

ST. MARY DIVERSION FACILITIES CATASTROPHIC PLANNING WALKTHROUGH

September 25 & 26, 2007

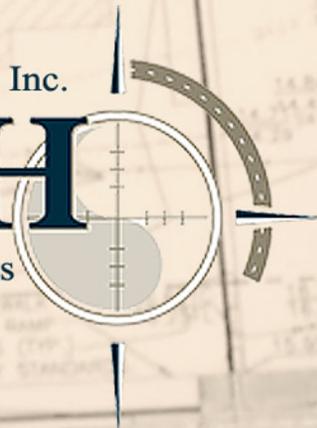


*"Lifeline of
the Hi-line"*

Montana DNRC
Conservation & Resource
Development Division

Thomas, Dean & Hoskins, Inc.

TD&H
Engineering Consultants



ST. MARY RIVER DIVERSION DAM

Background Data:

- concrete buttress weir with hydraulic and structural height of 6.5 feet
- reported 20,000 cfs discharge at 4468; abutment crest elevation 4471
- crest elevation 4457.5
- sluiceway invert elevation 4452
- 195 feet of fixed weir; two bays (95 feet each) and 5-foot bride pier
- 12-inch wooden flashboard added
- 6 sluiceways, total approximate length 56 feet
- western sluiceway, gated with two hoist-operated, wooden panels

Operation:

- sluiceway gates closed during diversion and not normally operated during season
- gates raised during off-season
- occasional midseason trash removal required
- manual monitoring and operation

Issues:

- severe concrete deterioration
- operation precludes fish passage (Bull Trout)
- lack of automation and remote control
- limited safety features

Estimated Replacement Costs: \$16.5 to \$18.5 million (2006) includes headgate structure

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Weir Collapse			
Piping/Erosion			
Fixed Sluiceway			
Sluiceway Gate			
Other			

CANAL HEADGATE STRUCTURE

Background Data:

- 8 steel gates, 5' x 5.5'
- 6 hydraulic operators, 2 manual
- concrete gate wall 20' high by 60' long
- floating trash boom

Operation:

- gates adjusted throughout season
- manually monitored and adjusted

Issues:

- concrete deterioration
- no effective fish deterrent (Bull Trout)
- several gates exhibit heavy leakage, problem during off-season
- trash buildup
- limited safety features

Replacement Costs: Included with diversion dam

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Structure Collapse			
Piping/Erosion			
Gates			
Operators/Stems			
Others			

CANAL PRISM REACH NO. 1 – Diversion Dam to Kennedy Creek Siphon

Background Data:

- approximately length; 25,000 ft
- approximate drop: 6.7 ft
- 1-bank contour canal with 26-foot flat bottom
- 2:1 (H:V) fills and 1½:1 cut sections
- two bridge crossings; Babb Bridge at Station 94+30 and Reid Bridge (Kennedy Creek) at Station 262+90

Operation:

- passive
- leakage from headgates flows during off-season

Issues:

- deteriorated prism
- no livestock fencing
- limited maintenance access
- relatively high seepage losses
- close proximity of U.S. Hwy 89
- scattered residential development from Station 140+00 to 200+00
- several large inflow inundation areas
- significant brush and tree cover on existing fill slope, scatter trees on cut slope; heavy from Station 200+00 to 254+00
- impact on old Babb domestic wells

Estimated Replacement Costs: \$9.2 to \$10.5 million (2005) depending on rehabilitation criteria and ultimate capacity.

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Backslope Stability			
Fill Slope Stability			
Turnouts			
Internal Erosion			
Overtopping/Freeboard Issues			
Others			

KENNEDY CREEK SIPHON

Background Data:

- 200 feet long,
- CIP horseshoe-shaped conduit, 9.25' high, 8.5' bottom width
- 850 cfs design capacity
- crosses under Kennedy Creek, atop active alluvial fan
- numerous training dikes to control Kennedy Creek migration

Operation:

- passive

Issues:

- potential hazard due to limited safety features
- difficult to perform inspections

Estimated Replacement Costs: \$2.3 to \$2.5 million (2006)

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Conduit Collapse			
Headwall Failure			
Piping/Erosion			
Exposure in Creek			
Channel Jumping			
Other			

CANAL PRISM REACH NO. 2 – Kennedy Creek Siphon to St. Mary River Siphon

Background Data:

- approximate length: 22,140 ft
- approximate drop: 2.1 ft
- 1-bank contour canal with 26-foot flat bottom
- 2:1 (H:V) fills and 1½:1 cut sections
- one bridge crossing; Memorial Bridge at Station 386+00
- Kennedy Creek check and wasteway

Operation:

- passive
- leakage from headgates flows during off-season, but drains at Kennedy Creek Wasteway

Issues:

- deteriorated prism
- no livestock fencing
- limited maintenance access
- relatively high seepage losses in first portion
- close proximity and conflict with 1.5 miles of Glacier County gravel road
- several larger inflow inundation areas
- significant brush and tree cover on existing fill slope from Station 312+00 to 353+00
- seepage near St. Mary River Siphon adds to slope instability
- large underdrain at Station 331+55

Estimated Replacement Costs: \$1.6 to \$13 million (2005) depending on rehabilitation criteria and ultimate capacity

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Backslope Stability			
Fill Slope Stability			
Turnouts			
Internal Erosion			
Overtopping/Freeboard Issues			
Other			

KENNEDY CREEK CHECK AND WASTEWAY

Background:

- check – 29’ wide by 11.5’ high
- three, 9’ wide by 10’ high wooden-faced, radial gates
- wasteway – 2’ lower, 13’ wide by 13.5’ high
- two, 6’ by ‘6 wooden-faced, radial gates
- hand-lain, grouted rip rap upstream and downstream of both structures
- grassy spillway located upstream

Operation:

- check structure is not operational
- 1 of 2 wasteway gates not used; other is wedged-shut and has been sealed with PE sheeting to reduce leakage
- operating wasteway gate could be used for emergency releases but is normally only opened during off-season.

Issues:

- limited functionality
- deteriorated concrete structures
- lack of automation and remote control
- limited safety features

Estimated Replacement Costs:

- check \$1.1 to \$1.4 million (2006)
- wasteway \$0.6 to \$0.7 million (2006)

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Check Gates			
Wasteway Gates			
Concrete Collapse			
Piping/Erosion			
Other			

UNDERDRAIN STRUCTURES

Background:

- seven underdrains, see Table for specifics

Station/Locations	Existing Underlain Structure	Proposed Replacement
331+55	Two 60" Φ RCP Pipes	In-Kind
791+34	180 LF - 4.5' x 4.5' Conc. Box	Two 72" Φ RCP
978+46	143 LF - 24" Φ RCP Pipe	48" Φ RCP
1051+68	140 LF - 30" Φ RCP Pipe	48" Φ RCP
1094+05	168 LF - 30" Φ RCP Pipe	48" Φ RCP
1132+33	143 LF - 30" Φ RCP Pipe	42" Φ RCP
1195+82	157 LF - 30" Φ RCP Pipe	42" Φ RCP

Operation:

- passive

Issues:

- conditions not known
- undersized for adequate inspection
- maybe undersized for current hydraulic design criteria

Estimated Replacement Costs: \$1.1 to \$1.3 million (2006)

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Structure Collapse			
Piping/Erosion			
Plugging			
Other			

ST. MARY RIVER SIPHON

Background Data:

- overall length – 3250'
- 2 riveted steel barrels each 425 cfs design capacity
- diameter varies from 90" to 84" and back to 90"
- wall thickness varies 1/4" to 3/8"
- approximate static head 165' (72 psi)
- 1st barrel (left) buried (1912 to 1915), 2nd barrel (right) above ground (1925-1926)
- concrete transition structures with grouted rip rap aprons
- crosses river on bridge
- impressed current cathodic protection

Operation:

- passive
- dewatered during off-season

Issues:

- leaks at numerous locations, mainly at expansion/contraction (E/C) joints
- both slopes moving, south side more than north
- corrosion
- hazardous condition at inlet due to limited safety features

Estimated Replacement Costs: \$29 to \$40 million (2006) depending on capacity, number of conduits, configuration, and material pipe type.

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Concrete Transitions			
Siphon Leaks			
Slope Movements			
Bridge Failure			
Progressive Slope Failure			
Siphon Supports			
Cathodic Protection			
Other			

CANAL PRISM REACH NO. 3 – St. Mary River Siphon to Station 715+00

Background Data:

- approximate length: 20,303 ft
- approximate drop: 5.6 ft
- 1-bank contour canal with 26-foot flat bottom
- 2:1 (H:V) fills and 1½:1 cut sections
- one bridge crossing; DeWolfe Ranch at Station 667+85
- Spider Lake (nonoperating)

Operation:

- passive

Issues:

- deteriorated prism
- no livestock fencing
- limited maintenance access
- moderate seepage losses on fill slope
- significant brush and tree cover on existing fill slope
- heavily wooded from Station 542+00 to 580+00
- large underdrain at Station 331+55
- 4 backslope instabilities, DeWolfe Ranch, DeWolfe Bridge, mid-section and East section 22 slides
- fill slope instabilities likely near Station 700+00

Estimated Replacement Costs: \$13 to \$14.5 million (2005) depending on rehabilitation criteria and ultimate capacity

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Backslope Stability			
Fill Slope Stability			
Turnouts			
Internal Erosion			
Overtopping/Freeboard Issues			
Other			

SPIDER LAKE CHECK

Background:

- three, 9' by 10' radial gates and operators have been removed
- Spider Lake was used as a re-regulating reservoir and helps control the flows from the St. Mary River Siphon outlet

Operation:

- check structure is not operational

Issues:

- nonfunctioning check drains Spider Lake each fall
- deteriorated concrete structures
- lack of automation and remote control
- lacking safety features

Estimated Replacement Costs:

- check \$0.6 to \$0.7 million (2006)

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Check Gates			
Concrete Collapse			
Piping/Erosion			
Other			

CANAL PRISM REACH NO. 4 – Station 715 to Hall Coulee Siphon

Background Data:

- approximate length: 19,850 ft
- approximate drop: 1.2 ft
- 1-bank contour canal with 26-foot flat bottom
- 2:1 (H:V) fills and 1½:1 cut sections
- two bridge crossings; Babb Bridge at Station 94+30 and Reid Bridge (Kennedy Creek) at station 262+90
- Hall Coulee Wasteway

Operation:

- passive

Issues:

- deteriorated prism
- no livestock fencing
- limited maintenance access
- moderate seepage losses on fill slopes
- several large inflow inundation areas
- heavy brush on existing fill slope from Station 715+00 to 757+00 and significant brush from Station 791+00
- underdrain at Station 791+34 (Cow Creek)
- 4 instabilities, Grizzly, Big Cut, 4th of July and Hall Coulee Slides

Estimated Replacement Costs: \$9.9 to \$12 million (2005) depending on rehabilitation criteria and ultimate capacity

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Backslope Stability			
Fill Slope Stability			
Turnouts			
Internal Erosion			
Overtopping/Freeboard Issues			
Other			

HALL COULEE WASTEWAY

Background:

- reported capacity of 918 cfs
- three, 6' by 5' wooden-faced, radial gates
- baffled apron drop energy dissipation
- 12-foot maintenance bridge over wasteway
- grassy spillway located downstream

Operation:

- wasteway structure is not operational
- wasteway gates not used; wedged-shut to reduce leakage
- hoist operators have been removed
- bridge use has been terminated

Issues:

- nonfunctioning
- deteriorated concrete structures
- lack of automation and remote control
- lacking safety features

Estimated Replacement Costs:

- \$0.7 to \$.08 million (2006)

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Wasteway Gates			
Concrete Collapse			
Piping/Erosion			
Other			

HALL COULEE SIPHON

Background Data:

- overall length – 1405'
- 2 riveted steel barrels each 425 cfs design capacity
- diameter – 78"
- wall thickness 1/4"
- approximate static head 85' (37 psi)
- 1st barrel (left) buried (1912 to 1915), 2nd barrel (right) above ground (1925-1926)
- concrete transition structures with grouted rip rap aprons
- crosses over petroleum product lines
- impressed current cathodic protection

Operation:

- passive
- dewatered during off-season

Issues:

- leaks at numerous locations, mainly at expansion/contraction (E/C) joints
- both slopes moving, less than St. Mary River Siphon
- corrosion
- hazardous condition at inlet due to limited safety features

Estimated Replacement Costs: \$12 to \$16 million (2006) depending on capacity, number of conduits, configuration, and material pipe type.

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Concrete Transitions			
Siphon Leaks			
Slope Movements			
Progressive Slope Failure			
Siphon Supports			
Cathodic Protection			
Other			

CANAL PRISM REACH NO. 5 – Hall Coulee Siphon to Station 1173+50

Background Data:

- approximate length: 24,290 ft
- approximate drop: 2.6 ft
- 1-bank contour canal with 26-foot flat bottom
- 2:1 (H:V) fills and 1½:1 cut sections
- one bridge crossing; Whiskey Gap at Station 987+65
- crosses over natural gas pipelines at Station 1107+80

Operation:

- passive

Issues:

- deteriorated prism
- no livestock fencing
- limited maintenance access
- moderate seepage losses on fill slopes
- several large inflow inundation areas
- 3 instabilities; Gravel Road Bridge, Martin and Pipeline slides
- 4 underdrains, Station 978+46, 1051+68, 1094+05, and 1132+33
- canal seepage near siphon outlet adds to slope instability

Estimated Replacement Costs: \$9 to \$11.5 million (2005) depending on rehabilitation criteria and ultimate capacity

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Backslope Stability			
Fill Slope Stability			
Turnouts			
Internal Erosion			
Overtopping/Freeboard Issues			
Other			

CANAL PRISM REACH NO. 6 – Station 1173+50 to Drop No. 1

Background Data:

- approximate length: 23,580 ft
- approximate drop: 4.3 ft
- 1-bank contour canal with 26-foot flat bottom
- 2:1 (H:V) fills and 1½:1 cut sections
- one bridge crossing; Emigrant Gap Bridge at Station 1363+85

Operation:

- passive

Issues:

- deteriorated prism
- no livestock fencing
- limited maintenance access
- moderate seepage losses on fill slopes
- several large inflow inundation areas
- one underdrain at Station 1195+80

Estimated Replacement Costs: \$7.3 to \$9.3 million (2005) depending on rehabilitation criteria and ultimate capacity

Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Backslope Stability			
Fill Slope Stability			
Turnouts			
Internal Erosion			
Overtopping/Freeboard Issues			
Other			

HYDRAULIC DROP STRUCTURES

Background Data:

- drops are concrete chutes with plunge pools/stilling basins
- 850 cfs design capacity
- sloping sidewalls
- vertical terminal drops
- safety cable and floats at Drop No. 1

Drop	Approx. Length	Approx. Height	Last Repaired
No.1	215	35	N/A
No. 2	205	28	Jan 2002
No. 3	140	27	2004-2005 off-season
No. 4	340	66	Scheduled ?
No. 5	259	56	N/A

Operation:

- passive

Issues:

- severe concrete deterioration
- chute “jumping” common
- lacking adequate safety features

Estimated Replacement Costs: all drops, \$5.6 to \$8.8 million (2006) depending type and capacity. Reconstruction of inter-connecting canals, \$2.9 to 3.7 million

Drop No. 1 Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Wingwall or Structure Collapse			
Piping/Erosion			
Chute Floor			
Slope Failure			
Other			

Drop No. 2 Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Wingwall or Structure Collapse			
Piping/Erosion			
Chute Floor			
Slope Failure			
Other			

Drop No. 3 Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Wingwall or Structure Collapse			
Piping/Erosion			
Chute Floor			
Slope Failure			
Other			

Drop No. 4 Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Wingwall or Structure Collapse			
Piping/Erosion			
Chute Floor			
Slope Failure			
Other			

Drop No. 5 Potential Failure	Likelihood of Failure	Severity of Damage	Likely Repair
Wingwall or Structure Collapse			
Piping/Erosion			
Chute Floor			
Slope Failure			
Other			