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FLOOD WARNING SYSTEMS MANUAL

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Gregory A. Mandt Date
Director, Office of Climate,
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CHAPTER 1 - INTRODUCTION

1.1 Purpose

The National Weather Service (NWS) has a responsibility to provide flood forecasts and warnings in support of its primary mission of protecting life and property. Communities can support NWS in this objective by implementing an automated flood warning system (AFWS) in coordination with the NWS hydrologic program. In turn, the NWS Hydrologic Services Program, provides certain forms of support to flood-affected communities that are developing and maintaining AFWSs.

AFWSs are defined as community-based or locally-based systems used to warn local areas of flood danger. AFWSs consist of many, if not all, of the following: rainfall, river, and other hydrologic gages; hydrologic models; a communications system; a community flood coordinator; and interested and capable volunteers.

The ultimate goal of the NWS's cooperative role in AFWSs is to protect life and property by achieving and maintaining a high level of community preparedness utilizing AFWSs to support local disaster and emergency services. This manual, which replaces the February, 1997 edition of Weather Service Hydrology Handbook No. 2, provides guidance for cooperating with local communities on AFWSs.

1.2 Types of Automated Flood Warning Systems

An AFWS is composed of sensors that report environmental conditions to a computer using an observation platform communication protocol and a second communication protocol by which information is sent between the base station and other computer system(s). An AFWS has either a stand-alone configuration or a network configuration and can consist of the following equipment: Sensor equipment reporting a range of environmental data from automatic reporting river and rainfall gages all the way up to full weather data sensing and reporting platforms, a communications system, automated data collection and processing equipment, a microprocessor, and analysis and forecasting software.

AFWSs have been designed, developed, and implemented by the NWS, other Federal agencies, state and local governments, and private vendors; and they vary in design, capability, and operation. A community must assess its needs to determine the level of sophistication (and associated costs) required. Automated system operation may vary from a simple flash flood alarm gage that audibly announces imminent flooding to a continuous computerized analysis of precipitation and streamflow and a hydrologic model to forecast flood levels.

Two general types of AFWS are described in this manual Automated Local Evaluation in Real Time (ALERT) systems and Integrated Flood Observing and Warning Systems (IFLOWS). Each have characteristics and a history which are important to understand when working with users who want to implement and maintain them.

1.2.1 Automated Local Evaluation in Real Time (ALERT)

The ALERT system was developed by the California-Nevada RFC in Sacramento, California, and consists of automated event-reporting meteorological and hydrologic sensors, communications equipment, and computer software and hardware. In its simplest form, ALERT sensors transmit coded signals, usually via very high frequency (VHF) and ultra high frequency (UHF) radio, to a base station, often through one or more relay or radio repeater sites (refer to Figure 1-1). The base station, which consists of radio receiving equipment and a microprocessor running ALERT software, collects these coded signals and processes them into meaningful hydrometeorological information. Processed information can be displayed on a computer screen according to various preset criteria, with both visual and audible alarms activated when these criteria are reached. Most systems have the capability of dialing up preselected lists of individuals or initiating other programmed actions when preset criteria are exceeded.

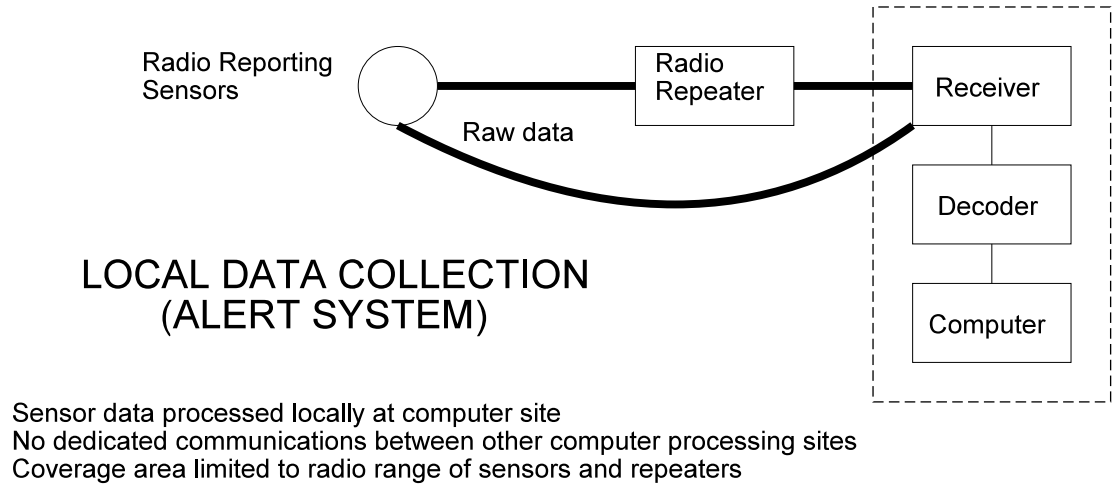

Figure 1-1. *Schematic of an ALERT system.*

ALERT systems in use today are quite sophisticated. Some have the capability to graphically display information, singly or in combination (such as the areal extent of flooding, inundation of roads, evacuation routes, supply depots, hospitals, population centers) on wall-size projection screens. A system can consist of more than one base station connected through repeater networks to pass along raw, unprocessed information from one user group to another.

ALERT systems are locally funded and supported. Many systems are owned or maintained by more than one participating organization with each ALERT participant owning or maintaining a small portion of the entire system. In many cases, the NWS does not own any of the equipment in a particular system. In some cases, local system sponsors have provided equipment to the NWS for use in its field offices because they recognize the benefits of NWS forecasts and warnings. ALERT systems are found throughout the United States and in some foreign countries.

1.2.2 Integrated Flood Observing and Warning System (IFLOWS)

IFLOWS was created in the late 1970's to assist flood prone communities in seven Appalachian states with development of automated flood warning systems. Administratively, IFLOWS is a cost-sharing partnership between Federal, state, and local government agencies. The NWS provides grant funding assistance to partner agencies in the designated states, who own, operate, and maintain their own IFLOWS networks. IFLOWS networks presently extend into 200 counties and have expanded into 13 contiguous states. The Program has a defined, centralized management structure in the Office of Climate, Water and Weather Services at the NWS headquarters. NWS Eastern Region Headquarters manages issues related to interaction between the majority of IFLOWS operational components and the WFOs.

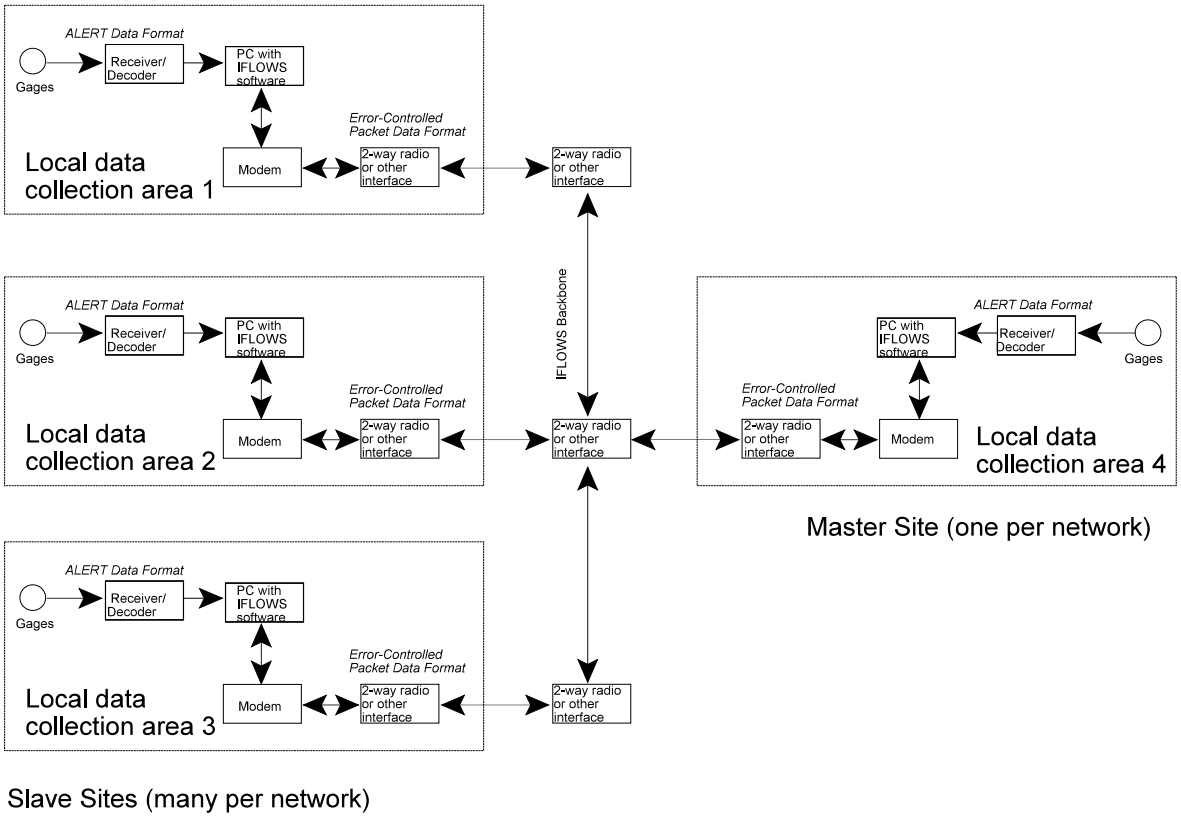

Figure 1-2. *Typical IFLOWS Network.*

IFLOWS operates as a wide-area network of VHF-radio ALERT-type systems with enhanced, full, two-way communications capability (data, text, and optional voice). Figure 1-2 is a schematic of a typical IFLOWS network. Each local office has a PC, IFLOWS software, and two communication ports. One communications port is used to collect, and process local ALERT-format gage data. The other communications port is used to exchange data and other information with other locations using an error-controlled packet data format, sometimes called the "IFLOWS backbone". One designated "master" site per network directs traffic on the backbone, routing data to correct destinations and preventing data packet collisions among "slaves". Present IFLOWS backbone communications systems employ a hybrid of communications media,

including VHF/UHF radio, microwave, leased telephone lines, and satellites. IFLOWS software integrates the gage collection and data exchange functions, making it possible for each locality to independently monitor its own gages, while enabling it to share data with others throughout the network. IFLOWS software also gives local users the ability to display gage data, set alarms, and exchange text messages with other network users.

Advances in communications and computer technology now make it possible to economically and reliably provide IFLOWS functionality via multiple communications paths. Although IFLOWS will continue to rely upon the standard ALERT-format VHF gage for source data, IFLOWS networks are being reconfigured to take advantage of technological advances. In the future IFLOWS networks will collect data centrally via a wide-area satellite network, distribute data optionally via the Internet, and provide users the option of using any software capable of processing ALERT-format gage data.

The website for IFLOWS is http://www.afws.net.

CHAPTER 2 - IMPLEMENTING AN AUTOMATED FLOOD WARNING SYSTEM

2.0 Introduction

This section describes the steps in the process of implementing an automated flood warning system. Major components to be considered for any AFWS would include the following. Each component is discussed in detail below.

- System Design
- Alternate Uses
- Memorandum of Understanding
- Procurement
- Installation
- Maintenance
- Backup System
- Transmitter Licenses

2.1 System Design

The process of determining the need and feasibility of implementing an AFWS will generate critical information required for its design. Through the support of the NWS, other Federal, state, and local agencies, and/or private consultants, the local flood risk will have been assessed, the type of local organization determined, and the financial and sociopolitical support defined. All of the following components of the warning system must be integrated into detailed design documents:

- Measurement and detection
- Data transmission
- Data processing and analysis
- Forecast preparation
- Forecast dissemination

Design may be accomplished through local resources supported by NWS or private consultants.

The software selection, such as NWS IFLOWS, or private vendor offerings, will influence the system design. The types, number, and location of gages, as well as their transmission paths to collection points, must be specified.

Prior to the procurement of equipment and as part of system design, all transmitter license approvals must be obtained from the Federal Communication Commission (FCC) (see Section 2.8).

2.1.1 Rain Gages

Number. The number of rain gages installed in an AFWS directly affects its performance. Generally, the more gages, the better the chances of detecting flood-producing rainfall. The number of gages required will depend to a large extent on the rainfall variability in the local area. Therefore, to adequately depict rainfall over a basin, mountainous areas usually will require more gages than flat lands. Areas subject to local convective storms will require more gages than areas that generally experience larger-scale, frontal-type storms. Obviously, availability of funds must also be factored in when determining the number of gages to be installed.

Exposure. Rain gages should be located on ground level and should not be located close to isolated obstructions, such as trees and buildings, that may cause erratic turbulence and affect the accuracy of the gage catch. Gages should also not be located in wide-open spaces or on elevated sites. The best location is where the gage is uniformly protected in all directions, such as an opening in a grove of trees. If a precipitation gage is near an object, then the distance between the gage and the object should be at least twice the height of the object.

2.1.2 Stream Gages

Stream gages provide information about the current state of the stream. In small watersheds, typical of those associated with AFWSs, streamflow observations are used to calibrate watershed models, verify forecasts from models, or trigger alarms when flooding is impending or occurring. The location of stream gages in an AFWS are guided by one or both of the following factors: (1) downstream public warning requirements and (2) forecast model requirements. Gages used for stage alarms should be located at key points of potential damage and at points that are far enough upstream to yield enough warning time for downstream locations.

2.1.3 Communication Media

AFWSs generally impose few restrictions upon communications design. Consequently, communications design varies depending on the desired area of coverage and resources available for transmission equipment. Currently, AFWSs exist which use VHF or UHF radio, microwave, satellite, dedicated leased telephone lines, or a combination thereof. A brief description of the more common communication elements for automated data collection follows.

Event-Reporting Hydrometeorological Sensors. These sensors are battery-powered, micro-processor-controlled counters interfaced with a modulator and VHF-FM radio transmitter.

Single-Frequency Repeater. The single-frequency repeater is used to extend the radio transmission range of event-reporting sensors. It receives an incoming signal, waits until the entire signal has been received, and regenerates and retransmits it on the same radio frequency.

Microwave Radio System. A microwave system is a series of back-to-back repeater transceivers that are capable of carrying many independent channels at the same time over long distances. Any site in a microwave system can, with the proper interfaces, provide audio communication with one or more sites in the system.

Radio Transceiver. Generally, a radio transceiver is used to extend communications beyond the limit of a microwave or other backbone communications system. Transceivers located at mountaintop sites are called "repeaters," and transceivers located at endpoints in the system are called "base stations."

Base Station. A base station is a final destination in the AFWS communications network. Data directly from sensors or repeaters, telephone lines, etc., are received by appropriate interface equipment and transmitted to the base station microcomputer. The computer accepts observation reports, processes and validates information, displays it as required by the users, and forwards data to the appropriate NWS computer, such as AWIPS.

Once local warning and response requirements have been determined, communication engineering expertise should be solicited to define the various communications media options that are available to meet requirements and their associated costs.

2.2 Alternate Uses

Increasing numbers of Federal, state, and local agencies are becoming involved in the implementation and operation of AFWS technology. These programs cover a broad spectrum of real-time environmental sensing. Applications cover highway safety, pollution control, and water management, for example. It may prove more efficient and cost effective for an organization to integrate flood recognition with other local program needs. At the very least, several programs could share the cost and utility of the various data collected. Another very important advantage is that a multipurpose system tends to be used and maintained regularly, ensuring reliable operations during flood episodes.

2.3 Memorandum of Understanding

When implementing an AFWS, both the NWS and the AFWS operator will benefit from an MOU that describes how the parties will cooperate and share in the support for the AFWS. A sample MOU for an AFWS is contained in Appendix A.

2.4 Procurement

There are two basic approaches for local procurement of the hardware for the AFWS. The first is to purchase the various hardware components from individual vendors (e.g., gages, radio repeaters, and modems from one vendor; computers from another; and possibly a network transceiver from a third vendor). The second approach is to purchase all required hardware from a single vendor specializing in supplying integrated warning system configurations. Information on possible vendors may be obtained from the ALERT Users Group (AUG), the Southwestern Association of ALERT Systems (SAAS), the ALERT~FLOWS users group or the National Hydrologic Warning Council (NHWC) (www.alertsystems.org).

2.5 Installation

Communities may find it feasible and cost effective to use local government agencies (such as the highway department, public works department, or others) to install much of the hardware for the AFWS. It may be necessary to supplement resident support with vendor support, particularly for installing and testing data transmission equipment. There are vendors who specialize in both supplying and installing complete warning system configurations. The local U.S. Geological Survey (USGS) office can provide guidance on proper installation procedures for stream-level sensors.

2.6 Maintenance

Proper maintenance of the AFWS is essential for its successful operation. The maintenance program must cover all elements of the AFWS: gages, data transmission system, software and computer, and preparedness/response system. Preventive (routine) maintenance schedules associated with the various hardware components should be followed. Because of the events-reporting nature of sensor platforms, the sensors and system must be operational at all times. Periodic testing of equipment is important. Some diagnostic "tools" are built into ALERT/IFLOWS equipment and software. The ALERT/IFLOWS gage transmitters are programmed to transmit twice a day for diagnostic purposes. There are diagnostic routines in the IFLOWS software that indicate potential radio communication problems.

Those users associated with the AFWS must be trained and kept current on their roles and responsibilities. Conducting practice drills in concert with the NWS, at routine intervals, has proven valuable in keeping the system at a high level of readiness. The local agency must prepare for life-cycle equipment replacement. The gages and communication equipment have useful (maintainable) life spans of about 10 years. The computer hardware life span is about 3 to 5 years. Generally, maintenance and life-cycle replacement costs each run around 10 percent of capital investment per year.

2.6.1 Funds for Maintenance

A community may use various funding sources (general local tax base, special surcharge, general/private donations, etc., or combinations thereof) to fund maintenance. Whichever method is chosen, it is important that it can produce recurring funds for the long term. As mentioned above, a rough estimate for maintenance funding is 10 percent per year of the initial capital cost of the AFWS.

2.6.2 Recommended Routine and Preventative Hardware Maintenance

Routine maintenance for all field sites should be scheduled at least once, and preferably twice, each year for servicing of the following equipment:

a. ALERT/IFLOWS Battery Gage

(1) Set up a rotating battery-change schedule at least twice per year, less frequently if solar panels are used.

(2) Check battery voltage, every visit. Check voltage before and during transmission.

(3) Check battery terminals for corrosion or loose terminals/connections, every visit.

(4) Check battery level to avoid dropping below manufacturer's specifications, every visit.

(5) Follow battery manufacturer's instructions for discharging battery prior to recharging.

Note: A solar panel charging system is highly recommended as part of the field installation.

b. Antenna

(1) Position antenna elements so that they are not directly above the rain gage's collector.

(2) Check reflective power in and out.

(3) Do visual inspection for gunshots or missing elements. Look for broken or exposed antenna cable.

(4) Check antenna clamps to be sure bolts are tight and verify antenna direction.

(5) Plug top of antenna mast; keep water out of standpipe.

c. Rain Gage Unit

(1) Check rain gage tipping bucket mechanism for proper balance, every visit.

(2) Check for spider webs, wasp nests, bird droppings, or other debris in the funnel, every visit.

(3) Check rain gage housing to be sure it is secured, every visit.

(4) Calibrate and clean rain gage tipping bucket, at least once per year.

(5) Seal bottom of tipping bucket housing with waterproof sealer.

(6) Make sure all holding screws are in place and tight so that the tipping bucket remains level in high winds and/or with some pushing on the standpipe.

d. Water Level Sensor (Shaft Encoder)

(1) Check reed switches when unit will not hold calibration.

(2) Rotate wheel several turns to make sure chain doesn't jump off sprocket, every visit.

(3) Check wires at terminal block and plug with ohmmeter, every visit.

(4) Calibrate to ensure accuracy, every visit.

e. Water Level Pressure Transducer

(1) Check for vandalism and for biological fouling, silting, sand, wood, plastic, etc, every visit.

(2) Check to make sure straps are holding, every visit. Replace straps or add more if movement is noticed.

(3) Check pressure transducer plug at transmitter for loose or broken wires, every visit.

(4) Reseal any electronic components in a liquid epoxy, when necessary.

f. Sensor Transmitter

(1) Clean radio frequency link device, once per year.

(2) Disconnect, clean, and reconnect the connections between main board, back board, and plug-in sockets to ensure positive electrical contact, once per year.

(3) Measure output in watts, every visit.

(4) Replace desiccant pack, once per year.

(5) Check frequency and modulation yearly.

g. Standpipes

(1) Re-level pipes if required.

(2) Seal any gunshot holes.

h. Base Station (Computer/Software/Radios)

(1) Check station, daily.

(2) Execute all commands and run all menu selections to make sure all are working properly, twice a month.

(3) Switch to standby power on a regular schedule to ensure proper operation.

i Repeater

(1) Check battery and connections, every visit.

(2) Check antennae for damage, every visit.

(3) Check coaxial transmission line and connectors to antennae for damage, every visit.

(4) Check commercial power and/or solar panel and connecting cables, every visit.

(5) Check frequency and modulation yearly.

j. Spare Equipment

(1) Keep spares on hand (at least 10 percent recommended) of each type of equipment used in the overall AFWS.

(2) Exchange or test spare equipment, monthly.

(3) Store equipment in a clean, dry environment.

Additional maintenance information is available from the Internet web site www.alertsystems.org.

2.6.3 Emergency Maintenance

ALERT/IFLOWS gages are programmed to report twice a day. If gaged data are not being received as scheduled, initiate emergency maintenance to check suspected gage malfunctions. If there is a store-and-forward repeater in the AFWS and a large number of gages appear not to be reporting, the likely culprit is the repeater.

A spare parts inventory should be maintained. This is particularly important for the electronics packages of the gages and repeaters.

2.7 Backup System

The NWS advises some backup for the AFWS. To ensure the integrity of its local flood warning effort, the community should maintain an auxiliary power supply (uninterruptible power supply, generator) and a backup data collection capability (redundant radio paths, radios, and computer). Where such backup cannot be automated, it may be necessary to establish a network of observers to report at least rainfall and river stages when the automated system is not functioning. Although circumstances vary, many areas of the country have found computerized backup to be less expensive and more reliable than maintaining an auxiliary network of observers.

If the AFWS includes a forecast model on a computer and other backup is not available, a manual forecast procedure should be readily available. Numerous manual forecast procedures in the form of simple look-up tables have been used for years and serve as an effective backup process during critical flood situations.

2.8 Transmitter Licenses

Many Automated Flood Warning Systems (AFWSs) transmit data via line-of-site radio signals. Specific procedures have been set up for obtaining licenses for the transmission of hydrologic data, which is the category that AFWS data come under. There are frequencies reserved strictly for the transmission of hydrologic data. They are dispersed in the VHF band (169.425 to 171.925 MHz) and in the UHF band (406.125 to 412.775 MHz).

2.8.1 Coordination

Both Federal agencies (e.g. National Weather Service) and non-Federal agencies (e.g., counties, cities, etc.) applications must be sent first to the Hydrologic Radio Frequency Coordination Group (HRFCG) prior to submission to the Interdepartment Radio Advisory Committee (IRAC) for Federal agencies and the Federal Communication Commission (FCC) for non-Federal agencies. The HRFCG reviews all applications for use of frequencies in the hydrologic bands, checks for possible impacts on already existing users of the frequencies, and recommends acceptance or rejection, based on its findings. All non-Federal users of these frequencies are secondary to Federal Government station users, and the hydrometeorological data being transmitted must be made available freely on request to government agencies.

The membership of the HRFCG includes representatives from the Tennessee Valley Authority, (TVA) and the Departments of Agriculture, Defense, Energy, Interior, and Commerce. The NWS representative serves as the permanent chairperson of the HRFCG.

2.8.2 Frequencies for Hydrologic Purposes

The HRFCG recommends to the IRAC and to the FCC the assignment of specific frequencies in the bands allocated for use jointly by Federal agencies and non-Federal users for transmission of hydrometeorological data for hydrologic purposes.

2.8.3 Application Process

Applications for use of hydrologic radio frequencies should be sent to:

Hydrologic Radio Frequency Coordinator
National Weather Service, SSMC2 13415
Office of Climate, Water and Weather Services
1325 East-West Highway
Silver Spring, MD 20910-3283
Email: larry.wenzel@noaa.gov

National Weather Service applications should be made through the appropriate NWS Regional Frequency Manager. The approval process can be quite lengthy, usually taking 4-6 months. When establishing new stations, begin the process as soon as site coordinates have been accurately established.

NWS applications will include a memorandum describing the proposed plan of operation and the following information for each proposed station on a Radio Frequency Assignment (RFA). Non-Federal agencies shall submit either a spread sheet or the FCC Form 601. The application consists of the following information:

a. Location name.

b. Type of station (sensing, repeater, base station, etc.) [specify sensing type (precipitation, river stage, etc.) in the remarks column].

c. Location of gages, etc. (latitude and longitude to nearest second).

d. Frequency or frequencies required. Indicate transmitting (T) and receiving (R) frequencies.

e. Output power of transmitter in watts.

f. Antenna characteristics:
   (1) antenna type (yagi, corner reflector, or collinear)
   (2) orientation if directional (three-digit number in degrees from true north or nondirectional, as appropriate)
   (3) gain in decibels (dB).

g. Height of antenna above ground (feet).

h. Gage site (ground) elevation (feet mean sea level [MEAN SEA LEVEL [MSL]).

i. Necessary band width of emission expressed in kilohertz using the letter K in lieu of the decimal (e.g., use 2K85 instead of 2.85 KHz).

j. Emission Classification Symbols (use "F2D").

k. Type of hydrologic data to be transmitted (precipitation, river stage, etc.).

l. Map showing location of transmitting and receiving stations and limits of operational area. A coordinate grid (latitude and longitude) should be shown on the map. When proposed stations are additions to or modifications of an existing network, the map should show the complete system that will exist after pending actions are completed.

m. Justify installation with an explanation of how the collected data will be used and why a radio is to be used in lieu of land lines.

n. Non-Federal agencies must have a letter from a Federal agency verifying that agency is a cooperator in the hydrologic data collection system and data will be provided at no cost to the Federal agency.

All requests for hydrologic frequencies are initially screened for two criteria:

a. The information transmitted must be of a hydrologic nature.

b. Non-Federal agencies must include a letter from a Federal Cooperator as indicated in the application process above.

The HRFCG Coordinator will scan the application into an electronic file (PDF) and resend the file to the HRFCG for review and comment. The group members then check the request against other current applications and records of existing installations and the effect upon each of their agencies' operations and for an appraisal from each member as to the appropriateness of using the hydrologic frequency spectrum for the purpose intended.

If a member of the HRFCG objects to the applicant's proposal, the Coordinator will recommend counter-proposals. When a counter-proposal is acceptable, the Coordinator will then advise the applicant of required revisions to the original proposal in order to overcome the objections.

When the request has received clearance from all group members, the Coordinator advises the appropriate NWS Regional Frequency Manager or the appropriate non-Federal applicant with an electronic letter and advises the IRAC or FCC that formal application may be made. The NWS Regional Frequency Manager submits the application to the NWS Frequency Manager while the non-Federal agency submits the application to the FCC. A copy of the Coordinator's clearance letter must be included by the all applicants to indicate that coordination with the HRFCG has been accomplished.

Applications to IRAC or FCC for frequency assignments are made within 3 months following the HRFCG action; otherwise, requests must be resubmitted to obtain clearance.

Any modification of existing networks or individual stations (where the data supplied under A(1) through (11) are changed) needs to be submitted in writing to the Coordinator. This submission will clearly describe the revised system or network with modifications to the original system or network. According to the nature of the change, the Coordinator will effect the necessary coordination with appropriate committee members for review.

When the authorized frequency assignment(s) are no longer needed by Federal agencies, termination of the operation(s) should be reported through individual agency channels to the IRAC Frequency Assignment Subcommittee or the FCC (non-Federal) in addition to notifying the HRFCG Coordinator.

2.8.4 License Renewal

Licenses are valid for a period of 5 years. The agency that holds the license is responsible for renewing the license before the expiration date. Renewal is accomplished by applying for radio frequency as if for the first time (Sections 2.8.3 or 2.8.4 above). When anticipating license renewals, applicants should initiate requests approximately 6 months before the license expiration date.

2.8.5 Responsibility of Licensee

The agency assigned these authorizations is responsible for the transmissions that take place. If the transmissions cause interference with another project, whoever holds the license will be ordered by the IRAC or FCC to rectify the situation.

CHAPTER 3 - STANDARDS FOR AUTOMATED FLOOD WARNING SYSTEMS

3.1 Overview

The primary purpose of AFWS standards is to ensure compatibility with NWS systems and operations. Any system meeting the standards specified in this chapter could effectively send data to NWS offices and receive products from NWS offices. In addition, these standards describe the sensor transmission system, the sensor communication protocols, and the data and product exchange formats of the "baseline" AFWS. The assumption is that private vendors are likely to market systems providing enhancements beyond this functional baseline, but NWS will not provide software with capabilities beyond the baseline. However, it is the intent of the NWS to structure the baseline software to facilitate the addition of applications to it by individual users. The NWS is free to enhance systems installed in its own offices as resources permit.

Although NWS standards for an AFWS establish technical requirements for compatibility with the NWS, they do not supersede regular policy channels for establishing NWS links to an AFWS under a properly ratified MOU. Meeting the following standards is a necessary but not sufficient condition for exchange of information with the NWS.

3.1.1 Network-Configured System

Through congressional mandate, NWS developed and supported implementation of IFLOWS. The NWS initially developed cooperative agreements with selected Appalachian state emergency services agencies. Under these agreements, NWS (1) develops the system design, (2) provides equipment and software, (3) provides upgrades to software, (4) supports equipment replacement, and (5) provides continuing technical support. Since its initial implementation, IFLOWS technology has expanded into other areas. Each participating state operates and maintains the system within its boundaries. As a result of its continuing involvement in IFLOWS, NWS exercises a significant degree of configuration management authority, both hardware and software and both government and vendor supplied. This is critical to the ability of the NWS to effectively manage IFLOWS.

IFLOWS usually operates as a wide-area network with two-way communication capability (voice, data, and text). These NWS-developed systems include specific software loads that operate in a limited number of hardware environments. The IFLOWS software is available to others outside the IFLOWS program area.

3.1.2 Stand-Alone-Configured System

Configurations of stand-alone, computer-based AFWSs, in particular ALERT systems, are funded, operated, and maintained by many cooperators. There are many vendors who can provide hardware, software, and support for such systems. In most cases, these AFWSs operate in a stand-alone configuration with one-way data collection per community or group of communities.

3.2 ALERT/IFLOWS Gage Formats

Message format for ALERT/IFLOWS observation platforms, as adopted by the NHWC, is:

a. ALERT/IFLOWS data transmissions utilize a frequency shift which represents a "zero" with a 1920 Hz audio tone and a "one" with a 2133 Hz audio tone.

b. ALERT/IFLOWS may use 300 or 1200 baud; however, 300 baud is recommended.

c. Each ALERT/IFLOWS message consists of 40 bits, representing four 8-bit characters, each preceded by a single start bit and followed by a single stop bit. The following table shows the order of transmission reading from **right to left**, then from **top to bottom.**

<-- Transmission Order <--

Stop	0	1	A_5	A_4	A_3	A_2	A_1	A_0	Start
Stop	0	1	A_{11}	A_{10}	A_9	A_8	A_7	A_6	Start
Stop	1	1	D_4	D_3	D_2	D_1	D_0	A_{12}	Start
Stop	1	1	D_{10}	D_9	D_8	D_7	D_6	D_5	Start

where:

$\mathbf{A_i}$ is the i^{th} bit of the reporting sensor address, where A_0 is the least significant bit and A_{12} the most significant.

$\mathbf{D_i}$ is the i^{th} bit of the reporting sensor data (accumulator) value, where D_0 is the least significant bit and D_{10} the most significant.

Start is the start bit for each character. It is always a space (0).

Stop is the stop bit for each character. It is always a mark (1).

This format provides an identifier range of 0 through 8191 and a data range of 0 through 2047. The bits identified with 1 or 0 are used to confirm that an incoming message is formatted in the ALERT/IFLOWS binary code.

d. No check sums or multiple transmissions are utilized in order to minimize interstation interference.

e. All sites will transmit their principal sensor identifier and its current accumulator value at 12-hour intervals.

3.3 ALERT/IFLOWS Functional Capabilities

The radio-reporting rain gage (RRRG), the most common sensor platform found in the AFWS, is a device used to measure and report rainfall from remote locations. It is installed outdoors, unattended, and often in remote or unprotected areas where commercial power is generally unavailable. The RRRG generally consists of a rain gage with a screened funnel and an electro mechanical tipping bucket, a radio-transmitting antenna and an electronics package: a battery-powered, microprocessor-controlled counter and a radio transmitter. When 1 millimeter of rain fills the RRRG's hinged bucket through the top opening of the funnel, the bucket "tips" spilling the water and tripping a switch then it is ready for the next 1 millimeter of rain. That trip count is then transmitted via radio to the base station.

In addition to reporting rainfall in ALERT/IFLOWS message format, various other environmental sensors (such as river stage, wind speed and direction, barometric pressure, temperature, relative humidity, water quality, and soil moisture) are marketed with this reporting format.

3.4 Selected ALERT/IFLOWS Technical Specifications

The microprocessor at a site provides the capability of recognizing and encoding data from the sensors and then transmitting the resulting information in real time on appropriate radio frequencies. The data collection/transmitter package must operate at unpowered, remote sites with a high level of reliability and the lowest possible maintenance requirements. In order to encourage the broadest possible involvement of many diverse organizations, the basic data collection/transmitter package must be as simple, reliable, and low priced as possible. At the same time, it must have the potential for cost-effective modifications that support the operation of a broad range of ancillary hydrometeorological sensors. The most up to date specifications may be obtained from any of the NHWC organizations found at the web site www.alertsystems.org.

CHAPTER 4 - RESPONSE PLANNING GUIDANCE

4.0 Introduction

A flood warning system to be fully effective will include a response plan which shows that the community has procedures for ensuring successful evacuations and that actions are taken to reduce property damages. A good response plan will cover the following elements:

- Warning Dissemination
- Evacuation and Rescue
- Damage Reduction
- Recovery
- Public Information
- Plan Implementation
- Plan Maintenance

4.1 Warning Dissemination Element

Planning Objective: To disseminate warnings which are accurate, timely, and reliable.

a. Establish procedures for distributing warnings and advisories which:

(1) ensure prompt attention to information concerning flood threats;

(2) specify what types of warnings are issued for various possible conditions;

(3) ensure that product content is commensurate with the expected severity of the flood;

(4) ensure that the NWS warnings are disseminated to need-to-know individuals in a timely manner; and

(5) ensure that locally generated advisories are coordinated with NWS.

b. Establish procedures for disseminating information concerning potential flood threats to special need-to-know recipients which:

(1) identify special recipients who are to be notified under various possible conditions of flood threat;

(2) describe the means of communications to be used in alerting each special recipient; and

(3) specify record keeping, acknowledgment, and other processes to assure notices are given and received.

c. Establish procedures for the dissemination of warnings to the general public which:

(1) are adequate to assure all affected persons receive warnings on a timely basis, notwithstanding telephone and power failures;

(2) provide for various levels of warning appropriate to the immediacy and seriousness of the flood threat;

(3) specify the conditions under which each means of warning dissemination will be used;

(4) describe the process by which parties responsible for each means of dissemination are instructed to begin distributing warnings; and

(5) take into consideration the time of day, day of week, or seasonal factors affecting the need for or means of warning dissemination.

4.2 Evacuation and Rescue Element

Planning Objectives: To prevent the loss of life due to flooding or to flood-related causes.

a. Evacuation Area Identification Task

(1) Identify areas that will be inundated at each potential level of flooding due to:

(a) overbank flows; and

(b) entry of floodwaters through sewers, drainage channels, or other means of access.

(2) Identify areas which will be inundated due to internal drainage or ponding unrelated to flood height in streams.

(3) Identify areas requiring evacuation for reasons other than inundation including:

(a) loss of access or escape routes;

(b) loss or curtailment of utility or other emergency services; and

(c) site-specific problems.

b. Evacuation Procedures Development Task

(1) Select evacuation destinations for each area to be evacuated which are:

(a) safe from flooding and other related hazards;

(b) easily identified to the public;

(c) within time and distance commensurate with the warning time; and

(d) suitable for use for the expected duration of flooding.

(2) Identify best available evacuation routes which are:

(a) safe from early flooding due to urban drainage or other impediments;

(b) passable in all weather; and

(c) adequate to handle expected traffic.

(3) Establish priorities for evacuation which take into account:

(a) time of flooding with respect to other areas;

(b) severity of flooding; and

(c) loss of escape routes.

(4) Establish procedures for carrying out evacuation which are consistent with the warning time available including:

(a) ensuring that the affected public is advised of the need to evacuate, safe destinations, routes, and time available for evacuation;

(b) providing general assistance in transportation and in preparing homes and businesses for evacuation;

(c) providing special assistance to those having unusual evacuation needs;

(d) assuring evacuation is complete;

(e) establishing traffic controls to prevent accidental entry into dangerous areas, identifying evacuation routes, and facilitating evacuation traffic; and

(f) establishing surveillance over the evacuation area to ensure safety of the area.

c. Reception Center Operations Task

(1) Estimate the duration, damage, and population affected in the case of a severe flood and determine reception center requirements including.

(a) number of evacuated persons likely to require emergency overnight housing;

(b) number of meals to be served;

(c) type and extent of medical or other care that may be required;

(d) required services, equipment, and supplies for operation; and

(e) required personnel for operation.

(2) Select reception centers which:

(a) are safe under conditions of severe flooding;

(b) have or can be provided with necessary equipment and services;

(c) provide sufficient space for required activities;

(d) are available on short notice for the required duration; and

(e) are readily identifiable to the public and accessible from all areas.

(3) Establish procedures for the operation of reception centers including:

(a) basis on which reception center operations will be activated and terminated;

(b) source and means of providing necessary supplies, equipment, and services;

(c) allocation of space for reception center functions; and

(d) provision of temporary assistance and information on long-term recovery aid.

d. Emergency Action Task

(1) Evaluate the areas subject to flooding or isolation during flood events with respect to the types of emergency activities which may be required including:

(a) emergency evacuation of persons from dangerous areas;

(b) emergency provision of medical attention, fire control, or other assistance;

(c) emergency operation or curtailment of power, water, gas, and other services;

(d) control or containment of toxics, explosive gases, and other dangerous commodities; and

(e) search for survivors.

(2) Determine requirements for conducting emergency actions including:

(a) personnel;

(b) transportation;

(c) heavy-duty equipment (e.g., boats, trucks, earthmovers, and others); and

(d) portable hand tools and other equipment.

(3) Establish procedures for carrying out emergency actions including:

(a) organization of rescue squads;

(b) placement of personnel and equipment for conducting emergency activities;

(c) coordination arrangements for identifying needs for assistance and responding to calls; and

(d) maintenance of communications.

4.3 **Damage Reduction Element**

Planning Objectives: To reduce public and private property damages from flooding or flood-related causes.

a. Flood-Fighting Task

(1) Identify needed flood-fighting actions to reduce overflow, seepage, and other types of flooding as well as erosion due to floodwaters including:

(a) assuring floodgates or sewer outlets are closed;

(b) temporary heightening of levees or floodwalls;

(c) securing of openings in levees and other embankments;

(d) containing overflows through manholes and other openings in the sewer system;

(e) pumping of internal drainage waters; and

(f) control of erosion at bridges, levees, building foundations, and roadway embankments.

(2) Establish flood-fighting procedures to control overflow, seepage, or other types of flooding with respect to:

(a) locations where each action is to be carried out;

(b) maintaining surveillance to determine the need for personnel, equipment, and further actions;

(c) priority for accomplishment; and

(d) extent of action required for various flood heights.

(3) Establish procedures for the evacuation or temporary removal and relocation of automobiles, furniture, valuables, clothes, business and personal records, machinery, and other movable property to reduce damage including:

(a) identification of types of action required at various locations and expected flood heights;

(b) arrangements for the provision of labor and transportation assistance; and

(c) identification of safe locations for storage of property.

b. Utility Management Task

(1) Establish procedures for the curtailment of utility services to flooded areas including:

(a) need for curtailment by area or individual property for each flood height;

(b) means for accomplishing curtailment (i.e., homeowner, utility staff, or other); and

(c) preparations to be made by property owner (within allowable time) prior to evacuation to minimize damage and facilitate the eventual return of services.

(2) Establish utility operation procedures to be used immediately prior to and during floods to:

(a) minimize losses and risks caused by damaged utility systems;

(b) reduce damage done to utility equipment, supplies, and operational capabilities; and

(c) maintain necessary utility services to vital community facilities.

c. Traffic Control Task

(1) Identify needs for traffic control prior to, during, and immediately after floods including:

(a) preventing accidental travel in areas which are or will be flooded;

(b) establishing evacuation routes and speeding evacuation traffic;

(c) facilitating access to evacuation areas for transportation, rescue, and other essential traffic;

(d) preventing use of damaged roadways and bridges; and

(e) controlling access to damaged areas.

(2) Establish procedures for traffic control which:

(a) identify areas to be controlled at each expected flood height;

(b) specify locations where traffic control is to be established;

(c) identify detours or types of control to be effected;

(d) specify placement of personnel, barricades, and signs to effect necessary control and means of enforcement; and

(e) restrict access to flood-damaged areas to residents and other authorized persons.

d. Maintenance of Vital Services Task

(1) Identify police, fire, medical, and other vital community services and facilities with respect to:

(a) location;

(b) vulnerability to interference by inundation, loss of access, or communications;

(c) interdependencies on other services and facilities including utilities;

(d) temporary flood proofing or other actions required to prevent the loss of service or function; and

(e) the need for and means of providing auxiliary power, heat, water, sewage disposal, and other services necessary for continued operation of vital facilities.

(2) Establish operational procedures for police, fire, utility repair, rescue, medical, and other services prior to and during floods including:

(a) placement of equipment and personnel to prevent loss of access due to flooding of roads and underpasses or failure of bridges;

(b) means of relaying calls for assistance and coordinating responses; and

(c) alternate routes for entering areas where traffic is controlled and avoiding evacuation routes.

(3) Establish procedures for evacuation or protection of important records and documents located in areas subject to flooding including those relating to:

(a) vital statistics;

(b) tax and payroll information;

(c) court records;

(d) utility records;

(e) property ownership; and

(f) business records.

4.4 Recovery Element

Planning Objectives: To initiate and carry out post-flood actions to maintain public health, return community services to normal at the earliest possible time, provide aid, and assist in recovery operations.

a. Maintenance of Public Health Task

(1) Establish procedures for handling of the dead including:

(a) morgue location and method of operation;
(b) handling of personal effects; and
(c) identification and release of bodies.

(2) Establish procedures for actions to preserve public health including:

(a) provision of emergency medical services and care for injured persons;

(b) procedure for locating missing persons and providing information to friends and relations;

(c) collection and destruction of contaminated foodstuffs;

(d) disinfection of private water supply sources and systems;

(e) inoculations and other preventive medical care;

(f) disease control; and

(g) control of insects, rodents, and other pests.

b. Return of Services Task

(1) Establish procedures for actions to resume provision of utility services including:

(a) preparations to be made by property owners;

(b) system preparations including decontamination of water supplies;

(c) sequence for returning services; and

(d) priority for resuming services.

(2) Establish procedures for returning to normal traffic patterns including:

(a) evaluation of road and bridge safety;

(b) debris clearance; and

(c) priority for providing access.

c. Rehabilitation and Repair Task

(1) Establish procedures for post-flood cleanup including:

(a) clearing, collecting, and disposing of debris and discarded goods;

(b) street washing;

(c) pumping basements; and

(d) returning material previously relocated for safekeeping.

(2) Establish procedures for management of damaged structures including:

(a) procedures for identification and evaluation of damage; and

(b) demolition or temporary repair of hazardous buildings.

(3) Identify the sources and programs for recovery assistance and the means of obtaining each including:

(a) volunteer organizations;

(b) mutual aid agreements;

(c) state assistance; and

(d) Federal assistance.

(4) Establish procedures for mobilizing assistance from each available source including:

(a) conditions under which requests for assistance will be made;

(b) channels to be followed in requesting assistance; and

(c) preparation of necessary requests, disaster declarations, or other documentation required as a condition of assistance.

4.5 Public Information Element

Planning Objectives: To develop community awareness and understanding of the flood hazard and to prepare for the accurate and timely provision of information during flood emergencies.

a. Community Education Task

(1) Prepare the materials for and carry out a continuing public information program, including letters to residents in evacuation areas to increase community awareness of floods and evacuation area residents' knowledge with respect to:

(a) the source, nature, frequency, and potential severity of floods;

(b) the community's system for flood recognition and dissemination of warnings to the public;

(c) the meaning of various types of warning announcements, siren signals, and/or evacuation notices;

(d) the areas likely to be inundated or evacuated at each level of expected flooding;

(e) procedures for evacuation including preparations for evacuation, routes, safe destinations, and identification of reception centers;

(f) actions which can be taken by property owners to reduce damages, including moving furniture and valuables, curtailing electrical power and gas service, and temporary flood proofing;

(g) means of requesting identification as a special warning recipient or receiving special assistance in evacuation; and

(h) safety and remedial actions to be taken when returning to flood-damaged buildings.

(2) Prepare and carry out a continuing program to provide technical information to those wishing to employ temporary flood proofing measures or needing to develop more detailed subplans for warning dissemination, evacuation, and damage reduction including:

(a) identification of areas where the depth and velocity of expected flooding and opportunities for egress enable the use of temporary flood proofing measures;

(b) procedures for temporary flood proofing;

(c) relation between forecast flood heights and on-site depths; and

(d) guidelines and criteria for warning dissemination and evacuation plans for hotels, motels, hospitals, and/or other facilities requiring more detailed arrangements.

b. Emergency Information Task

(1) Identify the types of emergency information to be conveyed to the public in the period prior to, during, and immediately following a flood including:

(a) early watches, warnings, and evacuation notices, worded appropriately to obtain maximum public response;

(b) information on actions to be taken, location of safe areas and areas to be avoided, location of reception centers, and ways of obtaining emergency assistance;

(c) actions being taken or to be taken to deal with the flood;

(d) calls for labor, equipment, or other types of assistance needed for evacuation, damage reduction, and/or recovery activities; and

(e) information concerning sources and availability of recovery assistance.

(2) Identify the means and procedures to be used in communicating each type of information with respect to:

(a) form and content of each type of message;

(b) handling of flood warnings and other related messages;

(c) source and verification of messages; and

(d) interfacing of communications equipment.

(3) Prepare warning announcements for use in various potential circumstances and expected flood heights which:

(a) provide specific information and instructions;

(b) reference an authoritative and familiar source; and

(c) ensure an immediate and adequate response to warning messages by the public and responsible officials by considering the various factors governing warning confirmation and warning belief.

4.6 Plan Implementation Element

Planning Objectives: To develop the administrative arrangements necessary for effective implementation of the flood preparedness plan.

a. Resource Identification Task

(1) Identify type and amount of resources required for implementing the plan including:

(a) technical, administrative, and other personnel;

(b) equipment and supplies; and

(c) facilities.

(2) Identify the sources of personnel, equipment, supplies, and facilities for implementing the plan including:

(a) community resources;

(b) private resources;

(c) assistance through mutual aid agreements; and

(d) Federal and/or state assistance.

b. Responsibility Allocation Task

(1) Evaluate each aspect of plan implementation with respect to:

(a) actions requiring detailed and specific assignments of responsibility; and

(b) actions suitable for assignment on an organizational basis.

(2) Assign responsibility for implementation of each aspect of the plan including:

(a) instructions as to how, when, and by whom implementation is to be assured;

(b) requirements for any necessary subplans or supplemental procedures; and

(c) establishment of a chain of command to ensure plan implementation will proceed in the absence or incapacity of key personnel.

c. Coordination Task

(1) Establish procedures for coordination of local governmental actions through an emergency operations center, if available, or other mechanisms including:

(a) identification of responsibilities to be assigned to the center;

(b) operational procedures for staffing and operation of the center to carry out the assigned responsibilities; and

(c) procedures for activation and termination of the center.

(2) Establish necessary arrangements, including mutual aid agreements, for use of facilities, equipment, personnel, and services necessary for implementation of the plan including:

(a) location of river and rainfall gages, participation of observers, and receipt of information from upstream areas;

(b) land rights for flood fighting and other purposes;

(c) use of reception centers, hospitals, and areas for property storage;

(d) use of vehicles for evacuation or movement of property;

(e) participation of volunteer organizations; and
(f) provision of necessary supplies, materials, construction equipment, and other items.

(3) Establish procedures to coordinate the local plan fully with state and other local plans for emergency operations including:

(a) integration with regional or statewide flood warning systems and communication networks, state flood disaster plans, and other local natural disaster plans;

(b) coordination of evacuation plans with those for flood control, particularly where closure of floodgates in levees or floodwalls may affect escape routes; and

(c) coordination with the NWS with respect to use of all available information and issuance of warnings.

(d) Other agencies with whom to consider coordination are;

U.S. Army Corps of Engineers	http://www.usace.army.mil/
U.S. Bureau of Reclamation	http://www.usbr.gov/main/
Natural Resources Conservation Service	http://www.nrcs.usda.gov/
U.S. Geological Survey	http://www.usgs.gov/
Tennessee Valley Authority	http://www.tva.gov/
Federal Emergency Management Agency	http://www.fema.gov/
National Park Service	http://www.nps.gov/
State Agencies	
Association of State Floodplain Managers	http://www.floods.org/
National Hydrologic Warning Council	http://www.alertsystems.org
ALERT Users Group	http://www.alertsystems.org
Southwest Association of ALERT Systems	http://www.alertsystems.org
ALERT~IFLOWS	http://www.alertsystems.org

(4) Establish procedures to guide and coordinate more detailed site-specific planning for warning dissemination, evacuation, and damage reduction in public and private buildings including:

(a) process for identifying locations where such plans are necessary;

(b) minimum elements and appropriate level of detail to be included in planning; and

(c) provision of technical assistance in planning.

4.7 Plan Maintenance Element

Planning Objectives: To update, extend, and improve the flood response plan and to ensure readiness for executing the plan.

a. Plan Updating Task

(1) Establish procedures and schedules for plan contents subject to rapid obsolescence including:

(a) addresses, telephone numbers, and names of key participants;

(b) assignments of responsibility;

(c) changes in flood potential;

(d) areas requiring evacuation;

(e) availability of facilities for reception centers;

(f) evacuation routes and priorities;

(g) flood-fighting requirements;

(h) utility extensions or system modifications; and

(i) traffic control requirements.

(2) Establish procedures for updating of plan contents based on specific events such as:

(a) construction of or modification in the operation of upstream water control structures which affect the height, severity, or time of flooding;

(b) natural or unplanned events which modify the flood potential; and

(c) construction or modification in the operation of facilities in or downstream of the community which increases the height, severity, or duration of floods.

b. Plan Improvement Task

(1) Describe needed and planned extensions of the warning system and response plan including:

(a) coverage of additional area; and

(b) incorporation of elements, tasks, and subtasks omitted from the initial plan.

(2) Describe needed and planned refinements to the warning system and response plan including:

(a) provision of additional observers, gages, and flash flood alarms to improve the flood recognition system;

(b) more detailed identification of areas to be evacuated;

(c) strengthening of communications involved in all aspects of the plan; and

(d) development of additional subplans for various affected organizations and locations.

(3) Establish procedures for the critical evaluation of performance in real and simulated implementation of the plan including:

(a) process for initiation, organization, and conduct of the evaluation; and

(b) process for modification of the plan based on findings of the evaluation.

c. Plan Practice Task

(1) Establish procedures and schedules for testing those aspects of the flood warning system and response plan which are susceptible to periodic use such as:

(a) procedures for communication with observer networks, the NWS, and other Federal offices, special warning recipients, organizations, and officials responsible for warning dissemination and plan execution, and others as may be appropriate;

(b) communications equipment including sirens, radio transmitters and receivers, flash flood alarm circuits, and others, with particular attention to battery-powered equipment;

(c) auxiliary sources of electrical power and other services;

(d) procedures for activating the emergency operations center, sending and receiving observer reports, handling messages, preparing forecasts, disseminating warnings, placing equipment and personnel for evacuation and rescue, protecting vital facilities, and other steps in execution of the plan;

(e) availability and operational status of equipment for evacuation, rescue, and damage-reduction activities; and

(f) availability and procedures to use key maps, lists, and other important plan documentation.

(2) Establish procedures and schedules for periodic simulation of those aspects of the warning system and response plan not susceptible to direct testing such as:

(a) decisions to issue warnings or direct evacuation;

(b) evacuation;

(c) implementation of traffic control procedures;

(d) activation of reception centers;

(e) curtailment of utility services; and

(f) procedures for rescue, handling of injuries and casualties, and public health measures.

CHAPTER 5 - SOFTWARE

5.0 Introduction

There are several software packages for collecting hydrometeorological data from commercial vendors, and information about them may be obtained from the National Hydrologic Warning Council web site http://www.alertsystems.org. A description of the IFLOWS software for AFWSs that is available from the NWS and how to obtain it follows.

5.1 IFLOWS Software

IFLOWS software has two major functions: real-time software processing, and user applications. The real-time software acquires, verifies, stores, and distributes sensor data, text messages, and NWS products. The application software allows the user to view data, set alarms, and send and receive text messages to other sites in the network. IFLOWS software also provides data feeds from the cooperator networks to NWS AWIPS via LDAD. IFLOWS software is currently used in cooperator networks in KY, NC, NY, PA, TN, VA, and WV, and at NWS WFOs with forecast responsibilities in these states.

NWS continues to support existing IFLOWS software configurations using contractor support. The IFLOWS Program Office (NWS Office of Climate, Water and Weather Services) is responsible for handling requests for IFLOWS software from those not directly cooperating in the IFLOWS Program. These requests may be forwarded to the address below:

National Weather Service Headquarters
Office of Climate, Water and Weather Services
IFLOWS Program Office
1325 East-West Highway
Silver Spring, MD 20910

IFLOWS is currently undergoing a communications and software design and configuration change that will make raw data available from all IFLOWS cooperator networks via the Internet. When this reconfiguration is complete, users will no longer be bound to a particular software package. Any software capable of processing ALERT data will be able to use the realtime IFLOWS database to support user applications. In addition, the NWS intends to provide web browser-based functionality that will allow existing cooperators to replace their stand alone IFLOWS software, if desired. The reconfiguration will also enable NWS to feed IFLOWS gage data directly to LDAD via the Internet, thereby eliminating the need for a stand alone PC at each WFO that requires IFLOWS data.

5.2 IFLOWS Technical Support

The NWS can provide technical assistance to cooperators using IFLOWS software. All participants in the IFLOWS Program are expected to develop a level of understanding of the software to deal with its day-to-day use. The NWS will support training of both NWS and

cooperator focal points as new versions of IFLOWS software are released. If an NWS WFOs experiences a problem with a cooperator IFLOWS network, the appropriate NWS office should contact the manager of the network.

CHAPTER 6 - SELECTED REFERENCES

6.0 Introduction

This section lists references on AFWSs and response planning.

6.1 References

Hydrology Subcommittee of the Federal Interagency Advisory Committee on Water Data. August 1985. *Guidelines on Community Local Flood Warning and Response Systems.*

National Weather Service, Office of Hydrology. August 1993. *Integrated Flood Observing and Warning System Management Guide.* Department of Commerce, NOAA, Silver Spring, Maryland.

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Owen, H. James. 1977. *Guide for Flood and Flash Flood Preparedness Planning*. Prepared for Department of Commerce, NOAA, National Weather Service, Silver Spring, Maryland.

Owen, H. James. 1979. *Information for Local Officials on Flood Warning Systems*. Prepared for Department of Commerce, NOAA, National Weather Service, Silver Spring, Maryland.

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APPENDIX A

SAMPLE MEMORANDUM OF UNDERSTANDING FOR

AUTOMATED FLOOD WARNING SYSTEMS (AFWS)

This sample Memorandum of Understanding for an Automated Flood Warning System contains the core responsibilities of both the Cooperator and the National Weather Service (NWS). Additional responsibilities, such as those related to the Cooperator donating or loaning base station equipment to the NWS, must be included.

MEMORANDUM OF UNDERSTANDING

BETWEEN THE

CITY OF DAVENPORT, STATE OF IOWA

AND

THE NATIONAL WEATHER SERVICE
OF THE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION,
AN AGENCY OF THE U.S. DEPARTMENT OF COMMERCE

FOR A

LOCAL FLOOD WARNING SYSTEM

IN DAVENPORT, IOWA

This Memorandum of Understanding between the National Weather Service of the National Oceanic and Atmospheric Administration (NWS/NOAA), an agency of the U.S. Department of the Commerce, and the City of Davenport located in the State of Iowa (Cooperator) is undertaken for the development and operation of a Local Flood Warning System (LFWS), also known as an ALERT (Automated Local Evaluation in Real Time) System.

The Parties, providing their best assurances, represent that they have a mutual interest in identifying and formalizing the basic flood control, forecasting and warning support services to be provided under this Agreement. The costs associated with this project have been equitably apportioned with each party bearing the costs associated with its participation. This agreement does not involve the transfer of funds between parties. All costs incurred by the parties under this agreement are subject to the availability of appropriated funds.

1. **Legal Authority**

NWS/NOAA's authority to conduct its meteorological and flood forecasting operations and activities is derived from several different sources:

15 U.S.C. § 313 et seq., which provides that the National Weather Service, under the direction of the Secretary of Commerce, shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation...the distribution of meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties; and

15 U.S.C. § 1525, the Department of Commerce's Joint Project authority.

2. **Purpose of Agreement**

The purpose of this agreement is to establish and outline the respective responsibilities of each Party in developing and implementing a program for the installation and operation of a LFWS for Duck Creek in and near the City of Davenport located in the State of Iowa, for the purpose of providing advance warning of (flash) flooding in the City of Davenport.

This project is necessary and essential to further the mission of the NWS/NOAA in that it will provide stage and rainfall data gaging the hydrologic activity in the Duck Creek area, which is needed to produce a specific forecast for residents along the Duck Creek.

The NWS/NOAA has determined that this project cannot be done at all or done as effectively without the participation of the City of Davenport, because they are the owners of the equipment used to monitor the creek and the providers of the data the NWS, without which the NWS would not be able to monitor the hydrologic activity in the Duck Creek basin.

3. **Responsibilities of the Cooperator**

A. Ensure development and operation of an emergency response plan prior to or concurrent with the execution of this MOU that includes:

- coordination with the NWS; and
- dissemination of warnings to the public.

B. Install, maintain, and operate the LFWS, including both hardware and software, at:

- the City of Davenport's emergency operations center,
- the NWS's base station at the Quad Cities National Weather Service Office, and
- field sensor and transmitter locations.

C. Provide calibration of the LFWS software hydrologic model on an ongoing basis.

D. Arrange for volunteer network observers that can provide rainfall and/or flood information and act as backup should automated equipment fail.

E. Provide training in a timely manner to the NWS on the operation of the LFWS, including changes and/or upgrades to the system.

F. Designate, by name or position, who shall act for the Cooperator as the local representative, designating also at least one back-up representative.

G. Establish an emergency operations center for the purpose of:

- receiving and recording all reports and flood conditions,
- promptly relaying or making available all such reports to the designated Cooperator's representative,
- serving as the official distribution point for all warnings and statements issued by or for the designated Cooperator's Flood Warning Coordinator.

  When emergency conditions and lack of time prevent warnings being issued by the NWS, the designated local official(s) shall be prepared to issue appropriate warnings, ensuring that, in addition to general public distribution, flood warnings or statements reach warning action points as listed in the Cooperator's response plan, and relaying stream and rainfall reports, flood data, and warnings to the Quad Cities NWS office as soon as possible after local requirements have been satisfied.

H. Monitor the LFWS and immediately notify the NWS of any significant problems.

I. Review annually with the NWS this MOU and the response plan, updating as necessary.

J. Conduct an annual drill, in coordination with the NWS, to test the system.

4. **Responsibilities of the National Weather Service**

A. Designate a primary NWS contact point (focal point), and at least one back-up contact point at the Quad Cities National Weather Service office, for routine coordination concerning LFWS training, maintenance, operations, and related issues. During flooding, the forecaster on duty is the primary NWS contact point.

B. Assist in selection of equipment appropriate to the LFWS.

C. Provide assistance in rain and stream gage site location.

D. Develop a self-help forecasting procedure in conjunction with the North Central River Forecast Center as data become available for use as backup for the primary procedure developed by the cooperator.

E. Utilize data from the LFWS and provide hydrometeorological forecast and warning service for the area served by the LFWS.

F. Provide appropriate warning distribution over NOAA Weather Wire Service, NOAA Weather Radio, and other NOAA product dissemination systems.

G. Provide training for the Cooperator's flash flood coordinators and local authorities, including network observers.

The scope of the training includes:

- the NWS flood/flash flood warning program
- local flood warning programs
- the need for emergency response planning
- how to establish and maintain observer networks, and
- periodic drills to test the system.

H. Conduct an annual drill, in coordination with the Cooperator, to test the system.

5. **TITLE TO EQUIPMENT**

Title to any equipment purchased under this Agreement shall remain vested with the purchaser of that equipment.

6. **RESOURCE REQUIREMENT**

No transfer of financial resources will occur under this Agreement. In the event that either party to this Agreement anticipates funding limitations that would result in the failure to meet all or any portion of their responsibilities, the responsible party will promptly notify the

appropriate contact person for this Agreement. Pursuant to each Party's in-kind contributions (to be attached hereto as Attachment A), all costs incurred by the Parties under this Agreement shall be equitably apportioned among the Parties, with each Party bearing its own costs of performance under this Agreement. Additional responsibilities by either party are listed on an Addendum attached hereto and made a part hereof.

Due to the nature of this agreement and the mutual benefit provided to both Parties, completion of each Party's responsibilities under this Agreement is subject to the availability of appropriated funds. Each Party will be responsible for obtaining its own funding for the activities agreed upon by the Parties. If adequate appropriations are not forthcoming, the Parties may terminate this Agreement upon mutual written consent.

7. **DURATION OF AGREEMENT, TERMINATION, AND AMENDMENTS**

Duration: This Agreement is rendered effective on the date of the last signature shown below upon execution by the Parties hereto. This Agreement shall be reviewed annually and updated if necessary. The Agreement shall remain in force until completion of the tasks identified herein, but will not be effective for a period in excess of five (5) years from the effective date. This agreement is subject to the availability of appropriated funds.

Termination: Any Party may terminate this agreement by providing 60 days written notice to the other party. All equipment shall be returned within 60 days to the purchasing Party of such equipment. Equipment shall be returned in the condition it was as the time of termination.

Amendments: On a quarterly basis, both agencies may reassess, study needs, funding availability, and public benefit and may reaffirm, revise, or create amendments or addenda to this Agreement, when signed by both Parties. The Agreement may be amended at any time by mutual consent of the Parties. Additional responsibilities by either Party are listed on an Addendum attached hereto and made a part hereof. Changes and/or modifications to this agreement shall be in writing.

IN WITNESS THEREOF, the Parties have duly acknowledged the aforementioned representations and executed this interagency agreement.

AGREED TO AND BY:

COOPERATOR - CITY OF DAVENPORT, IOWA

BY:_____

NAME:_____

TITLE:_____

ADDRESS: _____

_____

DATE:_____

NATIONAL WEATHER SERVICE

BY:_____

NAME:_____

TITLE:_____

ADDRESS: _____

_____

DATE:_____

Attachment

Attachment A

In-Kind Contributions From Each Party

City of Davenport: Has a base station and server, which is located in the city storm water office. The City paid for some of the flood studies and has purchased 5 ALERT Hydrolink gages. Two (2) of the five Hydrolink gages are for stage and rainfall. The remaining three (3) gages are for rainfall only. (TOTAL Value of Party's Contribution: $38,500.00)

NWS/NOAA: Will be using the LDAD or other computer to dial into the city's server and download the data. Data will be ingested into AWIPS and used to make forecasts, and to check radar estimated rainfall. No additional phone lines are required, IT focal points will be scripting the data. Final data ingest will be ported to our webpage as a provisional data page (similar to USGS) for display by web focal point.
(TOTAL Value of Party's Contribution: $38,500.00)