ARCADIA AREA DRAINAGE PROJECT

PROJECT NO. 94-21
APPENDIX G

JDA Report on Gages and SYSTEM Gate

FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY, ARIZONA
2801 WEST DURANGO STREET
PHOENIX, ARIZONA 85009

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ARCADIA AREA STORM DRAINAGE SYSTEM

PHOENIX, ARIZONA

GAGES AND CONTROLS REPORT

PREPARED FOR

THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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EXECUTIVE SUMMARY

Effective operation of the Arcadia Area Drainage System, including the Drainage System itself, the Old Cross Cut Canal and the Arizona Canal Relief Gates to the ACDC, will rely on the timely acquisition of field data and on the ability to have remote control of flow control devices. Such data acquisition and control for the Drainage System will supplement existing telemetry systems operated by the Flood Control District of Maricopa County (District) and Salt River Project (SRP) and will provide benefits to both.

For the Arcadia Area Drainage System, data needs to be collected from the following sources:

- New precipitation gages for the Arcadia Area;
- Existing precipitation gages in the ACDC watershed area;
- Existing and new flow instrumentation for the ACDC;
- Existing gate position and flow rate instrumentation for the Old Cross Cut Canal (OCCC) gates;
- New gate position and flow rate instrumentation for the Arizona Canal relief gates.

Controls needed for the Drainage System include:

- Existing control system of the Arizona Canal, including the OCCC gates;
- New control system for the Arizona Canal relief gates;

Recommendations are made for each of these existing and proposed data collection and control needs. Responsibilities for operation and maintenance by the Flood Control District of Maricopa County or by the Salt River Project are also recommended.

An engineer's estimate of cost for the gages and controls have been prepared. Cost is estimated at about $358,000 for the instrumentation recommended herein, including engineering, project administration, purchase and installation and computer modifications. Uncertainties in the estimate include programming requirements needed to link new remote stations to the central control computers of SRP and the District, as such could vary considerably depending on selected alternative.

ARCADIA AREA STORM DRAINAGE SYSTEM
PHOENIX, ARIZONA

GAGES AND CONTROLS REPORT

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1. INTRODUCTION

In order for the Arcadia Area Drainage System to be an effective flood control project, data on precipitation and flows must be collected and various flow control structures must be operated. Both collection of data and the control of operations may be performed either locally or remotely and also either manually or automatically.

The remote collection of data is preferred such that operations of a system may be conducted from a central control station. Such offers the benefit of decreased response time to changes in field conditions. Likewise, for control systems, remote operation offers more flexibility in operations but reliable local controls are also a necessity in the event of interruptions to the remote controls. Therefore, the emphasis of this report will be on remote data acquisition and controls but will also deal with the necessary local controls in order to provide a more fail-safe operation.

The Flood Control District of Maricopa County (District) and Salt River Project (SRP) both have in place telemetry systems for the remote collection of data. They both also have remote control capabilities with their telemetry systems, with SRP actively using its capabilities to control the operations of their canal systems, including the structures in the Arizona Canal within the study area.

For the Arcadia Area Drainage System, including the Arizona Canal Relief Gates, data needs to be collected from the following sources:

- New precipitation gages for the Arcadia Area;
- Existing precipitation gages in the ACDC watershed area;
- Existing and new flow instrumentation for the ACDC;
- Existing gate position and flow rate instrumentation for Old Cross Cut Canal (OCCC) gates;
- New gate position and flow rate instrumentation for the Arizona Canal relief gates.

Controls needed for the Drainage System include:

- Existing control system of the Arizona Canal, including the OCCC gates;
- New control system for the Arizona Canal relief gates;

For data collection, some data, such as precipitation, is required only for the needs of the District, while data such as canal levels is needed mainly by SRP. Other data, such as discharges from the relief gates or OCCC gates may be needed by both SRP and the District. Proposals for data collection systems additions and modifications are discussed in the following sections.

Control needs, as opposed to data collection, typically involves a sole responsibility for operation. Some oversight of the controlled operation by another agency may be necessary but very rarely can controls be shared. As such, the discussions of controls in the following sections will for the most part assume that SRP will maintain control of all operations directly involving the Arizona Canal, including the relief gates to the ACDC and the OCCC gates.

2. PRECIPITATION GAGES

The District operates an extensive network of precipitation gages throughout Maricopa County. The typical precipitation gage installation includes a tipping bucket type gage with data recorder and radio transmitter. The gage sites are monitored from the District's main offices.

Of interest to the Arcadia Area Drainage System are the existing gages used for the monitoring rainfall in the watershed directly contributory to the ACDC. Also of potential interest would be the addition of one or more new gages within the Arcadia Area itself for use in the monitoring of storm effects that would impact the Drainage System.

The existing precipitation gages in the ACDC watershed are:

- Gage #4635 - Tipping Bucket Gage at Tatum Wash (40th St. and Shea)
- Gage #4790 - Tipping Bucket Gage at Cudia City Wash (Tatum and Lincoln)
- Gage #4800 - Tipping Bucket Gage at Dreamy Draw Dam
- Gage #4830 - Tipping Bucket Gage at Cave Creek Detention Basin

Per the Conceptual Report entitled Arcadia Area Predesign Study - Arizona Canal Releases into ACDC, dated 6/6/95, the above gages are to be used in the operating criteria of the Arizona Canal Relief Gates.

One or two new precipitation gages are proposed for the Arcadia Area. Depending upon the final design of the Drainage system, these gages may be either informational only or may in some way be tied to the operation of the Drainage System. If, for example, two new gages were to be installed, it may be appropriate for one to be installed at the higher elevations of Camelback Mountain in order to measure precipitation from high intensity storms influenced by the mountain's orographic effects, and for the second to be installed perhaps in the area of the OCCC to measure precipitation from more widespread storms.

Design and installation of future precipitation gages is recommended to be in accordance with the standards used for existing gages, being updated as need be for advances in electronics and radio equipment. If SRP requires access to the precipitation gage data as a part of the operation of the ACDC Relief Gates or other reason approved by the District, a link between the District's control system's host computer and SRP's system could be installed.

3. ACDC GAGES

Flows within the Arizona Canal Diversion Channel are measured by means of stage-discharge relationships, with the stage data collected by the pressured transducers via the District's telemetry system. Existing pressure transducers that are used to gage flows in the ACDC in the reaches downstream of the Arcadia Area (plus the Cave Creek tributary to the ACDC) include the following:

- Gage #4808 - Pressure Transducer at the Cudia City Basin Wash Outlet
- Gage #4813 - Pressure Transducer at the ACDC and 14th Street
- Gage #4823 - Pressure Transducer at the ACDC and 43rd Avenue
- Gage #4833 - Pressure Transducer at Cave Creek and Sweet Water

To the extent that flows from the Arizona Canal are discharged to the ACDC by way of the Arizona Canal Relief Gates and the operating criteria are such as to restrict input depending upon ACDC flows, precipitation, etc, an additional ACDC gage will be needed immediately downstream of the Relief Gates. Such a location should be just downstream of the entrance to the ACDC box culvert section.

As was recommended for the precipitation gages, design and installation of a new ACDC gage is recommended to be based on the existing designs for pressure transducers, updated as need be for advances in electronics and radio equipment. And again, if SRP requires access to the ACDC flow data as a part of the operation of the ACDC Relief Gates or other reason approved by the District, a link between the District's control system's host computer and SRP's system could be installed.

4. ARIZONA CANAL RELIEF GATES

The Arizona Canal Relief Gates, as addressed in detail separately, will be for releases of excess water from the Arizona Canal to the ACDC. Such releases are expected to have a high likelihood of occurring during adverse conditions, and therefore provisions must be made for both remote and local operations of the gates. Gage data for the gates will need to be available to SRP for operations and to the District for monitoring.

A. Gages

Gages for the overall operating criteria of the Relief Gates will be the precipitation and flow gages per the Conceptual Report, as discussed above. The actual operation of the gates, however, will be based on levels in the Arizona Canal and on the gate openings.

Presently, SRP has instrumented the major gate structures of the Arizona Canal upstream and downstream of the proposed location of the Relief Gates. This existing instrumentation includes gages at the 1-8.0 check structure downstream of the gates, at the OCCC gates and at the Arizona Falls (1-5.0) gates. In addition to providing level and gate position indication, the instrumentation also provides flow calculation and gate control.

At the Relief Gates, gages similar to those at SRP's upstream and downstream gates structures will be needed. These will include level transmitters upstream and downstream of the gates and gate position indicators on each gate. In addition, as the Relief Gates will have a fish grate that may be susceptible to clogging with trash, a third level transmitter upstream of the fish grate may be needed for monitoring the differential levels across the grates. Manual readings of levels and gate positions may be needed at times and depth gages should be installed where easily visible, as should position indicators be installed on the gates.

In addition to levels and gate openings, flows through the gates will also be needed. Such can be calculated from the level and gate opening data and may be done in the field with the addition of a programmable logic controller or may be done at a central control station.

Construction and installation of the gages for the Relief Gates should be done in accordance with SRP standards as their operation and maintenance will be SRP's responsibility. The District will need to monitor gate discharges as a part of their responsibilities of operating the ACDC. Such may be done by adding a second transmitter in parallel with SRP's field instrumentation or by establishing a link to SRP's central control station.

B. Controls

Controls for the Relief Gates are recommended to be manual (i.e., controlled by an operator rather than automatically opening based flows or levels) and capable of being either locally or remotely controlled. Remote control will require the addition of a programmable logic controller to the onsite instrumentation for actuation of the gate controller. The remote operator will be responsible for monitoring of levels and gate positions as a part of the operations, as well as complying with the operational constraints of the Conceptual Report. Appropriate alarms should be programmed for conditions such as high water levels, high flows, high gate opening, etc.

Local control should be readily available at the onsite control panel and local operation should be performed manually based on levels, gate openings and rating curves provided to the operator. Emergency backup power should be made available at the site.

As operation of the Arizona Canal is solely the responsibility of SRP and as improper operation of the Relief Gates could conceivably endanger the canal, it is recommended that SRP be the sole operator of the Relief Gates, subject to the constraints of the Conceptual Report and the oversight of the District.

5. OLD CROSS Cut Canal

Gates at the Old Cross Cut Canal currently provide SRP with a spillway capacity of about 1000 cfs while the downstream capacity of the Canal is estimated to be 1900 cfs. To the extent that this additional capacity is utilized by the District for the Arcadia Area Drainage System, improvements in the gages and controls at the existing gate structure may be needed.

A. Gages

The existing gate structure at the OCCC has been instrumented by SRP, including upstream level indication, gate position and flow calculation. With the addition of flows from the Drainage System to the OCCC, it is recommend to add downstream level indication and to tie this level to a rating curve such that total flow in the OCCC may be calculated.

The addition of a downstream level instrument may be most beneficial to the District as it will perhaps be most useful in the monitoring of downstream flooding events. Data from the instrument may benefit both parties, however, and as such it may be useful to tie it into both SRP's existing controls and the District's telemetry system. The ability of the District to monitor flows from the OCCC gates is desirable.

B. Controls

It is envisioned at present that no additional controls will be needed at the existing gates. Depending upon the alternative selected for the Arcadia Area Drainage System, however, some changes may be necessary.

Operating procedure for the OCCC gates will depend upon the operating procedure adopted for the Relief Gates, as discussed separately. Any changes in operating procedure that will affect the controls will need to be addressed after the operating procedure is finalized.

6. ARCADIA AREA DRAINAGE SYSTEM

Gages and controls for the Arcadia Area Drainage System, if required, will depend upon the alternative or alternatives recommended to be implemented. At such time as recommendations are made and accepted, gages and controls for such will be analyzed. For planning purposes, gages and controls similar to those that would be needed for a new installation such as the Relief Gates may be needed and similar costs projected.

7. ENGINEER'S ESTIMATE FOR RECOMMENDED GAGES AND CONTROLS

The probable cost of construction of the gages and controls as discussed above is given on the following page. As with any cost estimate based on a preliminary study, changes made during final design of the gages and controls could substantially change the construction costs.

The Engineer's Estimate of the probable cost of the gages and controls is $358,000, including a 25 percent overall contingency and an additional 15 percent for engineering and administrative expense. Accuracy of the costs is estimated at plus or minus 20 percent. Much variability in costs could be expected due to the uncertainties in programming requirements needed to link new remote stations to the central control computers and in linking SRP's and the District's systems in order to share data. Likewise, the costs of gages and controls needed for the Arcadia Area Drainage System could be expected to vary considerably depending on selected alternative.

J. Davey
03/26/96

Engineer's Estimate of the Gages and Controls Construction Costs

ITEM	DESCRIPTION	APPROXIMATE QUANTITY	UNIT	UNIT COST	PROBABLE TOTAL COST*
1	Precipitation Gages				
	Tipping Bucket Unit	1	Each	$2,500	$2,500
	Radio Modem & Antenna	1	Each	$2,000	$2,000
	Power Supply	1	Each	$2,500	$2,500
	Field Installation	1	Lump Sum	$5,000	$5,000
	Programming Central Computer	1	Lump Sum	$5,000	$5,000
	Total Cost Per Unit				$17,000
	Number of Units	2	Each		x 2
	Total Costs				$34,000
2	ACDC Pressure Transducer				
	Pressure Transducer Unit	1	Each	$2,500	$2,500
	Radio Modem & Antenna	1	Each	$2,000	$2,000
	Power Supply	1	Each	$2,500	$2,500
	Field Installation	1	Lump Sum	$8,000	$8,000
	Programming Central Computer	1	Lump Sum	$8,000	$8,000
	Total Cost Per Unit				$23,000
	Number of Units	1	Each		x 1
	Total Costs				$23,000
3	Arizona Canal Relief Gates				
	Level Transmitters	3	Each	$2,500	$7,500
	Gate Position Potentiometers	2	Each	$2,000	$4,000
	Programmable Logic Controller	1	Each	$4,000	$4,000
	Radio Modem & Antenna	1	Each	$2,000	$2,000
	Power Supply	1	Each	$2,500	$2,500
	Field Installation	1	Lump Sum	$15,000	$15,000
	Programming Central Computer	1	Lump Sum	$15,000	$15,000
	Total Cost Per Unit				$50,000
	Number of Units	1	Each		x 1
	Total Costs				$50,000
4	Old Cross Cut Channel				
	Pressure Transducer Unit	1	Each	$2,500	$2,500
	Feed From SRP Flow Reading	1	Each	$5,000	$5,000
	Radio Modem & Antenna	1	Each	$2,000	$2,000
	Power Supply	1	Each	$2,500	$2,500
	Field Installation	1	Lump Sum	$10,000	$10,000
	Programming Central Computer	1	Lump Sum	$10,000	$10,000
	Total Cost Per Unit				$32,000
	Number of Units	1	Each		x 1
	Total Costs				$32,000
5	Arcadia Drainage System	1	Lump Sum	$50,000	$50,000
6	FCDMC Central Control Station Modifications	1	Lump Sum	$30,000	$30,000
7	SRP Central Control Station Modifications	1	Lump Sum	$30,000	$30,000
	Subtotal				$249,000
	25% Contingency				$62,000
	Subtotal				$311,000
	15% For Engineering and Administration				$47,000
	TOTAL				$358,000

* - rounded to nearest $1000