



Culvert Maintenance

CULVERT MAINTENANCE




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Class B Bridge Inspection Course




Culvert Maintenance

Culvert Maintenance

- Similar to bridges
 - approach road
 - channel
- Structurally different
 - upstream end
 - downstream end
 - barrel



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Culvert Maintenance

Maintenance Recommendations


Alberta Transportation Bridge Inspection & Maintenance System (Web 2017)

Maintenance Recommendations						
Completed Work						
Planned Work						
Work Type	Status	Rec. Year	Target Year	Inspector Comments	Department Comments	
PLACE ADDITIONAL RIP RAP						
REMOVE DRIFT ACCUMULATION						

- CULM and CULE form recommendations are identical



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Culvert Maintenance


Maintenance Recommendations

Alberta Transportation Bridge Inspection & Maintenance System (Web 2017)


Maintenance Recommendations						
Completed Work						
Planned Work						
Work Type	Status	Rec. Year	Target Year	Inspector Comments	Department Comments	
PLACE ADDITIONAL RIP RAP		2017		25m ³ C.I. at inlet		
REMOVE DRIFT ACCUMULATION		2017		At outlet		
Install Spots		2017		T.I. spots in R1-R6		
Concrete Flow		2017		Full length		
Other Action		2017		Install delineators along both shoulders		

Structural Condition Rating (Last/Now) / Sufficiency Rating (Last/Now) (%) Est. Repl. Yr 2025 Maint. Progn. (Y/N) Yes

- CULM and CULE form recommendations are identical



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Culvert Maintenance

Approach Road Maintenance

- Embankment
 - slides, slumps, etc.
 - repair by removing failed material & replacement with competent, compacted material
 - remaining items same as for bridges

Culvert Maintenance

Upstream / Downstream End Maintenance

- Upstream & Downstream ends have the same inspection items
- Head Wall
 - usually a low maintenance item
 - broken, spalled concrete
 - patch
 - scaled concrete
 - repair & seal (when salt applied to roads)

Culvert Maintenance

Upstream / Downstream End Maintenance (Cont'd)

- Collar / Concrete Slope Protection
 - scoured / eroded
 - compacted fill and rock riprap
 - settled & broken
 - replace with fill and riprap

Culvert Maintenance

Adding end treatment to existing culvert.



Culvert Maintenance

Upstream / Downstream End Maintenance (Cont'd)

- Wingwalls
 - deteriorated concrete
 - chip out and replace
 - separated from barrel
 - fill gap with flexible material
 - pushing inwards
 - strut between

Culvert Maintenance

Damaged floor at outlet transition.



Culvert Maintenance

Horizontal Strut



Upstream / Downstream End Maintenance (Cont'd)

- Cutoff Wall
 - usually buried if present
 - if not present and a problem with piping
 - Install cut off wall

Culvert Maintenance

Adding cut-off wall to existing culvert.



Culvert Maintenance

Wash out due to piping
(Brewster Creek Sunchild Road)



Culvert Maintenance

Upstream / Downstream End Maintenance (Cont'd)

- Bevel End
 - excessive heaving
 - remove and reset with end treatment
 - replace with new end treatment
 - folding in
 - add collar
 - current end treatment requirements are:
 - 1.5 to 3.0m special conditions
 - 3.0 to 4.5m upstream end only
 - >4.5m both ends

Culvert Maintenance

Heaved inlet on CSP culvert.



Culvert Maintenance

Upstream / Downstream End Maintenance (Cont'd)

- Scour Protection
 - Erosion / scour
 - add suitable size rock riprap with filter cloth to apron and/or around collar or bevel
- Scour / Erosion
 - scour / erosion
 - add rock riprap with filter cloth to suit velocities anticipated

Culvert Maintenance

High velocity at outlet during high water (Big or Bald Mountain Hwy 40)



Culvert Maintenance

Extreme turbulence at outlet.



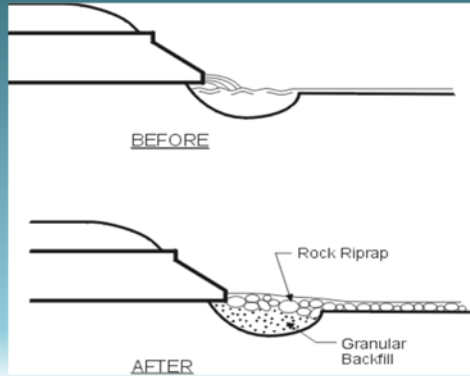
Culvert Maintenance

Downstream bed erosion and bank erosion at bend.



Culvert Maintenance

Downstream Apron Repair



Culvert Maintenance

Upstream / Downstream End Maintenance (Cont'd)

- Rock Riprap Material Size versus Stream Velocity

Riprap Class	Allowable Velocity
Class 1m	- 2.0 m / sec
Class 1	- 3.0 m / sec
Class 2	- 4.0 m / sec
Class 3	- 4.7 m / sec

Culvert Maintenance

Upstream / Downstream End Maintenance (Cont'd)

- Degradation
 - restore stream bed elevation
 - add material
- Aggradation
 - restore stream bed elevation
 - remove material

Culvert Maintenance

Stream degradation and scour hole.



Culvert Maintenance

Hanging outlet due to degradation and scour.



Culvert Maintenance

Typical scour and degradation at outlet



Culvert Maintenance

New rip rap added to bevel and apron



Culvert Maintenance

Streambed aggradation (Cougar Creek Canmore).



Culvert Maintenance

Restored inlet.



Culvert Maintenance

Barrel Maintenance

- Roof
 - Sagging 15% or more
 - Reverse curvature
 - add struts (or install liner if still adequate capacity).

Culvert Maintenance

Reverse curvature in roof



Culvert Maintenance

Barrel Maintenance

- Sidewall
 - deflecting
 - add struts (or install liner if adequate capacity)
 - corroded
 - Install liner
 - cathodic protection (not as common as previously)

Culvert Maintenance

Failed SPCSP culvert (inadequate backfill).



Culvert Maintenance

Soil side corrosion, perforated side wall.



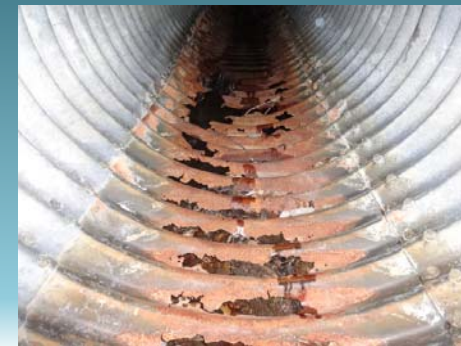
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Barrel Maintenance

- Floor
 - bulging
 - Place U/S cut-off wall if piping
 - add struts or install liner
 - corroding
 - cast concrete floor
 - cathodic protection


Culvert Maintenance

Floor perforations



Culvert Maintenance


Arch shaped CSP with heaved floor and deflecting roof.



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Strutted barrel



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Concrete arch culvert with curved wingwalls in Feb. (Weed Creek)



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Arch culvert after high water in July.



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Culvert outlet after high water.



Culvert Maintenance

Inlet of new culvert, following winter.



Culvert Maintenance

Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event - Outlet




Culvert Maintenance


Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event - Inlet




Culvert Maintenance

Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event







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Culvert Maintenance

Hwy. 40 Lineham Creek – Replacement with 8-14-8M SLW girders in 2015



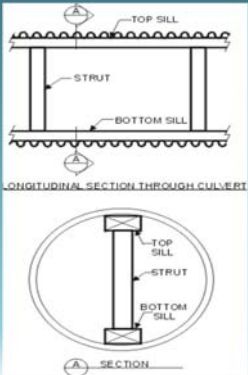



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Culvert Maintenance

Timber Strutting of Metal Culverts





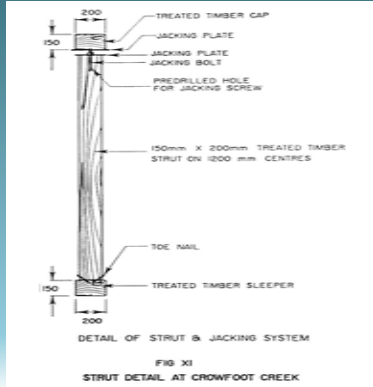
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Strut detail (Crowfoot Creek Hwy 1).





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Strutting arrangement for horizontal ellipse.

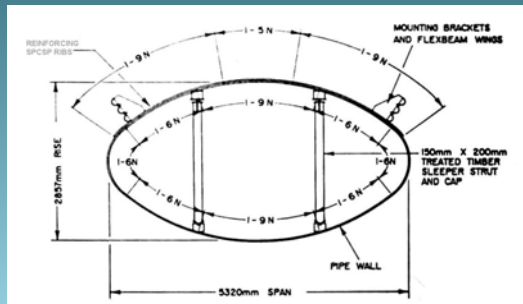


FIG X
STRUT SYSTEM AT CROWFOOT CREEK

Culvert Maintenance

Installing adjustable struts.



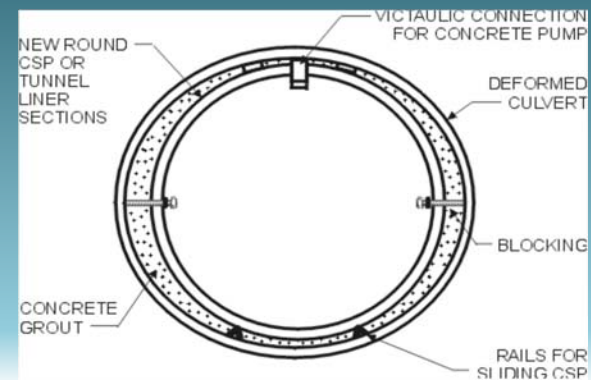
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Completed installation.



Culvert Maintenance

Culvert Liners



Culvert Maintenance

Installing a CSP liner.



Culvert Maintenance

SPCSP liner is assembled outside and then pulled into existing culvert.



Culvert Maintenance

For larger culverts, tunnel liner plates are used.



Culvert Maintenance

Liner installed ready for grouting.



Culvert Maintenance

Barrel Maintenance

- Circumferential Seams
 - separated
 - inject concrete or grout
 - Install inside coupler plates
- Longitudinal Seams
 - cracked
 - monitor
 - shotcrete reinforcement
 - cast 1/2 arc concrete
 - install liner

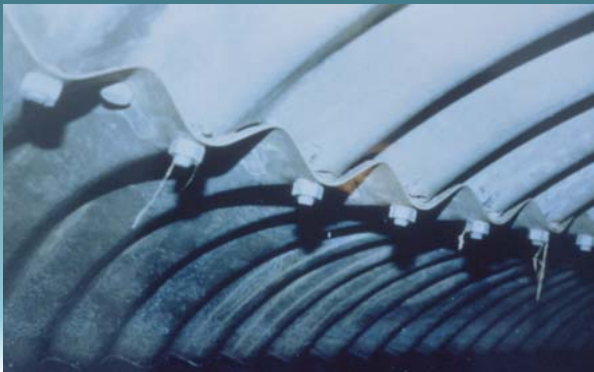
Culvert Maintenance

Properly lapped seam.



Culvert Maintenance

Incorrectly lapped seam with poor nesting



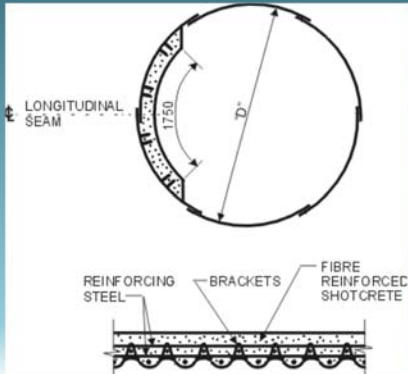
Culvert Maintenance

Incorrectly lapped seam with cracks



Culvert Maintenance

Longitudinal Seam Reinforcing



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Culvert Maintenance

Shotcrete repairs of cracked seams during winter.



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Culvert Maintenance

Reinforcing and shear connectors fastened to culvert.



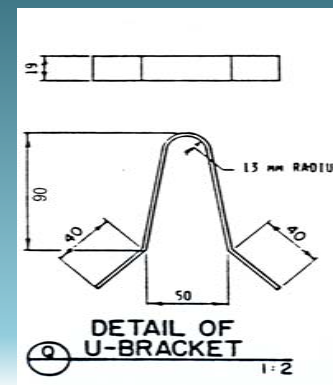
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Shear connector detail.



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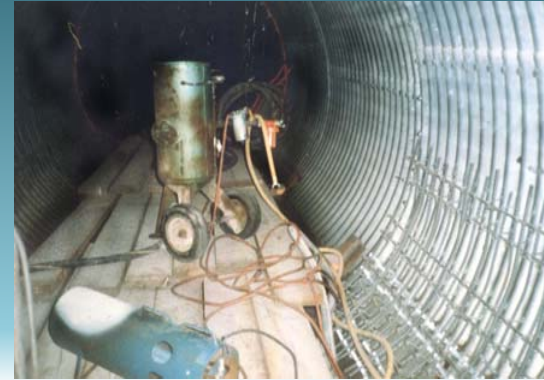
Culvert Maintenance

Shear connectors and rebar in place over cracked seam.



Culvert Maintenance

Shot blaster and heater for inside the culvert.



Culvert Maintenance

Heater inside culvert. Must be maintained at $+5^{\circ}$ C.



Culvert Maintenance

Applying the shotcrete.



Culvert Maintenance

Completed shotcrete reinforcing beams.



Culvert Maintenance

Bottom reinforcement for arch shaped culvert.
(Nose Creek Hwy 2)

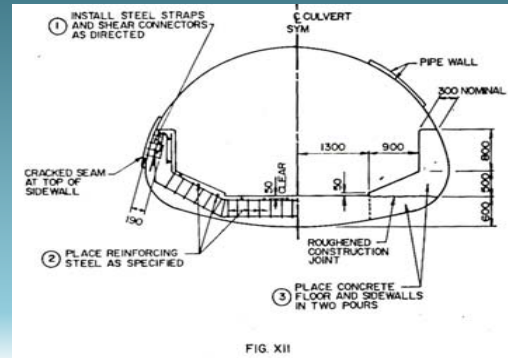


FIG. XII

Culvert Maintenance

Reinforcing installed for arch culvert reinforcement.



Culvert Maintenance

Floor cast inside arch culvert.

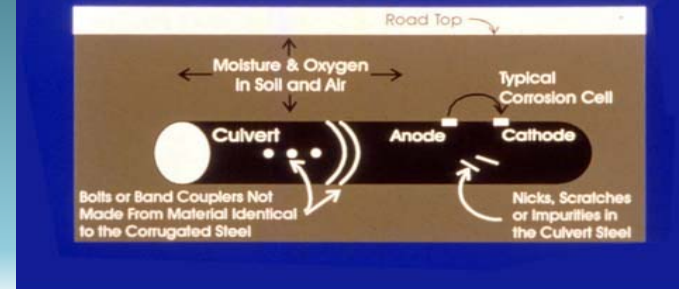


Barrel Maintenance

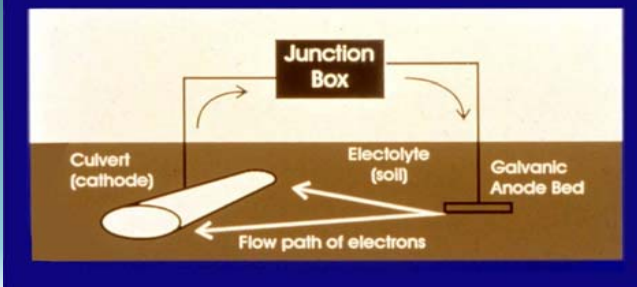
- Coating
 - Corrosion
 - Soil side corrosion
 - Liner
 - Cathodic protection (not as common as previously)

- Water side corrosion
 - Concrete floor
 - Liner

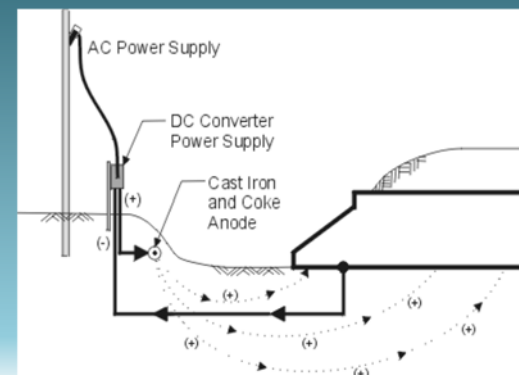
Galvanic Corrosion



Passive Cathodic Protection System

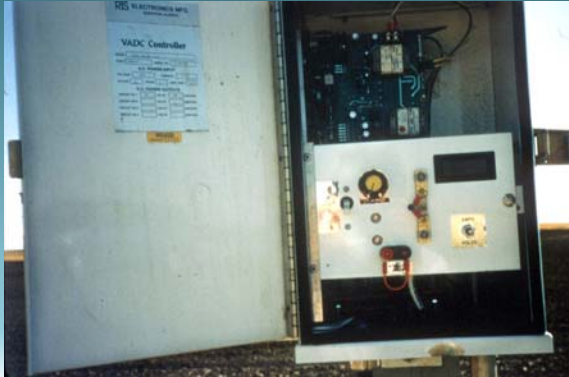


Culvert Cathodic Protection



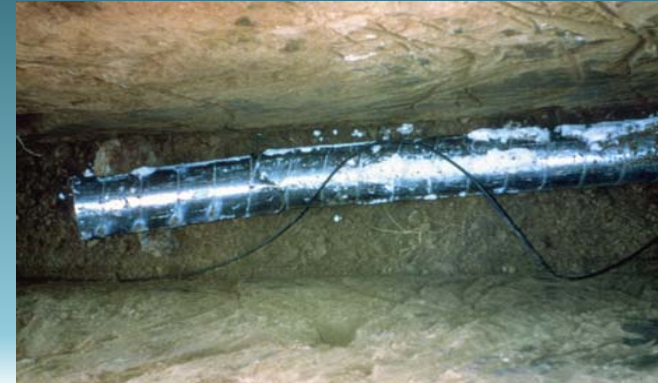
Culvert Maintenance

DC power supply (AC to DC converter).



Culvert Maintenance

Cast iron and carbon anode.



Culvert Maintenance

Cross-section of anode.



Culvert Maintenance

Barrel Maintenance (Cont'd)

- Fish Passage Adequacy
 - add baffles
 - cast concrete
 - rocks
 - weir type
 - repair / build downstream apron
- Waterway Adequacy
 - install additional culvert (jacking)
 - remove drift or silt
 - install stream lining

Culvert Maintenance

Channel Maintenance

- Similar to bridges - Degrading (scour), Aggrading
- Drift more of a concern
- Beavers are common
- High velocities at outlet

Culvert Maintenance

Drift collected at inlet (Whitecourt Creek).



Culvert Maintenance

Drift in strutted barrel



Questions???