

Appendix E.2 Engineering Assessment Reports

Birdwood Engineering Assessment Report Summary

Birdwood Canal consists of two river control gates and a 90° canal gate diversion structure directly adjacent to the river gates. After a site visit, the visible concrete elements of the river gate structures were deemed to be in good condition with no major signs of deterioration or degradation. The canal gate structure was noted to have numerous cracks, and the gates do not sit completely flush with corrugated metal pipes (CMPs). The timber headwall on the canal side of the structure is almost completely deteriorated, which has allowed erosion of embankment material. It was also noted that the CMPs have eroded and are allowing water to flow into the backfill.

Both structural and safety and operational improvements have been recommended for the structures. A full replacement of the canal gate structure and a replacement or modification of the sand chute structure is recommended to improve the canal structurally. The proposed improvements also include enhancements for operational safety, reliability, and accessibility. These proposed improvements consist of replacing timer stop logs with a more reliable and safe way to dam flow through river control gates, install a safer access platform for river control gates equipped with a 42" tall handrail, install automated gates for the river gate structure, install structure lighting for nighttime operation safety, raise canal gate structure elevation by about 4-5 feet based on operator experience, and to restore backfill grading behind the north sidewall of the river control gate structure.

The full engineering assessment report is provided at the end of this section.

Cody-Dillon Engineering Assessment Report Summary

The Cody Dillon canal diversion structure consists of a return gate structure to the north and a 90° canal gate structure directly adjacent to and east of the return gate structure. All river return gate walls showed minor concrete cracking, spalling, and water staining, but are in fair condition. The interior return gate walls are in good condition with little deterioration. The return gate end walls, primarily the west end wall, have extensive damage. The west end wall failed, and broken concrete is acting as riprap. There are some cracks in the canal gate structure, but these were found not to cause additional concerns for the structure. At the inlet side of the canal gate structure, the southern sidewall has a large vertical crack and has seemingly started rotating into the canal.

Both structural and safety and operational improvements have been recommended for the structures. The structural improvements recommended are replacing the western side wall of the return gate structure, evaluating the end of the east side wall of the return gate, improving the southern wall extending from the canal gate structure, sealing minor cracks in concrete walls, sealing gaps between base concrete repairs and upper wall sections, patching spalled concrete as needed, removing sedimentation of canal structure apron, and restoring grade at wall ends. The recommendations to better the safety and operations of the canal include the installment of a safer access platform across both structures with a 42" tall handrail, installment of an access crossing structure, installment of automated gates for the river return gates, addition of lights for nighttime operations, installment of an access ladder or stairs from structure down to gate, and the extension of the concrete apron to fully cover the area between the return gate inlet and the southern structure wall.

The full engineering assessment report is provided at the end of this section.

Keith-Lincoln Engineering Assessment Report Summary

The Keith-Lincoln structure consists of six river gates perpendicular to the channel and a two-cell diversion structure along the south riverbank, 90° to the river gates. Backfill erosion was noted behind each of the river gate sidewalls. The inspector deemed that all river control gate walls are in fair condition, with map cracking noted throughout most surfaces. The access walkway showed noticeable deflection. The canal gate structure and lift gates were said to be in good condition with no major signs of deterioration.

Both structural and safety and operational improvements have been recommended for the structures. The structural improvements include restoring the grades behind the river gate side walls in addition to adding scour protection, restoring scoured subgrade by using flowable fill, installing a riprap basin to protect against undermining of the structure, and installing a steel sheet pile cut-off wall if not already in place. The safety and operational improvements include adding a 42" tall handrail to the river gate and canal structure, updating the river gate automation for improved structure efficiency, cleaning river gates, patching holes in river gate surface, applying protective coating to river gate, replacing river gate seals to reduce water loss, cleaning canal gates, and replacing the canal gate seals to reduce water loss.

The full engineering assessment report is provided at the end of this section.

Paxton-Hershey Engineering Assessment Report Summary

The Paxton-Hershey Canal consists of a spillway structure to the north, four river gates toward the south riverbank, and a 90° diversion structure directly adjacent to and south of the river gates. The inspector reported the river gate wall to be in good condition with minor map cracking, concrete spalling, and water staining. The access platform showed noticeable deflection and transverse cracking in the top slab. The north retaining wall exhibited concrete spalling along its top corners, with damage being the greatest at its upstream end. Environmental buildup and debris are present throughout the entire structure. The canal gates and their components are in very poor condition. The canal gate walls exhibited concrete spalling, cracking and staining, and damage has resulted in significant section loss throughout the structure, exposing steel reinforcing present. Complete section loss through wall bases is present in some cells.

Both structural and safety and operational improvements have been recommended for the structures. The structural improvements recommended are to reconstruct the downstream retaining wall, replace failed spillway section, replace canal gate structure and reconnect to existing river gate structure, install scour mitigation sheet pile cut off walls, patch concrete at spalled locations, patch and seal construction joints in the spillway section, replace seals at all radial gates, patch and recoat radial gate surfaces, restore downstream riprap basin, and restore location of structure embankment erosion. The recommendations to support improved safety and operation are to install stairs or access ladders throughout the structure, install lighting to assist nighttime operations, automate and update the current gates and equipment of the river gate structure, and add a 42" tall handrail to all access platforms.

The full engineering assessment report is provided at the end of this section.

Platte Valley Engineering Assessment Report Summary

The Platte Valley Structure consists of a spillway structure to the north, six river gates toward the south riverbank, and a 90° diversion structure directly adjacent to and south of the river gates. All walls of the river control gates showed minor cracking, spalling, and water staining, with some walls showing more significant cracking or damage. Access slabs have noticeable deflection. The spillway and its components are in good condition with minor concrete damage. The construction joints did show some large cracks, and there is a lot of environmental and riprap buildup on the slabs. The downstream face of the upstream

spillway weir wall shows deterioration at its base. There is water seepage and environmental buildup on all faces of the spillway. The faces of all diversion structure walls showed extensive cracking, spalling, and water staining.

Both structural and safety and operational improvements have been recommended for the structures. The recommendations for improving the structures include repairing or reconstructing the north exterior wall of the newer main channel gates, reconstructing the downstream retaining wall, evaluating the upstream apron emergency repairs, repairing the western canal gate structure wall, replacing the intermediate and eastern canal structure walls, replacing the access platforms, installing scour mitigation sheet pile cut-off walls, patching concrete at spalled locations, patching and dealing construction joints in the spillway, replacing seals at all the radial gates, backfilling scoured region, and restoring the downstream riprap basin. The recommendations for safety and operational improvements are to install stairs or a ladder at the transition from the original to the newer main channel, add additional lighting for nighttime operations, update current gates and equipment for river gate and canal gate structure to allow for automated operation, and add a 42" tall handrail to all access platforms.

The full engineering assessment report is provided at the end of this section.

Suburban Engineering Assessment Report Summary

Suburban Canal consists of a spillway structure to the south, two river gates along the northern riverbank, and a 90° canal gate structure. A county bridge crosses the river upstream of the diversion structure. The river gate structure was deemed to be in good condition with some slight erosion at the end of the apron and backfill. The overflow spillway and downstream apron are in fair condition with heavy environmental buildup on most surfaces. The upstream side of the spillway has a timber pile wall aligned on the northern section, and it is severely eroded and no longer protects the weir. The canal structure's concrete apron is in poor condition and is split into two pieces by a large crack.

Both structural and safety and operational improvements have been recommended for the structures. The structural improvements include regrading the embankment behind the northern river gate to restore and protect the northern riverbank downstream of the river gate structure, replacing the canal gate structure in its entirety, constructing a riprap scour basin beyond the end of the canal structure apron, extending the sheet pile walls across the river channel, retrofitting a concrete apron to tie the sheet pile section to the existing structure, and installing a sheet pile scour protection wall. The safety and operational improvements include installing stairs or a ladder access point down into the structure, installing lighting for nighttime operation, adding a 42" tall handrail along wall edges and access walkways, and updating the current gates and equipment of the river gate to allow for automated operation.

The full engineering assessment report is provided at the end of this section.

BIRDWOOD IRRIGATION DISTRICT BIRDWOOD CREEK CANAL DIVERSION

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Existing Structure General Description

The Birdwood Canal diversion structure is located 5.5 miles northeast of Sutherland, Nebraska. The structure consists of two river control gates, and a 90° canal gate diversion structure directly adjacent to the river gates as shown in the Vicinity Map (Figure 1).

The river control gates consist of two cells that manage water levels by damming water with stop logs as necessary. The inlet of the canal diversion structure is a four-cell corrugated metal pipe (CMP) structure with one steel lift gate in each cell. The lift gates allow for water to be diverted from below the checked river water surface.

Current Maintenance & Operations

During the site visit, Olsson's inspectors were able to discuss operations and maintenance challenges with the ditch operator. The operator provided several suggestions to improve operations based on past experiences with the structure:

- Noted it would help to raise the top berm over the canal gate structure 4 to 5 feet so operators can still cross when water levels rise.
- Noted it would help to see improvements to sand screen structure to mitigate sand deposits that impede diversion canal operations.
- Noted it would help to have diversion canal gates that can be wirelessly operated from a cellphone or similar.

River Control Gates

The river control gates consist of an overall opening width of approximately 32' split into two 16'-0" wide cells by an intermediate concrete wall. A timber plank boardwalk access platform spans between the sidewalls and the interior wall. The walkway is fitted with a cable safety rail along one side. See Figure 2 for an overall view of the river control gate structure. While not visible during the site visit, it is understood that the structure has a concrete apron floor and assumed cut off walls at each end of the structure. The downstream end of the concrete apron has multiple drops (Figures 5 & 6), but exact geometry of the apron could not be determined due to the water level and channel flow. There are concrete walls on each side of the channel that run the length of the structure. It is assumed that the concrete apron has the same general profile as the observed flow pattern through the structure.

From speaking with the ditch operators it is understood that the river flow elevation is raised by installing timber planks (Figure 4). These planks are lowered into the upstream end of the flow to catch a railroad rail at the base of the structure. The water pressure then pins the plank up against another railroad rail that spans between the sidewalls and interior wall at about the same elevation as the walkway.

Condition of River Control Gates

Overall, the visible concrete elements of the river gate structure appear in good condition with no major signs of deterioration or degradation. Some cracking, minor concrete spalling, and surface wear was noted on the concrete but does not immediately cause concern for structure integrity. The north wall was also noted to have some locations of depressions in the backfill surface. The source of these depressions was not able to be determined during the site investigation (Figure 5).

Canal Gate Structure

The canal gate structure consists of four 54" diameter corrugated metal pipes (CMP) with a concrete headwall on the river side (Figure 7) and a timber headwall on the canal side (Figure 8). The concrete headwall has a minimum thickness of 1'-0". No fall protection railing is present on either side of the structure. Flow into the canal is controlled by opening hand operated screw gates (Figure 9). Water depth and flow in river did not allow for visual identification of subsurface geometry of the headwall. It is unknown if a concrete apron exists beyond the face of the headwall.

Condition of Canal Gate Structure

The concrete headwall of the canal structure has numerous cracks and it was noted that the gates do not sit completely flush with CMPs. The timber headwall on the canal side of the structure is almost completely deteriorated. This has allowed embankment material to erode. The ditch operator noted that a significant quantity of water moves outside of the pipes. This suggests that the existing CMP pipes have eroded and are allowing water to flow into the backfill rather than staying contained within the pipes. At time of visit, the CMP openings were filled approximately halfway with sand (Figure 8).

Ancillary Structure – Sand Chute

A sand chute structure is in place in the canal downstream of the canal gates. The intent of this structure is to flush sand that has been transported into the canal back to the river channel. The structure consists of a concrete apron with a step and a sidewall with a CMP. A screw gate is used to open or close the pipe opening. The CMP extends through the adjacent embankment and outlets into a pool connected to the river channel. At the time of inspection, timber planks were in place in front of the return pipe. It is expected that the timber cover is intended to help concentrate flow to better move sand deposits. Based on discussions with the ditch operator, the existing sand chute configuration is not very effective at transporting sand deposits back to the river. Beyond the current ineffectiveness issues, the structure is in good condition. The visible concrete components were in good condition with no major signs of deterioration. The connection of the CMP to the wall was in fair condition with some deterioration of the gate elements and deterioration concentrated around the pipe connection.

Recommended Improvements

Overall, the river gate structure appears to be in good condition and requires only minor improvements and maintenance to continue operating as intended. The canal gate structure is in worse condition and will require more significant modifications to improve functionality and reliability for operations. Due to the existing condition it is anticipated repair costs will be a high percentage of the structure replacement cost and therefore no maintenance recommendations are proposed. In addition to structural improvements, there are also a number of safety and operational improvements recommended for the structures. The following list provides a breakdown of each type of recommended improvement:

Structural Improvements

1. Full replacement of canal gate structure.
2. Replace or modify sand chute structure to improve effectiveness of sand removal from the canal.

Safety & Operational Improvements

1. Install a more reliable and safer way to dam flow through river control gates than current methods of using timber stop logs.
2. Install a safer access platform for river control gates, including 42" tall handrailing.
3. Install automated gates for the river gate structure.
4. Install structure lighting for nighttime operation safety.
5. Raise top of structure elevation for the canal gate structure crossing to maintain access through larger events. Ditch operators suggested a 4-5' raise in elevation based on past experience.
6. Restore backfill grading behind the north sidewall of the river control gate structure.

Figures



Figure 1. Site Map of Birdwood Irrigation District / Birdwood Creek Diversion Structure



Figure 2. Looking Southeast Along River Control Gate Structure.



Figure 3. Looking Northeast Toward River Gate Structure – Upstream End



Figure 4. Looking Northwest Along River Control Gate Structure

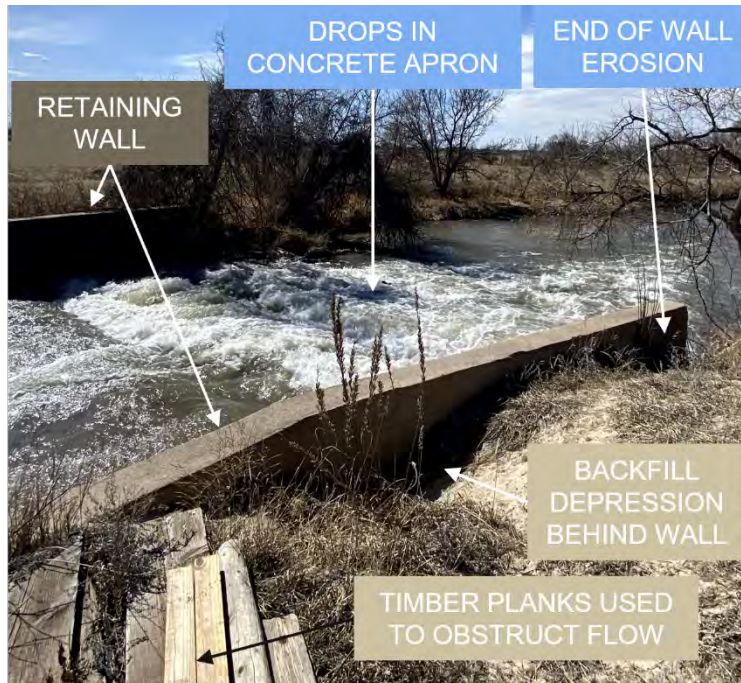


Figure 5. Looking Downstream from River Control Gate Structure



Figure 6. Looking South at River Control Gate Structure

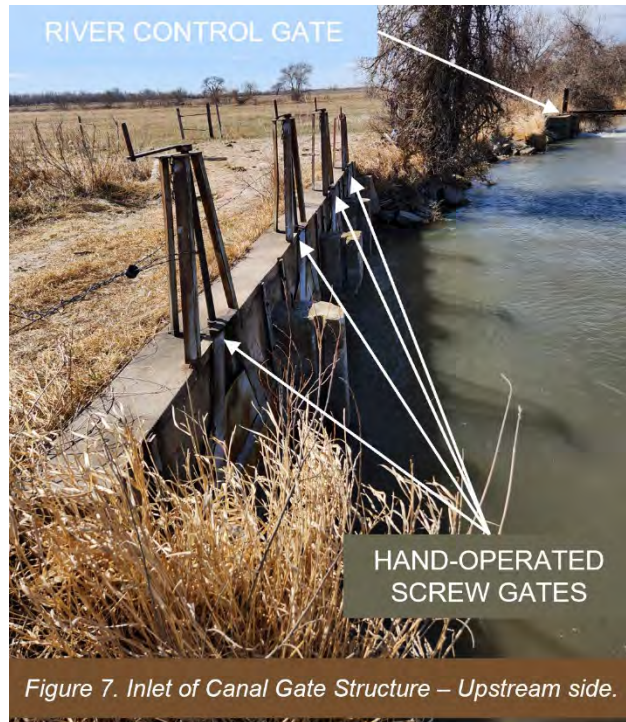


Figure 7. Inlet of Canal Gate Structure – Upstream side.



Figure 8. Outlet of Canal Gate Structure – Downstream side.



Figure 9. Inlet of Canal Gate Structure – Upstream side.



Figure 10. Inlet of Canal Gate Structure – Upstream side.





Figure 13. Screw Gate Deterioration

CODY DILLON IRRIGATION DISTRICT NORTH PLATTE CANAL DIVERSION

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Existing Structure General Description

The Cody Dillon Canal diversion structure is located approximately 7 miles northeast of North Platte, Nebraska. The structure consists of a return gate structure to the north and a 90° canal gate structure directly adjacent to and east of the return gate structure as shown in the Vicinity Map (Figure 1). Water is supplied through a feeder canal that carries diverted flows from the North Platte River by way of sand dams. Water flow rates into the canal are controlled at the canal gate structure and excess water is returned to the river.

The diversion structure consists of a series of rectangular concrete openings used to control flow. The return structure consists of four cells, all of which have steel channels embedded into the concrete walls where timber stop logs are slid into place as needed to dam flow from the feeder canal. The canal structure is a two-cell structure with the same stop log water control system to regulate flows into the canal. Excess flow from the feeder canal is returned to the North Platte River. During the site visit water was present in the feeder channel connection to the diversion structure. This prevented determination of whether a full concrete apron exists through the structure. A concrete apron was only visible at the gates and extended to the leading edge of the gate walls. Modifications have been made to the structure throughout its life for maintenance purposes. This includes supplemental concrete bases along all structure walls. It is understood that abrasion degradation occurred to the concrete walls over time leading to structural concern. To repair this issue, a widened wall base was poured to reestablish the wall bases.

Current Maintenance & Operations

During the site visit, Olsson's inspectors were able to discuss operations and maintenance challenges with the ditch operator. The operator provided several suggestions to improve operations based on past experiences with the structure:

- Automated gates for the river return structure to make operations more efficient and improve safety.
- Implement means to deter people from using the Feeder Canal for recreation (i.e. canoeing)
- Eliminate the need for the feeder canal by constructing a gate structure with spillway across the North Platte River, converting the existing diversion structure into a canal control structure.

River Return Gates

The cells of the return gate structure consist of four approximately 5'-0" wide cells with a concrete apron floor and a timber plank access platform. The concrete apron thickness was unable to be determined due to the presence of water in the channel. Steel channels are embedded into the concrete walls (Figure 3) for placement of timber stop logs to control water elevations and flow into the canal. Walls throughout the structure are consistently 1'-0" thick, while the reconstructed bases of the walls are 2'-0" thick (Figures 4 and 5).

Condition of River Return Gates

The bases of all walls have been previously repaired and these repairs are in fair condition. All walls exhibited minor concrete cracking, concrete spalling and water staining, with some walls exhibiting more significant or widespread damage. The interior return gate walls appear in good

condition with minor concrete spalling and erosion of the concrete surfaces near the flowline. The return gate end walls are in worse condition. The west end wall exhibits the most extensive damage. The feeder canal wall segment exhibits cracking and spalled concrete, while the portion of the wall through the return has failed above the elevation of the repaired base (Figures 6 and 7). Large vertical and longitudinal cracks have developed beyond the stop log channel causing the wall to rotate inward several inches (Figure 6). Similar longitudinal cracking was seen in the eastern return structure wall (Figure 8) but at the time of the inspection, no noticeable deflection of the wall face was noted. Both end walls appear to have extended further toward the Platte River channel in the past but either failed or were intentionally removed near the end of the concrete apron. Remnant pieces of concrete now act as riprap along the outlet bank (Figures 7 and 8).

Canal Gate Structure

The cells of the canal diversion structure consist of two approximately 5'-0" wide cells and a timber access platform. Steel channels are embedded into the concrete walls to allow installation of timber stop logs for water elevation and flow control (Figure 13).

Walls throughout the structure are consistently 1'-0" thick, while the reconstructed bases of the walls add 6" to each face. Both of the canal gate side walls extend into the canal approximately 12'. At this location the upper wall sections have been removed to allow installation of a timber access bridge (Figure 14). It is understood that this bridge is used for maintenance equipment crossing the canal. The northern side wall connects to the eastern wall of the return structure at a 90° corner. The southern side wall extends into the feeder canal paralleling the return gate structure entrance. The end of the wall deflects outward into the south bank of the feeder canal (Figures 18 and 20).

Condition of Canal Gate Structure

The bases of walls that have previously been repaired and the repairs appear in good condition. A gap has started to form between the repaired concrete and upper concrete along the southern wall face. The upper wall segments also appear in good condition with only minor cracking and abrasion of the concrete surface. A concrete apron exists through the canal gate structure but was covered by several inches of sediment at the time of inspection (Figure 15). This prevented an assessment of its condition. Vertical cracking in the wall base was noted at the location of the retrofit timber access bridge (Figure 16). It is estimated that the walls have cracked at this location due to the loading of the equipment utilizing the access. The cracking does not appear to be causing additional concerns for the structure.

At the inlet side of the canal gate structure, the southern sidewall has a large vertical crack at the location where it bends out into the southern bank of the feeder canal (Figures 18 & 19). It also appears this wall had started to rotate into the canal in the past. Anchor rods were installed through the wall to restrain the movement. Significant erosion has also occurred at the end of this wall. Concrete riprap has been placed at the end to prevent further erosion (Figure 20).

Recommended Improvements

Overall, the structures are in fair condition and require minor repairs and maintenance in most locations throughout the structural elements. Some larger improvements will also be required to maintain operations of the return structure. In addition to the structural improvements, a number of safety and operational improvements are recommended for the structures. The following list provides a breakdown of each type of recommended improvement:

Structural Improvements

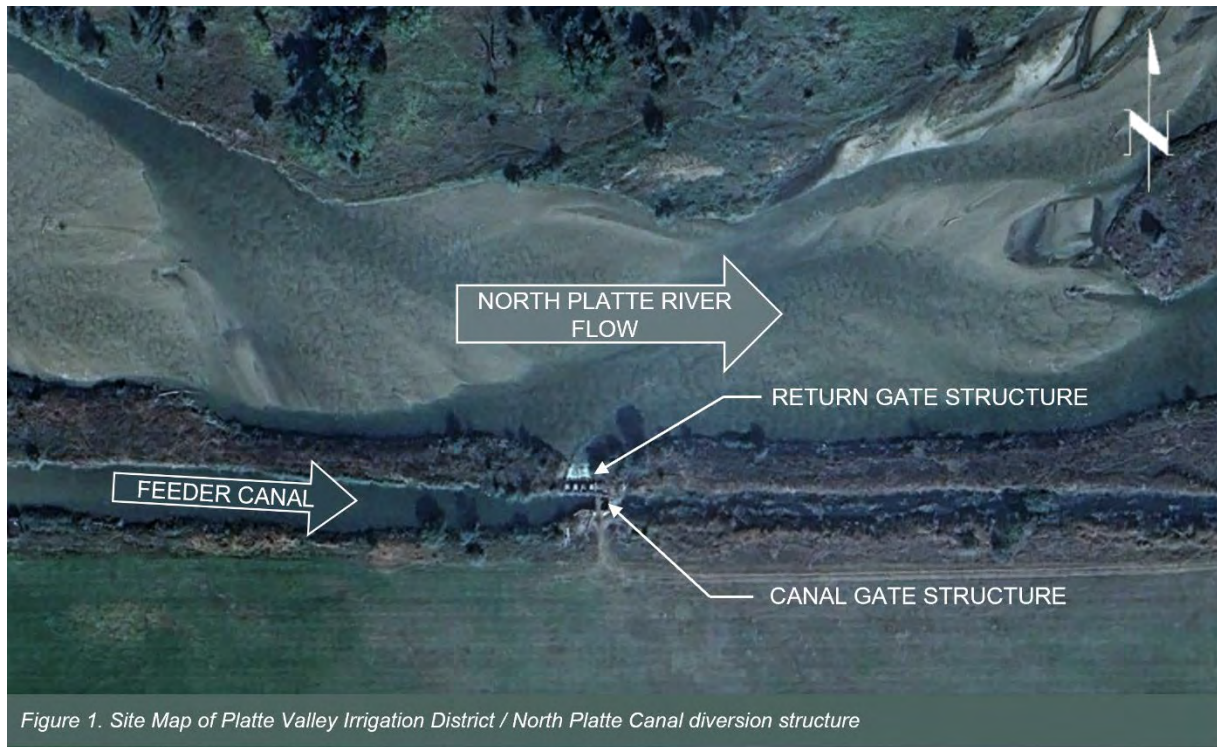
1. Replace the western side wall of the return gate structure including evaluation of extension of the wall end.
2. Evaluate end of east side wall of the return gate structure to determine if reconstruction of the wall end is necessary.
3. Improvements of Southern wall extending from the canal gate structure. This would include sealing the vertical crack between the wall and the canal gates as well as addressing the vertical crack at the wall bend.
4. Seal minor cracks in concrete walls.
5. Seal gaps between base concrete repairs and upper wall sections as needed throughout.
6. Patch spalled concrete as needed to maintain structure functionality.
7. Remove sedimentation of the canal structure apron.
8. Restore grade at wall ends and protect from future erosion.

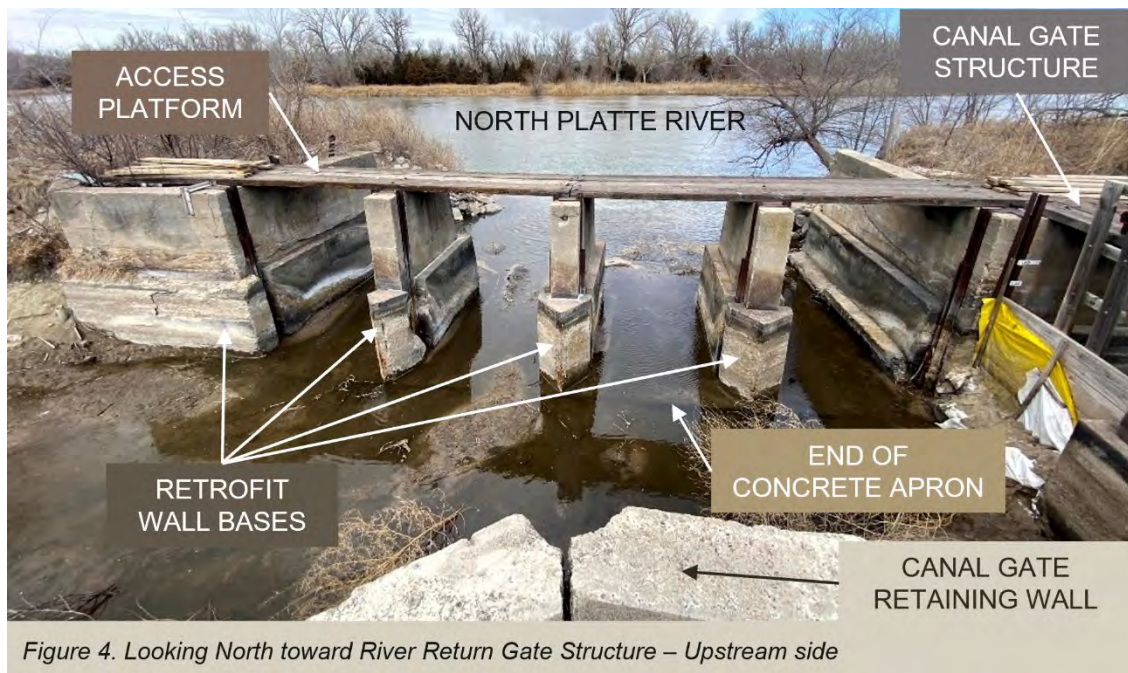
Safety & Operational Improvements

1. Install a safer access platform across both structures, including 42" tall handrail.
2. Install access crossing structure for equipment to cross the canal. Include properly designed foundation for the crossing.
3. Install automated gates for the river return gates that can be operated wirelessly in place of manual stop log methods.
4. Add lights to assist with nighttime operations.
5. Install access ladder or stairs from the structure down into the gate structures.
6. Extend concrete apron to fully cover the area between the return gate inlet and the southern structure wall.

It is anticipated that improvements could be completed by blocking flows from the feeder canal and sealing off the downstream end of the river return.

Figures





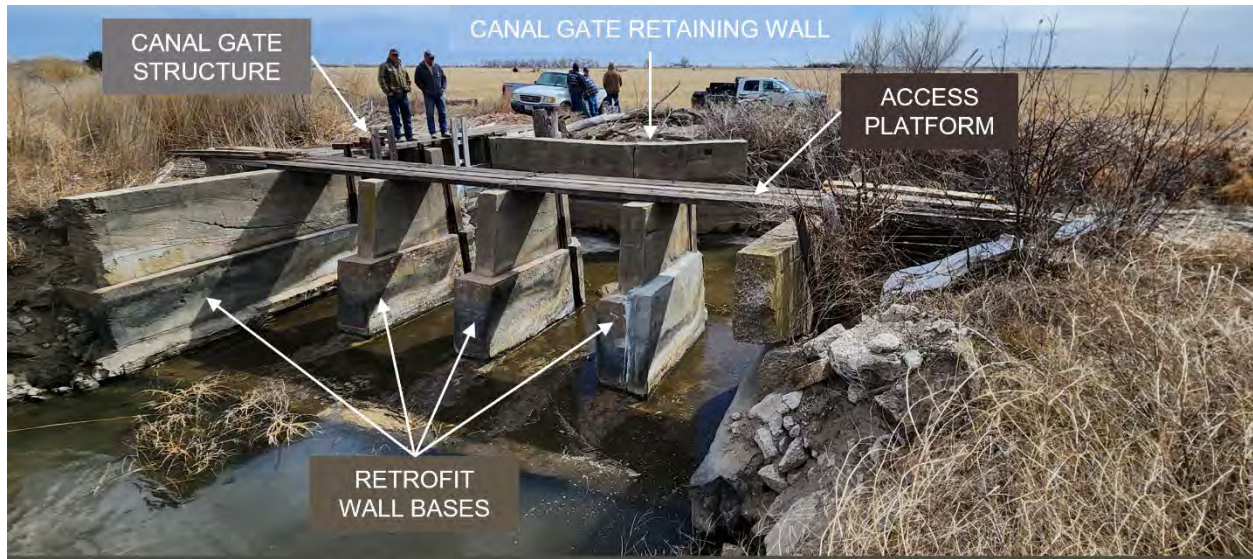


Figure 5. Looking South toward River Return Gate Structure – Downstream side



Figure 6. Close-up view of Wall Failure.



Figure 7. Southeast Retaining Wall at River Return Gate – Downstream side.

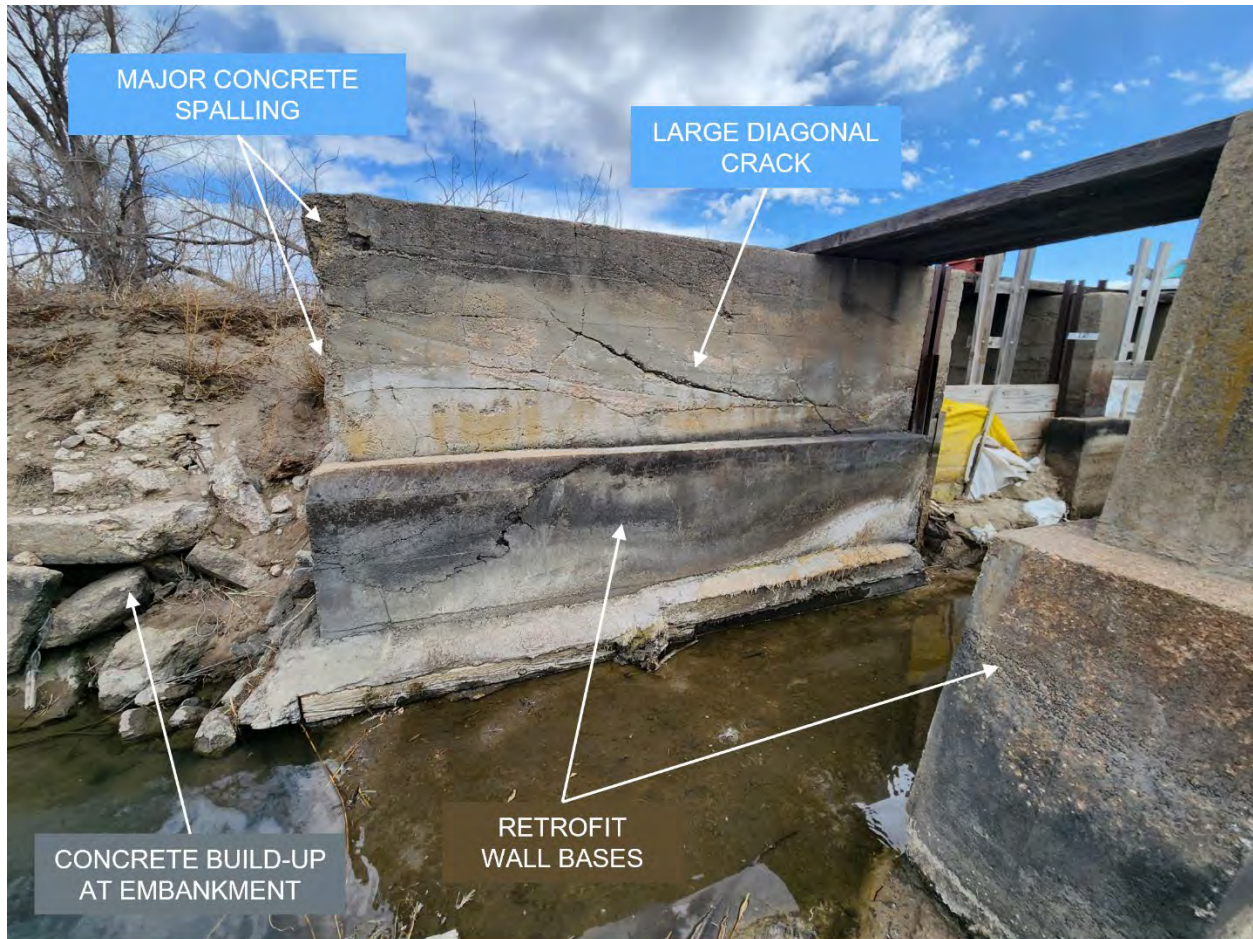
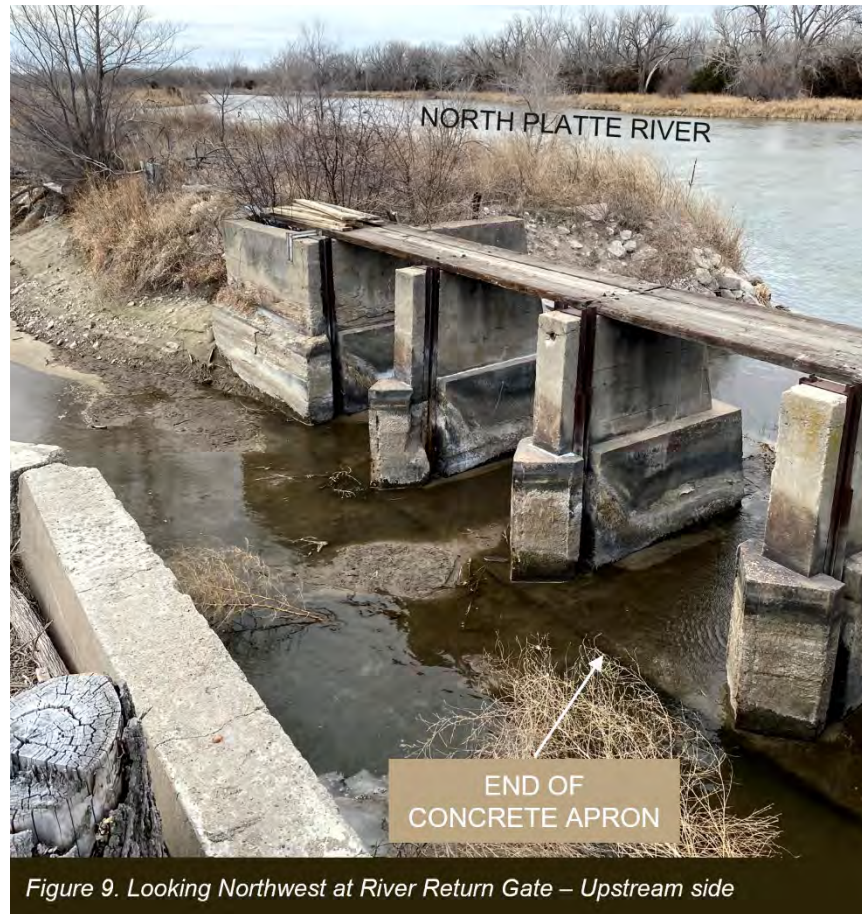


Figure 8. Northeast embankment and Retaining Wall at River Return Gate Structure – Downstream side



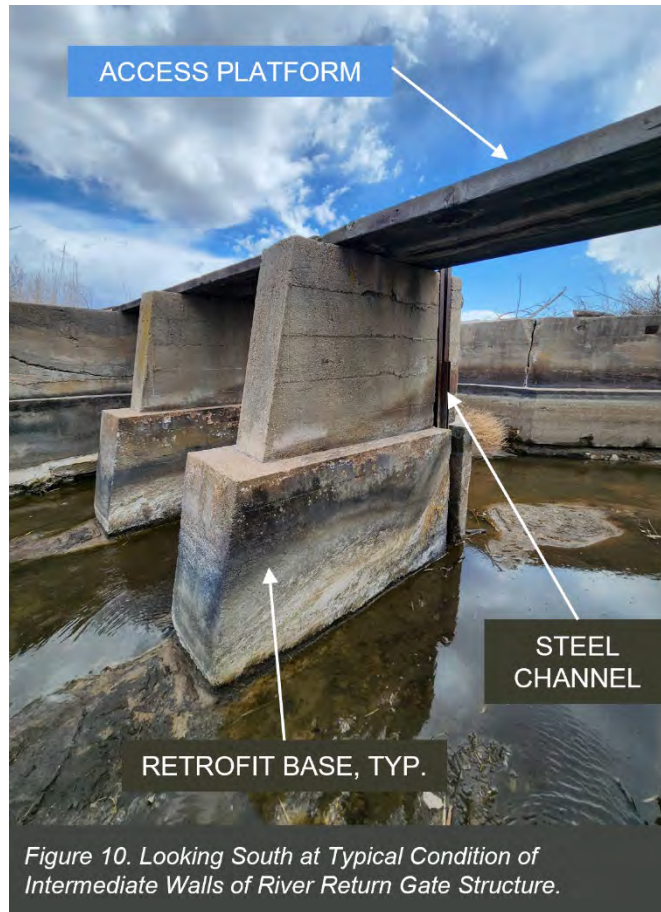


Figure 10. Looking South at Typical Condition of Intermediate Walls of River Return Gate Structure.

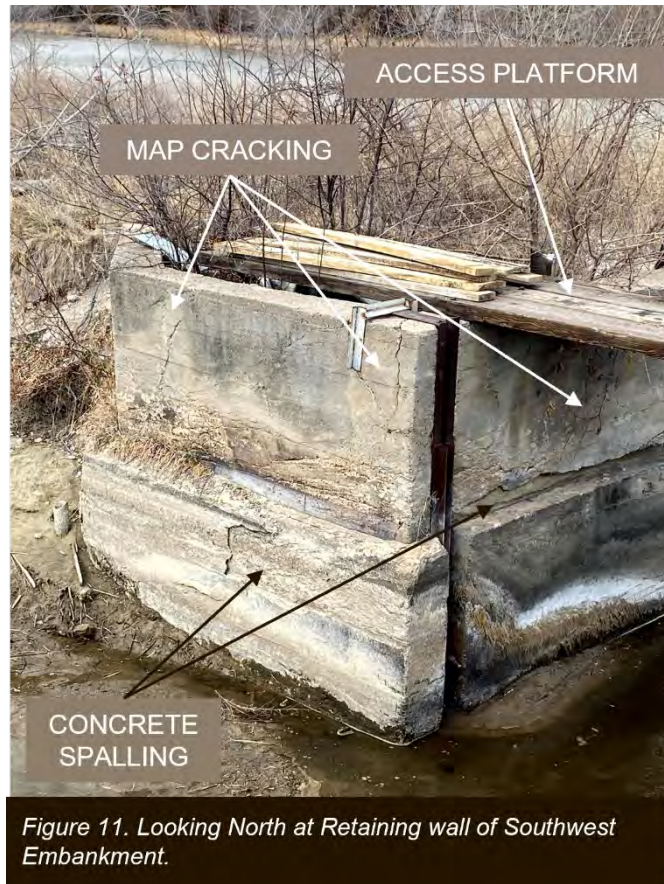


Figure 11. Looking North at Retaining wall of Southwest Embankment.

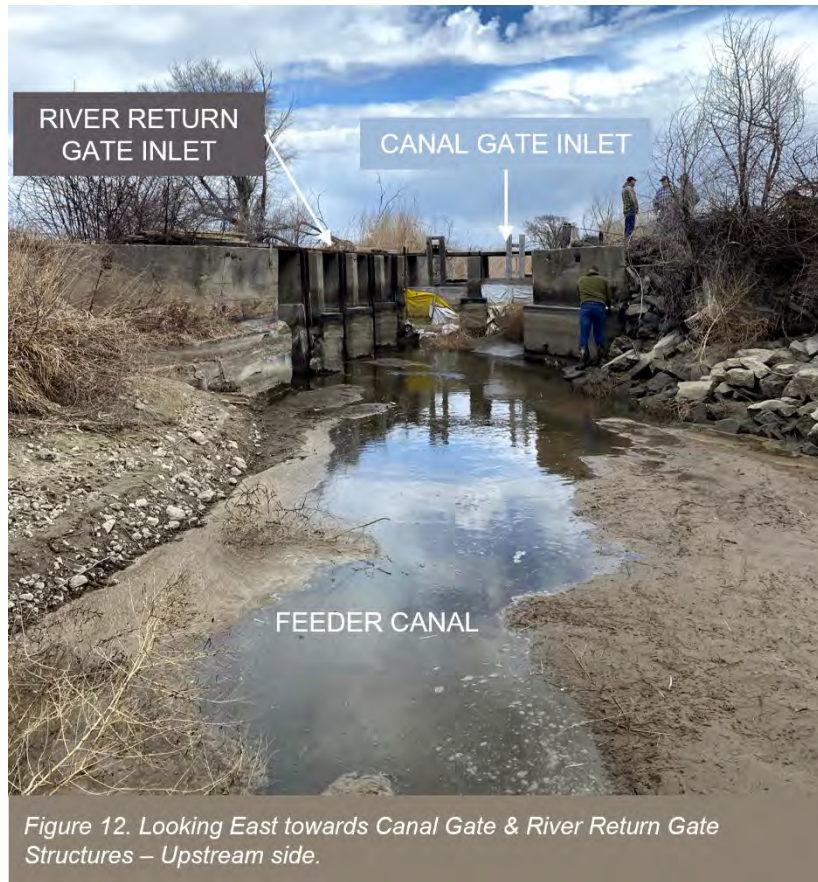


Figure 12. Looking East towards Canal Gate & River Return Gate Structures – Upstream side.



Figure 13. Canal Gate Structure Inlet – Upstream Side.



Figure 14. Retrofit Timber Access Bridge at Canal Gate Structure Outlet.



Figure 15. Looking at canal gates from downstream side.



Figure 16. Vertical Crack in Wall Base at Access Bridge.



Figure 17. Looking East towards Canal Gate Structure – Upstream side

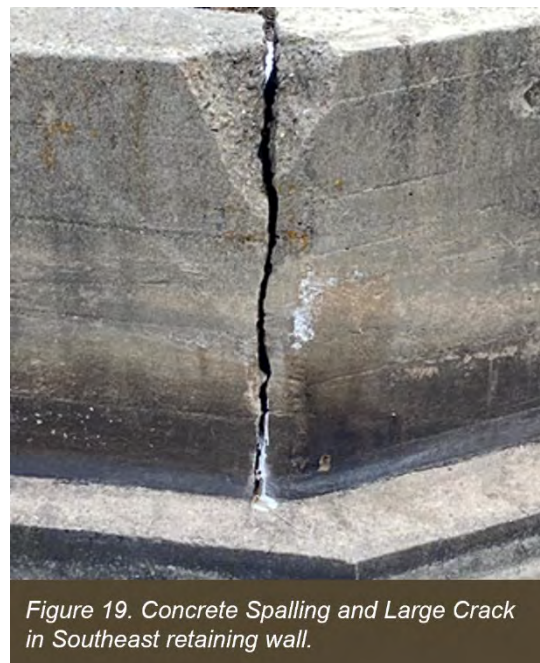
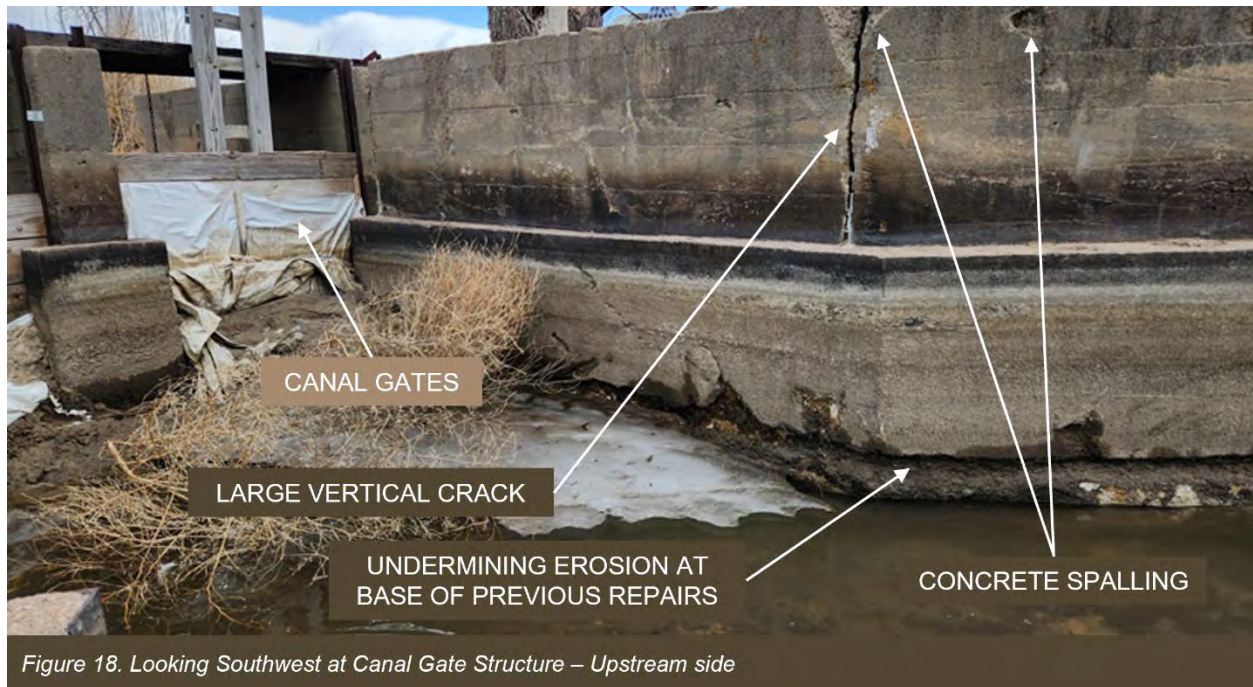




Figure 20. Southeast Retaining Wall of Canal Gate Structure.

KETIH LINCOLN IRRIGATION DISTRICT NORTH PLATTE CANAL DIVERSION

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Existing Structure General Description

The Keith Lincoln diversion structure, originally constructed in the early 1900s is located approximately 8 miles northwest of Paxton, Nebraska. The structure consists of six river gates perpendicular to the channel and a two-cell diversion structure along the south riverbank 90° to the river gates as shown in Figure 1.

The river control gates consist of six cells that manage water levels with steel radial gates that are opened and closed by motorized cable and pulley equipment mounted to the top of the gate walls. River gate operations have been made partially automated by way of second-hand retrofit equipment. It is understood that the effectiveness of the current automation is limited. A concrete apron is present along the inlet of the canal gates and extends to the intermediate wall of the first river gate. The apron then extends north across the river along the upstream face of the river gate structure. The concrete aprons extend through the river control gate structure and ends at the end of the intermediate structure walls on the downstream end. The canal structure consists of a two-cell box culvert section. The river face of the canal gate is sealed by a concrete wall above and below the hydraulic gate opening. The side of the opening is controlled by opening or closing a steel lift gate mounted to the river face of the structure. The base of the opening is located approximately half-way up the overall structure height. The canal side of the structure includes a short weir wall to create a splash basin within the gate structure. Concrete baffles are present within the splash basin. The depth of the basin could not be determined during the site visit due to accessibility. Flared concrete wing walls extend into the canal from the gate structure. A concrete apron is present through the limits of the walls. The apron slopes up in elevation from the flowline of the downstream side of the canal gate structure.

Current Maintenance & Operations

During the site visit, Olsson's inspectors were able to discuss operations and maintenance challenges with the ditch operator. He provided several suggestions to improve operations based on his experiences with the structure:

- Current gates are partially automated but do not operate in sync with each other, which limits the ability of the amount of water that can be diverted, and number of gates that can be operated simultaneously. Upgrading this system automation would greatly improve the structure efficiency and reliability.
- The canal currently appears to flows uphill; the water monitoring weir downstream in the canal is approximately 1'-0" higher than the flowline of the canal inlet.
- Noted excessive sand deposits that require periodic cleaning accumulate at the inlet of the canal gates.
- Seals for the river gates have worn away, some have been replaced by removing the seal and placing new concrete in the created voids.
- All gates currently operate without binding or pinching against walls.

River Control Gates

The river control gates consist of six 20'-0" wide cells with a concrete apron floor and concrete access platform. The downstream end of the concrete apron terminates at the ends of the interior walls and drops off into a riprap basin as shown in Figure 4. The concrete apron thickness could not be determined due to the presence of water in the channel. The access

platform across the cells consists of a cast in place concrete slab that is used to operate the control gates as well as reach the embankment to the north. Equipment to raise and lower the gates is mounted to the top of the walls. Interior walls are flat at the top before sloping down to the concrete apron on the downstream end as shown in Figure 4. Exterior walls are flat at the top before sloping down to the concrete apron on the downstream end as shown in Figures 5 and 6. Exterior walls are longer than interior walls so they can retain adjacent grade. Backfill erosion was noted behind each of the river gate sidewalls. Significant undermining at the downstream end of the southern wall was present. Erosion extended under the footing behind the existing sheet pile protection. Riprap has been placed behind the wall to mitigate further erosion.

The upstream river channel elevation is managed with steel radial gates attached to the walls of the structure. Radial gates are adjusted by a motorized gear and pulley system that is semi-automated. Radial gates are lowered to check up the main channel water surface elevation and facilitate the diversion of through the canal structure gates. The steel gates appear to be in fair condition with rusting present through most of the upstream faces. No full section loss through the entire plate thickness was noted at the time of the inspection. It was noted by the ditch operator that seals intended to prevent water from passing between the gates and the walls of the structure have begun to leak. His assessment was that embedded steel contact surfaces within the walls and concrete floor have deteriorated significantly leading to the poor seal. Some of the steel embeds have been removed and have left voids, which were repaired by placing new concrete.

Condition of River Control Gates

All walls are in fair condition with map cracking noted throughout most surfaces. Water staining and minor concrete spalling was also noted throughout the walls as shown in Figure 7. The condition of interior wall bases and the concrete apron could not be determined due to the presence of water in the channel. Based on what was able to be observed. These elements appear in good condition with only minor abrasion erosion at the wall bases noted. There is a drop off the end of the river gate apron as shown in Figures 4 and 7. Riprap has been placed at this drop for erosion protection. Due to flowing water, it could not be determined if the downstream end of the apron was undermined. Based on the surface condition of the apron, it is assumed that any undermining is not significant. The access walkway concrete slabs spanning the river gates exhibited noticeable deflection in some spans as shown in Figure 8, with transverse cracking noted in the concrete surface near the faces of the intermediate wall supports.

Canal Gate Structure

The canal gates consist of two 12'-6" wide cells with a concrete apron floor, splash basin and concrete access platform. The canal gate structure is in good condition and does not show any major signs of deterioration or structural deficiency. There are isolated locations with cracking and poor concrete consolidation that occurred during construction. Observed defects are minor and have not affected structural performance of the structure. Similarly, the concrete apron on the canal side of the structure is in good condition with no signs of undermining or damage. The lower portions of the apron and the bottom of the splash basin at the canal inlet were under water at the time of the inspection and could not be evaluated. Based on the conditions of the rest of the structure it is estimated that the underwater portions are in a similar condition. The lift gates also appear in good condition. The lift gate supports and housings still have protective

paint coatings and do not show signs of deterioration. The steel gates have surface rusting and other environmental build up consistent with the rest of the structural components exposed to the hydraulic flows as shown in Figure 9. There are no visible holes in the plates that would cause concern for leaking. Gate seals appear to be in fair condition with some locations where rubber gaskets looked dried out and cracked.

Recommended Improvements

Overall, the structures are in good condition and require structural improvements in isolated locations. There are also several safety and operational improvements recommended for the structures. The following list provides a breakout of each type of improvement:

Structural Improvements

1. Restore grades behind river gate side walls, specifically at the downstream end of the walls. Add scour protection to mitigate future migration of materials.
2. Restore scoured subgrade below the south river gate side walls by use of flowable fill.
3. Install riprap basin at the downstream edge of the river gate structure to protect against undermining of the structure from the downstream end. Install a steel sheet pile cut off wall if not already in place (Could not be determined during site visit due to water flow).

Safety & Operational Improvements

1. Add 42" tall handrail to river gate and canal structure access platforms.
2. Update the river gate automation to improve structure efficiency and safety of operations.
3. Clean river gates, patch any holes in the gate surface and apply protective coating.
4. Replace river gate seals to reduce water loss through the closed gates.
5. Clean canal gates and replace seals to reduce water loss through the closed gates.

Figures





Figure 2. Looking Northwest Toward River Gate Structure – Downstream End



Figure 3. Looking Northeast Toward River Gate Structure – Upstream End

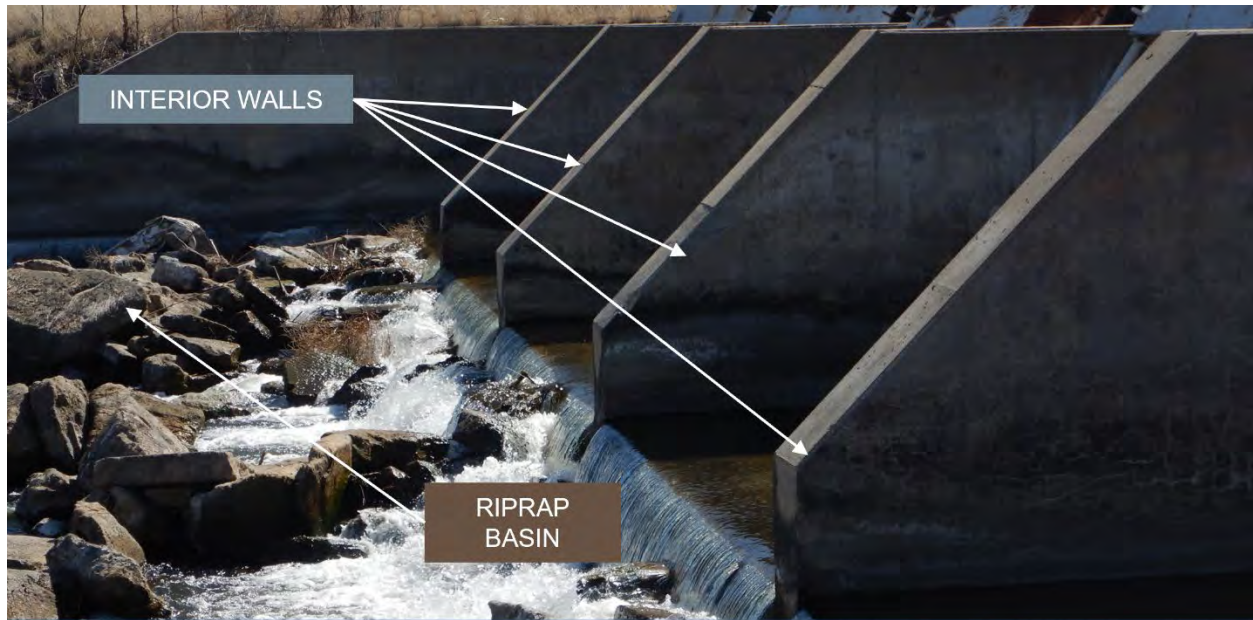


Figure 4. Interior Walls and Riprap Basin

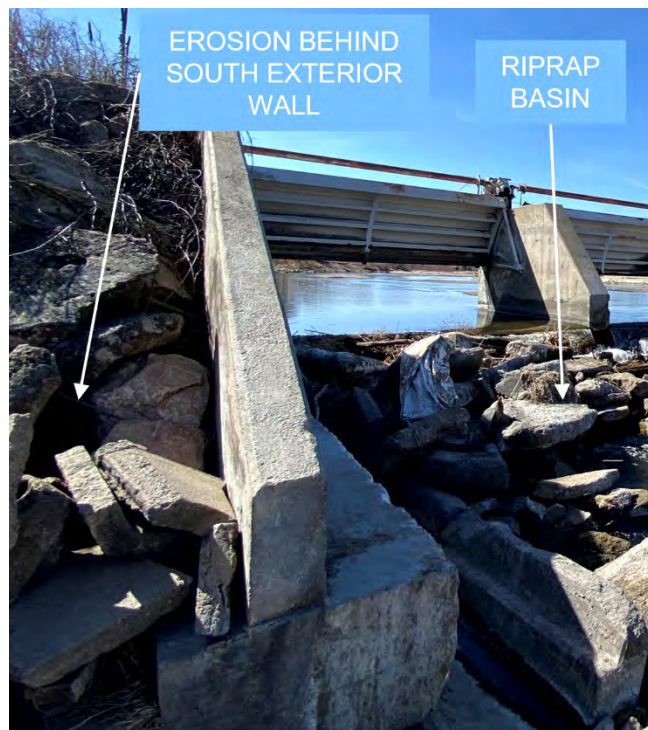


Figure 5. South Wall Erosion

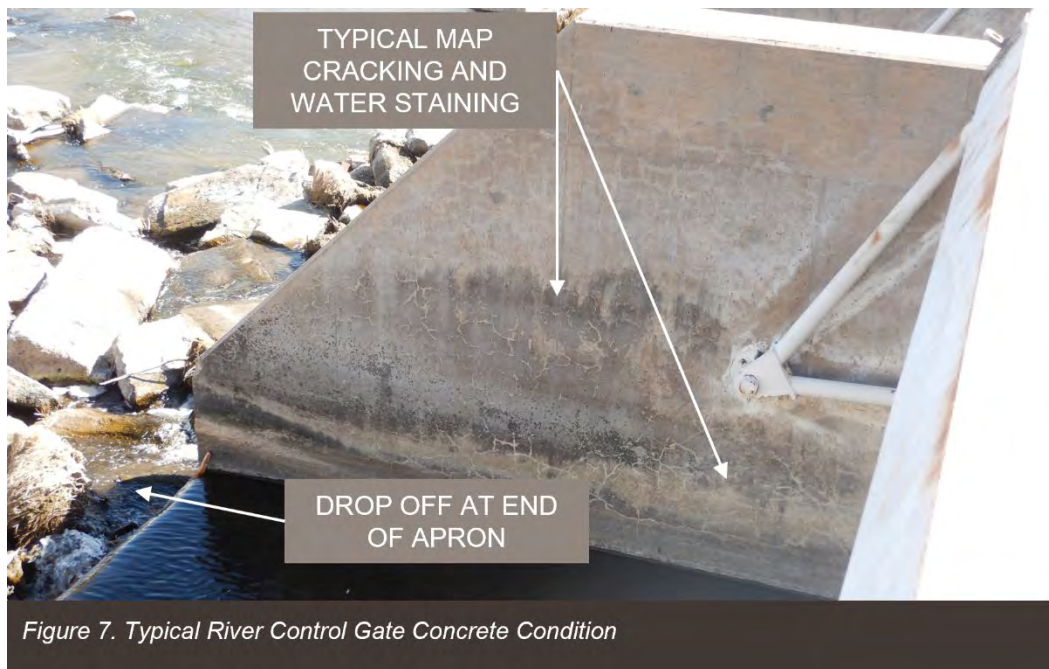
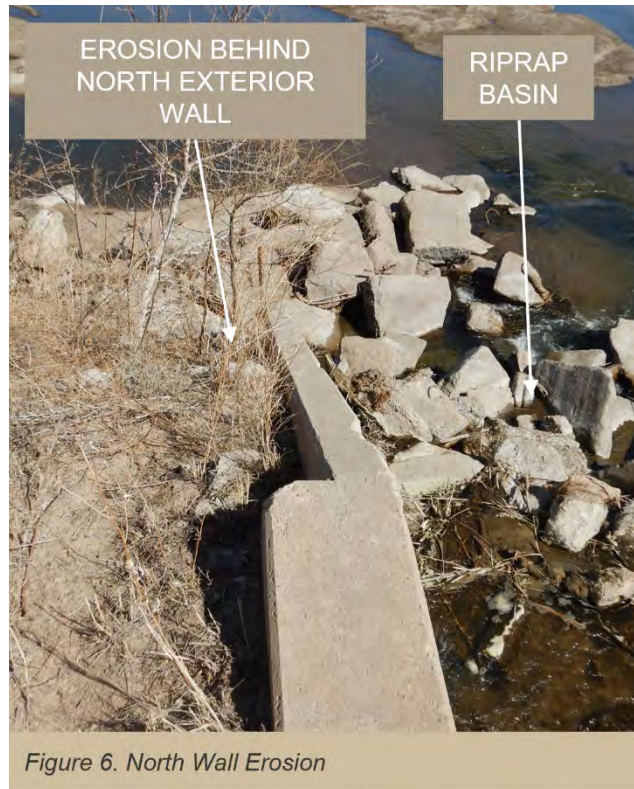




Figure 8. Typical Access Platform Condition



Figure 9. Looking Southeast Towards Canal Structure Inlet – Upstream End



Figure 10. Looking Northwest Towards Canal Structure Outlet – Downstream End



Figure 11. Concrete Apron, Canal Channel Bed, and Ponding Water



Figure 12. Splash Pad, Baffles and Ponding Water

PAXTON HERSHEY IRRIGATION DISTRICT NORTH PLATTE CANAL DIVERSION

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August 2025



Existing Structure General Description

The Paxton Hershey Canal diversion structure, originally constructed in the 1880s, is located 2.5 miles northwest of Sutherland, Nebraska. The structure consists of a spillway structure to the north, four river gates toward the south riverbank and a 90° diversion structure directly adjacent to and south of the river gates as shown in Figure 1.

The overflow structure consists of a weir and concrete apron. The weir is positioned upstream of the apron and the apron extends downstream. The river gates consist of four cells that manage water levels with steel radial gates that are opened and closed by hand operated equipment mounted to the top of the structure. The canal gates consist of seven cells that manage water levels with steel lift gates that can be raised or lowered by use of a handyman jack. The lift gates allow for water to be diverted from below the checked river water surface. The diversion canal takes a 90° turn directly south of the inlet and heads east. A concrete apron is present between the river gates and at the inlet of the canal gates. The concrete apron in front of the canal gate inlets is above the current water surface and was formed using steel sheet piling as formwork that now acts as facing for the apron.

Current Maintenance & Operations

During the site visit, Olsson's inspectors were able to discuss operations and maintenance challenges with the ditch operator. He provided several suggestions to improve operations based on his experiences with the structure:

- Automated gates for the river structure will make operations more efficient and improve safety.
- Noted that gates open and close without pinching or binding on concrete walls, but the gate steel is deteriorated and holes in the surface are starting to appear.
- Noted a need for stairs or another access method to not have to scale concrete walls between structures.
- The operator believes it may be beneficial to increase the capacity the Platte Valley structures and remove the Paxton-Hershey structures. This would require a new canal structure to divert a portion of the combined flows in the Platte Valley canal to the Paxton Hershey canal.
- Mentioned a past storm event that caused undermining of overflow spillway enough for a person to walk under it.
- Mentioned previously filling the downstream end of the overflow spillway with rock and concrete until the channel stopped washing away.

River Control Gates

River gates consist of four 15'-0" wide cells with a concrete apron floor and access platform as shown in Figures 2 and 3. The concrete apron thickness could not be determined due to the presence of water in the channel. The access platform consists of a cast in place concrete slab that is used to operate the control gates as well as reach the overflow spillway to the north.

Walls of the river gates are 2'-0" thick. The south wall is flat for its entire length, and intermediate and north walls are flat at the top before sloping down to the concrete apron on the downstream end. Based off conversations with the operator, and construction methods used at

similar gates, it is believed these walls are supported by timber piling. The upstream river channel elevation is managed with steel radial gates attached to the walls of the structure as shown in Figure 4. Radial gates are adjusted by a gear and pulley system that can be raised or lowered by hand operated equipment mounted to the top of the walls as shown in Figure 5. Radial gates are lowered to change the river water surface elevation and facilitate the diversion of water to the irrigation canal through the canal structure gates. Two small wooden steps are mounted to the exterior face of the north wall is used to access the overflow spillway.

Condition of River Control Gates

The river gate walls are generally in good condition. All walls exhibited map cracking, concrete spalling and water staining, with some walls exhibiting more significant or widespread damage as shown in Figure 7. Downstream faces of intermediate walls exhibited larger areas of concrete spalling at concrete corners, possibly due to debris that was previously transported through the gates. The gate walls also show signs of abrasion erosion deterioration near the base of the walls. The amount of section loss noted was not significant and no reinforcing steel was visible. The bottom of the north wall has been undermined at its downstream end at the connection to the overflow spillway as shown in Figure 8. It is assumed this erosion is connected to the previously failed section of spillway structure directly adjacent to the north wall. The concrete access platform across the river gates exhibited noticeable deflection and transverse cracking in the top slab near the interior and exterior walls as shown in Figures 9 and 10. The visible portions of concrete apron through the river gates appeared in fair condition with surface irregularities noted but no major signs of structural concern observed.

Spillway and Downstream Apron

The overflow spillway consists of a 215'-0" long concrete apron with a weir wall at its upstream end as shown in Figure 11. The thickness of the concrete apron was unable to be determined. A 16'-0" long retaining wall is present at the north end of the spillway. The top and front portions of the wall appear to be a retrofit to the original wall intended to increase the height. The spillway and its components are generally in fair condition except for a 25'-0" long region of the apron and weir wall at the connection between the river gates and the spillway at the southern end of the spillway. Typical damage to the structure consists of concrete spalling, cracking and staining. The weir wall in this region has previously failed. Based on the observed condition it is estimated that the spillway apron in this region split directly downstream of the weir wall resulting in the wall tilting backward (downstream). Repairs were completed by pouring concrete behind the failed wall section to stabilize and, attempt to seal off the resulting opening as shown in Figures 12 and 14. The structure was stabilized with this repair, but water appears to still be migrating through the repaired opening due to standing water and saturated sand downstream of the repair. In addition to the failed section of weir wall, there are two regions near the middle of the spillway apron that appear to be sagging due to slab settlement as shown in Figure 16.

Condition of Spillway

A gap at the connection between the north wall of the river gates and spillway has formed which is allowing water to pass through, potentially contributing to the erosion at the base of the north wall as shown in Figure 14. Larger cracks were present at construction joints between slab and weir wall sections and minor concrete spalls were present on corners of construction joints as shown in Figure 13. Water was present at construction joint locations throughout the spillway. It could not be determined if water was present because it has pooled up due to cracks and spalls forming low points, or because of water seepage through construction joints in the weir wall.

The north retaining wall exhibited concrete spalling along its top corners, with damage being the greatest at its upstream end. Concrete staining is present throughout the front face of the wall. The slope behind the retaining wall has begun to erode, leaving a void toward the downstream end.

Environmental buildup and debris are present throughout the entire structure. A large sand deposit is present on the apron downstream of the repaired portion of the weir wall. Built up riprap and tree limbs are present throughout the length of the spillway. The previously undermined region of the spillway apron was not visible at this time; however, it is believed this region could be contributing to apron settlement and surface irregularities. Concrete railroad ties have been placed along the riverbank at the north end of the structure as a method of slope stabilization.

Canal Gate Structure

The canal gates consist of seven cells with a concrete apron floor present in some of the cells and a concrete access platform as shown in Figures 17 and 18. Overall, the canal gates and their components are in very poor condition. The cell at the east end of the gates is 13'-6" wide, and all other cells are 5'-9" wide. The 13'-6" cell has a wall at its inlet that extends to approximately mid height of the cell. The top slab of the cells consists of two cast in place concrete slabs that are used as access platforms to reach the river gates. One concrete slab is original to the structure, and the adjacent slab was a retrofit to widen the platform. The retrofitted slab was constructed utilizing steel railroad rails as reinforcement with timber planks spanning between them to create a bottom surface to pour concrete on. The original portion was constructed using temporary formwork. An additional concrete apron is present at the inlet of the canal gates. This apron was constructed by installing steel sheet piling and pouring concrete between the sheet piling and front face of the inlet. The original and retrofit apron have been undermined at the downstream end at the connection to the river gates. The thickness of the apron could not be determined. The west exterior wall of the canal gates extends 10'-0" south into the canal channel (Figure 18), and a retaining wall extends 11'-0" west of the canal gate inlets along the riverbank (Figure 17). Concrete facing has been poured at the bases of all exterior walls.

Condition of Canal Gate Structure

Concrete apron floors are present in the 13'-6" wide cell, and three of the 5'-9" wide cells. Cells without aprons are believed to have previously had aprons that have failed and been removed from the structure as shown in Figure 24. Concrete aprons do not extend the entire width of the canal gate cells and drop off into the channel prior to the end of the cells. Environmental debris and large pieces of concrete are present in all cells. Canal gate walls exhibited concrete spalling, cracking and staining on all faces. Concrete spalling and cracking was significant on all faces of all walls as shown in Figures 18-25. Concrete damage was most likely caused by a combination of impacts from debris being transported by the river, water intruding through cracks and causing cracks and spalls to propagate further, and from aprons separating from the walls. Damage has resulted in significant section loss throughout the structure, with exposed steel reinforcing present on the upstream faces of intermediate walls. Complete section loss through wall bases is present in some cells.

A large scour hole is present at the base of the west exterior wall. The scour hole begins in a large, spalled region near the concrete apron in the west most cell and extends the length of the

wall. The full length of the scoured region could not be determined due to a large built-up region of rip rap in front of the wall.

The canal gates divert water from the main channel with vertical lift gates that allow for water to be diverted from below the water surface of the main channel. Each inlet gate can be raised or lowered by hand operated equipment. Lift gates in the 5'-9" wide cells extend to approximately mid height of the cells. Lift gates were not present in the 13'-6" wide cell. Lift gates exhibited minor rusting and staining from water on their surfaces.

Recommended Improvements

Overall, the river gates are in fair condition, requiring repairs to steel radial gates and equipment used to raise and lower them, in addition to minor concrete repairs. The overflow spillway is in poor condition, requiring more extensive repairs to concrete, joints, and potential scour mitigation methods. Canal gates are in very poor condition and a full replacement of the structure is recommended.

Structural Improvements

1. Reconstruct the downstream retaining wall of the river channel.
2. Replace failed spillway section directly north of the river gates.
3. Replace canal gate structure and reconnect to the existing river gate structure.
4. Install scour mitigation sheet pile cut off walls at upstream and downstream portions of the structure and connect to existing structural aprons or walls.
5. Concrete patching at spalled locations throughout all walls and slabs of the structures as required.
6. Patch and seal construction joints in the spillway structure to prevent further water seepage.
7. Replace seals at all radial gates.
8. Patch and recoat radial gate surfaces that have experienced excessive section loss.
9. Restore downstream riprap basin at the overflow weir structure.
10. Restore locations of structure embankment erosion and armor against future deterioration.

Safety & Operational Improvements

1. Install stairs or access ladders throughout structure.
2. Install lighting to assist with nighttime operations.
3. Update current gates and equipment of the river gate structure to allow for automated operation.
4. Add 42" tall handrail to all access platforms.

Figures





Figure 2. Looking South Toward River Gate Structure – Downstream End

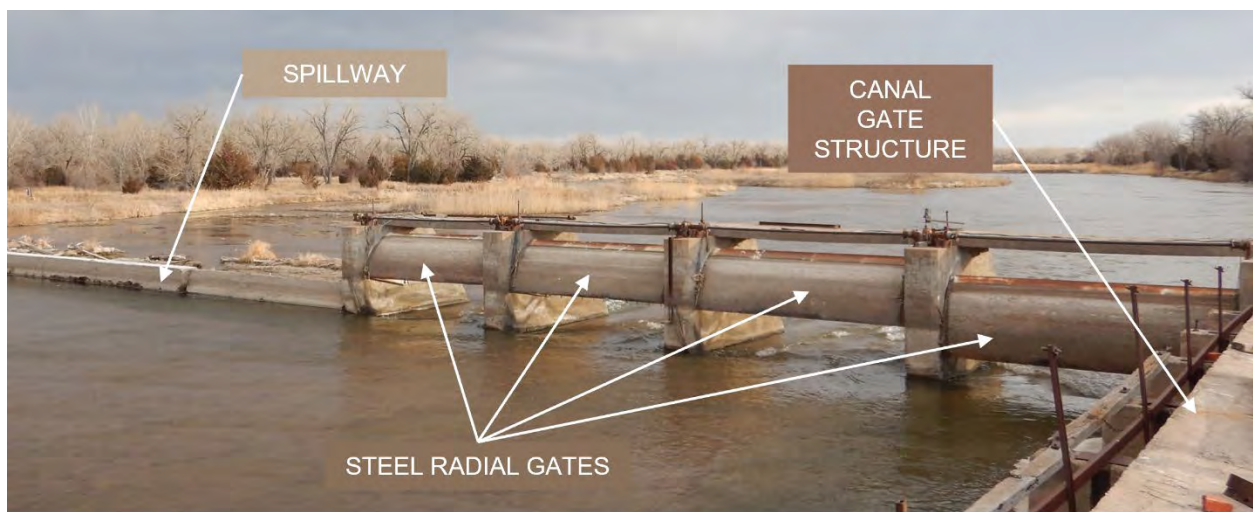


Figure 3. Looking North Toward River Gate Structure – Upstream End



Figure 4. Looking North Towards River Gate Structure – Upstream End

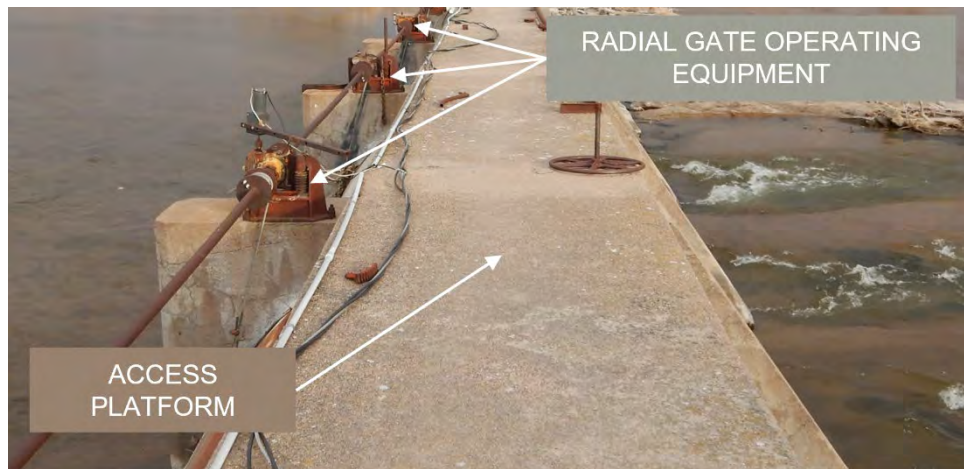


Figure 5. Looking Northwest Along River Gate Structure



Figure 6. Concrete Apron and Drop off



Figure 7. Typical River Gate Wall Condition



Figure 8. Undermining of North Exterior River Gate Wall



TRANSVERSE CRACKS
IN ACCESS PLATFORM

Figure 9. Typical Top of Access Platform Condition



ACCESS PLATFORM
SAGGING

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Figure 10. Typical Access Slab Sagging



Figure 11. Looking Southeast Along Spillway Structure



Figure 12. Failed Region of Spillway Weir

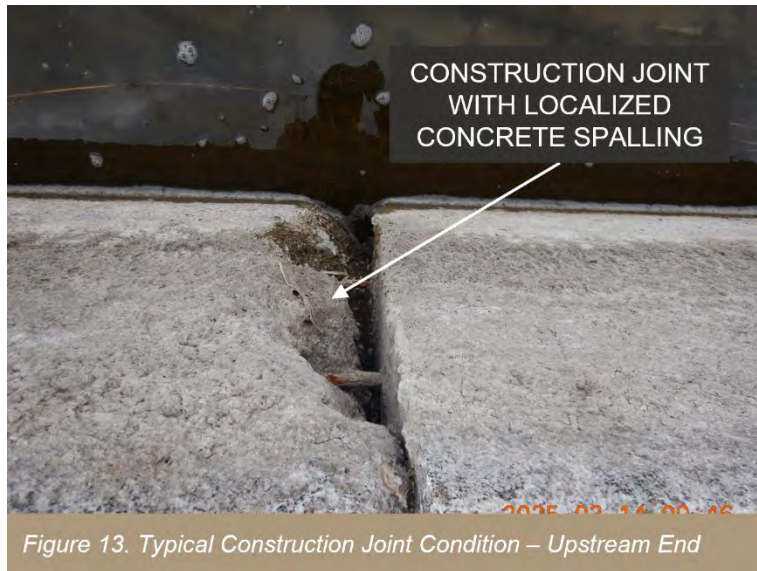


Figure 13. Typical Construction Joint Condition – Upstream End

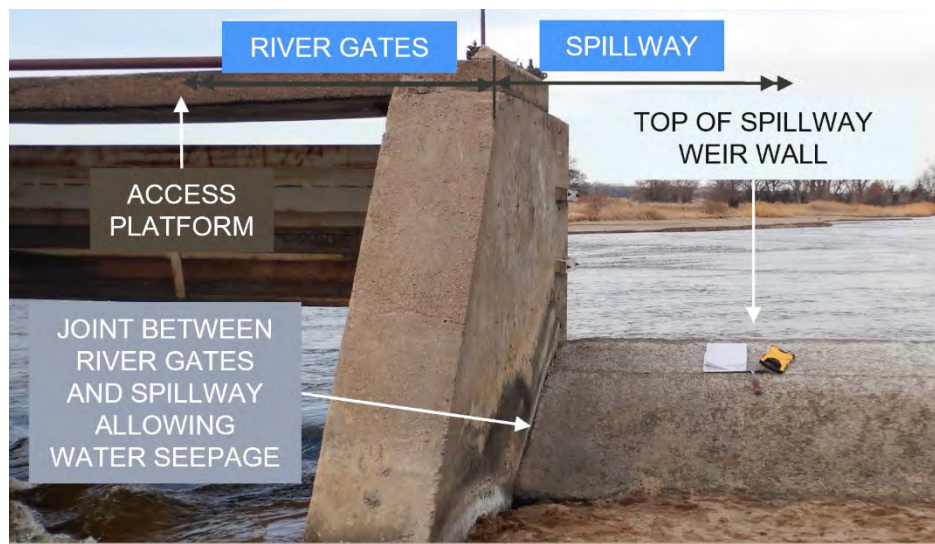


Figure 14. Interface of River Gate and Spillway – Downstream End



Figure 15. Typical Apron Condition and Environmental Buildup – Downstream End



Figure 16. Typical Apron Condition and Environmental Buildup – Downstream End

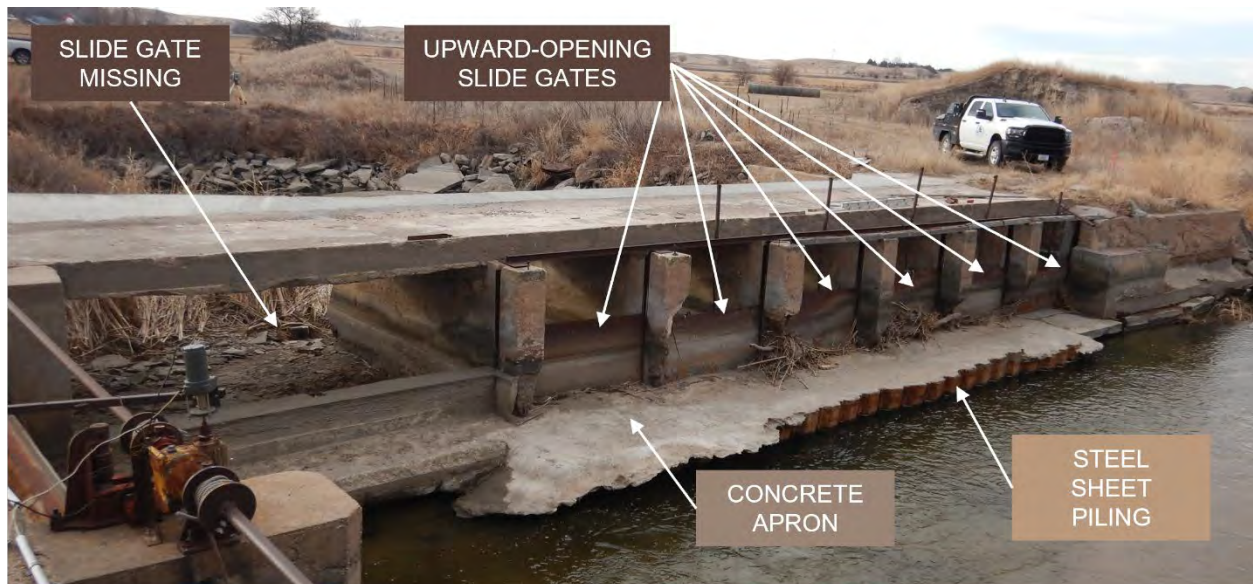


Figure 17. Looking Southwest Towards Canal Structure Inlet – Upstream End



Figure 18. South Exterior Wall of Canal Gate Structure – Downstream End

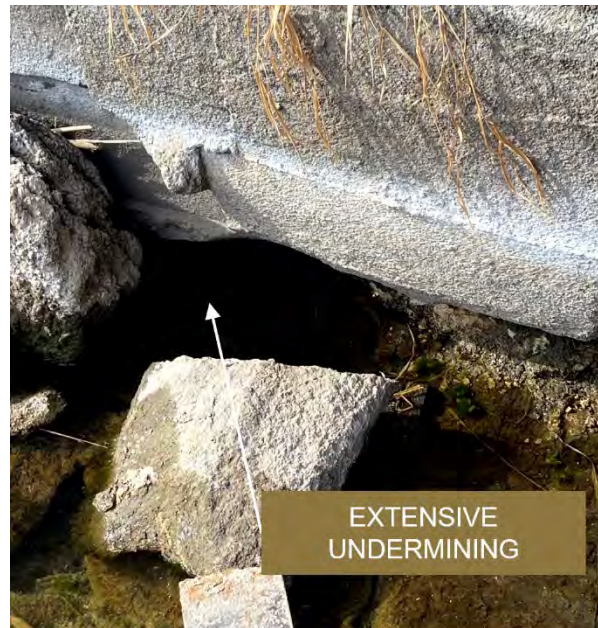


Figure 19. South Exterior Wall of Canal Gate Structure

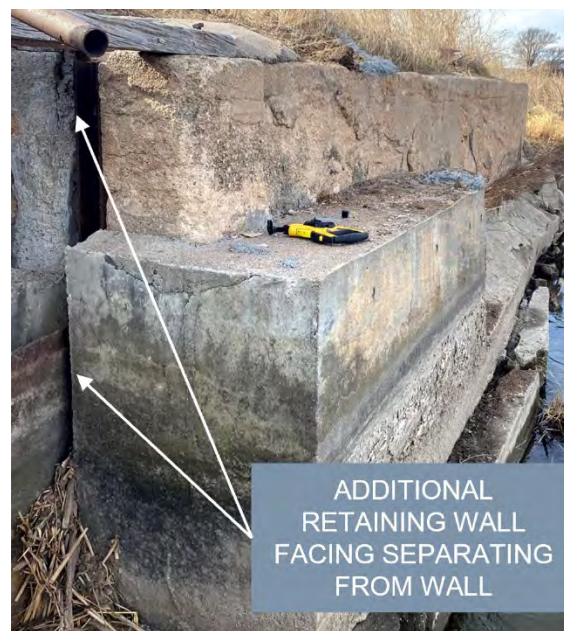


Figure 20. South Exterior Wall of Canal Gate Structure

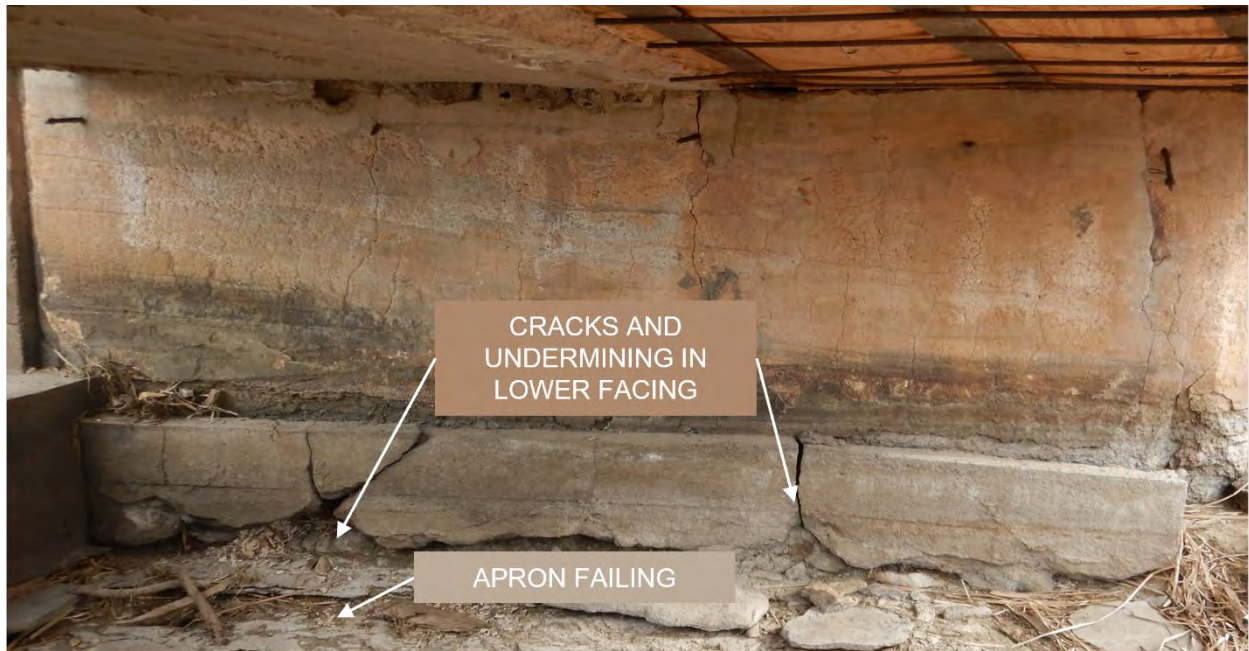


Figure 21. North Exterior Wall of Canal Gate Structure and Apron

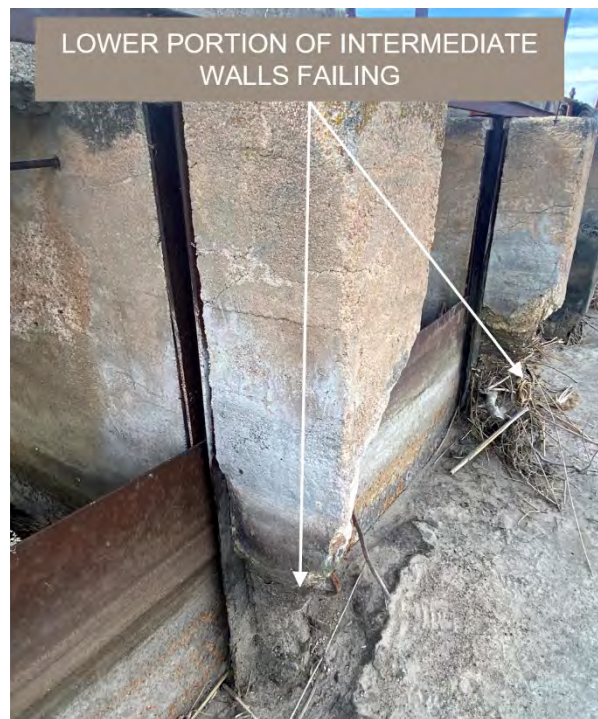
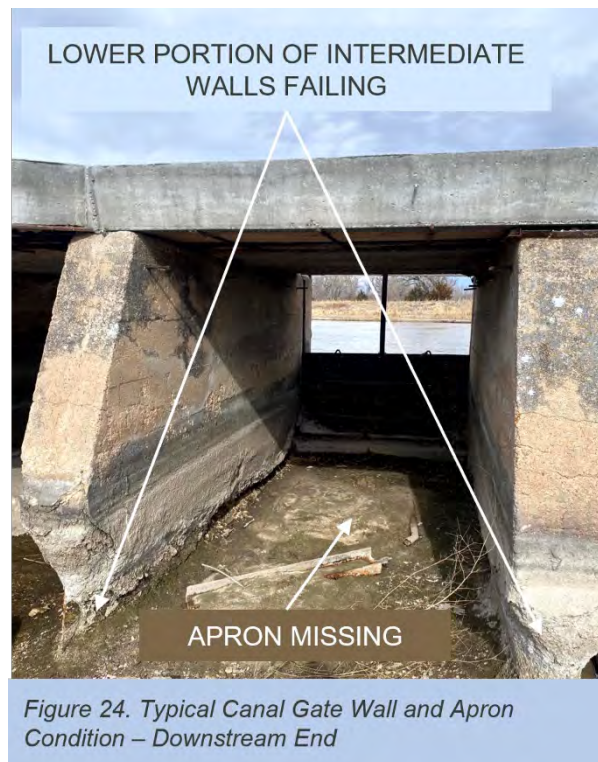
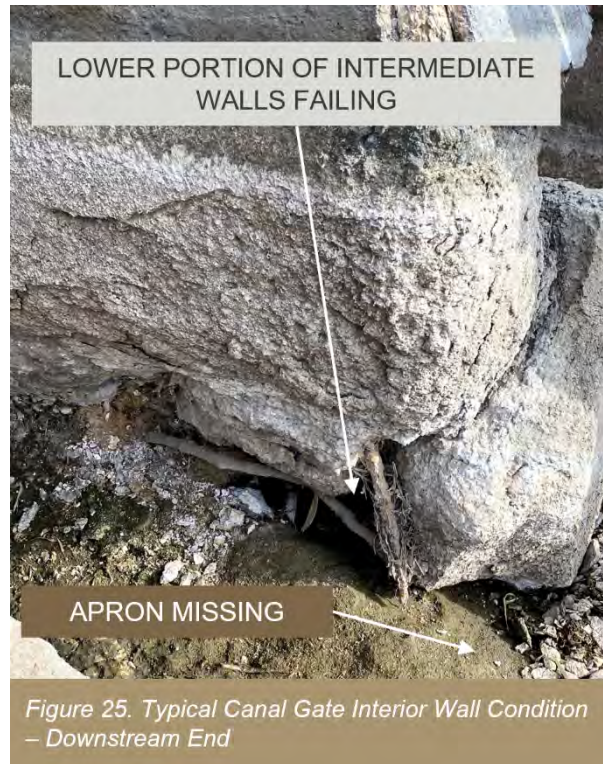


Figure 22. Typical Canal Gate Intermediate Wall Condition – Upstream End





PLATTE VALLEY IRRIGATION DISTRICT NORTH PLATTE CANAL DIVERSION

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August 2025



Existing Structure General Description

The Platte Valley Irrigation District / North Platte Canal diversion structure, originally constructed in the 1880s, is located 2.5 miles northwest of Sutherland, Nebraska. The structure consists of a spillway structure to the north, six river gates toward the south riverbank, and a 90° diversion structure directly adjacent to and south of the river gates as shown in Figure 1.

The spillway structure consists of a primary overflow weir with a downstream concrete apron and secondary energy dissipation weir. The river control gates consist of six cells, two of which are original construction and four that were built at a later date. The four newer cells were constructed at an elevation 4'-0" lower than the original two gates. All six cells manage water levels with steel radial gates that are opened and closed by hand operated equipment mounted to the top of the structure. The inlet of the diversion structure is a two-cell structure with five steel lift gates in each cell. The lift gates allow for water to be diverted from below the checked river water surface. The diversion canal takes a 90° turn directly south of the inlet and heads east. A concrete apron is present at the inlet of the diversion structure and extends to the inlets of the original two gates. Concrete aprons extend through the river control gate walls and the diversion structure.

Current Maintenance & Operations

During the site visit, Olsson's inspectors were able to discuss operations and maintenance challenges with the ditch operator. The operator provided several suggestions to improve operations based on past experiences with the structure:

- Automated gates for the river structure will make operations more efficient and improve safety.
- Lighting for nighttime operations would increase safety.
- Noted a need for stairs or another access method to not have to scale concrete walls between structures
- The operator believes it may be beneficial to increase the capacity of these structures, remove the Paxton-Hershey diversion structure and develop a secondary canal structure to divert flows to the Paxton-Hershey canal. This is due to both the current condition of the Paxton-Hershey canal and their proximity to each other.
- It was noted that the gate style of the existing diversion structure allows water to be diverted from below the water surface. It is presumed that this is beneficial because it seems to reduce issues with weed growth within the canal, as seeds tend to float at the top of the river channel and are not pulled into the diversion.
- Noted that previously there was a long timber retaining wall that extended upstream of the diversion. It has since deteriorated, allowing the channel to meander to the south and he has been working on filling a scour area where the river flows are starting to cut toward the canal channel. This is expected to ultimately bypass the control structure if not controlled.
- Noted two old concrete abutments along the diversion channel and he would like to see if a small bridge can be constructed for equipment access. It was also noted that a check gate and return structure may have previously been at this location.

River Control Gates

The original river control gates consist of two 16'-0" wide cells with a concrete apron floor and concrete access platform. The downstream end of the concrete apron drops approximately 1'-0" at the outlet of the control gates and extends approximately 10'-0" downstream before terminating as shown in Figure 6. The concrete apron thickness could not be determined due to the presence of water in the channel. The access platform across the cells consists of a cast in place concrete slab that is used to operate the control gates as well as reach the spillway structure to the north. Equipment to raise and lower the gates is mounted to the top of the walls. The south and intermediate walls are 1'-10" thick concrete walls, and the north wall is 1'-3" thick. Walls are flat at the top before sloping down to the concrete apron on the downstream end as shown in Figures 4-6. Based on conversations with the operator, and based on construction methods used for similar gates, it is believed these walls are supported by timber piling. An additional 1'-6" thick retaining wall at the south end of the structure extends 28'-0" downstream from the structure before turning at a 30° angle and extending 7'-6" into the riverbank. The retaining wall was cast behind the wall of the gate structure, and the color of the concrete is different from the gates, therefore it is assumed this wall was constructed after the original gates. The upstream river channel elevation is managed with steel radial gates attached to the walls of the structure (Figures 2-4). Radial gates are adjusted by a gear and pulley system that can be raised or lowered by hand operated equipment mounted to the access platforms (Figure 5). Radial gates are lowered to check up the main channel water surface elevation and facilitate the diversion of water to the irrigation canal through the canal structure gates. A retrofit light to assist with nighttime operations was present at the transition from the original gates to the newer gates (Figures 2 and 3).

The newer gates consist of four 14'-3" wide cells with a concrete apron floor and concrete access platform. The geometry and thickness of the apron could not be determined due to the presence of water in the channel. The access platform across the cells consists of a cast in place concrete slab that is used to operate the control gates as well as reach the overflow structure to the north. Equipment to raise and lower the gates is present on the top slab. The intermediate walls are 2'-0" thick concrete walls that are flat at the top before sloping down to the apron on the downstream end. Exterior walls are flat at the top before sloping down to a shorter wall that extends 20'-0" downstream. Based on conversations with the operator, and construction methods used at similar gates, it is believed these walls are supported by timber piling. Main channel flow rates are managed with radial gates attached to the walls of the structure. Radial gates are adjusted by a gear and pulley system that can be raised or lowered by hand operated equipment mounted to the access platforms. Radial gates are lowered to back up river flow and allow diversion through the canal gates.

Condition of River Control Gates

All walls exhibited minor concrete cracking, concrete spalling and water staining, with some walls exhibiting more significant or widespread damage (Figure 7). The retaining wall south of the original gates exhibited a large vertical crack near the connection to the gate structure (Figure 11). Concrete spalling and delamination are present throughout the entire face of the wall. A steel plate that appears to be part of a tie back that is buried in the soil beyond the back of the wall is present at the midpoint of the wall. This tieback was likely installed to prevent outward rotation of the retaining wall. The concrete base of the retaining wall has a thicker region that was likely poured to mitigate undermining of the wall. A small tree and other small

plants have begun to grow through the construction joint between the retrofit base and the rest of the wall (Figure 11).

Minor cracking and spalling were present on all faces of the intermediate walls. A crack at the construction joint between the exterior wall at the north end of the river gates and south wall of the spillway has developed and the corners of the walls exhibited spalling. A large diagonal crack has formed on the interior face of the north wall of the gate structure, and the wall appears to be rotating towards the south (Figures 8 and 10). Wall rotation is inhibiting the radial gate in this cell from completely opening as noted by the canal operator. The condition of the wall bases could not be determined due to the presence of water in the channel. Access slabs spanning the original two cells exhibited noticeable deflection and transverse cracking in the top slab near the interior and exterior walls. Cracks in the top slab at these locations, in addition to the noticeable deflection, indicate that these slabs have been overloaded.

Spillway and Downstream Apron

The overflow spillway consists of a concrete apron with a weir wall at the upstream end and an energy dissipation weir wall near the middle of the slab. A 15'-3" long retaining wall is present at the north end of the spillway that slopes down to the concrete apron. The weir wall at the upstream end of the slab extends to the north beyond the limits of this structure and is buried in the surrounding soil. Only small sections of the concrete wall were visible for the northern stretch of wall

The spillway and its components are generally in good condition with minor concrete damage, concrete staining, water seepage and environmental buildup present. Built-up riprap is present towards the north end of the slab. It was unclear if the slab has been undermined at the upstream or downstream ends. The concrete apron exhibited minor concrete cracking at various locations, but environmental buildup prevented the entire surface of the slab from being investigated. Larger cracks were present at construction joints between slab sections and minor concrete spalls were present on slab corners at construction joints (Figure 14). Water was present at construction joint locations. It was unclear if water was present because it has migrated up through the cracks from the bottom of the slab, because it has pooled up due to cracks and spalls forming low points, or because of water seepage through construction joints in the upstream weir wall. Environmental build up is present over a large portion of the south end of the slab and extends to the north into the channel. Environmental build up includes large portions of trees and layers of dirt built up on the surface of the slab and in the channel (Figures 13 & 15).

Condition of Spillway

The downstream face of the upstream weir wall exhibited deterioration at its base (Figure 16) throughout the length of the slab and minor concrete spalls were present on the bottom corner of the wall. Water was present throughout the undermined region of the wall. Undermining extended approximately the entire length of the wall. Larger cracks were present at construction joints between wall sections and minor concrete spalls were present on wall corners on the upstream and downstream faces of the wall. Damage was generally greater and spread over a larger area on the upstream face of the wall. Water seepage has occurred through the wall construction joints. Environmental buildup and concrete staining are present throughout the entire length of the wall on all faces. The secondary energy dissipation weir exhibited similar

damage to the primary overflow weir wall, with spalling and cracking centered at construction joint locations (Figure 14). Environmental build-up was present on all faces (Figure 15).

The north retaining wall exhibited concrete spalling along its top corner, and in small regions of its front face (Figure 17). Environmental buildup and concrete staining on the front face of the wall are present throughout the length of the wall. Environmental buildup at the base of the wall appeared to be saturated, however it was unclear if this was due to water pooling in this region, or if water has migrated through the base of the wall. The slope behind the retaining wall has begun to erode, leaving a sloped region down to the base of the wall. Attempts to mitigate the erosion have been made by placing concrete railroad ties behind the wall as a method of bank stabilization (Figure 17).

Canal Gate Structure

The Canal Gate structure consists of two 27'-0" wide cells with a concrete apron floor and concrete access platform. An additional concrete apron is present at the inlet of the diversion structure that has partially collapsed. This apron was recently repaired by installing steel sheet piling and pouring concrete in the voided area created from the apron failure. The thickness of the apron could not be determined due to the presence of water. The top slab of the cells consists of a cast in place concrete slab that is used as an access platform to reach the main channel gates. The slab was constructed utilizing steel railroad rails as reinforcement with timber planks spanning between them to create a bottom surface to pour concrete on. A handrail is present on the north edge of the top slab. The intermediate wall is flat at the top and slopes down to the surface of the apron. Metal stairs are present on the sloped face of the intermediate wall to allow for access. Exterior walls are 22'-6" long and are flat for their entire length. Based on conversations with the operator, and construction methods used at similar gates, it is believed these walls are supported by timber piling. The concrete apron extends to the end of the exterior walls before dropping off into the canal channel at its downstream end. A large scour hole that has been filled with riprap is present at the downstream end of the apron. An additional retaining wall at the west end of the structure extends upstream along the river channel, and curves into the slope before terminating. The diversion inlet gates consist of five vertical lift gates in each of the two cells (ten gates total) that allow for water to be diverted from below the water surface of the river channel (Figure 18). Each inlet gate can be raised or lowered by a handyman jack from the access platform.

Condition of Canal Gate Structure

The faces of all diversion structure walls exhibited extensive map cracking, spalling and water staining (Figure 21 and 24). A steel cover plate has been attached to the west faces of the intermediate and east exterior walls as a repair method (Figure 23). The ditch operator noted that water flows between the exterior wall cover plate and the wall during high flow events. The access platforms exhibited noticeable deflection and transverse cracking in the top slab near the interior and exterior walls (Figure 22).

The concrete apron appears to be in fair condition with no major signs of cracking or deterioration noted.

The steel gate structural components appear to be in fair condition with no major section loss noted. Surface rusting and minor section defects could be seen throughout but the ditch operator indicated all gates are currently functional (Figure 25).

Recommended Repairs

Overall, the structures are in fair condition but in need of repairs throughout. Some repairs are minor while others may require full replacement of structure components. In addition to structural repairs, several safety and operational improvements are recommended for the structures. The following list provides a breakdown of each type of recommended improvement:

Structural Improvements

1. Repair or reconstruct the north exterior wall of the newer main channel gates to allow gates to fully open and close.
2. Reconstruct the downstream retaining wall of the river channel.
3. Evaluate upstream apron emergency repairs and replace with long-term repair solution.
4. Repair western canal gate structure wall.
5. Replace intermediate and eastern canal structure walls.
6. Replace access platforms at the canal structure with steel or concrete catwalk.
7. Install scour mitigation sheet pile cut off walls at upstream and downstream portions of the structure and connect to existing structural aprons or walls.
8. Concrete patching at spalled locations throughout all walls and slabs of the structures as required.
9. Patch and seal construction joints in the spillway structure to prevent further water seepage.
10. Replace seals at all radial gates.
11. Backfill scoured region behind the north retaining wall of the overflow structure.
12. Restore downstream riprap basin at the overflow weir structure.

Safety & Operational Improvements

1. Install stairs or a ladder at the transition from the original and newer main channel gates to allow for easier and safer access between the two.
2. Add additional lighting to assist with nighttime operations.
3. Update current gates and equipment of the river gate and canal gate structures to allow for automated operation.
4. Add 42" tall handrail to all access platforms.

Figures

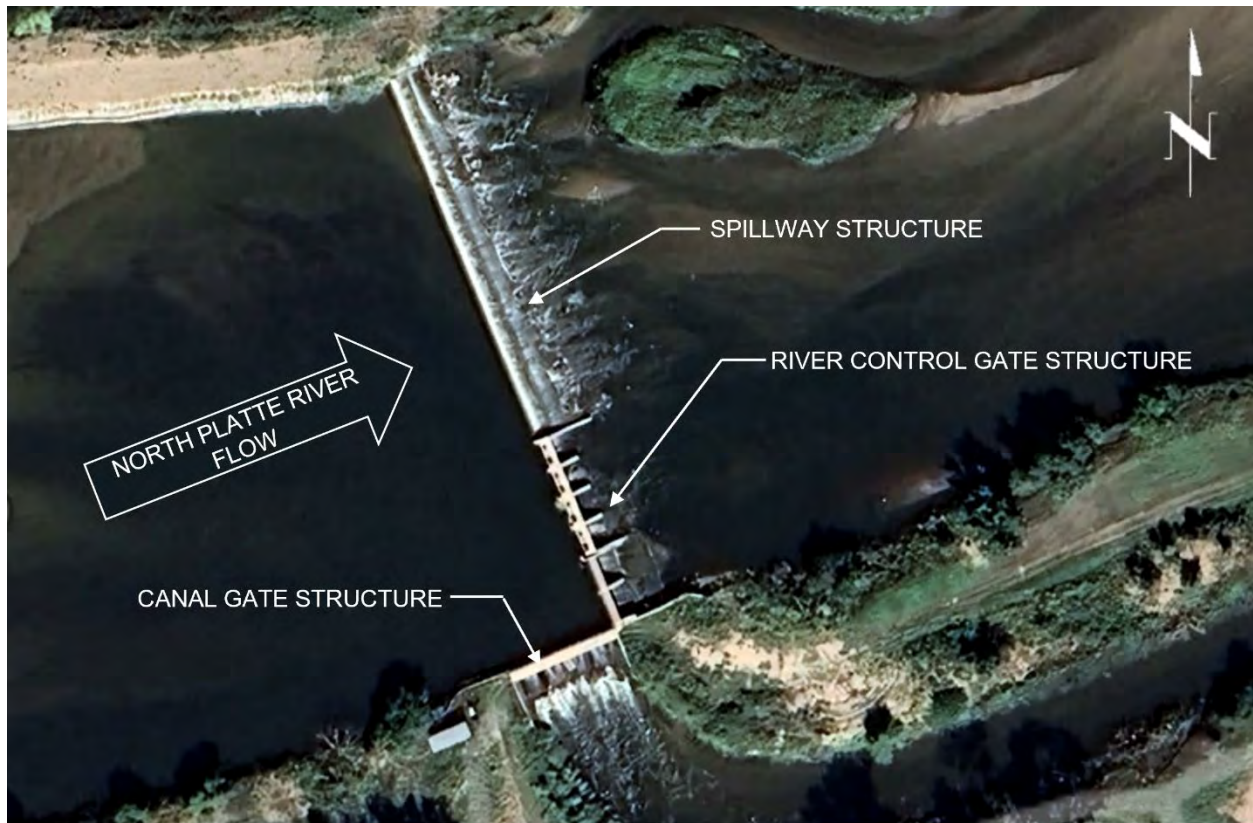


Figure 1. Site Map of Platte Valley Irrigation District / North Platte Diversion Structure



Figure 2. Looking Northwest Toward River Gate Structure – Downstream End

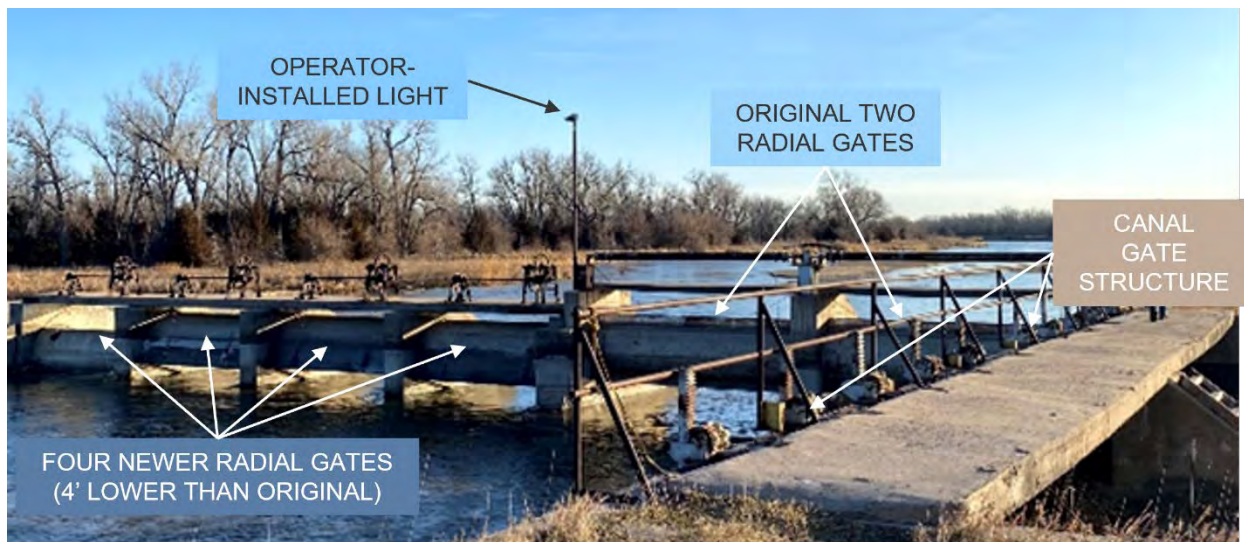


Figure 3. Looking Northeast Toward River Gate Structure – Upstream End



Figure 4. Looking Northwest Towards River Gate Structure – Downstream End

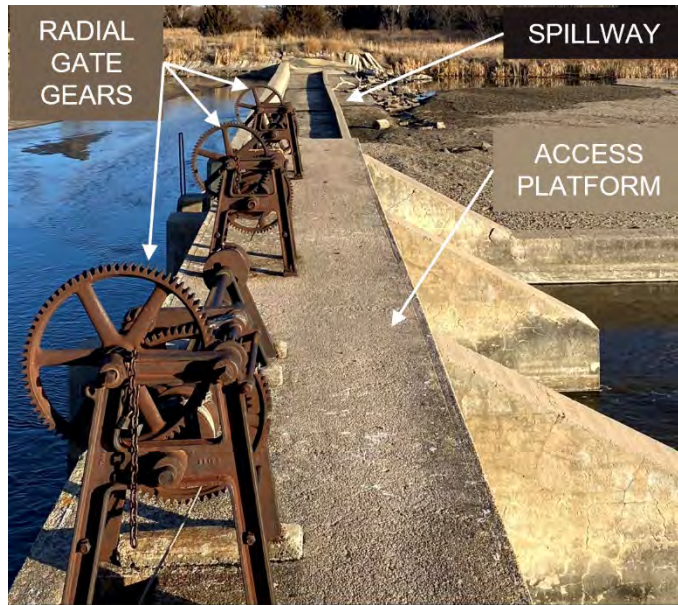


Figure 5. Looking Northwest Along River Gate Structure



Figure 6. Walls of River Gate Structure – Downstream End



Figure 7. Retaining Wall at South Embankment – Downstream End

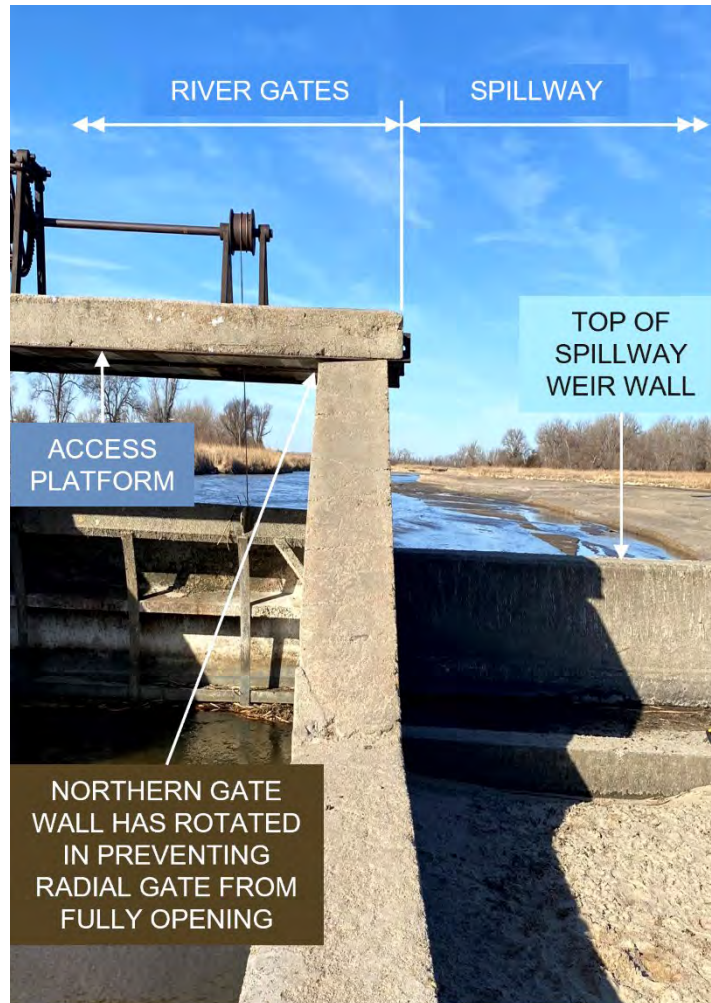
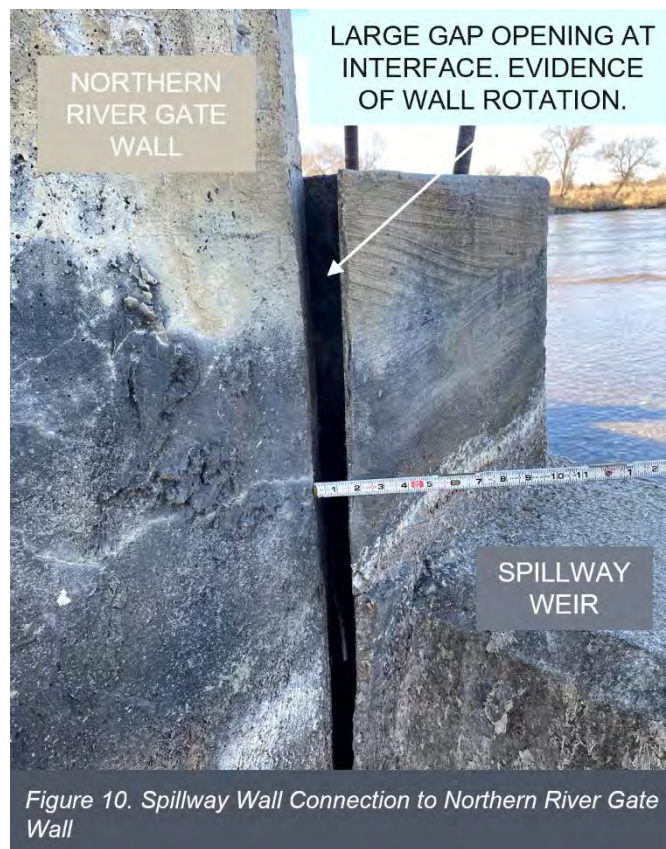
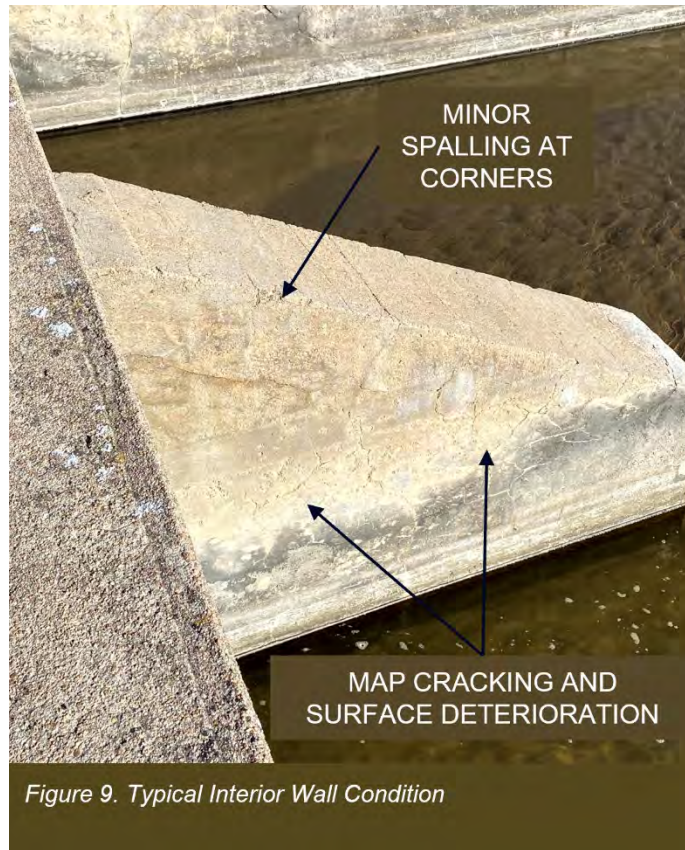


Figure 8. Interface of River Gate and Spillway – Downstream End



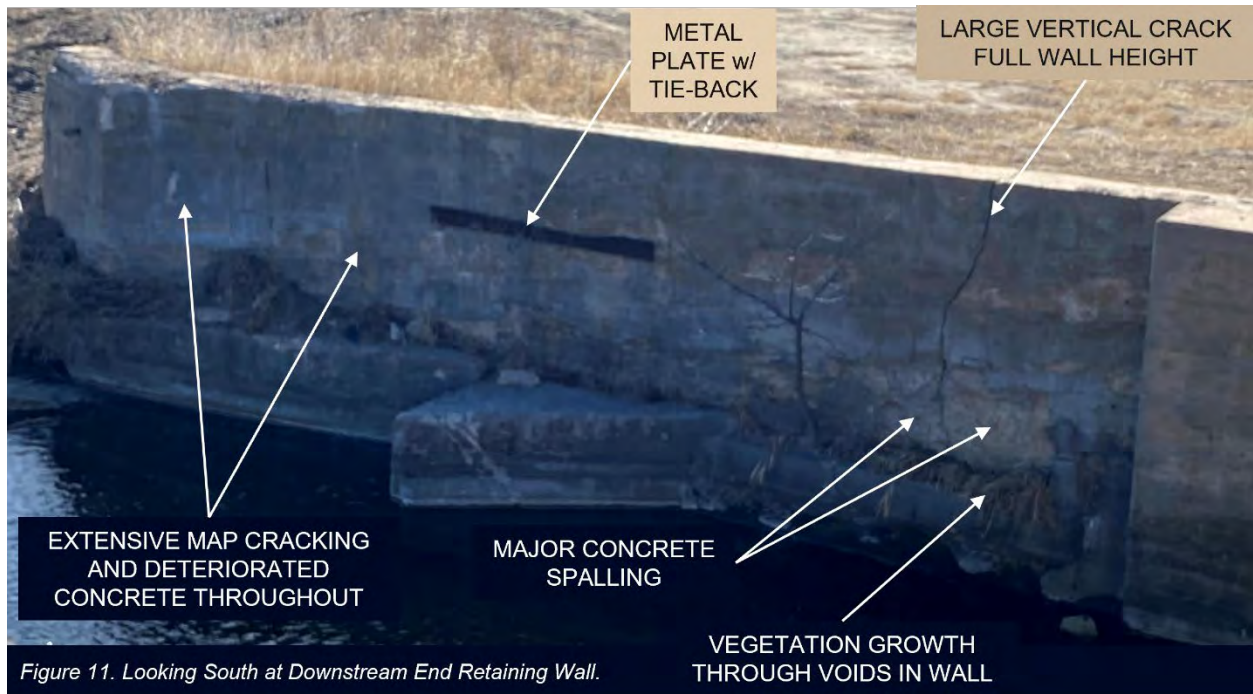




Figure 13. North Embankment – Downstream End

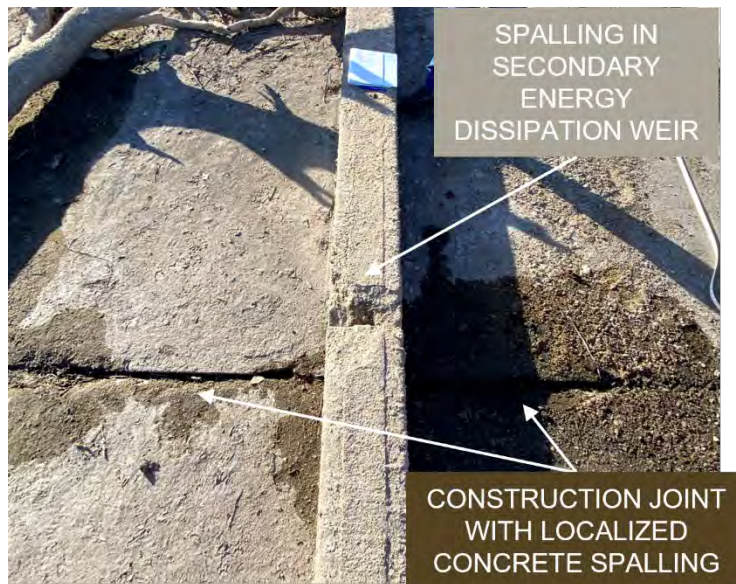


Figure 14. Secondary Energy Dissipation Weir Joint

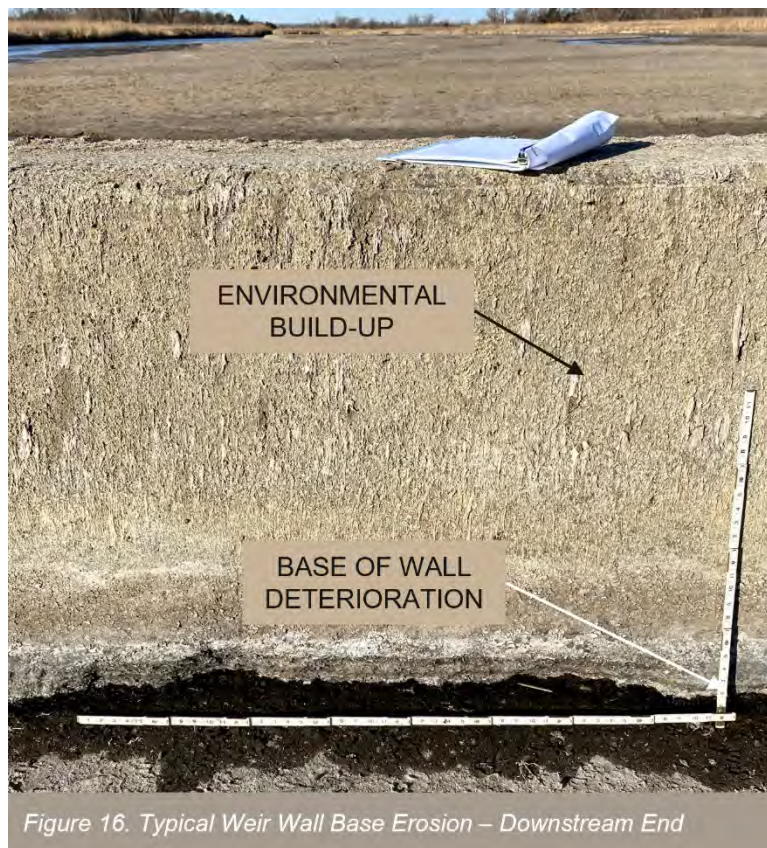




Figure 17. Retaining Wall at North Embankment – Downstream End



Figure 18. Looking Southwest Towards Canal Structure Inlet – Upstream End

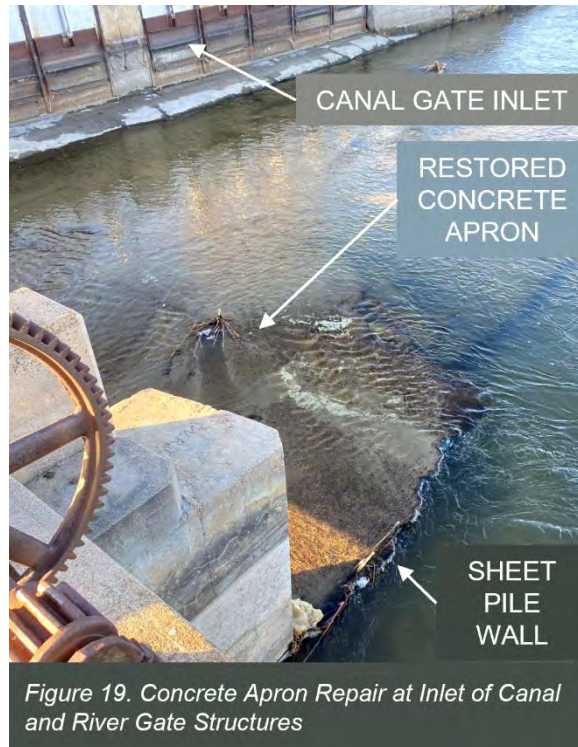




Figure 21. Intermediate Wall of Canal Gate Structure – Downstream End



Figure 22. Transverse Crack in Access Platform

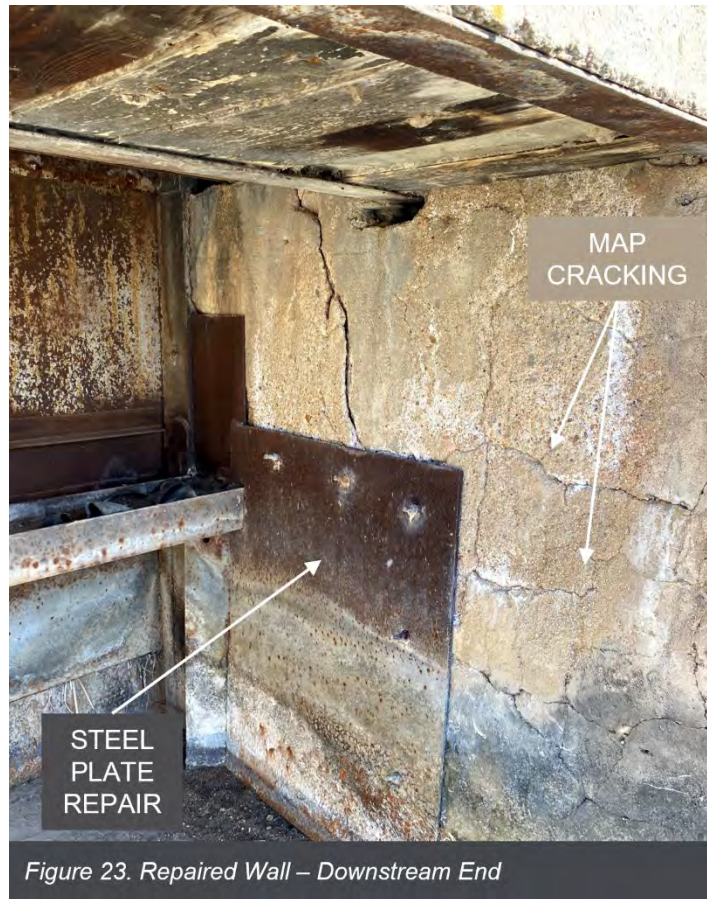


Figure 23. Repaired Wall – Downstream End



Figure 24. Typical Map Cracking and Spalling

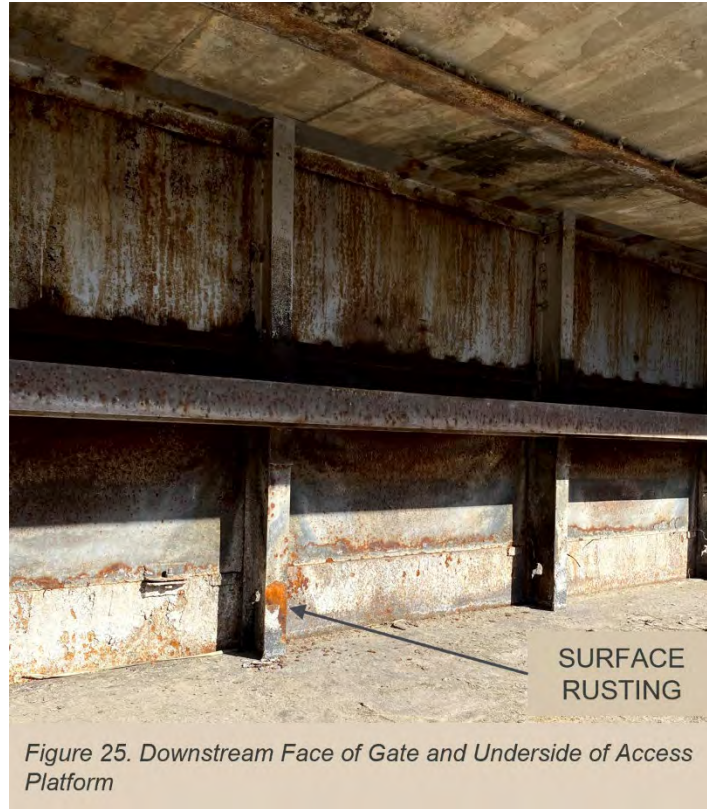


Figure 25. Downstream Face of Gate and Underside of Access Platform

SUBURBAN IRRIGATION DISTRICT NORTH PLATTE CANAL DIVERSION

Prepared for:



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Existing Structure General Description

The Suburban Canal diversion structure is located 3.5 miles northwest of Hershey, Nebraska. The structure consists of a spillway structure to the south, two river gates along the northern riverbank, and a 90° canal gate structure directly adjacent to and west of the spillway structure as shown in the Vicinity Map (Figure 1). There is also a county bridge that crosses the river directly upstream of the diversion structure.

The spillway structure consists of a primary overflow weir with a downstream concrete apron. South of the overflow weir wall are two permanently closed steel lift gates. From discussions with the ditch operator it is understood that steel lift gates used to make up the entirety of the overflow weir and at some point during the structures life they were removed and replaced with a concrete weir wall. The river control gates consist of two cells with concrete side walls and an intermediate concrete wall. The base of the gate structure includes a concrete apron that extends through the limits of the sidewalls. River water levels are managed with steel radial gates that are opened and closed by motorized equipment mounted to the top of the structure. A concrete access platform is mounted to the top of the gate structure walls.

The inlet of the canal gate structure is a four-cell concrete structure with concrete end walls, intermediate concrete walls, and concrete apron. A concrete access walkway spans between the structure walls. Steel lift gates are operated in three of the 4 cells by use of a handyman jack. The eastern most cell of the structure has been permanently closed off by a concrete wall that was poured in front of the opening. The lift gates allow for water to be diverted from below the checked river water surface. The irrigation canal extends south for approximately 900 feet before turning east. A triangular shaped concrete apron is present at the southeast corner of the structure between the canal inlet and spillway weir and the apron extends approximately 42-feet north along the upstream face of the spillway structure and through the full width of the canal gate.

Current Maintenance & Operations

During the site visit, Olsson's inspectors were able to discuss operations and maintenance challenges with the ditch operator. The operator provided a couple observations about the structure operations from his experience:

- It was noted that water is migrating behind the west wall of the canal structure and that they have tried multiple methods to cut the water off but have not had success.
- It was also noted that erosion issues existing along the northern bank of the river near the end of the river gate upstream side wall. Evidence of previous attempts to resolve this erosion was evident on site.

River Control Gates

The river gates consist of two 20'-6" wide cells with concrete apron floor and concrete access platform. The upstream limits of the concrete apron through the river gate is unknown due to the presence of sand over the apron at the time of the site visit. The access platform across the structure consists of an 8" thick cast in place concrete slab that is used to operate the river gates. Equipment to raise and lower the gates is mounted to the top of the walls. The intermediate wall is a 1'-8" thick concrete wall, and the north and south walls are 1'-3" thick. The north wall is flat at the top before sloping down to the concrete apron on the downstream end as shown in Figure 6. An additional 1'-3" thick retaining wall at the south end of the structure

extends 14'-0" downstream from the structure. This same wall extends approximately 20 feet upstream along a radial curve. The upstream river channel elevation is managed with steel radial gates attached to the walls of the structure. Radial gates are adjusted by a gear and pulley system that can be raised or lowered motorized equipment mounted to the top of the walls. Radial gates are lowered to check up the main channel water surface elevation and facilitate the diversion of water to the irrigation canal through the canal gates structure.

Condition of River Control Gates

Overall the river gate structure is in good condition with only minor concrete cracking and localized concrete spalling noted. Scour holes and undermining are present along the northern side wall at both the up and downstream ends (Figures 8 and 11). Based on the observed grading adjacent to the north wall, it appears a drainage swale currently exists behind the wall which may be the source of the noted erosion issues. There was also some observed undermining of the outlet end of the concrete apron (Figures 7 and 9). Exact limits of undermining could not be determined due to water flow at the time of inspection.

Spillway and Downstream Apron

The overflow spillway and downstream apron are in fair condition with heavy environmental build up on most surfaces. At the south end of the weir wall there are two remnant steel lift gates (Figure 12). The gates are no longer operational and are heavily rusted. No voids or large holes were noted in the steel at the time of the inspection. The downstream apron surface is irregular but does not show any signs of major defect or structural damage. One location near the connection to the river gate structure has experienced some localized erosion and section loss. The downstream end of the spillway apron is fully exposed with three visible layers of concrete. Some undermining of the downstream end of the apron was noted but did not extend far back under the apron concrete. The southern side wall of the spillway has a large vertical cracks through both the upper and lower sections of wall (Figure 15). The portion of the wall beyond the spillway apron has rotated and had a tree laying across it. Concrete rail ties and other debris have been placed downstream of this wall for bank stabilization (Figure 16).

The upstream side of the spillway has two conditions. The northern section has a timber pile wall aligned with the front face of the weir wall. The timbers are severely eroded and are no longer protecting the weir base. It is unclear if an alternate cutoff wall or protection is in place. The southern section of weir includes a triangular concrete apron through the intersection of the canal gate structure and the overflow spillway. This apron is in good condition with some surface irregularities but no major signs of defect or structural damage. Steel sheet piling is present along the river edge of the apron (Figure 14). Steel oxidation has occurred but appears intact. There is a gap between the upstream face of the overflow weir and the edge of the concrete apron (Figure 17) . It is unclear if this joint was intended to act as an expansion joint or if it has opened over time. The opening is consistent through the length.

Canal Gate Structure

The canal structure once had four operable inlet cells but at some point during the life of the structure, the eastern most cell was closed off by pouring a concrete wall across the opening and eliminating the steel lift gate. The remaining three cells are each approximately 8'-0" wide with concrete apron floor and concrete access platform spanning between intermediate walls. The access platform spans between the structure walls and appears to have been constructed by placing timber planks side by side and pouring a concrete slab on top of the wood. The

timber members have deteriorated significantly and it is expected that as these timbers continue to deteriorate over the top of the walls, the access platform will begin to settle and crack due to differential movement.

The western side wall consists of a U-shaped concrete wall that turns back at the upstream and downstream ends of the canal structure. The northern wall section parallels the river channel, while the southern section cuts back into the canal bank. The wall has map cracking present throughout and the top of the wall shows signs of deterioration and loss of concrete section. It appears this has been patched over time to try and restore the top of wall elevation (Figure 19). The base of the wall has a supplemental facing added to it. It is understood that this repair was completed to address deterioration of the base of the wall, likely resulting from abrasion erosion from the passing water. Undermining of the downstream end of the wall was observed and the ditch operator noted that water does pass through this embankment outside of the intended canal structure limits. No efforts to resolve this issue have been successful (Figures 20 and 21).

The canal structure concrete apron is in poor condition. It is split into two pieces by a large crack that extends through the width of the structure directly beyond the limits of the interior walls. Movement of the apron has occurred as is evident by the uneven surface (Figures 24 and 25). It appears the downstream apron section may have heaved some over time based on the observed conditions. The end of the concrete apron is fully exposed along with remnant sections of timber piling that was installed as a cut off wall (Figure 26). This piling has deteriorated significantly and is no longer functioning as intended. Much of the apron end has been undermined with large voids observed below. A large scour hole has developed in the canal directly downstream of the canal structure.

The canal structure gates consist of flat steel plates that slide within notches in the concrete walls. Each gate can be raised or lowered by a handyman jack. The steel plates are rusted with some section loss but no full depth holes were noted (Figure 24). In their closed position, some light was visible around the edges indicating a lack of water tightness.

Recommended Improvements

Overall, the river gate is in good condition while the overflow spillway and canal structures are in worse condition. Structural improvements are recommended throughout these structures to improve functionality. Full replacement of some components will be required. There are also a number of safety and operational improvements recommended for the structures. The following list provides a breakdown of each type of recommended improvement:

Structural Improvements

1. Regrade embankment behind the northern river gate wall to relocate drainage swale away from the structure. Restore and protect northern riverbank downstream of the river gate structure.
2. Replace canal gate structure in its entirety including end walls, interior walls, gates, access platform, and concrete apron. This would include the portions of wall that parallel the river both up and downstream of the canal.
3. Construct riprap scour basin beyond the end of the canal structure apron.

4. Extend sheet pile walls across the river channel upstream of the northern section of spillway and the river gates. Retrofit a concrete apron to tie the sheet pile section to the existing structure.
5. Install sheet pile scour protection wall on the downstream side of the spillway and river gates.

Safety & Operational Improvements

1. Install stairs or a ladder access points down into the various structure components.
2. Install lighting to assist with nighttime operations.
3. Add 42" tall handrail along wall edges and access walkways.
4. Update current gates and equipment of the river gate structure to allow for automated operation.

Figures



Figure 1. Site Map of Suburban Irrigation District / North Platte Diversion Structure



Figure 2. Looking South at Diversion structures.









Figure 9. Looking upstream at River Control Gates – Downstream side.

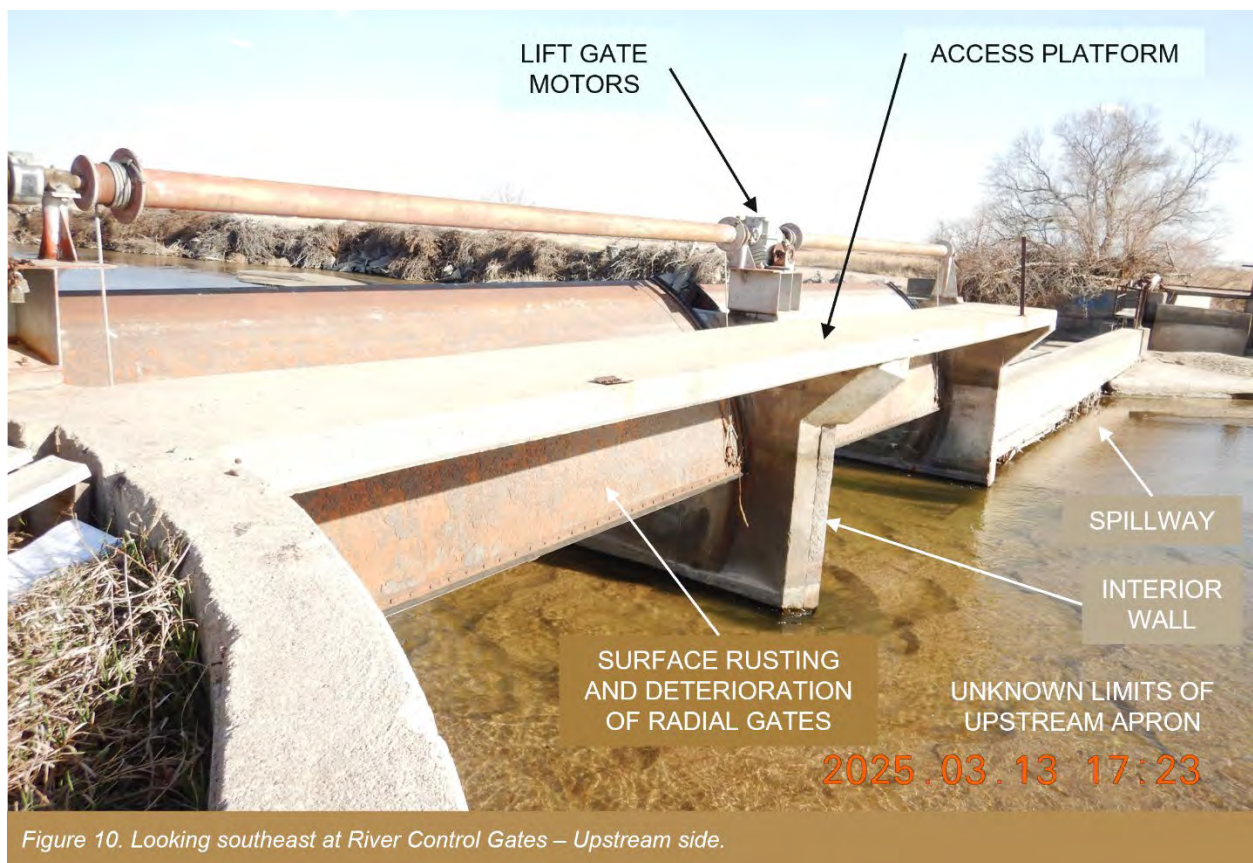


Figure 10. Looking southeast at River Control Gates – Upstream side.



Figure 11. Upstream end of Northern River Control Gate Wall.

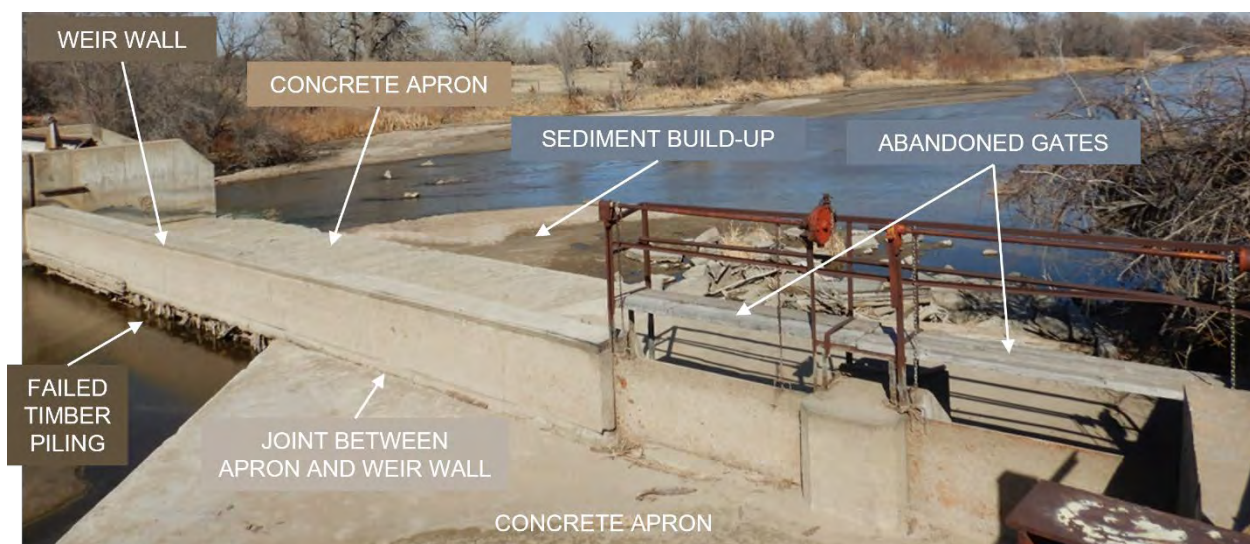


Figure 12. Looking North Along Spillway Structure – Upstream side.



Figure 13. Spillway Structure and Canal Gate Structure – Upstream side.

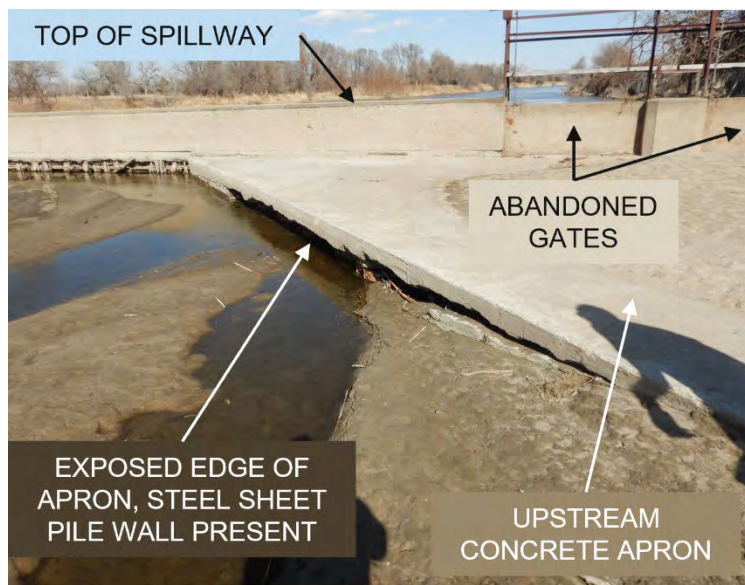


Figure 14 Erosion below concrete apron at Spillway – Upstream side.



Figure 15. Retaining Wall on South Embankment – Downstream side.



Figure 16. Southern Riverbank protection downstream of Spillway.

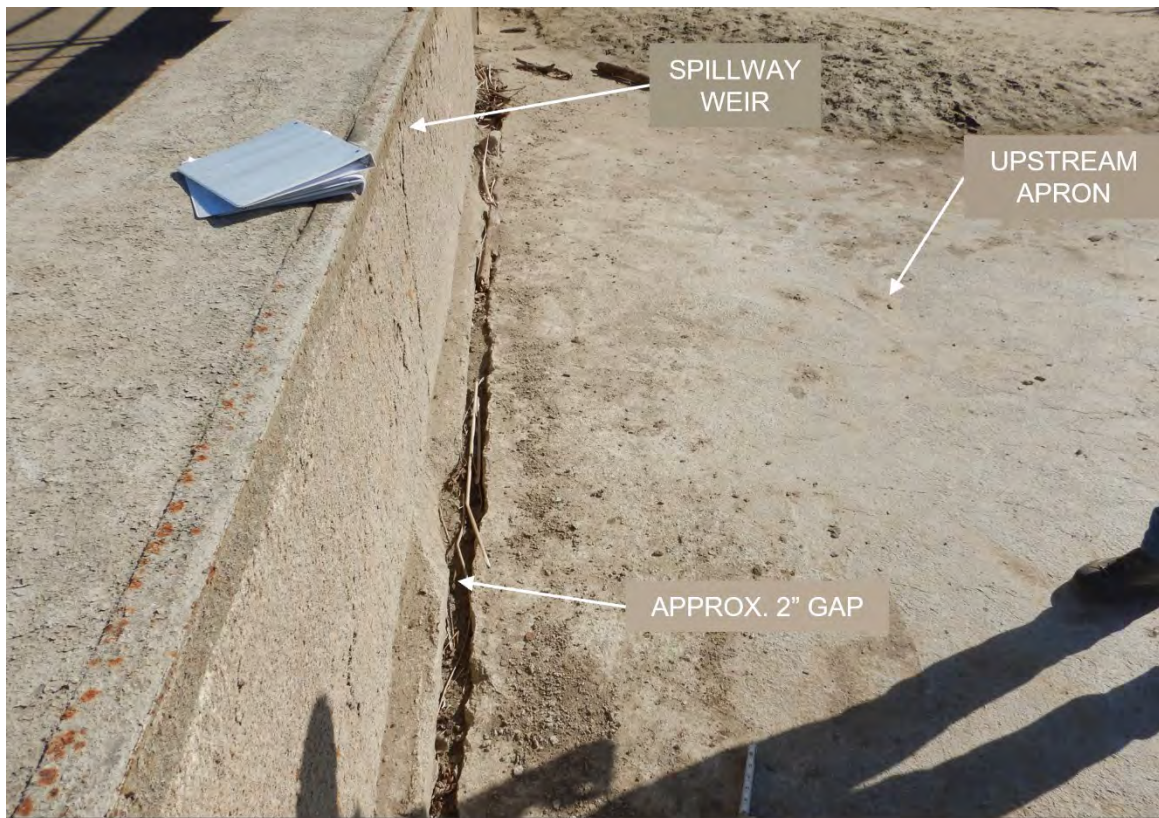


Figure 17. Gap between Weir Wall and Upstream Concrete Apron.



Figure 18. Looking Towards Canal Structure Outlet – Downstream End.

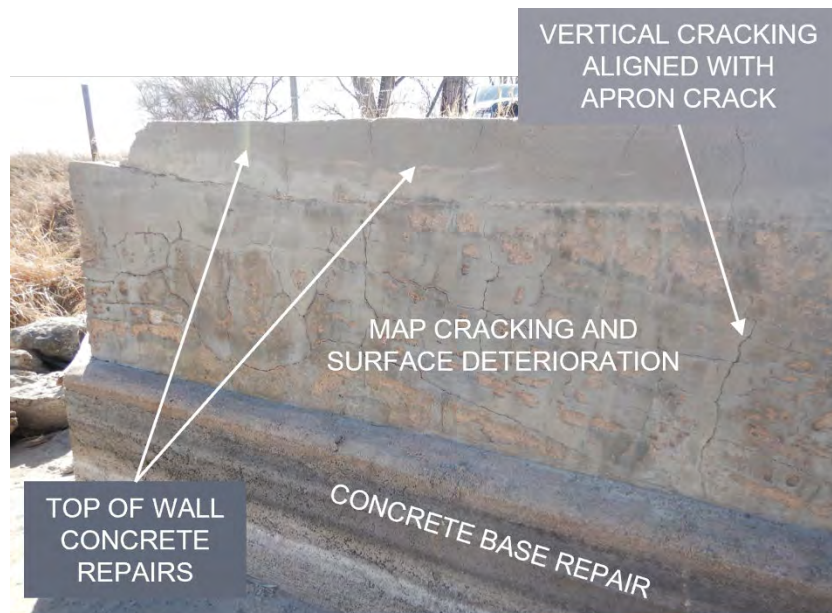


Figure 19. Western End Wall.

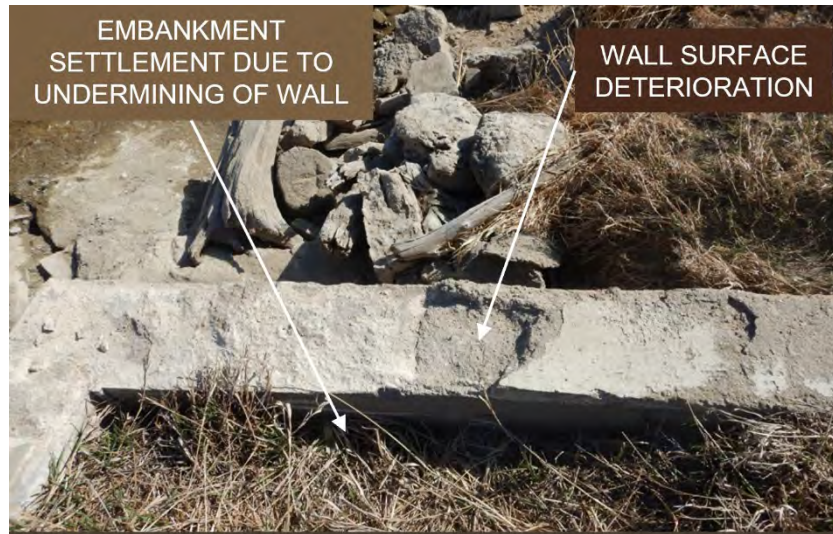


Figure 20. Downstream Wall of Western Canal Wall.

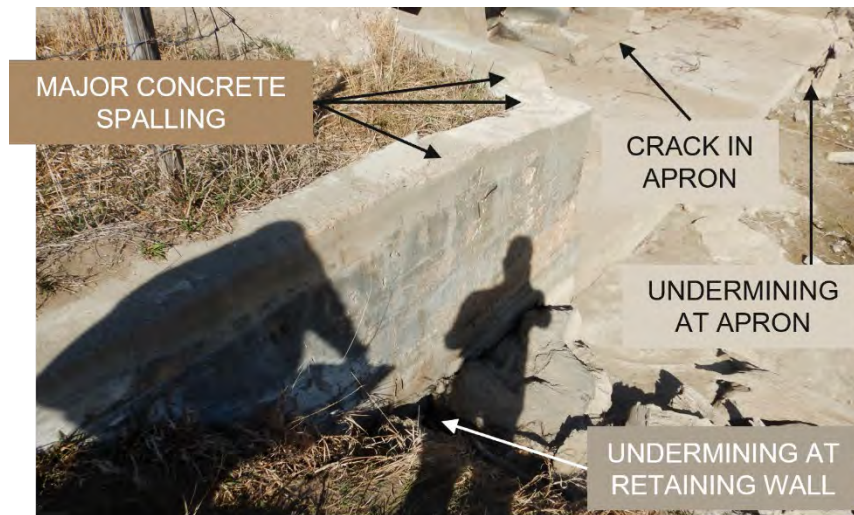
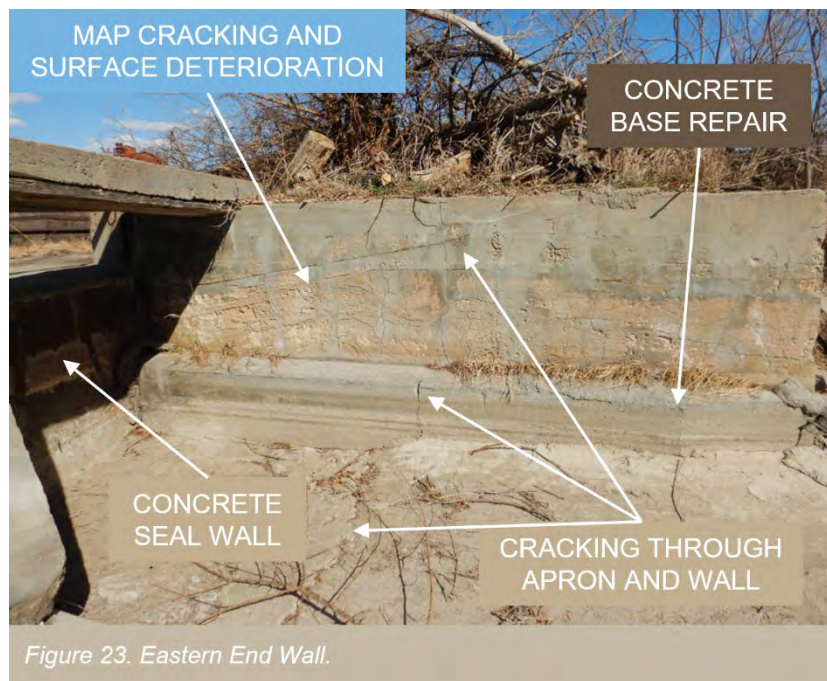


Figure 21. Canal Gate Structure Retaining Walls and Embankment – Downstream side.



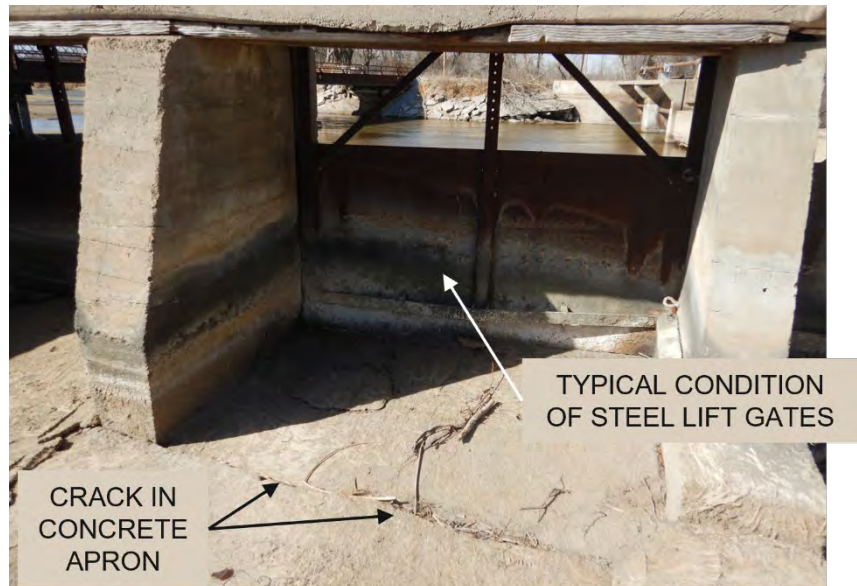


Figure 24. Crack in Canal Gate Structure Slab – Downstream end.

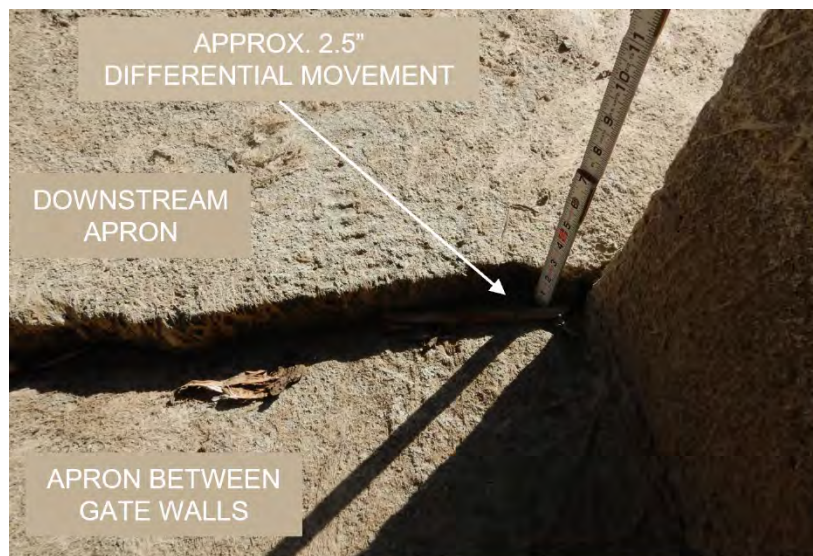


Figure 25. Apron Crack Differential Movement.

