RECLAMATION

Managing Water in the West

Hydraulic Laboratory Technical Memorandum PAP-1120

Hammond Conservancy District Irrigation System Assessment and Improvement Recommendations

Colorado River Storage Project – New Mexico

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Hydraulics Investigations and Laboratory Services Group
Denver, Colorado

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Background

Engineers from Reclamation's Hydraulic Investigations and Laboratory Services (HILS) Group – part of Reclamation's Technical Services Center (TSC) based in Denver – are working under agreement with Reclamation's Western Colorado Area Office (WCAO) in Durango to examine aspects of the water distribution system and water delivery operations at the Hammond Conservancy District (HCD) near Bloomfield, NM. WCAO had previously contracted with the consulting firm Tetra-Tech of Albuquerque, NM to perform an evaluation of the ". . . infrastructure, operations, and system efficiency of the Hammond Conservancy District (HCD) irrigation operations." A report documenting the Tetra-Tech evaluation was produced in July, 2014. Findings from this report along with first-hand observations made during the site visit by the HILS engineers contributed to the list of recommendations in this document.

Site Visit

A site visit was performed during April 20-22, 2015. On April 20, Tracy Vermeyen and Tom Gill of HILS were accompanied by Hammond ditch rider/maintenance specialist Randy Nye and by WCAO staff members Tyler Artichoker and Robert Stump for a tour through the District along the Main Canal. The same group, except Tyler Artichoker, continued on April 21 for a tour of the East Highline, the West Highline, and the Gravity Canals plus travel along a section of the Main Canal not inspected the previous day. On the morning of April 22, Tracy and Tom had an exit meeting where they presented draft recommendations to Randy and HCD Manager Teresa Lane at the district office.

A preliminary prioritization of items to be upgraded was performed by the HILS engineers following the April 20 & 21 travels through the District along each of the delivery canals. A prioritized list of recommendations was refined with input from HCD personnel during the exit meeting.

Recommendations

Priority 1 Recommendations

Recommendations with a Priority 1 designation are items that represent an immediate need or that can provide immediate benefits for improving system operations. These items include upgrade of existing physical features of the delivery system that currently impact operations along with the initial components needed for a robust, real-time remote monitoring, data collection, and control system at key points in the water distribution network.

Priority 1 recommendations that would serve all components of the District

- Installation of new radio base station equipment at the District Office. This would include installation of a programmable control unit with an integral long-range UHF radio system equipped with a display and keypad. This base unit would be programmed for two-way wireless communication with all field sites by following on-screen prompts directing appropriate keypress inputs. The unit may be linked via RS232 cable to a PC for automated data retrieval/data archiving tasks using a software package that is a free download from the radio/control unit manufacturer. Given discussion by District staff regarding past issues with surge problems coming in over the power grid, it may be advisable to consider linking the base unit to a low power consumption laptop computer and setting up all base station equipment (including the laptop PC) to be operated exclusively using a solar-charged battery powered system.
- Install an alarm alert system linked to the office base station including a call-box with pre-recorded phone messages that may be keyed up by the base radio/control unit.
- Installation of dedicated repeater sites (if a radio pathway check indicates repeaters are necessary). [Given that any of the proposed field stations may also function as a repeater without impacting local control or monitoring functions, there may well be no need for dedicated repeater site(s).]
- Acquisition of mobile units for HCD staff vehicles. These "ditch rider" units enable two-way communication with any other site within radio range. If there are locations in the district from which signal strength is insufficient between a mobile unit and a target field site, the ditch rider units may be programmed to enable the user to select a "direct" or a "repeat" radio path. The mobile units are equipped with cigarette lighter power cord and are typically linked to a magnetic mount antenna, a configuration that simplifies transfer of the unit from one vehicle to another (or to a piece of maintenance equipment).

Priority 1 recommendations identified for the Main Canal

- Perform a feasibility investigation for installing lining (or pipe) along the approximately 1,200-ft-long unlined reach of the Main Canal located between CR4660 and CR4665. This section was apparently scheduled to be lined as part of the installation of concrete lining project in either direction from this reach, but because of a high water table at the time the lining was installed it was left unlined.

- Investigate the feasibility of re-lining (or installing pipe) along the reach of the Main canal beginning at approximately the point where the canal passes under County Road 4990 just west of the Western Refining facility. The existing lining has deteriorated from this location downstream approximately 400 feet to an inverted siphon. On the exit side of the siphon the lining continues in poor condition for an additional distance. This area typically has a high groundwater table which apparently contributes to limited soil stability. The HCD staff has observed that the soil stability issue problem is exacerbated during and following events of significant precipitation runoff.
- Fabricate and install new staff gages at existing flumes (figure 1). The new gages would be scaled to provide direct readings both in actual flow depth, and in discharge. This would be a low cost item that would greatly simplify on-site monitoring of flow conditions at the existing flume sites. Main Canal flume sites would include:
    - The Diversion Dam site with a ramp-type long-throated flume
    - The ramp-type long-throated flume on the Bolack property (approximately ¾ mile upstream from the Store spill)

Figure 1. Typical long-throated flume that would receive a new staff gage to provide direct readings of both discharge and flow depth.

- Install a wireless monitoring/datalogging station at the Diversion Dam's ramp-type long-throated flume (figure 2). This station would be independent of the State's existing monitoring equipment.

Figure 2. Photograph of existing stilling well and staff gage for the ramp-type long-throated flume (not pictured) used to measure the diversion flow.

- Install a wireless monitoring/datalogging/remote control station at the Auxiliary Pumping plant. Add a pulse-output sensor to the existing propeller meter to enable remote monitoring of flow rate (figure 3). Install oil pressure, rpm, and temperature sensors to remotely monitor condition/operation of the pump engines. These upgrades should be installed when the pumps are changed over to the new energy supply (Natural gas, Propane, or Electricity) scheduled for Spring 2016.

Figure 3. In-line propeller meter on the discharge line from the Auxiliary Pumping Plant which measures water being delivered to the East Highline Canal.

- Install a wireless monitoring/datalogging/remote control station at the Armenta Pumping plant. Add pulse output sensors to the existing propeller meters in the East Highline and West Highline pipelines (figure 4).

Figure 4. Saddle mount Propeller meters on the discharge lines from the Armenta Pumping Plant which measure flow being delivered to the West and East Highline Canals.

- Replace the existing control/communications equipment at the spill structure near the Armenta inverted siphon entrance. The new equipment will be compatible with the existing gate motorization system. A new water level sensor would be installed.
- Install a new long-throated flume in the canal below the outlet of the Armenta inverted siphon equipped with a wireless monitoring/datalogging station. (A flat-bottomed, laterally-contracted flume that will readily pass sediments may be a superior alternative to a ramp-type flume).
- Replace the existing control/communications equipment at spill structure near the Sullivan Canyon inverted siphon entrance (figure 5). The new equipment will be compatible with the existing gate motorization system. A new level sensor would be installed.

Figure 5. Existing control/communications equipment installed at wasteway spill structure located upstream from the Sullivan Canyon siphon entrance.

- Install a new long-throated flume in the canal below the outlet of the Sullivan Canyon inverted siphon equipped with a wireless monitoring/datalogging station. (A flat-bottomed, laterally-contracted flume that will readily pass sediments may be a superior alternative to a ramp-type flume).
- Replace the existing control/communications equipment at spill structure near the Horn Canyon inverted siphon entrance. The new equipment will be compatible with the existing gate motorization system. A new level sensor would be installed.
- Install a new long-throated flume in the canal below the outlet of the Horn Canyon inverted siphon equipped with a wireless monitoring/datalogging station. (A flat-bottomed, laterally-contracted flume that will readily pass sediments may be a superior alternative to a ramp-type flume).
- Replace the existing control/communications equipment at the Store spill site. A new water level sensor and a gate position sensor for the spill control gate will be included.
- Install a monitoring/datalogging station at the existing ramp-type long-throated flume located approximately ¾ mile upstream from the Store spill site.

Priority 1 recommendations for the East Highline Canal

- Fabricate and install a new staff gage at the existing long-throated flume at the head of the canal. The new gage would be scaled to provide direct readings both in actual flow depth, and in discharge.

Priority 1 recommendations for the West Highline Canal

- Perform an investigation into the feasibility of re-lining (or installing pipe) along the reach of the West Highline Canal above Doyle's Wash Siphon. The soil along this reach consists largely of coarse grained sandy material. The concrete lining in this reach is severely fractured, suggesting instability in the underlying soil. The fractured lining and coarse underlying soil almost certainly result in high seepage losses along this canal section.
- Identify and correct issues with the existing pipeline across the LDS farm. [Identification efforts are currently ongoing.] Clean obstructions (if debris/sediment accumulation are identified that can be feasibly removed) or replace (if collapsed pipe is identified). Install manholes to simplify addressing future similar maintenance issues with this pipeline.
- Motorize the existing gate at the spill structure at the end of the canal and install radio/control equipment to automate the spill gate (to minimize spills) and to monitor and log spill flow rates.

Priority 1 recommendations for the Gravity Canal

- Perform an investigation into the feasibility of re-lining (or installing pipe) along the reach of the Gravity Canal between the outlet of the Armenta Invert Siphon and the 117+50 turnout. The concrete lining along this reach is highly fractured. The Gravity Canal along this reach is routed along a comparatively steep slope. Soil along the slope appears to be large rounded cobbles mixed with silt. Frost heave due to the fine-grained silt component is suspected by HCD personnel as being a key factor behind the degradation of the concrete lining. Slope stability following large precipitation events has also been an issue with significant amounts of the silt and cobble material sloughing down the slope into the canal from where it must be mechanically removed.
- Motorize the existing gate at the spill structure at the end of the canal (figure 6) and install radio/control equipment to automate the spill gate (to minimize spills) and to monitor and log spill flow rates.

Figure 6. Wasteway inlet at the end of the Gravity Canal.

Priority 2 Recommendations

Recommendations with a Priority 2 designation are sites where benefits of remote monitoring and/or remote operating capabilities will be significantly enhanced once improved capabilities represented by the Priority 1 items have been put in place.

Priority 2 recommendations for the Main Canal

- Install a monitoring/control communications station at the Diversion Dam to enable remote adjustment capability for the diversion control gate and monitoring of headwater level.
- Investigate improvement alternatives for the silt detention facility just below the diversion headworks. This may include construction of a sluice way to return sediments to the river and/or installation of a sediment exclusion mechanism at the diversion dam upstream of the diversion control gate.
- Automate the CHO structure at the headworks of the gravity canal. This would include:
    1. Installation of a monitoring/control communications station
    2. Motorization of both CHO gates with gate position sensors
    3. Installation of electronic water level sensing equipment upstream and downstream of the metering (front) gate of the CHO structure

- Motorize the gate controlling flow into the Armenta inverted siphon and link operation of the gate to the (Priority 1) upgraded control/communications unit recommended for installation to control the spill gate at the same location. This will allow the gate to be automated to maintain a target flow rate as measured at the (Priority 1) proposed flume below the Armenta inverted siphon outlet.
- Motorize the gate controlling flow into the Sullivan Canyon inverted siphon and link operation of the gate to the (Priority 1) upgraded control/communications unit recommended for installation to control the spill gate at the same location. This will allow the gate to be automated to maintain a target flow rate as measured at the (Priority 1) proposed flume below the Sullivan Canyon inverted siphon outlet.
- Motorize the gate controlling flow into the Horn Canyon inverted siphon and link operation of the gate to the (Priority 1) upgraded control/communications unit recommended for installation to control the spill gate at the same location. This will allow the gate to be automated to maintain a target flow rate as measured at the (Priority 1) proposed flume below the Horn Canyon inverted siphon outlet.

Priority 2 recommendations for the East Highline Canal

- Install a control/communications unit with a water level sensor at the existing flume at the head of the East Highline Canal to enable remote monitoring of flow at the site. [This together with the (Priority 1) addition of a pulse output module to the propeller flow meter in the East Highline pipe at the Armenta pumping plant will provide redundant flow rate monitoring capability. The flume would be expected to provide greater long-term measurement reliability than the propeller meter.]
- Install a motorized adjustable weir in place of stop-log control at the spill structure at the end of the East Highline Canal. Install a control/communications unit with a water level sensor at the spill structure. The adjustable weir could be automated to maintain a target water level at the lower end of the canal. Spill flow would be measured and data logged electronically.

No Priority 2 recommendations for the West Highline Canal.

Priority 2 recommendations for the Gravity Canal

- Raise the concrete spill weirs on both sides of the stop-log bay at check 131+50. The high water mark on the canal lining indicates that up to 6” of water routinely spills over these weir walls. Raising these weirs would

increase the degree of level control achieved by installing or removing stop logs.

- Raise the concrete spill weirs on both sides of the stop-log bay at check 173+50. The high water mark on the canal lining indicates a situation similar to that at the 131+50 check. Raising these weirs would increase the degree of level control achieved by installing or removing stop logs.

Priority 3 Recommendations

Recommendations with a Priority 3 designation are items that can further benefit HCD's daily operations. These are seen as items that either can provide a more prominent positive impact once the priority 1 & 2 items are in place, or items that presently represent less of an impact on daily operations than the higher prioritized items.

Priority 3 recommendations for the Main Canal

- Motorize the gate on the Manzanares Wash inverted siphon inlet and install a radio/control system to automate the gate to maintain a target water level to enhance the ability to deliver steady flow rates to upstream turnouts.
- Motorize the gate on the Munoz Wash inverted siphon inlet and install a radio/control system to automate the gate to maintain a target water level. This can enhance the ability to deliver steady flow rates to upstream turnouts and can provide a capability to minimize and monitor spill at this site.
- Install water level sensing equipment upstream and downstream of the Auxiliary pumping plant trash rack (figure 7) which would be linked to the radio/control unit to be installed at this site (Priority 1). This will enable ditch riders to remotely determine whether debris needs to be cleaned from the trash rack.
- Install water level sensing equipment upstream and downstream of the trash rack at the Armenta hydro-pump penstock intake. The level sensing system can be linked to the (Priority 2) radio/control equipment to be installed at the Gravity Canal headgate. This will enable remote monitoring of debris accumulation at this site.

Figure 7. Intake trash racks at the Auxiliary pumping plant which frequently get clogged with debris.

- Install sensors on the turbine and pump at the Armenta pumping plant linked to the (Priority 1) radio/control unit to be installed at the site. This will enable remote monitoring of pump/turbine operation and for triggering alarms conditions that warrant on-site attention.
- Install motorized actuators on the valves controlling flow into the East Highline and West Highline pipe lines at the Armenta Pumping Plant. Linking these actuators to the (Priority 1) radio/control unit to be installed at this site can enable remote adjustment of flow rates being delivered to the respective canals.

Priority 3 recommendation for the East Highline Canal

- Install an automated overshot gate in the currently stop-log controlled 119+55 (Goodman) check operated by a radio/control unit. The gate would be automated to maintain a target upstream water level. Automation of this check would represent a demonstration/test of the effectiveness of automated checks in this reach of the east Highline canal. Automated checks could facilitate passing flow changes downstream while maintaining a target upstream level.

No Priority 3 recommendations for the West Highline or Gravity Canals

Priority 4 Recommendations

Recommendations with a Priority 4 designation are seen as key improvements in reaching long-term operational and water delivery efficiency objectives. The impact of these improvements is seen as being enhanced once improved capabilities represented by the Priority 1-3 items are in place.

Priority 4 recommendation for the Main Canal

- Establish automate/remote control capability for two of the sluiceway radial gates at the diversion dam adjacent to the diversion control gate controlling flow passing downstream in the river channel (figure 8). This will enable maintaining upstream water level within a desired range while maintaining as much sediment sluicing flow as possible downstream in the river channel.

Figure 8. Radial gate hoists at the Hammond Diversion Dam.

Priority 4 recommendations for the East Highline Canal

- Install an automated overshot gate in the currently stop-log controlled 91+50 check operated by a radio/control unit. The gate would be automated to maintain a target upstream water level.
- Install an automated overshot gate in the currently stop-log controlled 129+50 (McKee) check operated by a radio/control unit. The gate would be automated to maintain a target upstream water level. Automation of these two checks would follow the (Priority 3) automation of the 119+55 check which is located between the 91+50 and the 129+50 checks. Automation of this string of checks could simplify what has been an operational bottleneck as flow changes need to be moved through this canal reach with limited available freeboard. This would enable HCD to provide water users along this reach to maintain the high water levels they seek while simplifying routing flow changes through the reach.

Priority 4 recommendation for the West Highline Canal

- Design and install a suitable low-headloss flow measurement system for the heading of the West Highline Canal. A previously installed ramp flume at the upper end of this canal has been removed – apparently due to a constriction in flow rate associated with the flume. Ramp-type long-throated flumes are generally recognized for being able to operate as a critical-flow measurement structure with the highest degree of submergence among critical-flow measurement alternatives. A minimum of a 10% drop in elevation (referenced from the flume crest) is typically needed for critical-flow (unsubmerged) operating conditions. Alternatives for consideration would include electronic flow measurement (i.e. acoustic-Doppler flow measurement technologies) that provides a no headloss flow measurement.

No Priority 4 recommendations for the Gravity Canal

Priority 5 Recommendations

Recommendations with a Priority 5 designation are described as representing capabilities that might not currently be feasible or that would be of modest impact in current operations. Rather these items would become feasible as previously discussed system upgrades come online.

Priority 5 recommendations for the Main Canal

- Restore automation of the Armenta pumping plant trash rack cleaning system (figure 9). A bar rack has been installed immediately upstream of the trash rack for safety. The gradually sloped safety rack was installed primarily to protect animals or humans from becoming impinged on the near vertical trash rack. This safety rack tends to collect a majority of the debris before it reaches the trash rack. Currently, debris from the safety rack is either removed by hand or dislodged and allowed to pass and be collected on the trash rack. The operation of the motorized trash cleaning apparatus on the trash rack is being triggered manually. Restoring automated cleaning would require development of a cleaning system for the safety rack or modification of the rack in some manner.

Figure 9. Armenta pumping plant trash rack cleaning system.

- Install automated/remotely operated overshot gates in the checks from check 1032 to the Green Acres siphon. District personnel indicate that flow rates through this concrete lined reach are modest in comparison to canal capacity. High water marks on the canal lining indicate a significant amount of available freeboard. The flow rate to canal capacity ratio results in an extended time duration that allow ditch riders to monitor the canal and get checks adjusted as delivery rates passing through this stretch change. Additionally, the canal capacity along this stretch could enable this section of the canal to be utilized for re-regulation storage. As improved spill monitoring and control capabilities from higher priority recommendations are put into place, more supply/demand mismatch flows

will be passed downstream. Use of in-canal storage along this reach could become a major contributing factor to improve canal delivery efficiency in long-term operations. In-canal storage would be a viable option once these checks are set up for automation/remote operation.

Priority 5 Recommendations for the East Highline Canal

- Install an automated/remotely operated overshot gate at the entrance to the Munoz Wash check. An automated gate at this site would enable the ability to maintain canal level above this check while passing changing flows as downstream demands change.
- Install an automated/remotely operated overshot gate at the 60+50 check. This would enable maintaining a steady upstream level while passing flow changes downstream.

No Priority 5 recommendations for the West Highline or Gravity Canals

Summary

The system upgrade recommendations listed under the five priority categories outlined above would significantly enhance the Hammond Conservancy District's ability to monitor their water delivery system and reduce operational spills. As HCD proceeds in upgrading its operational capabilities, achieving high delivery efficiency levels will likely require a more in-depth assessment of water storage alternatives along the delivery system. Capturing the bulk of supply/demand mismatch excesses in storage, as opposed to letting it leave the system as wasteway spills, may be a critical strategy for addressing competing demands for limited water supplies.

The identification and prioritization of recommendations in this report should be considered a starting point in a modernization process that will be carried out over a period of time. No cost/benefit analyses or cost estimates for these recommendations were conducted because that level of detail was beyond the scope of this study. As initial tasks are being undertaken or are nearing completion the identification and re-prioritization of subsequent tasks will likely be warranted. As a working level of familiarity is attained with the new technologies recommended as initial upgrades, HCD personnel may gain a new perspective on what would be an appropriate prioritization for subsequent tasks.