP REDEVELOPING OVER THE MONA PASSAGE AND WILL CONTINUE TO SPREAD EASTWARD OVER PUERTO RICO AND THE U.S. VIRGIN ISLANDS DURING THIS MORNING AND POSSIBLY THIS AFTERNOON. ISOLATED THUNDERSTORMS MOSTLY IN LINES ARE ALSO MOVING CLOSER TO THE SOUTH COAST OF PUERTO RICO AND WILL LIKELY MOVE INLAND ALONG THE SOUTH...SOUTHEAST AND EASTERN SECTIONS DURING THE NEXT HOUR OR SO AND REACHING THE ST THOMAS AND ST JOHN AREA DURING THE NEXT TWO HOURS.

A FLASH FLOOD WATCH MEANS THAT THE THREAT OF FLASH FLOODING EXISTS IN THE INDICATED AREA. PEOPLE IN THE WATCH AREA SHOULD REMAIN ALERT AND BE PREPARED TO TAKE QUICK ACTION IF FLOODING IS OBSERVED OR A WARNING IS ISSUED.

MOTORISTS SHOULD BE ALERT FOR FLOODING AND SHOULD NOT ATTEMPT TO CROSS FAST FLOWING OR RISING WATERS. RISING WATERS CAN EASILY SWEEP MOTOR VEHICLES DOWNSTREAM. IN MOUNTAINOUS AREAS AND STEEP TERRAIN...MUD AND LANDSLIDES WILL ALSO BE A THREAT.

STAY TUNED TO THE NOAA WEATHER RADIO OR YOUR LOCAL RADIO/TV STATIONS FOR FURTHER INFORMATION.

SJUFLWSJU
TTAA00 KSJU 061125
PRC003-005-021-025-039-061600-

BULLETIN-EBS ACTIVATION REQUESTED
FLOOD WARNING
NATIONAL WEATHER SERVICE SAN JUAN PR
720 AM AST MON JAN 6 1992

THE NATIONAL WEATHER SERVICE HAS UPDATED AND EXPANDED THE FLASH FLOOD WARNING ISSUED EARLIER THIS MORNING TO COVER THE NORTHERN COASTAL SECTIONS OF PUERTO RICO BETWEEN ARECIBO AND TOA BAJA AND ALSO ALONG THE SOUTH...SOUTHEAST AND EAST COASTAL SECTIONS FROM PONCE TO CEIBA. THIS WARNING ALSO COVERS THE MAIN RIVER BASIN ALONG NORTHERN PUERTO RICO...RIO GRANDE DE MANTI...RIO CIBUCO-RIO INDIO...RIO DE LA PLATA. THE SOUTH AND SOUTHEASTERN RIVER BASINS...HUMACAO RIVER BASIN...MAUNABO RIVER BASIN...GUAYAMA RIVER...RIO CANAS...RIO JACAGUAS...RIO COAMO...RIO JUEYES...RIO SALINAS.

THE EXTENSIVE AND WIDESPREAD RAINS THAT OCCURRED OVER PUERTO RICO DURING LAST NIGHT PRODUCED LARGE AMOUNTS OF RAIN IN THE UPPER WATERSHEDS. ALTHOUGH AT THIS TIME MOSTLY LIGHT RAIN COVERS THE CENTRAL AND EASTERN HALF OF THE ISLAND...A CONSIDERABLE AMOUNT OF RUNOFF IS FEEDING DOWN THE RIVERS TO THE COASTAL SECTIONS. A LINE OF ISOLATED THUNDERSTORMS IS ALSO MOVING VERY CLOSE TO THE SOUTH COAST OF PUERTO RICO AND WILL MOVE INLAND DURING THE NEXT HOUR...PRODUCING LOCALLY HEAVY RAINS ALONG THE SOUTH...SOUTHEAST AND EAST RIVER BASINS...DETERIORATING EVEN MORE THE FLOOD SITUATION ALONG THESE SECTORS.

LISTEN TO NOAA WEATHER RADIO FOR ADDITIONAL INFORMATION AND BE PREPARED TO EVACUATE LOW LYING AREAS.

SJUFFSSJU
TTAA00 KSJU 061151
PRZALL-061400-

FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PUERTO RICO
750 AM AST MON JAN 6 1991

...A FLOOD WARNING IS IN EFFECT UNTIL 12 NOON TODAY FOR THE NORTH SECTIONS OF PUERTO RICO FROM ARECIBO EASTWARD TO TOA BAJA...
...A FLOOD WARNING IS IN EFFECT UNTIL 12 NOON TODAY FOR THE SOUTH...SOUTHEAST AND EAST COASTAL SECTIONS FROM PONCE EASTWARD TO CEIBA...
...A FLASH FLOOD WATCH CONTINUES IN EFFECT FOR ALL OF PUERTO RICO...INCLUDING VIEQUES AND CULEBRA AND THE U.S. VIRGIN ISLANDS UNTIL 12 NOON TODAY.
...A FLASH FLOOD WARNING FOR ALL THE MUNICIPALITIES EASTWARD OF A LINE FROM ARECIBO TO PENUELAS HAS BEEN DISCONTINUED.

THE EXCESSIVE RAINS THAT OCCURRED OVER PUERTO RICO DURING LAST NIGHT HAVE CAUSED MANY RIVERS ALONG NORTH...SOUTH AND EAST COASTAL SECTIONS TO GO OUT OF THEIR BANKS. THIS PROMPTED THE ISSUANCE OF A FLOOD WARNING FOR THE COASTAL SECTIONS EARLIER THIS MORNING.

ELSEWHERE OVER PUERTO RICO THE RADAR INDICATES THAT THE RAINS HAVE DIMINISHED ALONG THE NORTHWEST AND ALONG THE NORTH COAST WEST OF MANATI. MOST OF THE LIGHT TO MODERATE RAINS ARE NOW CONCENTRATED ALONG THE SOUTH TO THE NORTH AND EAST OF YAUCO EXTENDING EASTWARD TO CEIBA.

THE RAINS ACROSS THE U.S. VIRGIN ISLANDS HAVE ALSO DECREASED DURING THE LAST HALF HOUR AS THE ACTIVITY IS MOVING NORTHEAST.

HOWEVER...ALL THE RESIDENTS OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS SHOULD REMAIN ALERT TO THE POTENTIAL FOR ADDITIONAL FLOODING DURING THE REMAINDER OF TODAY. ADDITIONAL BULLETINS AND STATEMENTS WILL BE ISSUED BY THIS OFFICE AS CONDITIONS WARRANT.

SJUFFASJU
TTAA00 KSJ1 061614
PRZALL-062200-

BULLETIN - IMMEDIATE BROADCAST REQUESTED
FLASH FLOOD WATCH
NATIONAL WEATHER SERVICE SAN JUAN PR
1200 PM AST MON JAN 6 1992

THE NATIONAL WEATHER SERVICE HAS EXTENDED THE FLASH FLOOD WATCH FOR ALL OF PUERTO RICO UNTIL 600 PM THIS EVENING.

RAINS HAD ENDED OVER PURTO RICO DURING THE MORNING BUT THE RISK OF ISOLATED FLOODING REMAINS. NO WIDESPREAD HEAVY RAINS ARE EXPECTED TO OCCUR THIS AFTERNOON. ANY HEAVY RAINS WILL BE FROM ISOLATED THUNDER STORMS AND PROBABLY NOT EXCEED A FEW INCHES.

BUT MANY RIVERS ARE NEAR FLOOD LEVELS AND ALL OF PUERTO RICO HAS VERY WET GROUND. SO WITH THIS SITUATION ONLY A FEW INCHES OF RAIN IN ONE SPOT COULD CAUSE FURTHER FLOODING.

A FLASH FLOOD WATCH MEANS THAT THE THREAT OF FLASH FLOODING EXISTS. PEOPLE IN PURTO RIC0 SHOULD REMAIN ALERT AND BE PREPARED TO TAKE QUICK ACTION IF FLOODING IS OBSERVED OR A WARNING IS ISSUED.

MOTORISTS AND PEDESTRIANS SHOULD NOT ATTEMPT TO CROSS FLOODED ROADS OR PATHS. SEVERAL PEOPLE DIE EACH YEAR IN PUERTO RICO CROSSING FLOODED STREAMS AND ROADS.

SJUFFSSJU
TTAA00 KSJU DDHHMM
PRZALL-062200-

FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PR
1215 PM AST MON JAN 6 1992

...FLASH FLOOD WATCH CONTINUES FOR ALL OF PUERTO RICO UNTIL 600 PM THIS EVENING...

...FLASH FLOOD WARNINGS FOR PUERTO RICO HAVE EXPIRED...
...FLASH FLOOD WATCH FOR THE U.S. VIRGIN ISLANDS HAS EXPIRED...

THE FLASH FLOOD WATCH FOR PUERTO RICO CONTINUES BECAUSE THE GROUND IS VERY WET AND MANY RIVERS ARE NEAR FLOODING. WIDESPREAD RAINS ARE NOT EXPECTED DURING THE AFTERNOON BUT EVEN AN ISOLATED THUNDERSTORM COULD CAUSE FLOODING.

THE FLASH FLOOD WARNING FOR PUERTO RICO WERE ALLOWED TO EXPIRE AT NOON. REPORTS FROM CIVIL DEFENCE INDICATE THAT THE RIVERS HAVE RETREATED. THE ONLY FLOODED AREA REMAINING IS ROUTE 2 NEAR BARCELONETA.

THE FLASH FLOOD WATCH FOR THE U.S. VIRGIN ISLANDS HAS EXPIRED. RAINS ENDED THERE EARLY IN THE MORNING AND NO FURTHER HEAVY RAINS ARE EXPECTED.

REMEMBER A FLASH FLOOD WATCH MEANS FLASH FLOODING IS POSSIBLE. PEOPLE IN THE WATCH AREA SHOULD BE ALERT TO THE POSSIBILITY OF ENCOUNTERING FLOODED AREAS WHILE DRIVING OR WALKING. AND STREAMS AND RIVERS MAY RISE RAPIDLY EVEN THOUGH IT IS NOT RAINING IN YOUR AREA.

SJUFFSSJU
TTAA00 KSJU DDHHMM
PRZALL-062100-

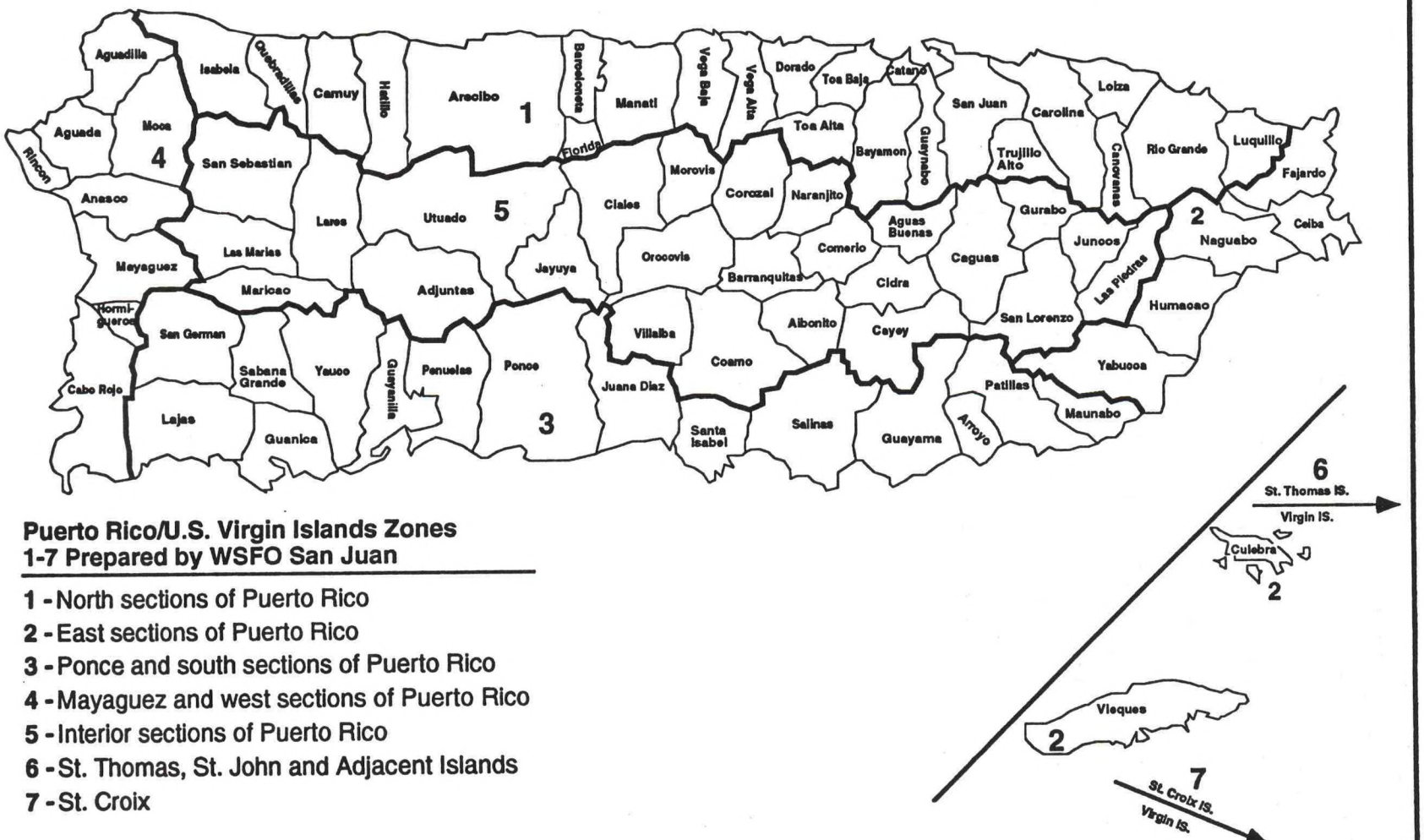
FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PR
351 PM AST MON JAN 6 1992

...FLASH FLOOD WATCH FOR PUERTO RICO HAS BEEN CANCELLED...

THE GROUND IS VERY WET AND MANY OF THE RIVERS REMAIN AT BANKFULL BUT NO SIGNIFICANT RAINS DEVELOPED OVER PUERTO RICO SINCE EARLY THIS MORNING. THE BEST CHANCE FOR FURTHER RAIN WAS DURING THE AFTERNOON WHEN AN ISOLATED THUNDERSTORM COULD HAVE DEVELOPED BUT NONE DID.

ONLY A FEW LIGHT SHOWERS DEVELOPED IN EASTERN PUERTO RICO. NO WIDESPREAD OR HEAVY RAINS ARE EXPECTED TONIGHT. THIS WILL ALLOW THE GROUND TO DRAIN AND THE RIVERS TO RECEDE. NO FURTHER THREAT OF FLOODING IS EXPECTED.

Puerto Rico / U.S. Virgin Islands
Zone Forecast Boundaries



Puerto Rico/U.S. Virgin Islands Zones
1-7 Prepared by WSFO San Juan

1 - North sections of Puerto Rico
2 - East sections of Puerto Rico
3 - Ponce and south sections of Puerto Rico
4 - Mayaguez and west sections of Puerto Rico
5 - Interior sections of Puerto Rico
6 - St. Thomas, St. John and Adjacent Islands
7 - St. Croix

APPENDIX C

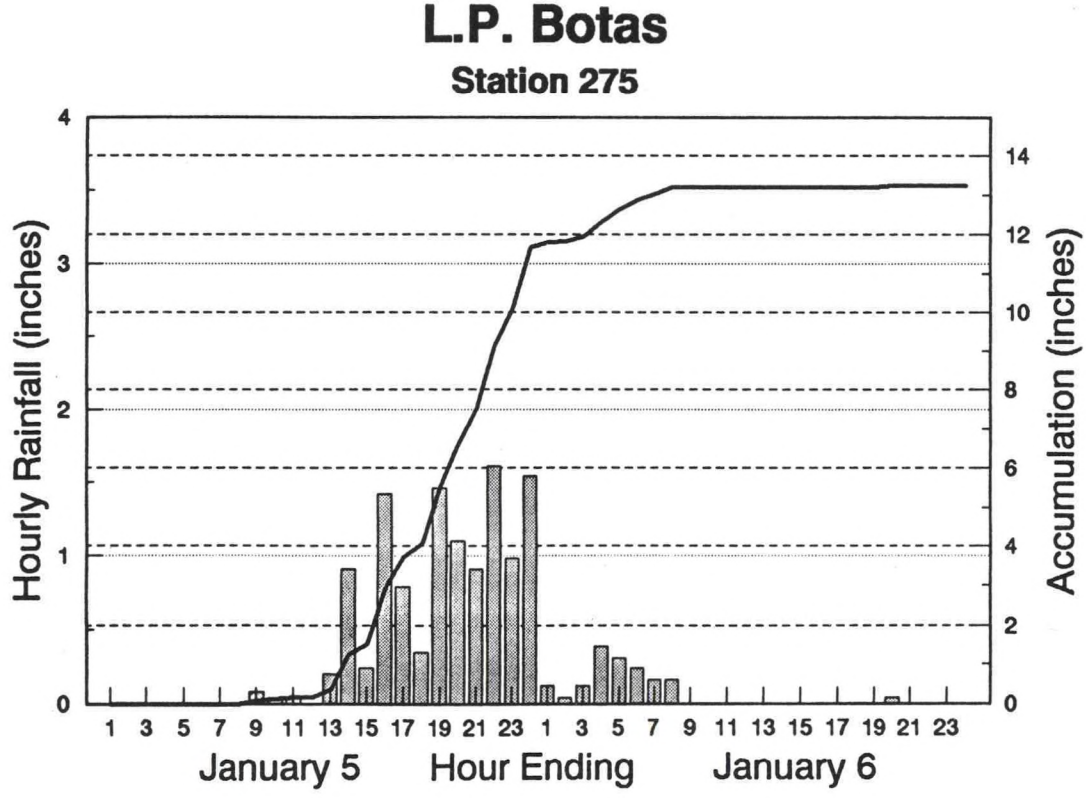
SUMMARY OF WATCHES AND WARNINGS ISSUED BY WSFO SAN JUAN, PUERTO RICO

Date	Time	Bulletin	Valid til	Region
January 5	5:33 p.m.	Watch	10:00 p.m.	North, East and Interior
January 5	6:45 p.m.	Warning	8:45 p.m.	Barranquitas, Coamo, Aibonito, Caguas
January 5	6:50 p.m.	Warning (correction)		Same as above
January 5	6:56 p.m.	Warning	9:00 p.m.	St. Thomas, St. John
January 5	7:07 p.m.	Warning	9:15 p.m.	Cidra, Comerio, Las Piedras, Cayey, Gurabo, San Lorenzo
January 5	7:33 p.m.	Warning	9:30 p.m.	Guayama, Salinas
January 5	8:05 p.m.	Watch	2:00 a.m.	South
January 5	8:50 p.m.	Warning	10:45 a.m.	Aguas Buenas, Canovanas, Carolina, Catano, Dorado, Toa Baja, Toa Alta
January 5	9:43 p.m.	Warning	3:45 a.m.	Guayama, Salinas, Albonito, Coamo, Patillas, Comerio, Barranquitas, Cidra, Humacao, Yabucoa, Las Pidras, Aguas Buenas, Caguas, Cayey, Gurabo, San Lorenzo, Bayamon, Guaynabo, Canovanas, Carolina, Catano, Dorado, Toa Baja
January 5	9:52 p.m.	Warning	3:45 a.m.	Toa Alta, Villalba, Trujillo Alto, Vega Alta, Vega Baja
January 5	10:06 p.m.	Watch	8:00 a.m.	North, East, Interior, St. Thomas, St. John

Date	Time	Bulletin	Valid til	Region
January 6	1:23 a.m.	Warning	7:00 a.m.	East of Arecibo-Penuelas
January 6	2:08 a.m.	Watch	8:00 a.m.	Interior, West, Vieques, Culebra, St. Croix
January 6	4:18 a.m.	Statement		
January 6	6:05 a.m.	Warning		Barceloneta
January 6	7:02 a.m.	Watch		Puerto Rico U.S. Virgin Islands
January 6	7:25 a.m.	Warning	12:00 p.m.	Arecibo to Toa Baja, Ponce to Cieba
January 6	7:51 a.m.	Statement		
January 6	12:14 p.m.	Watch	6:00 p.m.	Puerto Rico
January 6	12:15 p.m.	Statement		Warning for Puerto Rico cancelled Watch for U.S. Virgin Islands cancelled
January 6	3:51 p.m.	Statement		Watch for Puerto Rico cancelled

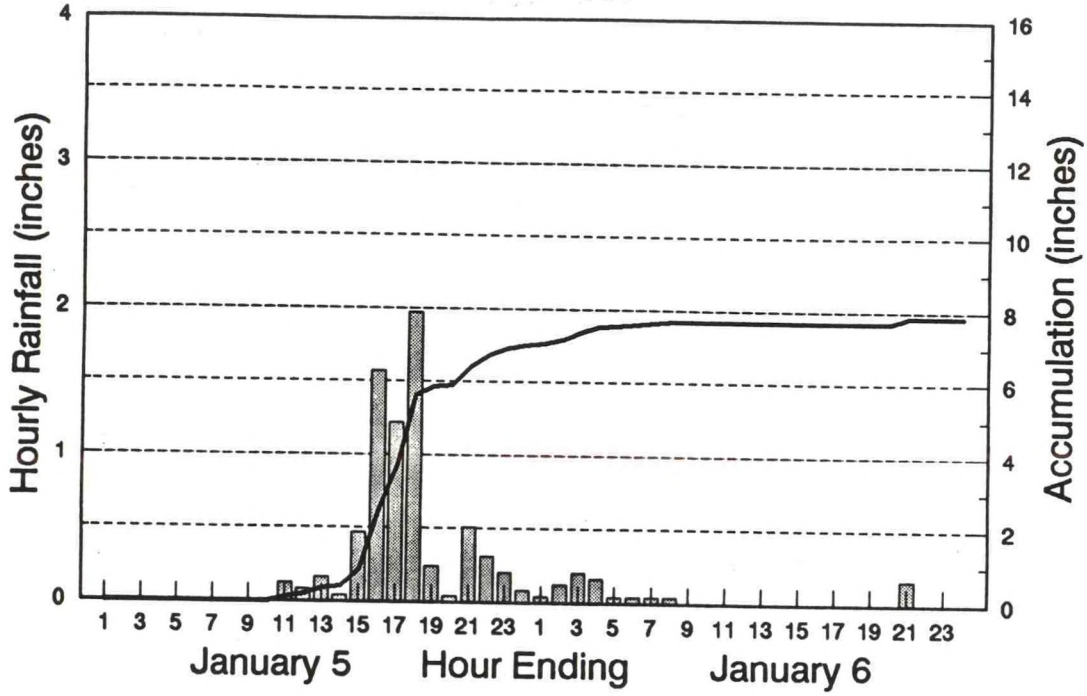
APPENDIX D

DATA COLLECTED BY THE ALERT SYSTEM



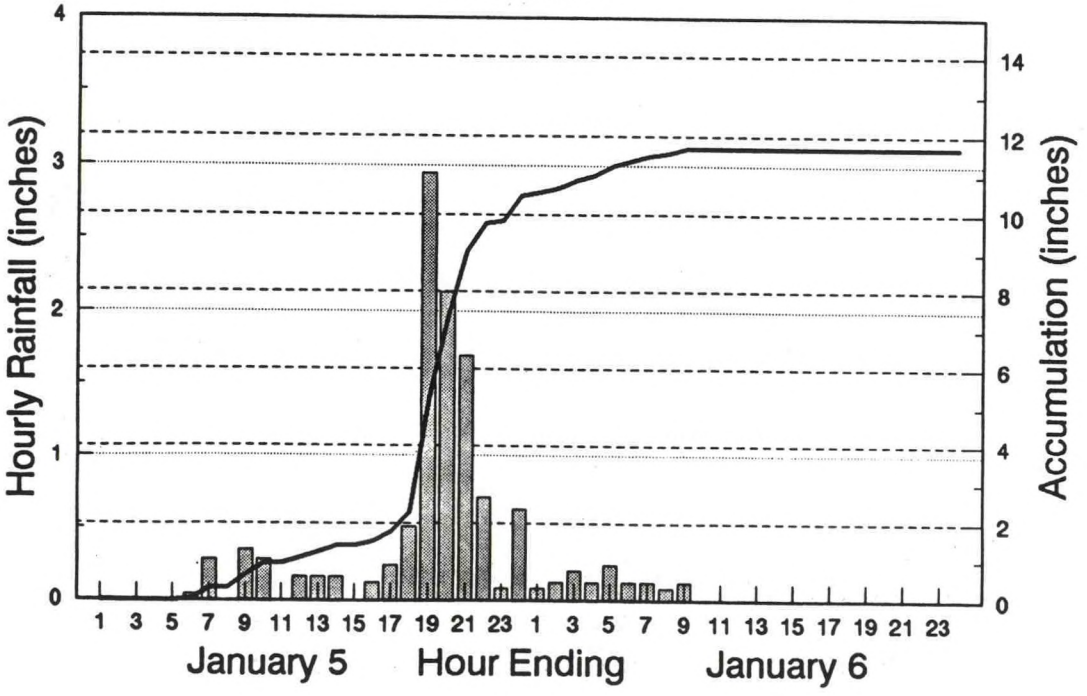
Rio Cibuco

Station 397



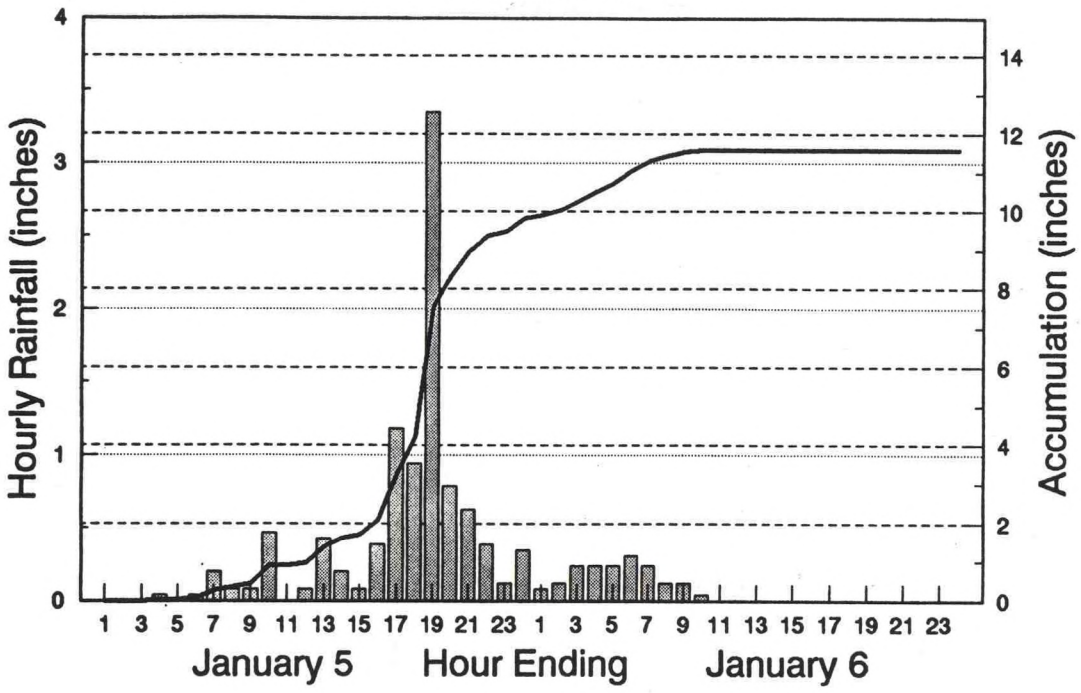
S Lorenzo

Station 502



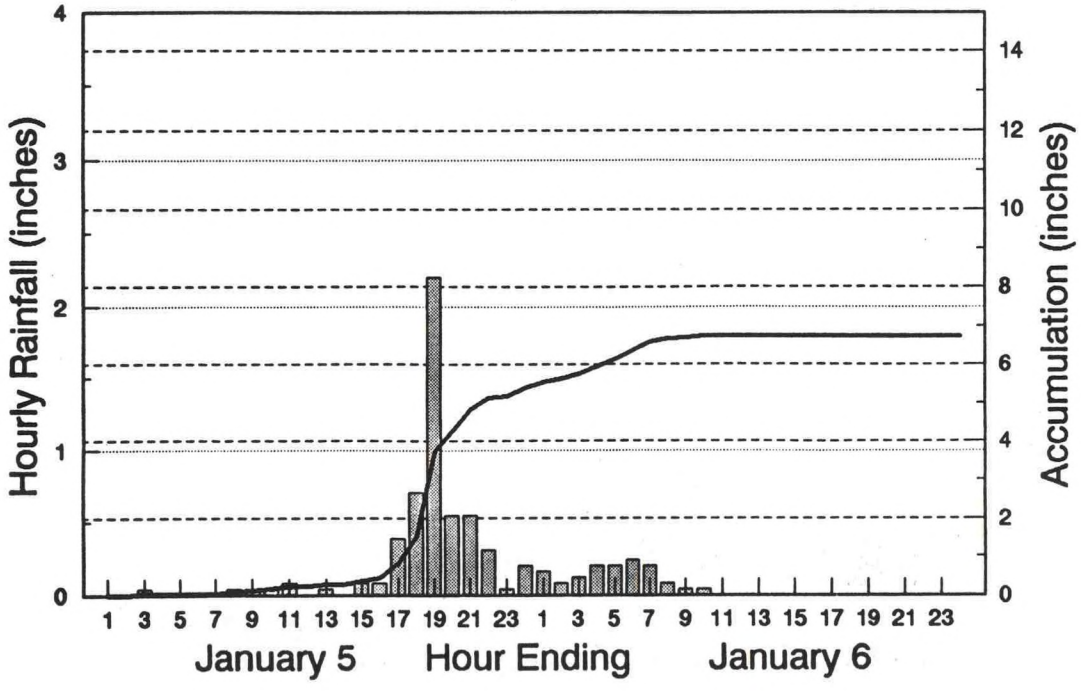
Trbo Caguas

Station 503



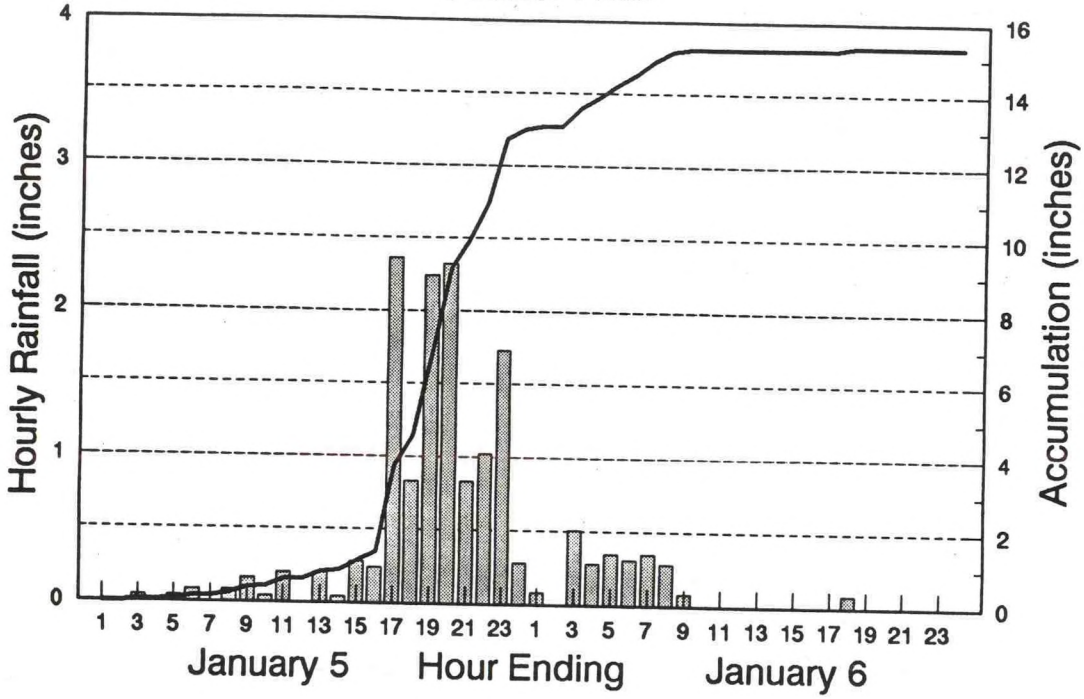
Valenciano

Station 506



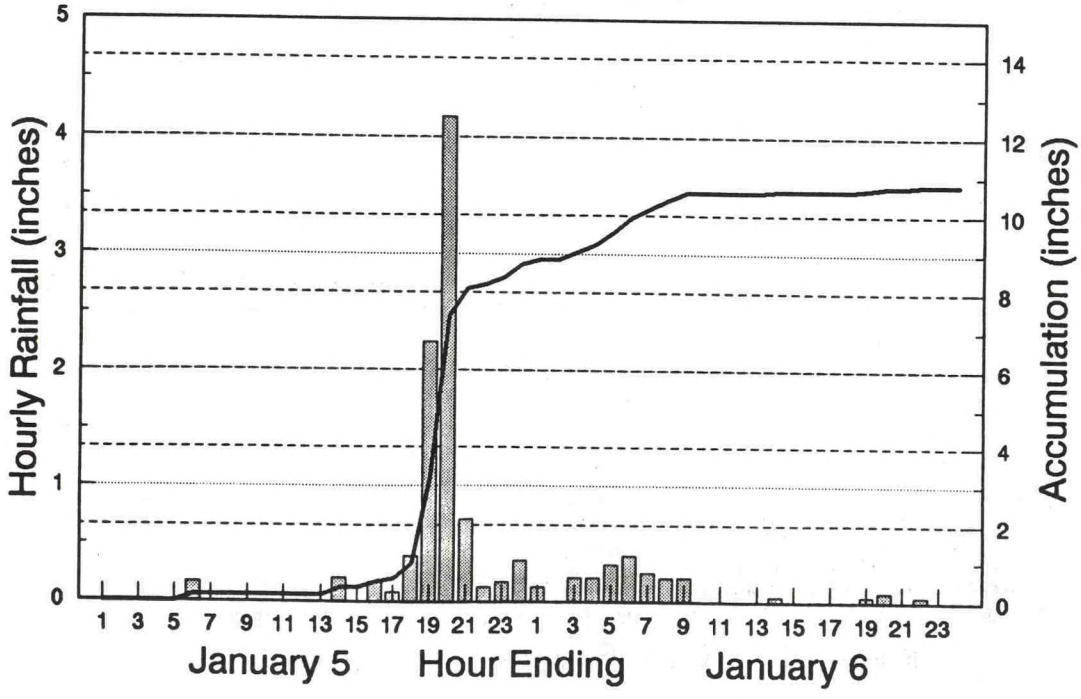
Cuyon

Station 1133



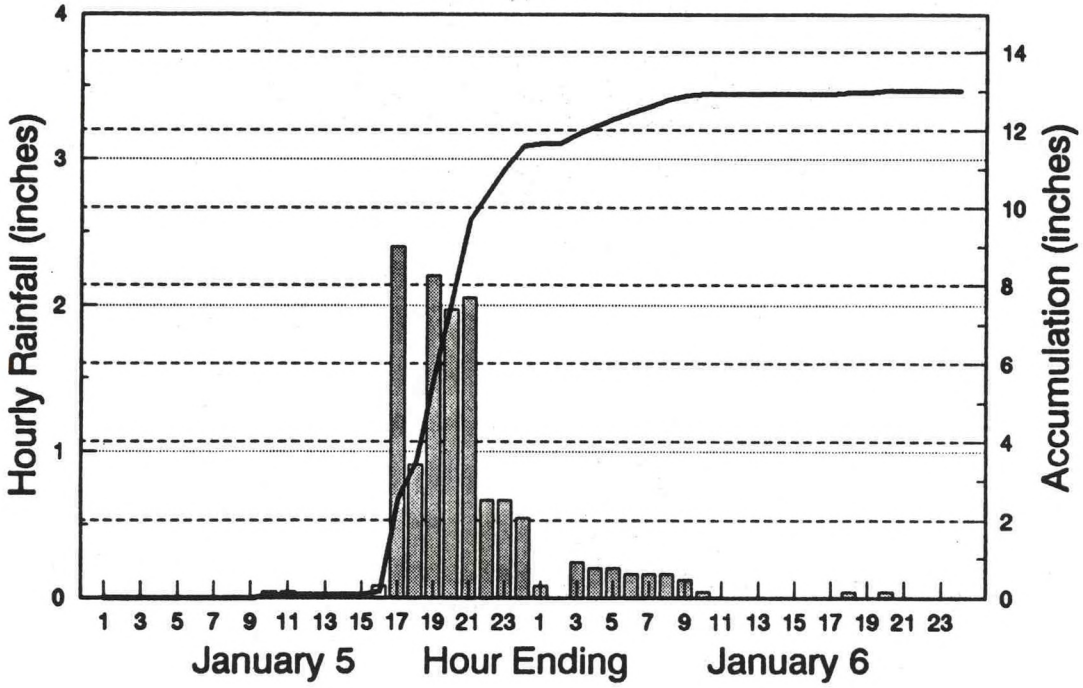
Guamani

Station 1211



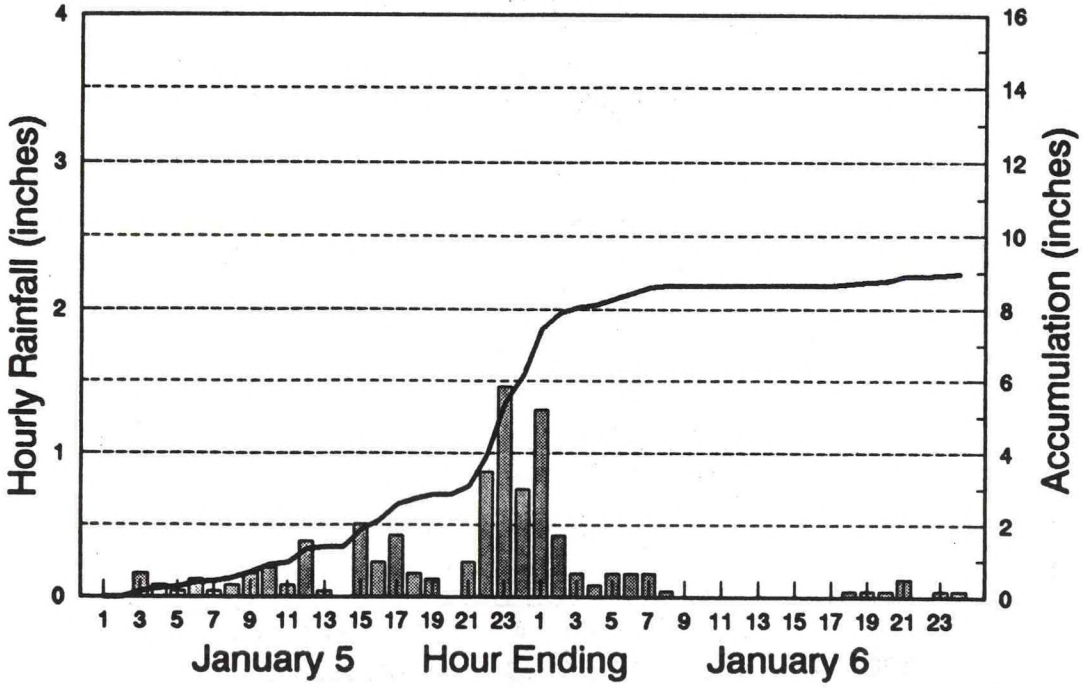
L.P. Cidra

Station 1273



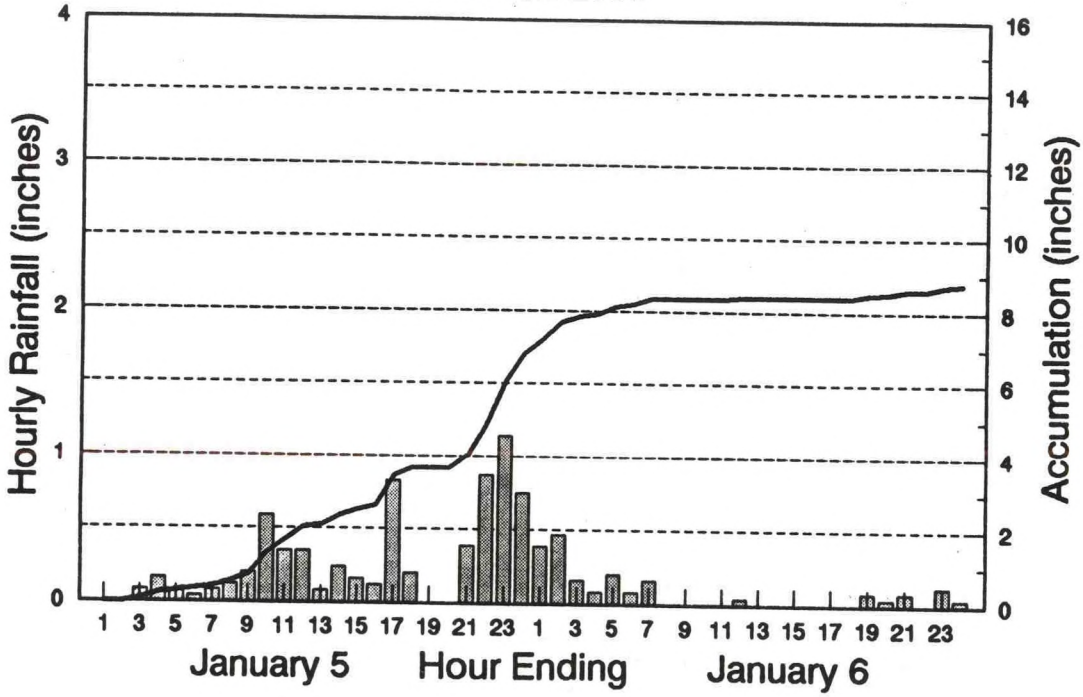
Rio Vivi-Utu

Station 2033



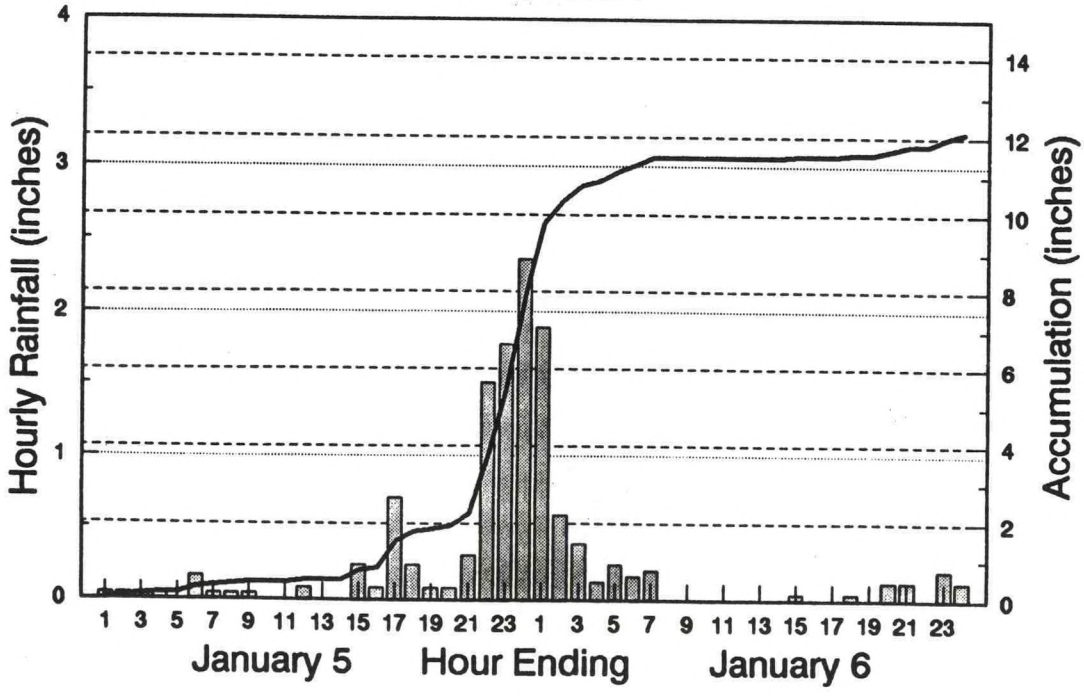
Jayuya

Station 2035



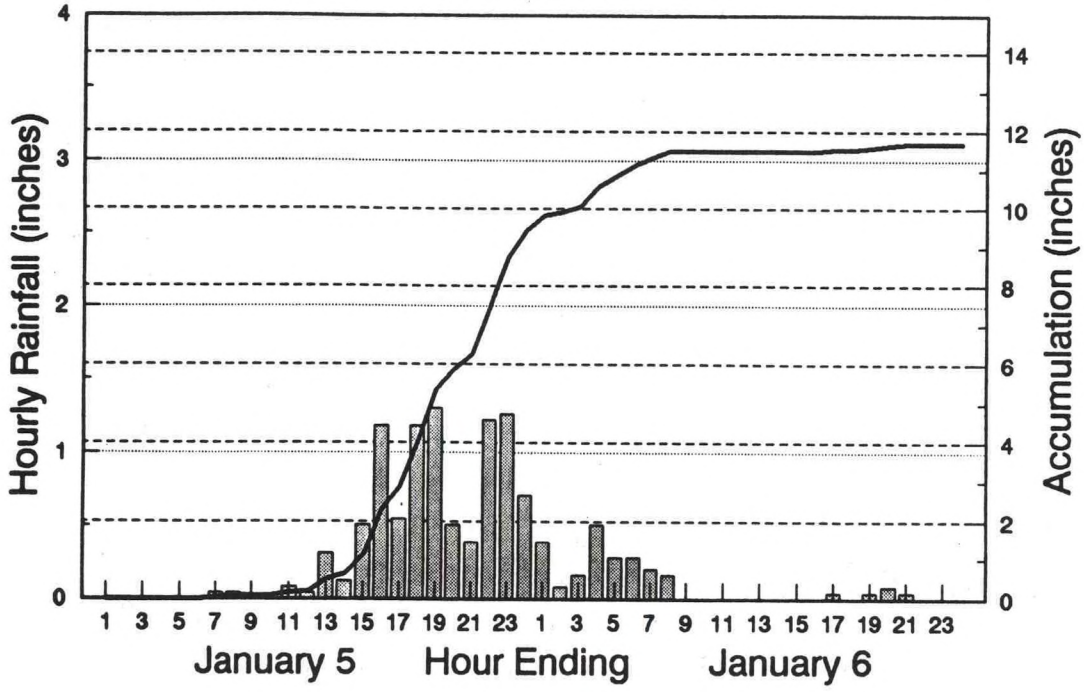
Tallaboa

Station 2231



Manati-Oroc

Station 2391



APPENDIX E

HOURLY AND CUMULATIVE RAINFALL FROM SELECTED ALERT GAGES

LOIZA BASINS HOURLY PRECIPITATION (inches)

Data for	#501	#502	#503	#504	#505	#506	#507	#508
01/05/92								
0000 thru 0100 AST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0100 thru 0200	0.04	0.00	0.00	0.04	0.04	0.00	0.00	0.00
0200 thru 0300	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
0300 thru 0400	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.00
0400 thru 0500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0500 thru 0600	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00
0600 thru 0700	0.00	0.28	0.20	0.00	0.00	0.00	0.00	0.00
0700 thru 0800	0.04	0.00	0.08	0.00	0.00	0.04	0.00	0.00
0800 thru 0900	0.00	0.35	0.08	0.00	0.00	0.04	0.00	0.00
0900 thru 1000	0.00	0.28	0.47	0.00	0.00	0.04	0.00	0.00
1000 thru 1100	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00
1100 thru 1200	0.00	0.16	0.08	0.00	0.00	0.00	0.00	0.00
1200 thru 1300	0.00	0.16	0.43	0.00	0.00	0.04	0.00	0.00
1300 thru 1400	0.12	0.16	0.20	0.00	0.12	0.00	0.12	0.16
1400 thru 1500	0.20	0.00	0.08	0.08	0.24	0.08	1.38	1.06
1500 thru 1600	0.63	0.12	0.39	0.04	0.24	0.08	0.71	0.20
1600 thru 1700	1.69	0.24	1.18	0.39	1.30	0.39	0.39	0.31
1700 thru 1800	1.61	0.51	0.94	0.43	0.63	0.71	0.47	0.24
1800 thru 1900	0.35	2.95	3.35	1.57	0.24	2.20	0.31	0.08
1900 thru 2000	0.04	2.13	0.79	0.39	0.00	0.55	0.20	0.00
2000 thru 2100	0.12	1.69	0.63	0.16	0.43	0.55	0.43	0.35
2100 thru 2200	0.16	0.71	0.39	0.08	0.12	0.31	0.08	0.04
2200 thru 2300	0.12	0.08	0.12	0.12	0.16	0.04	0.16	0.20
2300 thru 2400	0.12	0.63	0.35	0.20	0.12	0.20	0.08	0.12
01/06/92								
0000 thru 0100 AST	0.39	0.08	0.08	0.20	0.12	0.16	0.12	0.00
0100 thru 0200	0.08	0.12	0.12	0.16	0.12	0.08	0.04	0.00
0200 thru 0300	0.20	0.20	0.24	0.12	0.16	0.12	0.20	0.20
0300 thru 0400	0.24	0.12	0.24	0.16	0.12	0.20	0.43	0.16
0400 thru 0500	0.12	0.24	0.24	0.20	0.08	0.20	0.08	0.00
0500 thru 0600	0.08	0.12	0.31	0.16	0.08	0.24	0.00	0.00
0600 thru 0700	0.04	0.12	0.24	0.08	0.04	0.20	0.04	0.00
0700 thru 0800	0.04	0.08	0.12	0.04	0.08	0.08	0.08	0.04
0800 thru 0900	0.12	0.12	0.12	0.04	0.04	0.04	0.04	0.00
0900 thru 1000	0.04	0.00	0.04	0.04	0.00	0.04	0.00	0.00
1000 thru 1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1100 thru 1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1200 thru 1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1300 thru 1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1400 thru 1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1500 thru 1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1600 thru 1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1700 thru 1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1800 thru 1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1900 thru 2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 thru 2100	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
2100 thru 2200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2200 thru 2300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2300 thru 2400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SOUTHEAST RIVER BASINS HOURLY PRECIPITATION (inches)

Data for	#252	#255	#1211
01/05/92			
0000 thru 0100 AST	0.00	0.00	0.00
0100 thru 0200	0.00	0.00	0.00
0200 thru 0300	0.00	0.00	0.00
0300 thru 0400	0.00	0.00	0.00
0400 thru 0500	0.00	0.00	0.00
0500 thru 0600	0.00	0.04	0.16
0600 thru 0700	0.04	0.04	0.00
0700 thru 0800	0.00	0.00	0.00
0800 thru 0900	0.04	0.00	0.00
0900 thru 1000	0.00	0.04	0.00
1000 thru 1100	0.00	0.00	0.00
1100 thru 1200	0.00	0.00	0.00
1200 thru 1300	0.04	0.00	0.00
1300 thru 1400	0.08	0.00	0.20
1440 thru 1500	0.08	0.12	0.00
1500 thru 1600	0.04	0.00	0.16
1600 thru 1700	0.20	0.08	0.08
1700 thru 1800	0.20	0.20	0.39
1800 thru 1900	1.65	2.05	2.24
1900 thru 2000	1.02	1.85	4.17
2000 thru 2100	1.50	0.91	0.71
2100 thru 2200	0.91	0.51	0.12
2200 thru 2300	0.04	0.04	0.16
2300 thru 2400	0.39	0.51	0.35
01/06/92			
0000 thru 0100 AST	0.08	0.20	0.12
0100 thru 0200	0.08	0.12	0.00
0200 thru 0300	0.16	0.12	0.20
0300 thru 0400	0.24	0.20	0.20
0400 thru 0500	0.28	0.31	0.31
0500 thru 0600	0.24	0.31	0.39
0600 thru 0700	0.12	0.20	0.24
0700 thru 0800	0.12	0.12	0.20
0800 thru 0900	0.12	0.04	0.20
0900 thru 1000	0.04	0.00	0.00
1000 thru 1100	0.00	0.00	0.00
1100 thru 1200	0.00	0.04	0.00
1200 thru 1300	0.00	0.00	0.00
1300 thru 1400	0.00	0.00	0.04
1400 thru 1500	0.00	0.00	0.00
1500 thru 1600	0.00	0.00	0.00
1600 thru 1700	0.00	0.00	0.00
1700 thru 1800	0.00	0.00	0.00
1800 thru 1900	0.00	0.04	0.04
1900 thru 2000	0.00	0.00	0.08
2000 thru 2100	0.04	0.00	0.00
2100 thru 2200	0.00	0.00	0.04
2200 thru 2300	0.00	0.00	0.00
2300 thru 2400	0.00	0.00	0.00

LA PLATA AND MANATI RIVER BASINS HOURLY PRECIPITATION (inches)

Data for	#271	#275	#393	#1272	#1273	#1277	#2391	#2395
01/05/92								
0000 thru 0100 AST	0.00	0.00	0.00	0.00	0.00			
0100 thru 0200	0.00	0.00		0.00	0.00	0.04		
0200 thru 0300	0.00	0.00		0.00	0.00	0.00	0.00	0.00
0300 thru 0400	0.00	0.00		0.00	0.00	0.00	0.00	0.04
0400 thru 0500	0.00	0.00		0.04	0.00	0.00	0.00	0.00
0500 thru 0600	0.00	0.00		0.00	0.00	0.00	0.00	0.00
0600 thru 0700	0.00	0.00		0.00	0.00	0.00	0.04	0.04
0700 thru 0800	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.16
0800 thru 0900	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
0900 thru 1000	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.20
1000 thru 1100	0.00	0.04	0.43	0.00	0.04	0.04	0.08	0.20
1100 thru 1200	0.00	0.00	0.31	0.00	0.00	0.00	0.04	0.20
1200 thru 1300	0.00	0.20	0.00	0.04	0.00	0.04	0.31	0.04
1300 thru 1400	0.00	0.91	0.04	0.00	0.00	0.39	0.12	0.04
1400 thru 1500	0.00	0.24	0.71	0.00	0.00	0.31	0.51	0.35
1500 thru 1600	0.00	1.42	0.59	0.28	0.08	1.14	1.18	0.08
1600 thru 1700	0.00	0.79	0.51	0.47	2.40	0.55	0.55	1.06
1700 thru 1800	0.00	0.35	0.67	0.43	0.91	1.69	1.18	0.71
1800 thru 1900	0.00	1.46	0.20	0.59	2.20	0.31	1.30	0.00
1900 thru 2000	0.00	1.10	0.12	0.43	1.97	0.16	0.51	0.00
2000 thru 2100	0.00	0.91	0.20	0.31	2.05	0.39	0.39	0.08
2100 thru 2200	0.00	1.61	0.20	0.28	0.67	0.43	1.22	0.35
2200 thru 2300	0.00	0.98	0.16	0.31	0.67	0.20	1.26	0.20
2300 thru 2400	0.00	1.54	0.08	0.28	0.55	0.04	0.71	0.16
01/06/92								
0000 thru 0100 AST	0.00	0.12	0.00	0.28	0.08	0.12	0.39	0.16
0100 thru 0200	0.00	0.04	0.16	0.24	0.00	0.04	0.08	0.08
0200 thru 0300	0.00	0.12	0.16	0.20	0.24	0.12	0.16	0.51
0300 thru 0400	0.00	0.39	0.16	0.20	0.20	0.16	0.51	0.08
0400 thru 0500	0.00	0.31	0.04	0.16	0.20	0.08	0.28	0.08
0500 thru 0600	0.00	0.24	0.00	0.16	0.16	0.08	0.28	0.04
0600 thru 0700	0.00	0.16	0.08	0.12	0.16	0.04	0.20	0.00
0700 thru 0800	0.00	0.16	0.04	0.16	0.16	0.04	0.16	0.04
0800 thru 0900	0.00	0.00	0.00	0.12	0.12	0.04	0.00	0.00
0900 thru 1000	0.00	0.00	0.00	0.12	0.04	0.00	0.00	0.00
1000 thru 1100	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.04
1100 thru 1200	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00
1200 thru 1300	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00
1300 thru 1400	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00
1400 thru 1500	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00
1500 thru 1600	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
1600 thru 1700	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00
1700 thru 1800	0.00	0.00	0.00	0.08	0.04	0.00	0.00	0.00
1800 thru 1900	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
1900 thru 2000	0.00	0.04	0.00	0.08	0.04	0.00	0.08	0.00
2000 thru 2100	0.00	0.00	0.20	0.00	0.00	0.00	0.04	0.04
2100 thru 2200	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
2200 thru 2300	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.04
2300 thru 2400	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00

SOUTH COAST RIVER BASINS HOURLY PRECIPITATION (inches)

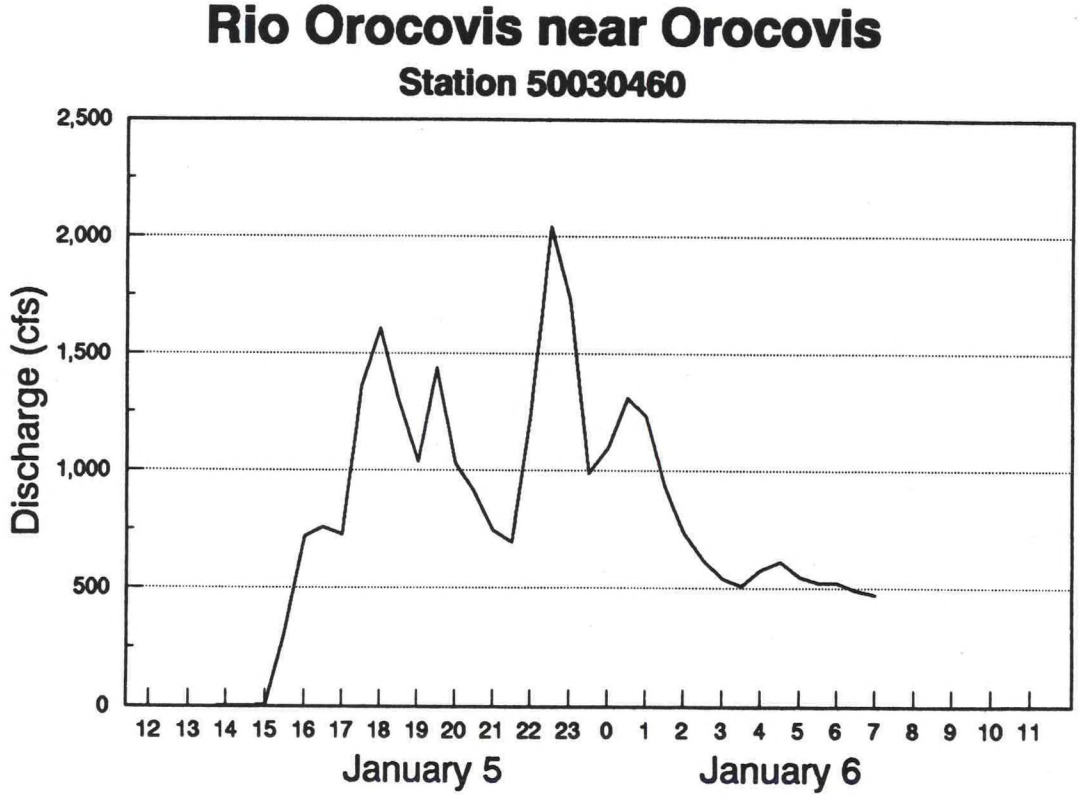
Data for	#1131	#1133	#1312	#2231	#2311	#2315
01/05/92						
0000 thru 0100 AST	0.00	0.00	0.00	0.04	0.00	0.04
0100 thru 0200	0.00	0.00	0.00	0.04	0.08	0.04
0200 thru 0300	0.00	0.04	0.04	0.04	0.00	0.04
0300 thru 0400	0.00	0.00	0.04	0.04	0.16	0.12
0400 thru 0500	0.00	0.04	0.00	0.00	0.00	0.04
0500 thru 0600	0.00	0.08	0.00	0.16	0.04	0.04
0600 thru 0700	0.04	0.00	0.08	0.04	0.04	0.08
0700 thru 0800	0.00	0.08	0.20	0.04	0.04	0.08
0800 thru 0900	0.00	0.16	0.00	0.04	0.08	0.12
0900 thru 1000	0.00	0.04	0.31	0.00	0.28	0.20
1000 thru 1100	0.00	0.20	0.12	0.00	0.16	0.20
1100 thru 1200	0.00	0.00	0.20	0.08	0.08	0.08
1200 thru 1300	0.04	0.20	0.00	0.00	0.08	0.04
1300 thru 1400	0.00	0.04	0.04	0.00	0.00	0.12
1400 thru 1500	0.00	0.28	1.06	0.24	0.28	0.16
1500 thru 1600	0.00	0.24	0.47	0.08	0.16	0.04
1600 thru 1700	0.00	2.36	0.43	0.71	0.39	0.43
1700 thru 1800	0.00	0.83	0.91	0.24	0.00	0.04
1800 thru 1900	0.00	2.24	0.63	0.08	0.28	0.04
1900 thru 2000	0.00	2.32	0.35	0.08	0.00	0.12
2000 thru 2100	0.00	0.83	0.39	0.31	0.31	0.28
2100 thru 2200	0.00	1.02	0.83	1.50	1.73	1.54
2200 thru 2300	2.13	1.73	1.06	1.77	2.40	1.85
2300 thru 2400	1.06	0.28	1.93	2.36	2.24	1.65
01/06/92						
0000 thru 0100 AST	0.35	0.08	1.18	1.89	0.79	0.43
0100 thru 0200	0.00	0.00	0.24	0.59	0.63	0.47
0200 thru 0300	0.59	0.51	0.16	0.39	0.31	0.20
0300 thru 0400	0.75	0.28	0.20	0.12	0.16	0.12
0400 thru 0500	0.43	0.35	0.28	0.24	0.24	0.16
0500 thru 0600	0.20	0.31	0.16	0.16	0.16	0.08
0600 thru 0700	0.31	0.35	0.20	0.20	0.16	0.16
0700 thru 0800	0.20	0.28	0.04	0.00	0.00	0.00
0800 thru 0900	0.04	0.08	0.00	0.00	0.00	0.00
0900 thru 1000	0.00	0.00	0.00	0.00	0.00	0.00
1000 thru 1100	0.00	0.00	0.00	0.00	0.00	0.00
1100 thru 1200	0.00	0.00	0.00	0.00	0.00	0.00
1200 thru 1300	0.00	0.00	0.00	0.00	0.00	0.00
1300 thru 1400	0.00	0.00	0.00	0.00	0.00	0.00
1400 thru 1500	0.00	0.00	0.00	0.04	0.00	0.00
1500 thru 1600	0.00	0.00	0.00	0.00	0.00	0.00
1600 thru 1700	0.00	0.00	0.04	0.00	0.08	0.04
1700 thru 1800	0.00	0.08	0.00	0.04	0.12	0.04
1800 thru 1900	0.00	0.00	0.08	0.00	0.08	0.16
1900 thru 2000	0.00	0.00	0.20	0.12	0.16	0.08
2000 thru 2100	0.00	0.00	0.00	0.12	0.12	0.08
2100 thru 2200	0.00	0.00	0.24	0.00	0.20	0.04
2200 thru 2300	0.00	0.00	0.00	0.20	0.20	0.12
2300 thru 2400	0.00	0.00	0.00	0.12	0.08	0.00

WESTERN INTERIOR RIVER BASINS HOURLY PRECIPITATION (inches)

Data for	#397	#2031	#2033	#2035	#2039	#3195
01/05/92						
0000 thru 0100 AST	0.00	0.00		0.00	0.00	0.00
0100 thru 0200	0.00	0.00	0.00	0.00	0.00	0.00
0200 thru 0300	0.00	0.00	0.16	0.08	0.00	0.00
0300 thru 0400	0.00	0.00	0.08	0.16	0.00	0.00
0400 thru 0500	0.00	0.04	0.04	0.08	0.00	0.00
0500 thru 0600	0.00	0.00	0.12	0.04	0.00	0.04
0600 thru 0700	0.00	0.00	0.04	0.08	0.04	0.00
0700 thru 0800	0.00	0.04	0.08	0.12	0.00	0.20
0800 thru 0900	0.00	0.04	0.16	0.20	0.00	0.00
0900 thru 1000	0.00	0.04	0.20	0.59	0.04	0.00
1000 thru 1100	0.12	0.24	0.08	0.35	0.00	0.08
1100 thru 1200	0.08	0.55	0.39	0.35	1.38	0.00
1200 thru 1300	0.16	0.00	0.04	0.08	0.04	0.04
1300 thru 1400	0.04	0.08	0.00	0.24	0.00	0.04
1400 thru 1500	0.47	0.35	0.51	0.16	0.08	0.12
1500 thru 1600	1.57	0.08	0.24	0.12	0.16	0.00
1600 thru 1700	1.22	0.00	0.43	0.83	0.00	0.00
1700 thru 1800	1.97	0.12	0.16	0.20	0.16	0.00
1800 thru 1900	0.24	0.16	0.12	0.00	0.20	0.08
1900 thru 2000	0.04	0.00	0.00	0.00	0.00	0.00
2000 thru 2100	0.51	0.16	0.24	0.39	0.00	0.00
2100 thru 2200	0.31	0.24	0.87	0.87	0.08	0.00
2200 thru 2300	0.20	0.08	1.46	1.14	0.12	0.00
2300 thru 2400	0.08	0.12	0.75	0.75	0.00	0.00
01/06/92						
0000 thru 0100 AST	0.00	2.48	1.30	0.39	0.83	0.00
0100 thru 0200	0.00	0.51	0.43	0.47	0.20	0.00
0200 thru 0300	0.00	0.20	0.16	0.16	0.08	0.00
0300 thru 0400	0.16	0.00	0.08	0.08	0.00	0.00
0400 thru 0500	0.00	0.08	0.16	0.20	0.04	0.00
0500 thru 0600	0.00	0.04	0.16	0.08	0.00	0.00
0600 thru 0700	0.00	0.00	0.16	0.16	0.12	0.00
0700 thru 0800	0.00	0.00	0.04	0.00	0.00	0.00
0800 thru 0900	0.00	0.00	0.00	0.00	0.00	0.00
0900 thru 1000	0.00	0.00	0.00	0.00	0.00	0.00
1000 thru 1100	0.00	0.00	0.00	0.00	0.00	0.00
1100 thru 1200	0.00	0.00	0.00	0.04	0.00	0.00
1200 thru 1300	0.00	0.00	0.00	0.00	0.00	0.00
1300 thru 1400	0.00	0.00	0.00	0.00	0.00	0.00
1400 thru 1500	0.00	0.00	0.00	0.00	0.00	0.00
1500 thru 1600	0.00	0.00	0.00	0.00	0.00	0.00
1600 thru 1700	0.04	0.00	0.00	0.00	0.00	0.00
1700 thru 1800	0.04	0.00	0.04	0.00	0.00	0.00
1800 thru 1900	0.04	0.00	0.04	0.08	0.00	0.00
1900 thru 2000	0.04	0.00	0.04	0.40	0.00	0.00
2000 thru 2100	0.16	0.00	0.12	0.08	0.00	0.00
2100 thru 2200	0.20	0.00	0.00	0.00	0.00	0.00
2200 thru 2300	0.12	0.00	0.04	0.12	0.00	0.00
2300 thru 2400	0.04	0.00	0.04	0.04	0.00	0.00

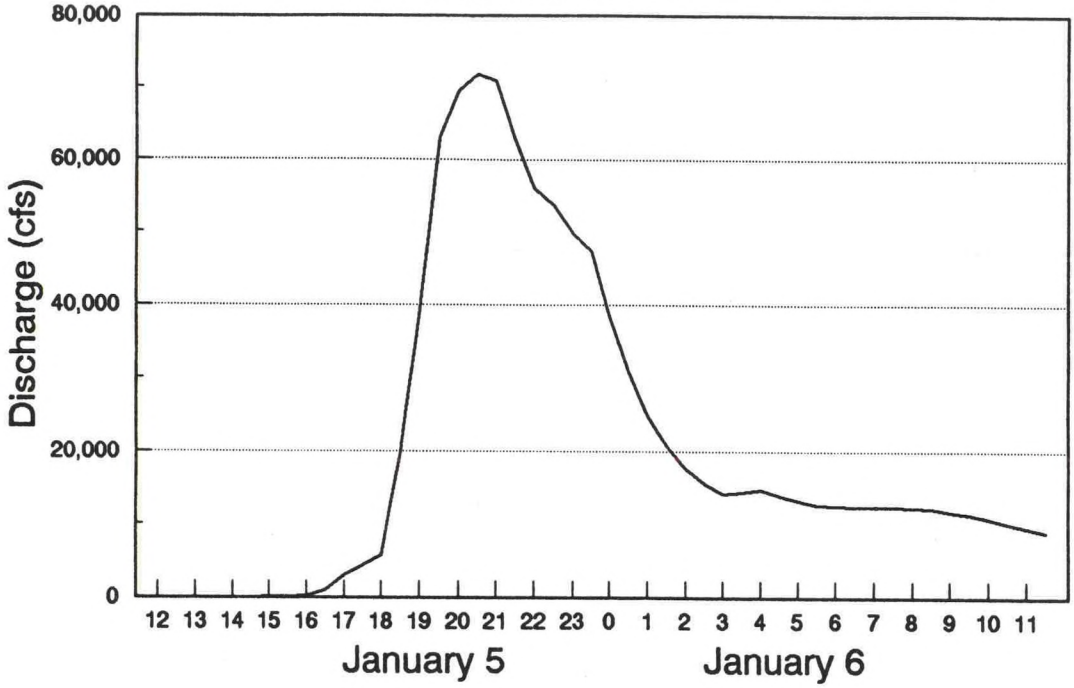
APPENDIX F

HYDROGRAPH DEPICTIONS FOR SELECTED STATIONS



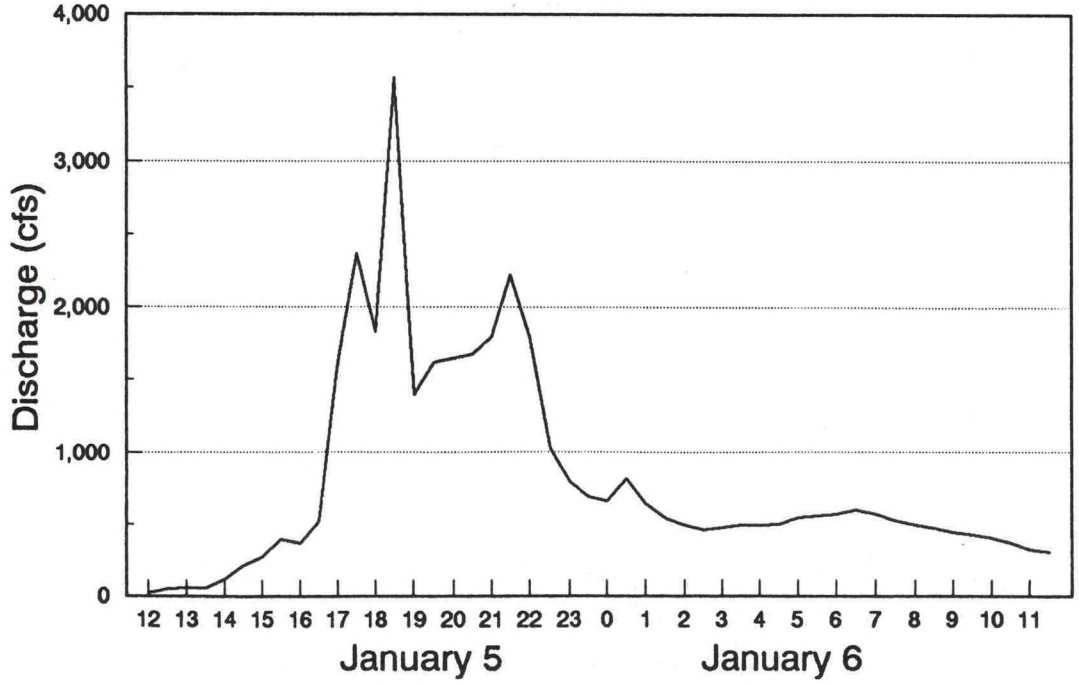
Rio de la Plata at Proyecto la Plata

Station 50043000



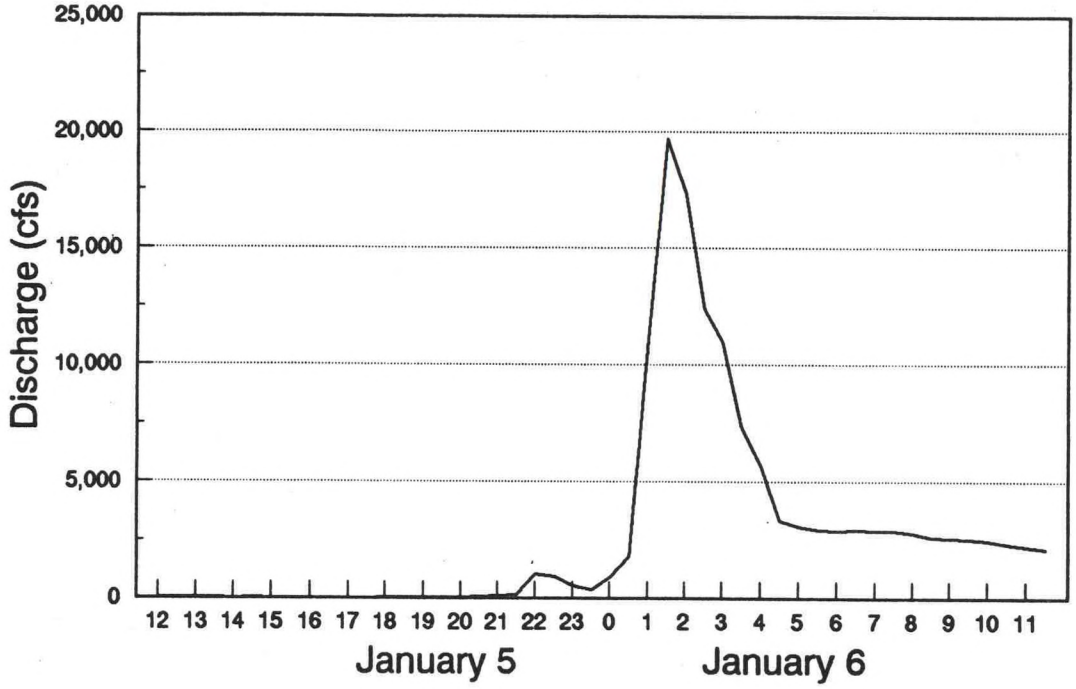
Rio Turabo above Borinquen

Station 50053025



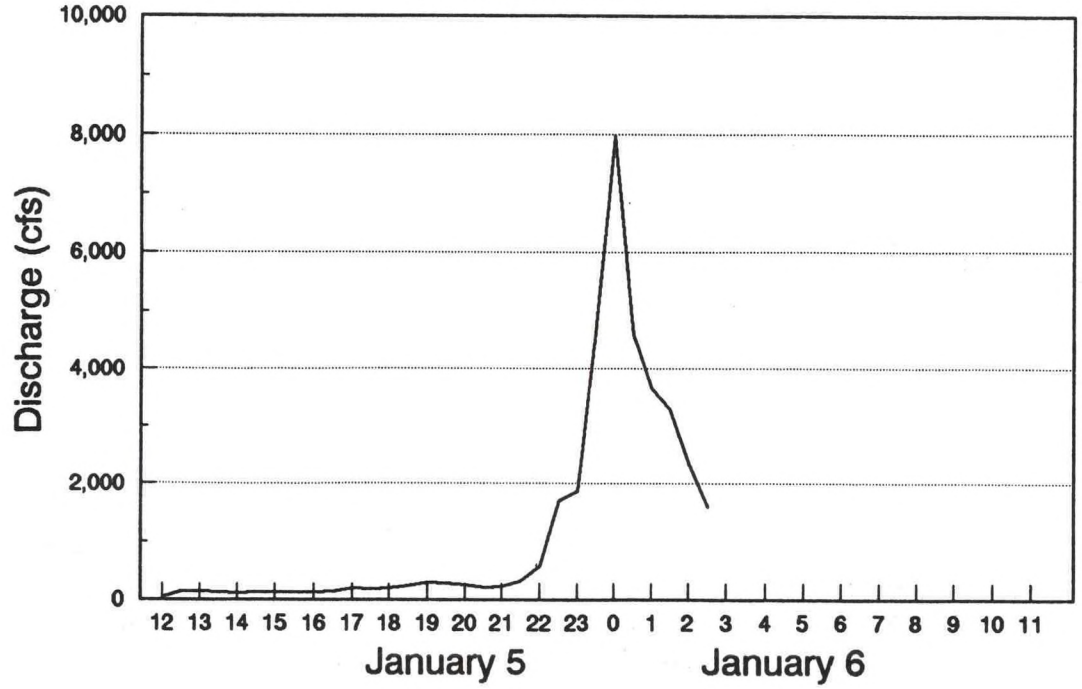
Rio Jacaguas at Juana Diaz

Station 50111500



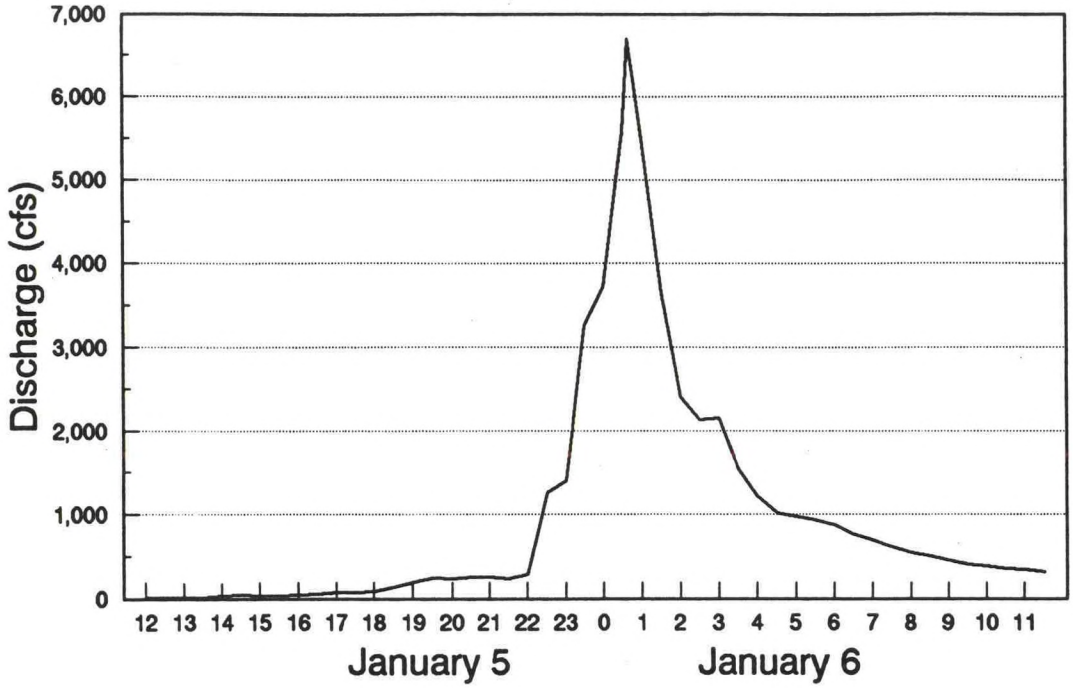
Rio Cerillos above Lago Cerillos near Ponce

Station 50113800



Rio Portugues near Ponce

Station 50115000



*U.S. G.P.O.:1992-313-153:60515