Implementing Arrangement #19

Development of a High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) System
Pursuant to the
Agreement between the American Institute in Taiwan
and the
Taipei Economic and Cultural Representative Office
in the United States
for
Technical Cooperation in Meteorology and Forecast Systems Development

Article I - Scope

This Implementing Arrangement describes the scientific and technical activities to be undertaken by the American Institute in Taiwan (AIT), through its designated representative, the Global System Division (GSD), (formally the Forecast Systems Laboratory) of the Earth System Research Laboratory (ESRL) of the National Oceanic and Atmospheric Administration (NOAA), United States Department of Commerce. It provides for continuing development of the forecast system being developed by the Joint Forecast Systems Project. This project is a cooperative effort between AIT's designated representative, NOAA/ESRL/GSD, and the Central Weather Bureau (CWB), the designated representative of the Taipei Economic and Cultural Representative Office in the United States (TECRO). This Implementing Arrangement is of mutual interest to both AIT and TECRO, hereafter referred to as the parties. The products of this implementing Arrangement will provide substantial value through development of new and upgraded capabilities and applications that can be integrated into other NOAA/ESRL/GSD systems.

Article II - Authorities

The activities described in this Implementing Arrangement will be carried out under the general terms and conditions established by the Agreement between the American Institute in Taiwan and the Taipei Economic and Cultural Representative Office in the United States for Technical Cooperation in Meteorology and Forecast Systems Development (AIT-TECRO Agreement), and any subsequent revision as agreed to by the parties. This Implementing Arrangement is the nineteenth such arrangement under a succession of umbrella agreements between AIT and TECRO.

This Implementing Arrangement is hereby attached to that Agreement and becomes part of the Agreement.

Article III - Services

During the period of Implementing Arrangement #19, AIT's and TECRO's designated representatives respectively, the NOAA/ESRL/GSD and CWB joint team, will focus on two tasks: (1) the development of a High-resolution Quantitative Precipitation Estimation and

Quantitative Precipitation Forecast (HRQ2) System, and (2) continuing interaction on earlier cooperative projects. Tasks under this Implementing Arrangement range from full scale developmental collaboration to system upgrades and support that allow systems to operate with the latest technical and scientific capabilities and specifications. These ongoing activities, described in more detail in the Statement of Work, will include the following two tasks:

Task #1 - High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) System

During Implementing Arrangement #18, AIT's and TECRO's designated representatives, NOAA/ESRL/GSD and CWB respectively, continued to focus on the Quantitative Precipitation Forecast (QPF) for water accumulation and debris flow based on a new advanced 3D variational (3DVAR) data assimilation scheme as NOAA/ESRL/GSD's part of HRQ2 task. This new task will support the operational needs from threats from flash flood, debris flow and landslide. Motivated by CWB's request to establish a 3-D variational approach for the model initialization, AIT's and TECRO's designated representatives, NOAA/ESRL/GSD and CWB respectively, selected to implement the GSI (Gridpoint Statistical Interpolation) analysis system which is used operationally by NOAA/NCEP (National Centers for Environmental Prediction). The GSI package is customized for CWB for the input data format in order to ingest CWB's own data. The initial CWB GSI package was tested and evaluated near the end of June 2006 with radar data and conventional observation data. GSI is set up for ingest of both radar radial velocities and satellite radiance data. For work in 2007, an effort will be required to assess the availability of satellite radiance data from geosynchronous or polar orbiting satellites and to write the software to deliver this to GSI. Satellite radiance data will enhance the analysis in the oceanic areas surrounding Taiwan. Before GSI can be utilized for short term precipitation forecasting, a diabatic scheme similar to that already in LAPS must be added to the GSI capability. During Implementing Arrangement #19, NOAA/ESRL/GSD and CWB will continue to include additional new observation data available for LAPS GSI.

GSI has the capability of ingesting model error statistics (variances) for optimizing its analysis. For this time phase, the ensemble error statistics are made up of sequential runs of the background model (either NFS15 or WRF). Error will be recovered from an independent analysis and statistics generated. These statistics will be updated within GSI to optimize the analysis at any time.

The new focus is to adopt a multiscale 3DVAR analysis scheme called STMAS (Space and Time Mesoscale Analysis System) as part of LAPS III for surface observations and other remote sensing data such as radar data. STMAS will be extended to 3DVAR and eventually a 4DVAR approach. In its 3DVAR version, STMAS will provide multiscale analysis using an inhomogeneous observation distribution. Like GSI, STMAS can make use of updating error statistics and can be configured with a diabatic capability. These two large efforts (GSI and STMAS) may need to be prioritized by CWB management.

STMAS uses a sequence of variational minimization in both the space and time domains to obtain multi-scale grid analysis, which cannot be done through a single 3DVAR

analysis. At NOAA/ESRL/GSD, STMAS is currently running every 15 minutes in real time using dense surface observation data. The STMAS analysis provides a good verification tool for high resolution model forecasts.

During Implementing Arrangement #19, AIT's and TECRO's designated representatives, NOAA/ESRL/GSD and CWB respectively, will extend STMAS development from using only surface data to include remote sensing data from CWB's advanced radar network, and maybe satellite data. The goal is to develop STMAS as an advanced operational nonlinear analysis tool at CWB in Taiwan to improve local analysis and more importantly provide a prediction system during severe weather. An advantage of STMAS is that it has been developed at NOAA/ESRL/GSD and is not subject to unexpected changes or upgrades as would be GSI.

NOAA/ESRL/GSD has developed and accessed techniques to measure atmospheric Integrated Precipitable Water (IPW) values using ground-based Global Positioning System (GPS) receivers since 1993. The NOAA GPS-IPW network currently consists of 405 sites. There are three types of sites in the network; NOAA Wind Profilers Sites (NPN), Other NOAA Sites (ONS), and Other Agency Sites (OAS). The network is controlled by a software processing system developed by NOAA/ESRL/GSD. The current ground-based GPS-Met observing software system consists of data acquisition, geodetic modeling, IPW processing and data evaluation, display and dissemination.

During Implementing Arrangement #19, AIT's and TECRO's designated representatives, NOAA/ESRL/GSD and CWB respectively, will ingest GPS observation data from the CWB GPS-Met network and process these data using the current NOAA GPS-Met Observing System. NOAA/ESRL/GSD then will transfer IPW values back to CWB for evaluation.

AIT's designated representative, NOAA/ESRL/GSD, understands that the National Severe Storms Laboratory (NSSL) will continue research towards the refinement, development, and maintenance of applications required for the Central Weather Bureau (CWB), Water Resources Agency (WRA) and the Soil and Water Conservation Bureau (SWCB) operations. The NSSL research is directed towards improving the monitoring and prediction of flash floods and severe storm identification and short-term forecasting for the Taiwan environment. The NSSL research and development for IA#19 will focus the implementation of advanced QPE and VSQPF techniques as per: 1) implementation of a new HRQ2 infrastructure and code set, 2) the implementation of an advanced radar quality control specifically tuned for the Taiwan environment; 3) 500 meter resolution product generation; 4) assessment in using dual polarization radar for radar intercomparison and calibration; 5) verification and assessment of application performance.

<u>Task #2 - Continuing Interaction on Earlier Cooperative Projects</u>

Several earlier cooperative tasks have been completed. Technology has been transferred successfully and is beginning to be used operationally at CWB. NOAA/ESRL/GSD's development activities in these areas continue, and further NOAA/ESRL/GSD-CWB

interaction is important to keep CWB staff up-to-date on current developments. This task will allow continuing interaction at an appropriate level, including new software releases of the forecast information system including the AWIPS/D2D (OB7), radar display using D2D to replace POP, dual head display support, advanced ALPS training by NOAA/ESRL/GSD, AFPS text formatter technical support, and Internet-based forecast workstation (FX-C) with advanced drawing capability with touch screen support, NOAA data support, visitors training, exchange of visits, copying papers and reports, and e-mail interaction.

Article IV - Responsibilities of AIT

In addition to participation in the joint project team, AIT, through its designated representative, NOAA/ESRL/GSD shall:

A. Provide overall coordination project activities at the NOAA/ESRL/GSD facility in Boulder, Colorado;

B. Provide administrative support for preparing reports for delivery to TECRO's designated representative, CWB, in accordance with this Implementing Arrangement;

C. Assign appropriate staff to perform the activities defined in this Implementing Arrangement and provide support in accordance with the terms of the umbrella agreement; and

D. Fulfill its responsibilities under the Statement of Work for Implementing Arrangement #19.

Article V - Responsibilities of TECRO

In addition to participation in the joint project team, TECRO through its designated representative, CWB shall:

A. Provide overall coordination for project activities at the CWB facilities;

B. Assign appropriate staff to perform the activities defined in this Implementing Arrangement and provide support in accordance with the terms of the umbrella agreement; and

C. Fulfill its responsibilities under the Statement of Work for Implementing Arrangement #19.

Article VI - Financial Provisions

In accordance with the AIT-TECRO Agreement, TECRO is required to reimburse AIT for all costs incurred by AIT's designated representative, NOAA/ESRL/GSD, in association with the project covered by this Implementing Arrangement. AIT shall transfer to NOAA/ESRL/GSD all payments made by TECRO to AIT for costs incurred by NOAA/ESRL/GSD in association with this Implementing Arrangement.

The total cost for activities described in this Implementing Arrangement is mutually agreed to be U.S. $850,000. TECRO agrees to transfer fifty percent of the funds to AIT in advance, with the remaining fifty percent to be transferred upon completion of the year's activities, to the extent that funds for this purpose have been provided by TECRO.

The performance by AIT's designated representative of activities under this Implementing Arrangement is subject to the availability of funds.

Article VII - Intellectual Property Considerations

No intellectual property considerations are expected to arise in conjunction with activities described in this Implementing Arrangement. Existing system designs and computer software of the NOAA/ESRL/GSD Forecast System are in the public domain. Reports, specifications, and computer software prepared under this Implementing Arrangement also will be in the public domain once NOAA and CWB have approved them in final form.

Article VIII - Effective Date, Amendment, and Termination

This Implementing Arrangement is effective on the date of the last signature hereto and will terminate on March 30, 2009. This Implementing Arrangement may be amended by mutual written consent of the parties, and may be terminated by either party by providing 60 days written notice to the other party. The estimated completion date for the activities described in this Implementing Arrangement is June 30, 2008.

FOR THE AMERICAN INSTITUTE IN TAIWAN

Barbara J. Schrage

Barbara Schrage
Managing Director

11/5/07

Date

FOR THE TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE IN THE UNITED STATES

11/26/07

Date

Statement of Work
For Implementing Arrangement #19
Development of a High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) System

Between the American Institute in Taiwan
and the
Taipei Economic and Cultural Representative Office in the United States

1.0 - Background and Objectives

This Statement of Work addresses tasks that will be undertaken by the joint team of the Global Systems Division (GSD) of the Earth System Research Laboratory, (ESRL), the designated representative of the American Institute in Taiwan (AIT) and personnel of the Central Weather Bureau (CWB), the designated representative of the Taipei Economic and Cultural Representative Office in the United States (TECRO) in accordance with the terms of Implementing Arrangement #19 of the Agreement between the American Institute in Taiwan and the Taipei Economic and Cultural Representative Office in the United States for Technical Cooperation in Meteorology and Forecast Systems Development, which provides for technical cooperation between AIT's designated representative, the U.S. National Oceanic and Atmospheric Administration's Global Systems Division (NOAA/ESRL/GSD), and TECRO's designated representative, the Taiwan Central Weather Bureau (CWB). The two designated representatives cooperate on the development of meteorology and forecast systems.

The WFO-Advanced system currently under development at NOAA's GSD of the ESRL in Boulder, Colorado, has been deployed as an essential part of the AWIPS (Advanced Weather Interactive Processing System) for the U.S. National Weather Service (NWS). The WFO-Advanced system development has been a very important cooperative activity between NOAA/ESRL/GSD and CWB.

The WFO-Advanced system is a realization of the generic FX-Advanced (GSD X-window Advanced) system. Figure 1 illustrates the WFO-Advanced components:

- National and local data feeds
- GSD's Local Analysis and Prediction System (LAPS)
- Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPE-SUMS)
- Geographical Information System (GIS) data
- The interactive display system (D2D)
- The AWIPS Forecast Preparation System (AFPS)
- 3-D visualization
- Hydrological applications developed at the NWS Office of Hydrology
- A component that contains General X applications

- Local Data Acquisition and Dissemination System (LDAD)

Two tasks are included in the Statement of Work: (1) the development of a High-resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) System, (2) continuing integration on earlier cooperative projects, such as data support and forecast workstation upgrade.

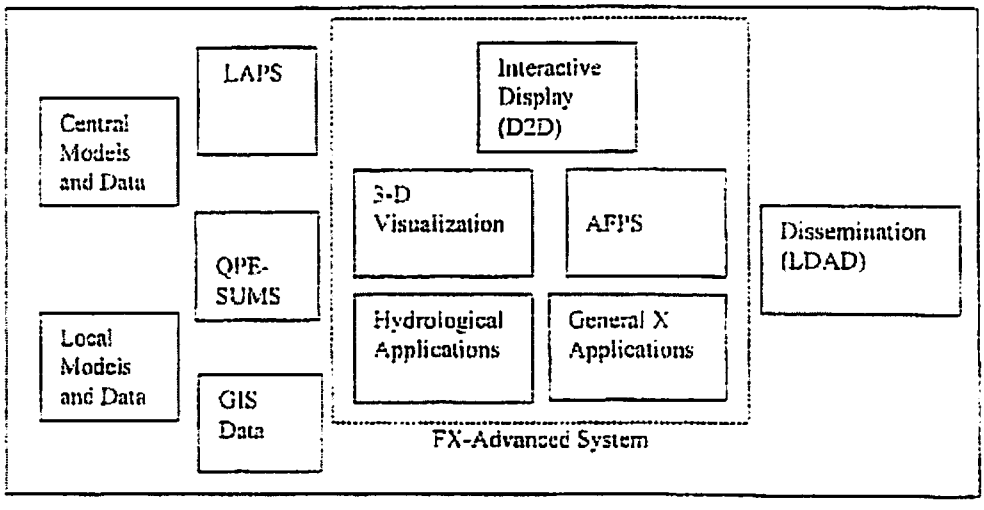

Figure 1 WFO-Advanced

The tasks will be undertaken by the NOAA/ESRL/GSD-CWB Joint Team as the designated representatives of AIT and TECRO working at the NOAA/ESRL/GSD facility in Boulder, Colorado, and by CWB staff at the CWB facility in Taipei, Taiwan, as appropriate. This Statement of Work addresses only tasks that will be undertaken by the NOAA/ESRL/GSD-CWB Joint Team under the terms of Implementing Arrangement #19. It describes the performance period, deliverables, and resource requirements.

2.0 - Task Descriptions

In terms of the overall program schedule, the following two tasks have been identified as being critical during the January 1 to December 31, 2007, time period. These are listed below, along with the estimated proportion of resources that is to be allocated to each task.

- Task #1 – High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) System
- Task #2 – Continuing interaction on earlier cooperation projects

These two tasks are described in more detail below.

Task #1 - High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) System

During Implementing Arrangement #18, NOAA/ESRL/GSD and CWB continued to focus on the Quantitative Precipitation Forecast (QPF) for water accumulation and debris flow based on a new advanced 3D variational (3DVAR) data assimilation scheme as NOAA/ESRL/GSD's part of HRQ2 task. This new task will support the operational needs from threats from flash flood, debris flow and landslide. Motivated by CWB's request to establish a 3-D variational approach for the model initialization, AIT's and TECRO's designated representatives, NOAA/ESRL/GSD and CWB respectively, selected to implement the GSI (Gridpoint Statistical Interpolation) analysis system which is used operationally by NOAA/NCEP (National Centers for Environmental Prediction). The GSI package is customized for CWB for the input data format in order to ingest CWB's own data. The initial CWB GSI package was tested and evaluated near the end of June 2006 with radar data and conventional observation data. GSI is set up for inges: of both radar radial velocities and satellite radiance data. For work in 2007, an effort will be required to assess the availability of satellite radiance data from geosynchronous or polar orbiting satellites and to write the software to deliver this to GSI. Satellite radiance data will enhance the analysis in the oceanic areas surrounding Taiwan. Before GSI can be utilized for short term precipitation forecasting, a diabatic scheme similar to that already in LAPS must be added to the GSI capability. During implementing Arrangement #19, NOAA/ESRL/GSD and CWB will continue to include additional new observation data available for LAPS GSI.

GSI has the capability of ingesting model error statistics (variances) for optimizing its analysis. For this time phase, the ensemble error statistics are made up of sequential runs of the background model (either NFS15 or WRF). Error will be recovered from an independent analysis and statistics generated. These statistics will be updated within GSI to optimize the analysis at any time.

The new focus is to adopt a multiscale 3DVAR analysis scheme called STMAS (Space and Time Mesoscale Analysis System) as part of LAPS III for surface observations and other remote sensing data such as radar data. STMAS will be extended to 3DVAR and eventually a 4DVAR approach. In its 3DVAR version, STMAS will provide multiscale analysis using an inhomogeneous observation distribution. Like GSI, STMAS can make use of updating error statistics and can be configured with a diabatic capability. These two large efforts (GSI and STMAS) may need to be prioritized by CWB management.

STMAS uses a sequence of variational minimization in both the space and time domains to obtain multi-scale grid analysis, which cannot be done through a single 3DVAR analysis. At NOAA/ESRL/GSD, STMAS is currently running

every 15 minutes in real time using dense surface observation data. The STMAS analysis provides a good verification tool for high resolution model forecasts.

During Implementing Arrangement #19, AIT's and TECRO's designated representatives NOAA/ESRL/GSD and CWB respectively, will extend STMAS development from using only surface data to include remote sensing data from CWB's advanced radar network, and maybe satellite data. The goal is to develop STMAS as an advanced operational nonlinear analysis tool at CWB in Taiwan to improve local analysis and more importantly provide a prediction system during severe weather. An advantage of STMAS is that it has been developed at NOAA/ESRL/GSD and is not subject to unexpected changes or upgrades as would be GSI.

NOAA/ESRL/GSD has developed and accessed techniques to measure atmospheric Integrated Precipitable Water (IPW) values using ground-based Global Positioning System (GPS) receivers since 1993. The NOAA GPS-IPW network currently consists of 405 sites. There are three types of sites in the network; NOAA Wind Profilers Sites (NPN), Other NOAA Sites (ONS), and Other Agency Sites (OAS). The network is controlled by a software processing system developed by NOAA/ESRL/GSD. The current ground-based GPS-Met observing software system consists of data acquisition, geodetic modeling, IPW processing and data evaluation, display and dissemination.

During Implementing Arrangement #19, AIT's and TECRO's designated representatives NOAA/ESRL/GSD and CWB respectively, will ingest GPS observation data from the CWB GPS-Met network and process these data using the current NOAA GPS-Met Observing System. NOAA/ESRL/GSD then will transfer IPW values back to CWB for evaluation.

The following summarizes the schedule and resources required for the NOAA/ESRL/GSD part of Task #1:

Resources Required:	35.3 % NOAA/ESRL/GSD/CWB
Deliverables and Schedule:	
1. STMAS/GSI 3DVAR data assimilation software (on-line version)	11/30/07
a. conventional data ingest development	8/31/07
b. STMAS 3D variational analysis is extended using conventional data	11/30/07
c. Improve radar data and adding polar orbiting satellite data into GSI 3D variational analysis	11/30/07
2. Establishment of ensemble based error statistics generator for input into GSI or STMAS	11/30/07
3. GSI software update	11/30/07
4. IPW values using CWB GPS-Met network	11/30/07

AIT's designated representative NOAA/ESRL/GSD understand that the National Severe Storms Laboratory (NSSL) will continue research towards the refinement, development, and maintenance of applications required for the Central Weather Bureau (CWB), Water Resources Agency (WRA) and the Soil and Water Conservation Bureau (SWCB) operations. The NSSL research is directed towards improving the monitoring and prediction of flash floods and severe storm identification and short-term forecasting for the Taiwan environment. The NSSL research and development for IA#19 will focus the implementation of advanced QPE and VSQPF techniques as per: 1) implementation of a new HRQ2 infrastructure and code set, 2) the implementation of an advanced radar quality control specifically tuned for the Taiwan environment; 3) 500 meter resolution product generation; 4) assessment in using dual polarization radar for radar intercomparison and calibration; 5) verification and assessment of application performance.

The following summarizes the schedule and resources required for the NSSL on behalf of AIT's designated representative NOAA/ESRL/GSD part of Task #1:

Resources Required: 35.3 % NSSL/CWB

Deliverables and Schedule:

1. Define HRQ2 system components and data ingest modules	3/31/07
2. Provide to CWB new HRQ2 executables configured for 500 meter resolution	6/30/07
3. Develop quality control neural network encompassing Taiwan QC training sets	9/30/07
4. Implement radar calibration analysis tool using dual polarization radar	11/30/07
5. Quarterly progress report & annual review	3/31/07, 6/30/07 9/30/07, 11/30/07

Task #2 - Continuing Interaction on Earlier Cooperative Projects

Several earlier cooperative tasks have been completed. Technology has been transferred successfully and is beginning to be used operationally at CWB. NOAA/ESRL/GSD's development activities in these areas continue, and further NOAA/ESRL/GSD-CWB interaction is important to keep CWB staff up-to-date on current developments. This task will allow continuing interaction at an appropriate level, including new software releases of the forecast information system including the AWIPS/D2D (OB7), radar display using D2D to replace POP, dual head display support, advanced ALPS training by NOAA/ESRL/GSD, AFPS text formatter technical support, and internet-based forecast workstation (FX-C) with advanced drawing capability with touch screen support, NOAA data support, visitors training, exchange of visits, copying papers and reports, and

e-mail interaction.

The following summarizes the schedule and resources required for Task #2:

Resources Required:	29.4 % NOAA/ESRL/GSD/CWB
Deliverables:	
1. Dual-head display support	3/31/07
2. Relevant documents, reports and electronic information	(as needed)
3. AWIPS upgrade software (OB7) and support	11/30/07
4. Advanced ALPS workstation training	11/30/07
5. AFPS text formatter evaluation support	11/30/07
6. FX-C software with enhanced drawing capability (touch screen application)	11/30/07
7. NOAAPORT data feed support	11/30/07
8. Visitors support including necessary training and travel	11/30/07

3.0 - Schedule

Tasks	Functions	Milestones
1.	Provide initial STMAS 3DVAR system (from NOAA/ESRL/GSD)	12/07
1.	Provide improved HRQ2 QC system (500m resolution), QC neural network and radar calibration tool (from NSSL)	12/07
2.	Provide technical support and software upgrade of AWIPS, ALPS, AFPS text formatter evaluation, FX-C, NOAAPORT data transmission relevant document and technical support on WINS II with AWIPS functions (from NOAA/ESRL/GSD)	12/07

Schedule by Month

TASKS	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1
Task 1 (GSD)												
STMAS3DVAR data Assimilation (on-line version)	x	x	x	x	x	x	x	x	x	x	x	x
Add radar data and polar orbiting satellite data into STMAS	x	x	x	x	x	x	x	x	x	x	x	x
Provide ensemble based error statistics	x	x	x	x	x	x	x	x	x	x	x	x
GSI software upgrade	x	x	x	x	x	x	x	x	x	x	x	x

IPW computed from CWB GPS-Met network	x	x	x	x	x	x	x	x	x	x	x	x
Task 1 (NSSL)												
Define HRQ2 components	x	x	x									
HRQ2 (500m) software	x	x	x	x	x	x						
Develop QC neural network	x	x	x	x	x	x	x	x	x			
Implement radar calibration tool	x	x	x	x	x	x	x	x	x	x	x	x
Verification and assessment of application performance	x	x	x	x	x	x	x	x	x	x	x	x
Task 2 (interaction on earlier projects)												
Provide relevant documents and information	x	x	x	x	x	x	x	x	x	x	x	x
AWIPS upgrade software. AWIPS radar display technical support, AWIPS dual-head hardware support ALPS training	x	x	x	x	x	x	x	x	x	x	x	x
FX-C software with enhanced capabilities using touch screen NOAAPORT data support	x	x	x	x	x	x	x	x	x	x	x	x
AFPS text formatter evaluation support	x	x	x	x	x	x	x	x	x	x	x	x
Support CWB visitors		x	x	x	x	x	x	x	x	x	x	x

4.0 - Budget

The following are the estimated costs for Implementing Arrangement #19

Tasks	Personnel	Travel/Training	Total
Task #1 (GSD)	$ 285,000	$ 15,000	$ 300,000
Task #1 (NSSL)	$ 285,000	$ 15,000	$ 300,000
Task #2 (GSD)	$ 230,000	$ 20,000	$ 250,000
Total	**$ 800,000**	**$ 50,000**	**$ 850,000**

As stated in Implementing Arrangement #19, the funds available from TECRO to support the tasks, traveling and meeting expenses described in this Statement of Work, will be a total of US$ 850,000. TECRO agrees that US$ 500,000 will be provided by its designated representative CWB, US$ 250,000 by the Water Resources Agency (WRA) on behalf of CWB and US$ 100,000 by the Soil and Water Conservation Bureau (SWCB) on behalf of CWB. All budget figures are estimated. Actual amounts will be accrued for purposes of fulfilling the financial arrangements described in the

Implementing Arrangement, in accordance with the terms of the Agreement.

All programs within the Global Systems Division (GSD) use the same budget procedures, whether they are base-funded programs or externally-funded programs. Beginning in FY91, a facility charge has been applied to all programs to cover management and administrative costs as well as the use of the NOAA/ESRL/GSD facility and all associated equipment and data.

NOAA/ESRL/GSD staff time is charged at the employee's salary plus the normal NOAA benefit, leave, and overhead charges. NOAA/ESRL/GSD professional staff people are primarily in the civil service grade scales of GS-11 to GS-14. Contract staff is in equivalent categories.

5.0 - CWB Joint Team Assignments at NOAA/ESRL/GSD

Several tasks encourage CWB staff in residence at NOAA/ESRL/GSD. The primary effort of CWB staff at NOAA/ESRL/GSD during the Implementing Arrangement #19 period will be directed toward developing the HRQ2 task. It is important that CWB staff be available to work at NOAA/ESRL/GSD facilities during the period. Specific assignments will be made to most efficiently use the available personnel resources. Assignments for the CWB staff members would be as follows:

- Development of a high-resolution QPE and QPF system for the Taiwan area (at NOAA/ESRL/GSD) and setup of AFPS text formatter environment.