Alaska Railroad Corporation
Snow River Flood Mitigation

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UAA College of Engineering
University of Alaska Anchorage

Alaska Railroad Corporation Est. 1914

Malamute Consulting Firm

Abstract

The Alaska Railroad Corporation (ARRC) is a full-service freight and passenger railroad that experiences flooding due to glacial outbursts called jökulhlaups in the Snow River area (15 miles north of Seward, AK). This phenomenon creates catastrophic draining of glacial lakes that scour and damage structures, resulting in temporary closures of tracks and financial losses. Alternatives analyzed addressed river hydraulics, existing structures, and railroad requirements; then, combined the best solutions into a Chosen Alternative. With a flow of 7,102 cfs and an average velocity of 14.6 ft/s, three box culverts (taking 65% of flow) with a permeable subbase (35%) and track raises were determined to be the most effective, economic, and maintenance-free choices, estimated at $2.1 million.

Project Team

Malamute Consulting Firm (**MCF**)
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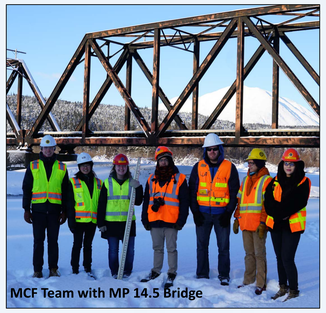
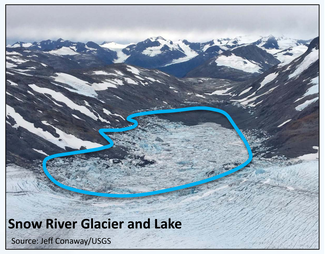

MCF Team with MP 14.5 Bridge

Client

The Alaska Railroad Corporation (ARRC) is a full-service freight and passenger railroad that services communities from Seward to Fairbanks, Alaska.

Background

Snow River is a 28-mile tributary that is fed by Snow Glacier in the Kenai Mountains and deposits into Kenai Lake. Jökulhlaups effects this area biennially (every other year) and occurs when a lake fed by glacial meltwater breaches and drains catastrophically.


Snow River Glacier and Lake
Source: Jeff Conaway/USGS

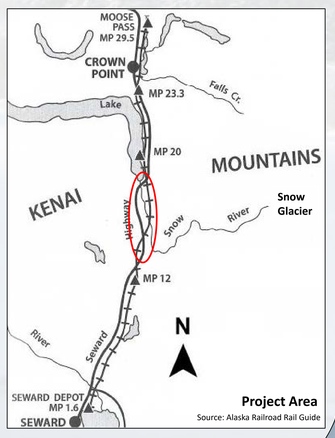

Eroded Track Support ~MP 16.2
Source: ARRC

In 2019, Snow River released
4.5 billion gallons = 69,000 Olympic pools

Existing Conditions

The Snow River railroad system sits within the US Chugach National Forest and shares right-of-way with Alaska DOT&PF's Seward Highway.

Existing structures include:
- A 716 ft bridge at MP 14.5
- Smaller bridges
- Culverts
- Tunnels at MP 14.3 and 18.37

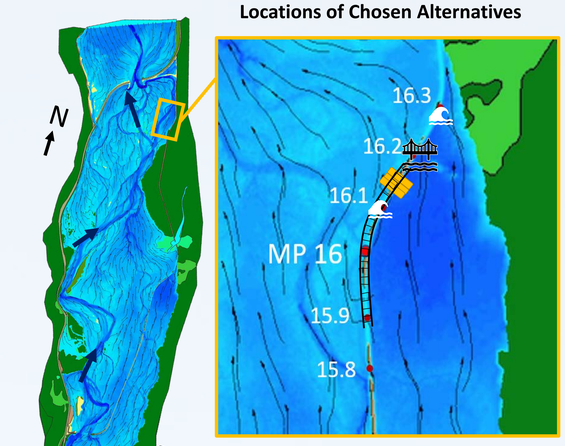


Project Area
Source: Alaska Railroad Rail Guide

Chosen Alternative

The chosen alternative is a combination of permeable subbase, box culverts, and track raises. This dynamic combination successfully drains the deepest flooded region on the east side of MP 16 – MP 16.3. During peak flood events, a total flowrate of 7,102 cfs will be alleviated.

Locations of Chosen Alternatives

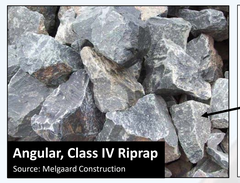


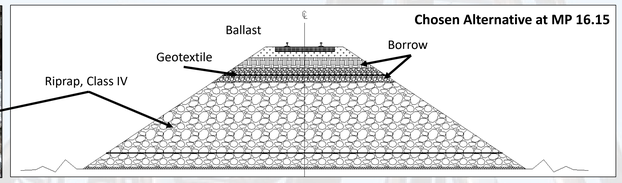
Source: USGS SMS model for ARRC

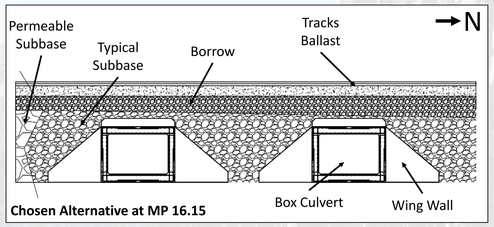
Permeable Subbase: base layer of riprap to allow water to flow freely from one side of the track to the other.

Details
- Proposed to extend 75 ft south of MP 16.15 and 50 ft north of the bridge at MP 16.2
- Able to discharge 2,496 cfs (35% of total flow)
- Able to withstand velocities up to 14.64 ft/s
- Consists of class IV riprap to provide maximum voids (30%), with a seepage velocity of 0.05 ft/s
- Riprap stability and clogging testing needed before implementation

Bottom Line: Permable subbase will allow water to flow through the track structure to prevent flooding, while also adding protection for scour and erosion.


Angular, Class IV Riprap
Source: Melgaard Construction





Chosen Alternative at MP 16.15

Culverts: are conveyance structures with openings of less than 10 ft.

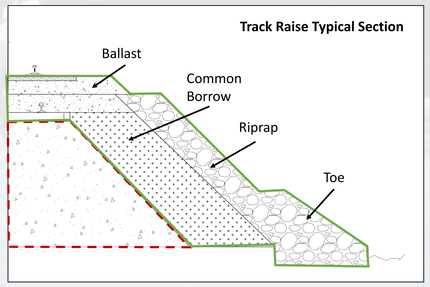
Details
- Proposed three, 9 ft by 9 ft, concrete, box culverts centered at MP 16.15, with 10 ft spacing in-between
- Able to discharge 4,606 cfs (65% of total flow)
- Withstand velocities up to 14.64 ft/s
- 55 ft long, equivalent to width of track structure
- Include wingwalls to support riprap

Bottom Line: Culverts provide increased capacity key locations.

Track Raising: involves raising existing railroad track to increase elevation and mitigate track flooding.

Details
- Proposed track raise of 18" from MP 15.9 – MP 16.4, approximately 2,700 ft where flood water has previously overtopped
- Advised for the whole project area to undergo a track raise but tunnels and MP 14.5 bridge limit this
- Grade not to exceed railroad standard of 2% (2 ft rise or fall over 100 ft length)

Bottom Line: Set elevations of existing structures limit track raises. However, raises should be done in flood prone regions in conjunction with ARRC projects.



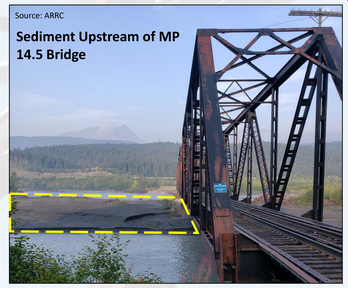
Other Considered Alternatives

Dredging: removal of sediment in river

Pros
- Improved capacity during flooding

Cons
- Unknown if sediment is the main issue
- Need hydraulic model to determine river changes
- Permitting constraints
- Requires annual maintenance

Bottom Line: Dredging has unknown benefits that require maintenance and permitting.


Source: ARRC
Sediment Upstream of MP 14.5 Bridge


Undersized MP 16.2 Bridge During 2019 Flood Event
Source: ARRC

Bridges: openings of 10 ft or greater

Pros
- Significant conveyance capacity at a specific location

Cons
- Long length required for needed capacity
- Expensive to construct and maintain

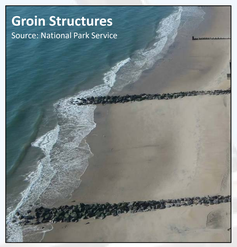
Bottom Line: The total bridge length and associated cost were unfeasible.

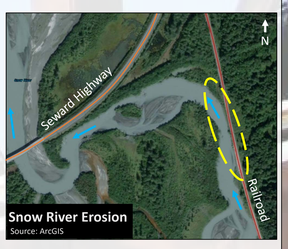
Groins: bank armoring

Pros
- Decreases erosion

Cons
-Could cause downstream erosion
-Potential to impact wildlife

Bottom Line: Could reduce erosion but has potential for effects on wildlife.


Groin Structures
Source: National Park Service



Snow River Erosion
Source: ArcGIS

No Build

Pros
- No environmental impact

Cons
- Leaves track in threat of continued damage
- Would not improve hydraulic condition

Bottom Line: No build alternative would result in continued repair costs and disruption to ARRC services.

Cost Estimate

Description	Total
Structural Section Retrofit	
Equipment	$ 201,134
Labor	$ 664,715
Materials	$ 313,821
Subtotal -	*$ 1,179,700*
Track Construction	
Equipment	$ 164,353
Labor	$ 204,029
Materials	$ 69,192
Subtotal -	*$ 437,600*
Culvert Construction	
Equipment	$ 23,346
Labor	$ 23,632
Materials	$ 67,500
Subtotal -	*$ 115,500*
Design & Support	
Engineering and Design	$ 161,000
Management	$ 191,300
GRAND TOTAL -	**$2,085,100**

Cost estimations are based on previous ARRC projects and engineer's estimates.

A full break down of costs are included in the main report.

Acknowledgments

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