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Paper W 9

PRELIMINARY ANALYSIS OF ERTS-RELAYED WATER-RESOURCES DATA IN THE DELAWARE RIVER BASIN[1]

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ABSTRACT

Preliminary analysis of ERTS-DCS data from water-resources stations in the Delaware River basin indicates that the Data-Collection System is performing well. Data-Collection Platforms have been successfully interfaced with five stream-gaging stations and three ground-water observation wells and are being interfaced with 12 water-quality monitors in the basin. Data are being relayed during four or five ERTS orbital passes per day, which is within the design specifications of the ERTS-DCS.

1. INTRODUCTION

This paper is a brief progress report on research being conducted for the Earth Resources Technology Satellite (ERTS) project, "Near Real Time Water Resources Data for River Basin Management," Goddard Space Flight Center identification (GSFC ID) IN 340, and on research being conducted by the Pennsylvania District, Water Resources Division (WRD), U.S. Geological Survey, to test the ERTS Data Collection System (DCS) on water resources sites in the Susquehanna River basin. A major objective of this research is to "... determine whether standard operational water resources (field) instrumentation can be interfaced successfully with DCS platforms and the data made to flow operationally to data users.", as stated in the proposal to perform the ERTS project. Real progress has been made to meet this objective; progress which indicates DCS has a great potential for managing existing field instrumented stations in the U.S. Geological Survey's Hydrologic Data Network and for monitoring water resources for management and flood warning.

The progress that has been made now permits the preparation and release, on a daily basis, of a water-resources summary of the form of the teletype release shown in Figure 1. The summary is produced from computer-processed DCS data from the Delaware River basin.

1/ Approved for publication by the Director, U. S. Geological Survey

DEL-RIV-RA-COM
TO DRBC
FM USGS HDQ
ATTN: D. GOODELL

ERTS-NASA
USGS DELAWARE RIVER BASIN-DATA COLLECTION SYSTEM EXPERIMENT
WATER RESOURCES SUMMARY
FEBRUARY 23, 1973

WATER QUALITY STATIONS

TIME	S.C. UMHOS	D.O. MG/L	TEMP F/C	PH
DELAWARE RIVER AT REDY ISLAND				
12:40 55EST, FEBRUARY 22,1973	3720	12.2	35/ 1.5	6.8
20:59:36EST, FEBRUARY 22,1973	5360	12.6	35/ 1.5	7.1
21: 9: 0EST, FEBRUARY 22,1973	3120	12.6	35/ 1.5	6.9
22:39:15EST, FEBRUARY 22,1973	3400	12.5	35/ 1.5	6.9
9:27: 5EST, FEBRUARY 23,1973	5740	12.8	35/ 1.5	7.1
11: 9:24EST, FEBRUARY 23,1973	3160	12.4	36/ 2.0	7.0
DELAWARE RIVER AT CHESTER				
20:53:40EST, FEBRUARY 22,1973	260	9.2	39/ 4.0	6.8
21: 0:21EST, FEBRUARY 22,1973	264	9.4	40/ 4.5	6.8
9:25:19EST, FEBRUARY 23,1973	260	9.1	40/ 4.5	6.9
9:39: 7EST, FEBRUARY 23,1973	260	9.4	39/ 4.0	6.8
11: 6:40EST, FEBRUARY 23,1973	264	9.3	40/ 4.5	6.8

SURFACE WATER STATIONS

TIME	GAGE HEIGHT FEET	DISCHARGE CFS
DELAWARE RIVER AT MONTAGUE		
20:53:19EST, FEBRUARY 22,1973	5.61	3100
21: 0:14EST, FEBRUARY 22,1973	5.65	3190
22:40:44EST, FEBRUARY 22,1973	6.00	3980
9:24:59EST, FEBRUARY 23,1973	6.03	4060
11: 7:50EST, FEBRUARY 23,1973	5.91	3760
11:14:57EST, FEBRUARY 23,1973	5.88	3690
DELAWARE RIVER BELOW TOCKS ISLAND		
20:54:46EST, FEBRUARY 22,1973	5.92	3360
21: 1:50EST, FEBRUARY 22,1973	5.91	3330
9:24:57EST, FEBRUARY 23,1973	6.01	3630
DELAWARE RIVER AT TRENTON		
20:57:20EST, FEBRUARY 22,1973	9.69	9890
9:24:54EST, FEBRUARY 23,1973	9.77	10300
11: 7: 9EST, FEBRUARY 23,1973	9.77	10300
LEHIGH RIVER AT BETHLEHEM		
20:54:57EST, FEBRUARY 22,1973	3.20	1520
22:39:43EST, FEBRUARY 22,1973	3.20	1520
9:27:52EST, FEBRUARY 23,1973	3.19	1510
11: 7:15EST, FEBRUARY 23,1973	3.18	1500
SCHUYLKILL RIVER AT PHILA.		
20:52: 3EST, FEBRUARY 22,1973	6.40	2400
22:44:12EST, FEBRUARY 22,1973	6.40	2400
9:24:15EST, FEBRUARY 23,1973	6.40	2400
11: 7:57EST, FEBRUARY 23,1973	6.40	2400

GROUND WATER STATIONS

TIME	WELL DEPTH FEET
SALEM CITY NUMBER 1	
20:55:57EST, FEBRUARY 22,1973	23.31
20:59: 7EST, FEBRUARY 22,1973	23.33
9:24:48EST, FEBRUARY 23,1973	23.33
11: 7:34EST, FEBRUARY 23,1973	23.36
PENNS GROVE NUMBER 2A	
12:49:21EST, FEBRUARY 22,1973	18.01
20:51:41EST, FEBRUARY 22,1973	18.05
22:35:28EST, FEBRUARY 22,1973	18.06
9:25:36EST, FEBRUARY 23,1973	18.10
11: 9: 4EST, FEBRUARY 23,1973	18.10
SWELL CHEM. CO. NUMBER 5	
20:54:15EST, FEBRUARY 22,1973	36.06
22:35:55EST, FEBRUARY 22,1973	36.00
22:49:12EST, FEBRUARY 22,1973	36.14
9:22:46EST, FEBRUARY 23,1973	35.89
11: 8: 0EST, FEBRUARY 23,1973	36.05

THESE DATA WERE RELAYED BY THE ERTS OBSERVATORY AND ARE PROVISIONAL. THE SYMBOLS -- INDICATE DATA WERE SUSPECT AND WERE DELETED. THIS SUMMARY WAS PREPARED BY THE CURRENT RECORDS CENTER IN PHILADELPHIA USING REMOTE TERMINAL ACCESS TO THE GEOLOGICAL SURVEYS 360/65 COMPUTER IN WASHINGTON, D.C. CALL 215-597 7357 FOR FURTHER INFORMATION.

END OF SUMMARY

DEL-RIV-RA-COM

Figure 1 - Daily water-resources summary of conditions in the Delaware River basin, compiled from ERTS Data Collection Platform data.

This processing is done in near-real time, which means that the data usually are processed and released to water-resources agencies within a few hours of the time of acquisition from an ERTS orbital pass over eastern North America. The daily summary (Figure 1) also allows the Geological Survey to monitor the performance of field instrumentation, and therefore provides the potential for more efficient management of the operation of the instruments. The summary also provides water-resources agencies with the status of water resources over a large geographical area. The research described herein is providing the Pennsylvania district with the learning experience of simulating an operational data-relay system, an experience that is a prerequisite to operational data-relay systems.

2. DELAWARE RIVER BASIN RESEARCH

Twenty Data Collection Platforms (DCP) are being installed on water-resources stations in the Delaware River basin for the project, "Near Real Time Water Resources Data for River Basin Management." These stations, and many others in the basin, are operated by the Geological Survey in cooperation with several Federal, State, and local agencies. The water-resources stations that are being instrumented with ERTS DCP's have been chosen cooperatively by members of the staff of the Delaware River Basin Commission (DRBC) and by the principal investigator. The DRBC is a regional water-resources management agency that was created by the Delaware River Basin Compact, a public law adopted by the United States of America, and the States of Pennsylvania, New York, New Jersey, and Delaware. The Compact requires the DRBC to adopt and maintain a Comprehensive Plan for the conservation and development of water resources in the basin. The water-resources stations chosen for the ERTS project include stream gages, ground-water observation wells, and water-quality monitors. DCS data from these stations can keep the DRBC, and other water-resources agencies, informed on the status of streamflow and water quality at key surface-water locations in the basin, and on the status of ground-water levels in coastal plain aquifers. The DCP locations are shown on the sketch map in Figure 2. The DCP's monitor streamflow at key points in the basin and monitor water quality in the Delaware River and in the estuary.

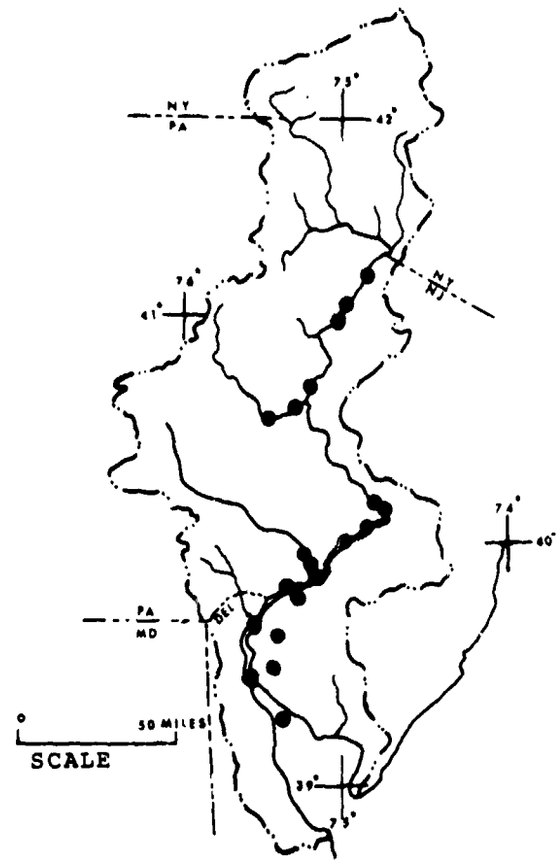

Figure 2 - Map showing locations of ERTS DCP's in the Delaware River Basin.

3. SUSQUEHANNA RIVER BASIN RESEARCH

As a reaction to the June 1972 record flood of Hurricane Agnes, which caused the loss of human life and billions of dollars in property damage, the Pennsylvania District of the Geological Survey's Water Resources Division is field installing four DCP's on stream gages in the Susquehanna River basin. The main purpose of these installations is to test DCP's ability to gather basic data that could be used for monitoring streamflow and for flood forecasing in the basin. During the flood, conventional communications with many key gaging stations were lost, although in most cases the station continued to function. Even though the ERTS-DCS only provides data during the 8-12 o'clock time frames in the morning and evening, battery operated DCP's probably would have worked well and provided very useful data from many of the stations that were out of communication.

Two of the DCP's being installed were provided to the Pennsylvania district by the ERTS project, "Susquehanna River Basin Study Using ERTS-A Data," GSFC ID UN 159. The remaining two DCP's have been provided to the district by the Department of the Interior's EROS Program. The installation, maintenance, and data processing from the platforms are being conducted by the district in cooperation with the Susquehanna River Basin Commission (SRBC), which has a role in the Susquehanna River basin analogous to the DRBS's role in the contiguous Delaware River basin. The location of the DCP's being installed in the Susquehanna River basin is shown in the map of Figure 3.

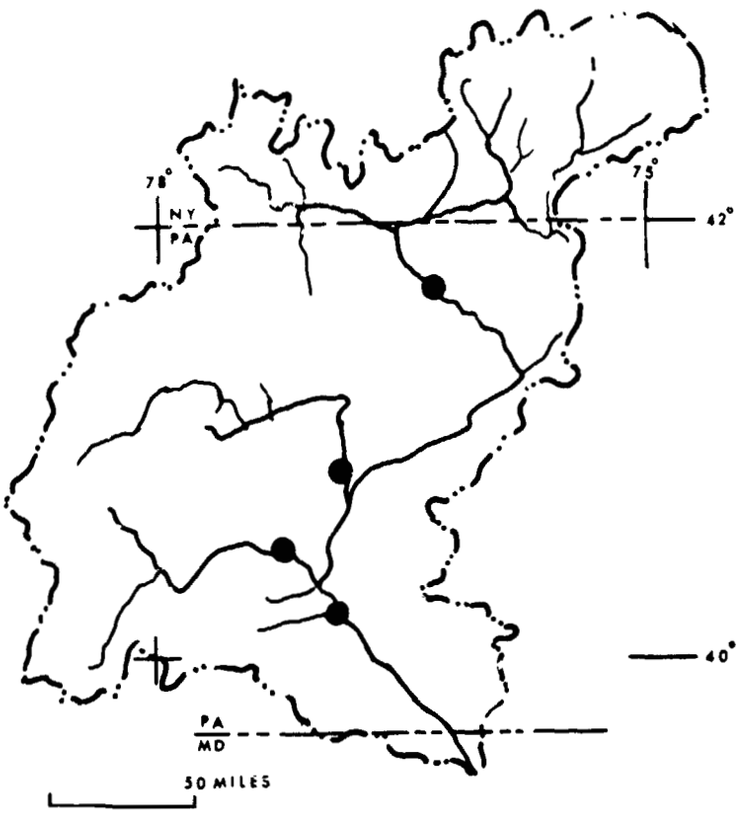

Figure 3 - Map showing locations of DCP's in the Susquehanna River basin.

4. STATUS OF DATA COLLECTION PLATFORMS

Antennas for 19 of the 20 DCP's to be installed in the Delaware River basin have been installed and the platforms successfully field tested. The 20th location has been temporarily delayed by a major renovation of the site, a Coast Guard lighthouse on an island in Delaware Bay. The DCP will be installed in the spring when construction at the site has been finished, and when the weather conditions ameliorate to make the site less hazardous to access. Three of the four DCP's have been installed on stream gages in the Susquehanna River basin. The temporary unavailability of interface equipment has prevented the fourth site from being completely instrumented. In both basins we have been very successful in installing and operating all of the stream gages and ground-water observation wells. There has been a problem in successfully interfacing many of the water-quality monitors to the DCP's. More often than not, the problems have been found to be in the water-quality monitors themselves, which always have been troublesome devices, occasionally in the interface equipment, but not in the DCP's. Several of the water-quality monitors have been successfully interfaced and operated. In particular, the DCP and water-quality monitor at Reedy Island, Delaware, an isolated island in the southern part of the Delaware River estuary, has operated almost flawlessly from early in the ERTS experiment.

The 24 DCP sites, shown in Figures 2 and 3, are providing a test of the DCP's under a wide range of environmental conditions. Two DCP's are on islands in the Delaware River estuary, where visibility of the sky is virtually unobstructed and where communication with the satellite is excellent. Another DCP is directly underneath one of the spans of the Delaware Memorial Bridge. The bridge roadway is about 150 feet above the antenna and obstructs a swath of the sky that lies directly overhead, and extends in each direction in approximately an east-west orientation. Much of the western sky also is blocked out by the support tower of one of the bridges. Yet despite these obstructions, communications with ERTS by this DCP has been excellent, although occasionally one finds a 6-minute gap between two data transmissions during a pass; the hiatus undoubtedly caused by ERTS being obscured by the bridge structure at the time of one DCP transmission. Several DCP's are located in urban environments around Philadelphia and Easton, Pennsylvania, and the DCS is working well within the one-transmission-per-12-hour period specification of the system. Several DCP's

in the more remote areas of the Pocono mountains are also working well within the specifications of the system, but because they lie in river valleys surrounded by mountains of modest elevation, some of the passes are lost when ERTS is low on the horizon. Despite these constraints, we have not had to change the transmission frequency to 90 seconds from 180 seconds to acquire the data.

The one environmental condition we will have to meet in Pennsylvania, that we have not been able to test to date, is heavy snowfall. Presumably, the DCP will become ineffective with a significant accumulation of wet snow upon the antenna. It is anticipated that we may have to place hemispherical domes over the antennas to discourage snow accumulation. However, we may have to rely on the experience of other experiments if the winter of 1972-73 continues to deny us this test.

There have been very few failures of the DCP's themselves. Three of the DCP's were returned to the U.S. Geological Survey's ERTS-DCP depot facility at the Mississippi Test Facility for maintenance when they ceased operating They were made operational again by the replacement of either the transmitter card or the programer card. The performance of the DCP's to date has exceeded our expectations. A longer environmental test should be provided to verify this performance rate.

Approximately half of the DCP's operate in locations where there is electrical line power and at these locations, line power stepped down through a transformer, has been used to operate the platform. Characteristically there is line power at water-quality monitor locations and at some gaging stations. Ultimately, at these locations, we expect to configure the DCP's to operate on line power with standby battery power. The utility in having the platform operating, even though the water-resources monitor is not, is that we can detect the failure rapidly. The rest of the platforms are operating on four 6-volt dry cell batteries each in series. Several of the DCP's have been operating more than four months on their original set of batteries. These platforms also seem to be working well in areas where winter temperatures frequently are well below freezing, temperatures at which battery efficiency becomes low. Our plan is to allow the DCP's to operate with these batteries until they begin to fail from insufficient power, as a determination of nominal battery efficiency.

Our apprehension about the potential for vandalism at the sites, and of the antennas in particular, prompted us to go to some length in making the installations as secure and as unobtrusive as possible. In every location the DCP itself is well protected inside either a field structure, such as a 4-foot square gage house, or inside an institutional structure, such as a municipal water purification plant In a few cases, we were able to install the antenna inside the structure too. The only constraint on this procedure is that the roof of the structure must not contain any significant amount of reinforcing steel which may ground the signal. Also, the shelter must be large enough to contain the 46-inch diameter antenna. We are considering trimming a few inches off the diameter of one of the antennas at a station, where it could not fit the gage house, as a test of the overall design of the antenna relative to the actual DCP transmitter power.

Where the antenna is mounted on the exterior of the shelter, the antenna usually is painted to blend in more unobtrusively with the surroundings. To date no significant vandalism has occurred. This is due in part to measures we have taken to install the sites as securely as possible. but the suspicion that we have been lucky lingers on.

5. NEAR-REAL-TIME DATA PROCESSING

The following is a discussion of our data processing procedure for near-real-time processing of ERTS-DCS data from the Delaware River basin. The software being written for implementing the Susquehanna River basin DCP data parallels the software presently operational for the Delaware basin activities. When the software for each basin is operational, the programs will probably be concatenated to allow all the DCS data to be processed together. The timeliness of the data processing is constrained by the orbital characteristics of the ERTS satellite and by the configuration of our processing system.

ERTS-DCS specifications state that there be a very high probability that at least one message per 12-hour period will be received from each operating DCP. This specification is being met. Nominally, on the approximately 14 daily polar orbits ERTS makes each day, data are successfully relayed from Delaware River basin DCP's during four or five of the daily ERTS orbital passes.

Data are usually relayed during two or three passes between 8:00 a.m. to 12 noon eastern standard time (1300 to 1700 Greenwich Mean Time), and during two or three passes between 8:00 p.m. and 12 midnight (0100 to 0500 GMT). The opportunity for relaying data during the morning occurs as ERTS makes passes in a generally north to south direction over the western Atlantic to the central North America area. The evening opportunity occurs when ERTS passes are made in a generally south to north direction over the same area. More often than not we get two good passes, in a data relay sense, during each period; a third pass, if we get it, generally only picks up one to four of the DCP's. The third pass generally puts ERTS very close to the horizon and the period of radio visibility lasts a minute or two compared to the 10 or 15 minute-period of the better passes.

With one ERTS orbital period (103 minutes) of the time DCP data are relayed during a pass and received at the NASA Data Processing Facility (NDPF), the data are forwarded to the Pennsylvania district by NASA teletype. Figure 4 is an example of the format of the teletyped data. The information on the teletype is in a different format than, and is a subset of, the information that is punched on cards at the NDPF, and forwarded to users at a more leisurely rate through the mail. The card format can be found in the ERTS Data Users Handbook. The only additional information found in the teletype listing that is not found in the card format is the item labeled CS at the end of a data line. It is a checksum value, which is used to verify the data in the eight octal data words labeled D1-D8. The checksum value is the units value of the octal sum of the individual octal characters in the field from the columns labeled C (message quality) to D8. It is provided to help detect teletype transmission errors which, in our experience, have been found to be very rare. Note that the data messages are being relayed by the DCS at about 3-minute intervals during a pass (Columns MM and SS specify number and seconds, respectively). Normally the data messages received from a DCP during any one period of mutual visibility are generally, but not always, the same. Our procedure is to process only one of the several identical messages, since only time is different from one message to the next.

G

[illegible]
29/1931Z

[illegible]
ATT R PAULSON USGS HARRISB PHONE 717 [illegible] 3420

S	Y	DDD	HHMM	SS	PID	C	D1	D2	D3	D4	D5	D6	D7	D8	D9
N	[illegible]	251	1502	19	6030	7	377	377	166	257	367	255	227	326	6
N	3	251	1505	26	6030	7	377	377	166	257	367	255	227	326	6
N	3	251	1508	33	6030	7	377	377	166	257	367	255	227	326	6
N	3	251	1511	40	6030	7	377	377	166	257	367	255	227	326	6
N	3	251	1503	24	6046	7	73	365	377	377	377	377	377	377	5
N	3	251	1506	33	6046	7	73	365	377	377	377	377	377	377	5
N	3	251	1509	42	6046	7	73	365	377	377	377	377	377	377	5
N	3	251	1512	51	6046	7	73	365	377	377	377	377	377	377	5
N	3	251	1502	38	6067	7	377	377	275	372	331	373	337	327	1
N	3	251	1509	27	6067	7	377	377	275	372	327	373	377	327	1
N	3	251	1512	41	6067	7	377	377	275	372	327	373	377	327	1
N	3	251	1503	24	6114	7	377	377	173	151	374	232	211	310	0
N	3	251	1506	28	6114	7	377	377	173	151	374	232	211	310	0
N	3	251	1509	31	6114	7	377	377	173	151	374	232	211	310	0
N	3	251	1512	35	6114	7	377	377	173	151	374	232	211	310	0
N	3	251	1502	09	6115	7	237	21	377	377	377	377	377	377	4
N	3	251	1505	36	6115	7	237	21	377	377	377	377	377	377	4
N	3	251	1509	03	6115	7	237	21	377	377	377	377	377	377	4
N	3	251	1512	30	6115	7	237	21	377	377	377	377	377	377	4
N	3	251	1503	41	6116	7	37	231	377	377	377	377	377	377	5
N	3	251	1507	13	6116	7	37	231	377	377	377	377	377	377	5
N	3	251	1510	44	6116	7	37	231	377	377	377	377	377	377	5
NO MESSAGES					6124										
N	3	251	1501	13	6215	7	373	177	377	377	377	377	377	377	1
N	3	251	1504	32	6215	7	373	177	377	377	377	377	377	377	1
N	3	251	1507	51	6215	7	373	177	377	377	377	377	377	377	1
N	3	251	1511	10	6215	7	373	177	377	377	377	377	377	377	1
N	3	251	1503	37	6223	7	37	156	377	377	377	377	377	377	3
N	3	251	1507	11	6223	7	37	36	377	377	377	377	377	377	0
N	3	251	1510	46	6223	7	37	36	377	377	377	377	377	377	0
N	3	251	1503	53	6227	7	337	333	377	377	377	377	377	377	3
N	3	251	1507	00	6227	7	337	333	377	377	377	377	377	377	3
N	3	251	1510	06	6227	7	337	333	377	377	377	377	377	377	3
NO MESSAGES					6275										
N	3	251	1505	16	6277	7	167	63	377	377	377	377	377	377	4
N	3	251	1508	29	6277	7	167	63	377	377	377	377	377	377	4
N	3	251	1511	41	6277	7	167	63	377	377	377	377	377	377	4
N	3	251	1505	05	6306	7	377	377	377	377	377	377	377	7	7
N	3	251	1508	11	6306	7	377	377	377	377	377	377	377	377	7
N	3	251	1511	13	6306	7	377	377	377	377	377	377	377	377	7
N	3	251	1503	19	6312	7	377	377	377	377	377	377	377	377	7
N	3	251	1506	29	6312	7	377	377	377	377	377	377	377	377	7
N	3	251	1509	39	6312	7	377	377	377	377	377	377	377	377	7
N	3	251	1512	50	6312	7	377	377	377	377	377	377	377	377	7
N	3	251	1504	16	6322	7	223	146	377	377	377	377	377	377	7
N	3	251	1507	52	6322	7	223	146	377	377	377	377	377	377	7
N	3	251	1511	29	6322	7	223	146	377	377	377	377	377	377	7
N	3	251	1504	41	6331	7	377	377	377	377	377	377	377	377	7
N	3	251	1507	42	6331	7	377	377	377	377	377	377	377	377	7
N	3	251	1510	43	6331	7	377	377	377	377	377	377	377	377	7
N	3	251	1502	32	6332	7	377	377	147	231	353	333	317	275	0
N	3	251	1505	54	6332	7	377	377	147	231	353	333	317	275	0
N	3	251	1509	15	6332	7	377	377	147	171	353	333	317	275	0

Figure 4 - Portions of teletype listing of Delaware River basin DCP data received from NASA Data Processing Facility at Goddard Space Flight Center. The data are from one ERTS pass.

These data are processed by the Pennsylvania district using remote terminal access to the Geological Survey's 360/65 computer in Washington, D.C. There is an advantage to using this system rather than a small stand-alone computer; the advantage is that computer algorithms developed by our experiment, with little or no modification, can be and have been made available to others in the USGS system. The one disadvantage is that our jobs must wait in queue to be executed. Nominally our turnaround time is under 2 hours, although, when the system goes down, it can be significantly longer. For a truly operational system, a stand-alone computer capable of remotely accessing the national system would be required.

The job output from the computer is partitioned by the software into two parts, one is for inhouse consumption and the other (see Figure 1) is for release to other agencies. The software performs several manipulations to the data. These include associating the DCP identification number with a particular water-resources station, correcting temporal information from the annual day number and Greenwich Mean Time to calendar day and Eastern Standard Time, and a rather involved manipulation of the actual platform data. For our particular application the manipulation includes breaking down the octal or hexidecimal data to 64 bits, inverting the bits (interchanging 0's to 1's), reordering the eight sets of eight bit data words, and then extracting the decimal values actually made available to the DCP's in the field by our water-resources instruments. For water-quality monitors, these values are converted to the several water-quality parameters in the proper engineering units. For stream gages, stream stage is extracted, which is used by the software to compute streamflow from rating tables, one of which is available for each station. For ground-water observation wells, well-water level is extracted.

Much of this information is put on the printed output as the data are processed and summarized. Figures 5, 6, and 7 are examples of the output provided. These summaries help field technicians monitor the performance of the platforms and help them ascertain which stations require field maintenance or repair. These summaries also help data processing personnel choose which platforms and stations are working well enough to permit the data to be processed for the summary of Figure 1.

EROS-NASA
USGS DELAWARE RIVER BASIN DATA COLLECTION SYSTEM EXPERIMENT
FEBRUARY 23, 1973

LIST OF PARITY PASSED DATA

PRODUCT REQUEST	USER ID	PLAT ID	SAT ID	TIME YR	DAY	HR	MIN	SEC	RS ID	ERROR FLAG	MSG QUAL	DATA FORM	DATA BITS	QUALITY BITS
SC	I340	6114	1	3	53	17	42	55	G	0	7	H	FFFF7669F6C9EFCA	FFFFFFFFFFFFFFFF
SC	I340	6215	1	3	53	17	43	21	G	0	7	H	E77FFFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6030	1	3	54	1	54	27	N	0	7	H	FFFF00F2000021FF	FFFFFFFFFFFFFFFF *
SC	I340	6046	1	3	54	1	55	57	N	0	7	H	3B73FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6046	1	3	54	1	59	7	N	0	7	H	3B33FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6067	1	3	54	1	51	48	N	0	7	H	FFFFBFF99BF9BF9B	FFFFFFFFFFFFFFFF *
SC	I340	6114	1	3	54	1	52	36	N	0	7	H	FFFFE6A8ECB9CBCA	FFFFFFFFFFFFFFFF
SC	I340	6114	1	3	54	2	2	0	N	0	7	H	FF6DA9FB79CBCA	FFFFFFFFFFFFFFFF
SC	I340	6115	1	3	54	1	52	3	N	0	7	H	9FFDFFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6116	1	2	54	1	53	19	N	0	7	H	5F79FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6116	1	3	54	2	0	14	N	0	7	H	5F59FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6215	1	3	54	1	51	41	N	0	7	H	E75FFFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6223	1	3	54	1	54	46	N	0	7	H	5FB6FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6223	1	3	54	2	1	50	N	0	7	H	5F76FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6227	1	3	54	1	54	57	N	0	7	H	3FFBFFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6275	1	3	54	1	57	46	N	0	7	H	FFFFBC78DD797DC7	FFFFFFFFFFFFFFFF *
SC	I340	6277	1	3	54	1	57	20	N	0	7	H	AF69FFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6306	1	3	54	1	57	29	N	0	7	H	FFFFFFFFFFFFFFFF	FFFFFFFFFFFFFFFF *
SC	I340	6312	1	3	54	1	53	46	N	0	7	H	FFFFFFFFFFFFFFFF	FFFFFFFFFFFFFFFF *
SC	I340	6322	1	3	54	1	54	15	N	0	7	H	939FFFFFFFFFFFFF	FFFFFFFFFFFFFFFF
SC	I340	6331	1	3	54	1	56	54	N	0	7	H	FFFFFFFFFFFFFFFF	FFFFFFFFFFFFFFFF *
SC	I340	6332	1	3	54	1	53	40	N	0	7	H	FFFF7B79ECFB90C6	FFFFFFFFFFFFFFFF
SC	I340	6332	1	3	54	2	0	21	N	0	7	H	FFFF7B99ECD80FBF	FFFFFFFFFFFFFFFF
SC	I340	6073	1	3	54	1	54	45	N	0	7	H	3F39FFFFFFFFFFFF	FFFFFFFFFFFFFFFF *
SC	I340	6402	1	3	54	1	53	56	N	0	7	H	DFBEFFFFFFFFFFFF	FFFFFFFFFFFFFFFF *

Figure 5 - Raw data converted to the standard DCS card format from the teletype format provided by NDPF.

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DETAILED CHECK OF EACH PARITY PASSED MESSAGE FOLLOWS

TIME OF MESSAGE RECEPTION AT NOPF	PRODUCT REQUEST	USER ID	PLAT ID	SAT ID	TIME YR	TIME DAY	TIME HR	TIME MIN	TIME SEC	RS ID	ERROR FLAG	MSG QUAL	DATA FORM	DATA /QUALITY
12:42:55EST, FEBRUARY 22,1973	SC	I340	6114	1	3	53	17	42	55	G	0	7	H	FFFF7669F6C9EFCA ORIGINAL 0000899609361035 FFFFFFFFFFFFFFFF QUALITY
20:52:36EST, FEBRUARY 22,1973	SC	I340	6114	1	3	54	1	52	36	N	0	7	H	FFFFE6A8ECB9C8CA ORIGINAL 0000195713463435 FFFFFFFFFFFFFFFF QUALITY
21: 2: 0EST, FEBRUARY 22,1973	SC	I340	6114	1	3	54	2	2	0	N	0	7	H	FFFF6DA9F879C8CA ORIGINAL 0000925607863435 FFFFFFFFFFFFFFFF QUALITY
22:39:15EST, FEBRUARY 22,1973	SC	I340	6114	1	3	54	3	39	15	G	0	7	H	FFFF6EA9F749DACA ORIGINAL 0000915608562535 FFFFFFFFFFFFFFFF QUALITY
9:27: 5EST, FEBRUARY 23,1973	SC	I340	6114	1	3	54	14	27	5	N	0	7	H	FFFFE6F8E889BDCA ORIGINAL 0000190714464235 FFFFFFFFFFFFFFFF QUALITY
11: 9:26EST, FEBRUARY 23,1973	SC	I340	6114	1	3	54	16	9	26	N	0	7	H	FFFFF8C8F869DEC9 ORIGINAL 0000073707962136 FF FFFFFFFFFFFF QUALITY
20:51:48EST, FEBRUARY 22,1973	SC	I340	6067	1	3	54	1	51	48	N	0	7	H	FFFF8FF998F98F98 ORIGINAL 0000400664064064 FFFFFFFFFFFFFFFF *QUALITY
22:46:18EST, FEBRUARY 22,1973	SC	I340	6067	1	3	54	3	46	18	G	0	7	H	FFFF9FF889F89F89 ORIGINAL 0000600446046046 FFFFFFFFFFFFFFFF *QUALITY
9:22:59EST, FEBRUARY 23,1973	SC	I340	6067	1	3	54	14	22	59	N	0	7	H	FFFF8FF998F98F98 ORIGINAL 0000400664064064 FFFFFFFFFFFFFFFF *QUALITY
11:11:12EST, FEBRUARY 23,1973	SC	I340	6067	1	3	54	16	11	12	N	0	7	H	FFFF8FF998F98F98 ORIGINAL 0000400664064064 FFFFFFFFFFFFFFFF *QUALITY
20:53:40EST, FEBRUARY 22,1973	SC	I340	6332	1	3	54	1	53	40	N	0	7	H	FFFF7879ECFB9DC6 ORIGINAL 0000848613046239 FFFFFFFFFFFFFFFF QUALITY
21: 0:21EST, FEBRUARY 22,1973	SC	I340	6332	1	3	54	2	0	21	N	0	7	H	FFFF7899ECDB8F8F ORIGINAL 0000846613247840 FFFFFFFFFFFFFFFF QUALITY

Figure 6 - Partially reduced data, including a conversion of temporal data and a partial inversion of data bits.

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RAW DATA SUMMARY

TIME	GAGE/ WELL	S.C.	D.O.	TEMP	PH
SHIP JOHN SHOAL LIGHTHOUSE					
PLATFORM ID NO.= 1					
***ERTS PLATFORM IS NOT INSTALLED AT THIS STATION ***					
DELAWARE RIVER AT REEDY ISLAND					
PLATFORM ID NO.=6114					
12:42:55EST. FEBRUARY 22.1973	0000	093	610	359	689
20:52:36EST. FEBRUARY 22.1973	0000	134	634	355	719
21: 2: 0EST. FEBRUARY 22.1973	0000	078	634	355	692
22:39:15EST. FEBRUARY 22.1973	0000	085	625	355	691
9:27: 5EST. FEBRUARY 23.1973	0000	144	642	350	719
11: 9:26EST. FEBRUARY 23.1973	0000	079	621	363	707
DELAWARE RIVER AT DEL. MEM. BR.					
PLATFORM ID NO.=6067					
23:51:48EST. FEBRUARY 22.1973	0000	640	640	640	640
22:46:18EST. FEBRUARY 22.1973	0000	460	460	460	460
9:22:59EST. FEBRUARY 23.1973	0000	640	640	640	640
11:11:12EST. FEBRUARY 23.1973	0000	640	640	640	640
DELAWARE RIVER AT CHESTER					
PLATFORM ID NO.=6332					
20:53:40EST. FEBRUARY 22.1973	0000	130	462	98	684
21: 0:21EST. FEBRUARY 22.1973	0000	132	470	406	684
9:25:19EST. FEBRUARY 23.1973	0000	130	496	400	684
9:32: 7EST. FEBRUARY 23.1973	0000	130	472	398	688
11: 6:40EST. FEBRUARY 23.1973	0000	132	468	400	686
DELAWARE RIVER AT PIER 11,PHILA					
PLATFORM ID NO.= 5					
***ERTS PLATFORM IS NOT INSTALLED AT THIS STATION ***					
DELAWARE RIVER AT TORRESDALE					
PLATFORM ID NO.=6331					
20:56:54EST. FEBRUARY 22.1973	0000	000	000	000	000
9:27:30EST. FEBRUARY 23.1973	0000	000	000	000	000
11:12:20EST. FEBRUARY 23.1973	0000	000	000	000	000
DELAWARE RIVER AT BRISTOL					

Figure 7 - Summary of data, sorted by DCP, ID, to provide field technicians with the operational status of the DCP's.

The data that are judged to be valid are compiled, summarized and formatted into the daily externally released summary. This summary is placed in an on-line data set in the Washington computer center. Instead of returning the summary with the rest of the job output on the line printer of the batch remote terminal from which the job is submitted, the data set containing the summary is accessed

by a low speed ASR-33 teletypewriter terminal, which is also available in the Pennsylvania district office. The reason this summary is accessed by the ASR-33 is because, as it is retrieved, a punched paper tape of the summary is produced on the teletype. After the summary is retrieved, and is humanly reviewed and judged to be provisionally valid, the paper tape is used to transmit the summary to external agencies over the ASR-33, operating in the teletype mode over Western Union's TWX lines, rather than the low speed terminal mode over telephone lines.

The software we have devised to process the DCP data provides the operation of the data-relay system with important information about the operational status of the equipment in the system, and provides water-resources summaries for a large geographical area for water management purposes.

6. PRESENT ACTIVITIES

Our present activities are centered on attempting to increase the number of water-quality monitors operating in the system, and on increasing the availability of near-real-time data to water-data users. As part of the latter activity and in reaction to the devastating flood of Hurricane Agnes of June 1972, we are attempting to make DCP streamflow data available to flow forecasters in near-real time. We are revising our software to process streamflow data from both the Delaware and Susquehanna River basins and to make it available to the National Weather Service's River Forecast (RFC) Center in Harrisburg, Pennsylvania, which is responsible for flow forecasting in both basins. There is, and has been, a close working liaison between USGS hydrologists and RFC hydrologists in the operation of stream gages which provide the RFC with data for river flow forecasting. The DCS data will provide a parallel and backup system of data communications from several gaging stations and provides an excellent operational test of the DCS. We continue to work with staff members of the DRBC and, as of late, with staff members of the SRBC.

7. CONCLUSIONS

The first several months of our activities with the DCS have been rather hectic, and it has been a learning experience. We have made real progress in installing and operating DCP's on a variety of standard U.S. Geological Survey operating water-resources instruments. These instruments are a small subset of the large set of instruments that the Geological Survey operates across the United States, a growing number of which are being accessed in real time by a variety of conventional telemetry systems. Problems still remain in completing our interfacing of the DCP's with the water-quality monitors, but progress is being made now, and most of the DCP installations are performing well. We have established a computer processing system, which we have configured in a near operational mode, and it is functioning fairly well. The processing system will continue to evolve as we develop algorithms to assist us in screening the data for DCP and water-resources field instrumentation malfunctions.

From a very pragmatic and utilitarian point of view, the DCS is being demonstrated to be a viable system, which has great potential for improving the efficiency and management of field instrumentation and the earth-resources conditions which they monitor.