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CONTROL ENHANCEMENT FOR MIRDAN CANAL INITIAL EVALUATION AND RECOMMENDATIONS

by

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INITIAL EVALUATION & RECOMMENDATIONS

At the request of the Nebraska-Kansas Area Office (NKAO), control problems at Mirdan Canal have been briefly investigated in Reclamation's Technical Services Center (TSC) in Denver. Two separate control issues have been raised:

1. Control of storm inflows to Taylor-Ord Canal entering Mirdan Canal Reach 1 through the Taylor-Ord inlet.

2. Fluctuating flows from Taylor-Ord Canal entering Mirdan Canal, causing fluctuating water levels that interfere with maintaining steady turnout deliveries in Mirdan Canal Sections 2 and 3.

Background information for this short study came from the Designer's Operating Criteria for Mirdan, Geranium, and Scotia Canal and Lateral Systems; design specifications for Mirdan Canal; written notes from Mike Kube (NKAO); a draft letter dated August 22, 1994, from Ronald Wolf (Twin Loups District) to Robert Prouty (NKAO); and conversations with Mike Kube, Art Glickman (TSC), T. R. Haider (TSC), and Ronald Wolf. David Ehler (TSC) provided information on control equipment and cost.

STORM INFLOWS

Based on previous events, storm runoff into Taylor-Ord Canal can increase the inflow from the Taylor-Ord inlet to Mirdan Canal Section 1 to at least 500 ft^3/s. If this happens while Mirdan Canal is flowing at full capacity, total flow in Mirdan Canal could exceed 1200 ft^3/s.

This is a canal conveyance and wasteway capacity problem, not an automatic control problem. Automatic controllers at Mirdan Canal check structures may help pass storm flows through Mirdan Canal when canal flow is low, because check gates could be raised by the controllers. However, this won't help when canal flow is high; check gates already will be open. Therefore, automatic gate controllers cannot provide the capability to pass storm inflows through Mirdan Canal.

To handle storm inflows requires increased hydraulic capabilities. The existing canal does not have sufficient capacity to convey maximum storm inflow on top of canal flows, so the canal conveyance capacity and/or wasting capacity needs to be increased. Siphons will be particularly constricting because of the additional head required to push excess flow through the siphon pipes. Therefore, to avoid extensive canal enlargement, flood water should be wasted before it reaches the siphons.

Although a wasteway right at the Taylor-Ord Canal inlet would be ideal for canal operations, a good place to divert the water may not exist at that site. If a wasteway is added further downstream, the canal may need to be enlarged to convey storm flows to the wasteway. Although the South Turtle Creek wasteway could be enlarged and used to waste excess storm inflows from Taylor-Ord Canal, Mirdan Canal would have to be enlarged between the Taylor-Ord inlet and the South Turtle Creek wasteway. The best place to add a wasteway may be just upstream from the siphon at station 601 + 69, using the old wasteway chute. This appears to be the first good place to waste water downstream from the Taylor-Ord inlet.

More study is required to determine the feasibility of other wasteway sites and enlargement of Mirdan Canal between the Taylor-Ord Canal inlet and a new wasteway.

FLOW FLUCTUATIONS

North Loup River Public Power and Irrigation District (NLRPPID) canal flows routinely fluctuate, causing unpredictable fluctuations in the flow entering Mirdan Canal from the Taylor-Ord Canal inlet. By agreement, the Twin Loups District can neither prevent these fluctuating inflows nor waste the excess, so these flow fluctuations must be carried downstream to Davis Creek Reservoir. The resulting canal water level fluctuations interfere with maintaining steady turnout deliveries in Mirdan Canal Sections 2 and 3.

Automatic gate controllers could help keep canal water levels more constant. Existing check structures could be retrofitted with local automatic control equipment to keep the upstream water surface near a target level. Mirdan Canal Sections 2 and 3 contain 13 check structures in series. This type of application can be problematic for local automatic control, causing flow oscillations that increase as they move downstream. Using a PID (proportional, integral, derivative) algorithm should help to prevent this problem, but careful calibration of algorithm constants will be important for stable operation.

Automating all 13 check gates may not be necessary. Initially, a few key structures should be selected. Laterals 36.3 and 37.1 have been mentioned as being particularly in need of a more constant delivery water surface. By limiting initial automation to a few structures, benefits could be tested for a low cost.

Wing walls (bypass weirs) might be used at some of the check structures to help dampen flow oscillations. Where the additional canal water depth can be tolerated, some of the manually-controlled gates might be set so that upstream depth slightly exceeds the height of the wing walls.

Communication between automatic controllers and a headquarters office (master station) is highly recommended. As a minimum level of communication, alarm conditions should be sent to the master station to alert operators of on-site problems. Typically, radios are the most feasible means of communication.

Estimated costs for control equipment and installation are shown in Appendix 1. These costs reflect modern technology for a simple system. Depending on site-specific conditions, additional infrastructure may be required, such as equipment enclosures and radio antenna towers. Roughly, local automatic control for Mirdan Canal would cost about $5,000 for each control site (check structure) and $6,000 for a master station. (Cost per site will be higher if there are only a few sites than if there are a large number of sites.)

G-6.1 LATERAL

The letter from Ronald Wolf to Robert Prouty states that the G-6.1 lateral is difficult to operate because small flow mismatches cause water level fluctuations in the open channel portion. Mr. Wolf's suggestion to replace the open portion with pipe is a good solution; putting the entire lateral into pipe would definitely cure the operating problems. A less expensive solution might be to automatically control the lateral head gate based on water level in the open portion, so as to maintain a relatively constant water level by automatic head gate adjustments. The technical and economic feasibility of this alternative should be explored.

CONCLUSIONS

1. Insufficient hydraulic capacity presently exists in Mirdan Canal to accommodate maximum storm inflows from Taylor-Ord Canal. As the canal system presently exists, a large storm event could raise canal water levels above the top of canal banks and cause a failure. Additional wasteway capacity is required and canal banks may need to be raised. Detailed studies are needed to design these system improvements.

2. Non-structural improvements can help alleviate canal control problems from fluctuating flows. Local automatic upstream water level controllers can be added to existing check gate structures to reduce water level fluctuations.

APPENDIX 1

LOCAL AUTOMATIC UPSTREAM WATER LEVEL CONTROL
EXAMPLE COST ESTIMATE

ON-SITE EQUIPMENT:

Microprocessor	$ 1,100
RF Modem	305
Radio	480
Antenna & Mast	150
Power Supply & Charger	250
Battery	60
Water Level sensor	500
Control Interface (relays)	50
Relay Driver	175
Gate Position Indicator	20
Enclosure	180

Subtotal - equipment	$ 3,270
Labor (3 to 5 staff days)	1,500

Total per site	$ 4,770

MASTER STATION:

486 computer (use existing?)	$ 2,000
RF modem	305
Radio	480
Antenna & mast	150
Notebook Computer (NB)	1,400
SC32A interface adapter for NB	145
PC208 Software	200
PC208 (2nd for NB)	50

Subtotal - equipment	$ 4,730
Labor (3 to 5 staff days)	1,500

Total	$ 6,230