

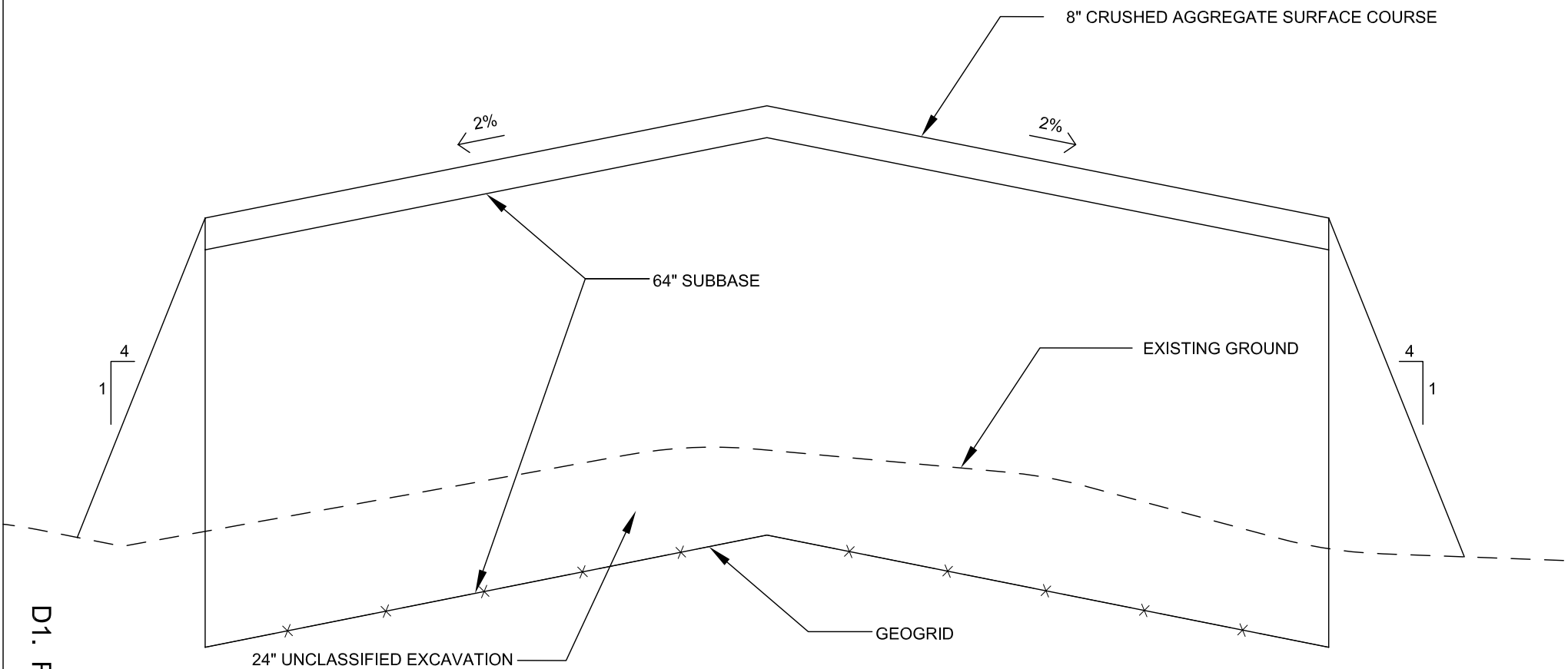
APPENDIX D

Engineering, Cost Calculations

- D1. Road Typical Section
- D2. Construction Pay Items, Quantities, and Base Costs for Road Typical Section
- D3. Bridge and Significant Water Crossings Cost Estimates
- D4. Maintenance and Operations Cost Considerations
- D5. Preliminary Corridor Alternatives Terrain Profiles
- D6. Preliminary Corridor Alternatives Road Cost Estimates
- D7. Preliminary Corridor Alternatives Cost Estimates Summary
- D8. Refined Corridor Alternatives Terrain Profiles
- D9. Refined Corridor Alternatives Road Cost Estimates
- D10. Refined Corridor Alternatives Cost Estimates Summary

WAAPS ROAD TYPICAL SECTION

PERMAFROST-RICH SOILS



D1. Road Typical Section

Western Alaska Access Planning Study
Planning Level Cost Estimates
Construction Pay Items, Quantities, and Base Costs for Road Typical Section

Typical Section Assumptions for Cost Estimates	Notes
30-foot roadway surface	Minimum 20-foot surface per AASHTO; 30-foot roadway width matches current Northern Region planning assumptions for new roads and existing Northern Region roads with the same functional classification.
6-foot total section	Section thickness will vary along length of road, depending upon soils.
8" crushed aggregate surface course over 64" embankment fill	8" surface will not vary; embankment fill thickness will vary to meet total section thickness needs along road. Where Borrow is readily available, it shall be used. However, it is anticipated that borrow may not be readily available along the full length of the route, in which case Subbase may be offered as an alternative at a higher cost.
Geogrid under entire section	Geogrid offers heartier strength and stiffness than <i>Geotextile, Stabilization</i> , however its use can be avoided if existing soils are expected to be only moderately poor, in which case a stabilization geotextile would more likely be employed at a lower cost.
2-foot excavation depth	Conservative assumption for cost estimating purposes - thaw stability will vary along the length of road and there will be areas where the organic mat will be left in place (i.e., no excavation).
4:1 side slopes	Geotechnical recommended minimum due to anticipated permafrost.

Estimated Per-Mile Costs for Typical Section Pay Items					
Pay Item No.	Item Description	Unit	Quantity per Mile	Unit Costs used in Estimates¹	Cost per Mile
201(3A)	Clearing and Grubbing	Acre	9.5	\$10,000	\$95,000
203(3)	Unclassified Excavation	CY	11,750	\$20	\$235,000
301(3)	Aggregate Surface Course	CY	3,910	\$40	\$156,400
203(6)	Borrow	CY	59,450	\$25	\$1,486,250
634(1)	Geogrid	SY	17,600	\$8	\$140,800
TOTAL BASE COST PER MILE					\$2,113,450
FOR WAAPS COST ESTIMATES USE:					\$2.2 million per mile

Notes

¹Unit Costs used in final cost estimates are based on DOWL HKM design estimates, historic bid prices, and discussion with Northern Region design/engineering staff.

Western Alaska Access Planning Study
Planning Level Cost Estimates
Bridge and Significant Water Crossings Cost Estimates

Basic Bridge Costs in 2009 Dollars				
River	Yukon	Koyukuk	Minor River Crossing	Stream Crossing
Deck Dimensions	5,280 ft x 33 ft	1,320 ft x 33 ft	150 ft x 33 ft	80 ft x 33 ft
Deck Area (SF)	174,240	43,560	4,950	2,640
Cost per SF (2009)	\$350	\$350	\$350	\$350
Base Cost (\$M)	\$61.0	\$15.2	\$1.7	\$0.9
+ Roadway Items @ 15%	\$70.13	\$17.53	\$1.99	\$1.06
+ Contingencies @ 20%	\$84.16	\$21.04	\$2.39	\$1.28
+ Mobilization @ 10%	\$92.57	\$23.14	\$2.63	\$1.40
+ Engineering/Envt/ROW @ 15%	\$106.46	\$26.61	\$3.02	\$1.61
+ ICAP @ 4.88%	\$111.66	\$27.91	\$3.17	\$1.69
2009 Cost of Bridge (\$M)	\$111.7	\$27.9	\$3.2	\$1.7

Assumptions

1. The bridge span required at a Yukon River crossing is estimated at approximately one mile.
2. The bridge span required at a Koyukuk River crossing is estimated at approximately a quarter mile.
3. The bridge span required at each minor river crossing is assumed to be an average of 150 feet.
4. The bridge span required at each stream crossing is assumed to be an average of 80 feet.
5. Bridge width of 33 ft assumes a 30 ft roadway surface and two-1.5 ft bridge rails.
6. Contingencies based on STIP Phase 4 Funding Template and Yukon River Crossing Estimate (YRCE) provided by DOT&PF Bridge Design section.
 - The order in which contingencies have been applied to produce the final cost has been adjusted to match the construction cost estimating formula presented in the STIP Phase 4 Funding Template.
 - Roadway Items @ 15% (30% in YRCE) - Some roadway items are assumed to be included in the WAAPS road construction cost estimates, but a factor has been left in for bridge-specific construction item needs.
 - Contingencies @ 20% (20% in YRCE) - Contingencies/Misc. Items set at 20% to match % used in STIP Phase 4 Funding Template.
 - Mobilization @ 10% (10% in YRCE) - Mobilization of bridge construction equipment assumed separate from road construction equipment.
 - Engineering @15% (30% in YRCE) - multiplier assumed to include engineering, design, environmental, and ROW costs; due to the scale of the WAAPS project, it is expected that the Engineering contingency will be a smaller % of the total construction costs than for a smaller, stand-alone project.
 - ICAP @ 4.88% (4.66% in YRCE) - ICAP varies year to year; 4.88% is the % used in the STIP Phase 4 Funding Template for 2009.

Western Alaska Access Planning Study

Maintenance & Operations Cost Considerations

Maintenance & Operations Considerations for Cost Estimates

- Costs based on Dalton Highway
- Routine maintenance
 - \$24,000/mile/year in FY08
- Major maintenance
 - Funding varies each year - \$10 million in FY08, \$13 million in FY09
- Facilities maintenance
 - Funding varies each year - \$1.9 million in FY08 for six maintenance stations
- Capital improvement projects funding
 - Varies each year - \$19 million in FY09

Routine Maintenance Cost Assumptions

- \$24,000 per mile for routine road maintenance
- \$300,000 per maintenance station per year for facilities maintenance

Up-front M&O Cost Considerations

- Construction of new maintenance stations (M.S.)
 - Each M.S. responsible for 50-75 miles of road
 - Approximately \$12-15 million per station – includes housing, utilities, fencing, etc.
- Cost to equip new maintenance stations
 - \$1.5-2 million to equip the station (2 graders, 2 tankers, 2 plows, blower, dozer, trailer, 2 8-yard trucks, sander, loader, boiler truck)

Maintenance Facility Capital Cost Assumptions

- Estimated cost to construct and equip a new maintenance station = \$15.5 million
- The number of new maintenance stations needed assumes that a station would be placed at each terminus of the route with stations between termini spaced roughly every 60 miles.
- It is assumed that existing maintenance stations are currently maintaining their maximum highway mileage and could not take on additional maintenance for the new route.

Due to file size, Appendix D, Page D5 must be downloaded separately from

www.westernakaccess.com

Western Alaska Access Planning Study
Planning Level Cost Estimates
Preliminary Alternatives Road Cost Estimates
Preliminary alternatives presented in Chapter 3 of report

Road Construction Costs in 2009 Dollars				
Corridor Alternative	Route 1	Route 2a	Route 2b	Route 3
Total Miles	440	510	450	620
Slope 0-5% (mi)	360	280	260	450
Cost per mile (\$M/mi)	\$2.2	\$2.2	\$2.2	\$2.2
Slope 5-10% (mi)	50	110	100	120
Cost per mile (\$M/mi)	\$3.1	\$3.1	\$3.1	\$3.1
Slope >10% (mi)	30	120	90	50
Cost per mile (\$M/mi)	\$4.7	\$4.7	\$4.7	\$4.7
Base Road Construction Cost (\$M)	\$1,088	\$1,521	\$1,305	\$1,597
+ Contingency @ 20%	\$1,306	\$1,825	\$1,566	\$1,916
+ Mobilization @ 10%	\$1,436	\$2,008	\$1,723	\$2,108
+ Engineering/Envt/ROW @ 15%	\$1,652	\$2,309	\$1,981	\$2,424
+ ICAP @ 4.88%	\$1,732	\$2,422	\$2,078	\$2,543
2009 Road Construction Costs (\$M)	\$1,732	\$2,422	\$2,078	\$2,543
Average Cost per Mile (\$M/mi)	\$3.9	\$4.7	\$4.6	\$4.1

Notes

1. Mileage through each terrain range based on 7/20/09 ArcGIS analysis from Allied GIS, Inc. (see page D5).
2. • \$2.2M/mi for flat terrain (0-5%) derived from calculated cost estimates for a conservative typical section (see page D2).
 - \$3.1M/mi for rolling terrain (5-10%) and \$4.7M/mi for mountainous terrain (>10%) derived from higher average per-mile costs for similar projects through more difficult terrain and published studies comparing construction costs in flat, rolling, and mountainous terrain.
3. Flat terrain assumed to be predominantly wetland areas; the typical section and cost estimates reflect this assumption.
4. Typical roadway section assumed to have 8" crushed aggregate surface course, 64" subbase, 24" unclassified excavation, 4:1 side slopes, and a geogrid.
5. Assumed clearing area 78 feet wide (30-foot roadway surface with side slopes extending 24 feet beyond each shoulder).
6. Contingencies based on STIP Phase 4 Funding Template and discussions with Northern Region design/engineering staff.

Western Alaska Access Planning Study
Planning Level Cost Estimates
Preliminary Alternatives Cost Estimates Summary - Roads, Bridges, and Maintenance Facility Capital Costs
Preliminary alternatives presented in Chapter 3 of report

Construction Costs in 2009 Dollars					
Corridor Alternative		Route 1	Route 2a	Route 2b	Route 3
ROAD	Proposed New Length (mi)	440	510	450	620
	Road Costs (\$M) ¹	\$1,732	\$2,422	\$2,078	\$2,543
BRIDGES	Major River Crossings	Koyukuk	Koyukuk	Yukon + Koyukuk	Yukon
	Cost - Major Crossings (\$M) ²	\$28	\$28	\$140	\$112
	Number of Minor River Crossings ³	10	14	13	35
	Cost - Minor Crossings (\$M) ²	\$32	\$45	\$42	\$112
	Number of Stream Crossings ³	94	147	132	160
	Cost - Stream Crossings (\$M) ²	\$160	\$250	\$224	\$272
	Total Water Crossings Cost (\$M)	\$220	\$323	\$406	\$496
Road & Bridge Construction Costs (\$M)		\$1,952	\$2,744	\$2,483	\$3,038
M&O	Number of Maintenance Stations	8	9	8	11
	Maintenance Facility Capital Costs (\$M) ⁴	\$124	\$140	\$124	\$171
TOTAL CONSTRUCTION COST (\$M)⁵		\$2,076	\$2,884	\$2,607	\$3,209
Average Inclusive Cost per Mile (\$M/mi)		\$4.7	\$5.7	\$5.8	\$5.2

Notes

1. Road construction cost estimates are detailed on pages D2 and D6.
2. Water crossing construction cost estimates are detailed on page D3.
3. Number of minor river and stream crossings derived from an atlas overlay created with ArcGIS software using a USGS Quad at a scale of 1:250,000.
 Minor crossings were assumed to be those named as rivers or listed as anadromous.
 Stream crossings were assumed to be those named as creeks or unnamed streams shown on the USGS Quads.
4. Maintenance Facility Capital cost estimates are detailed on page D4.
5. All cost estimates presented in 2009 dollars.

Due to file size, Appendix D, Page D8 must be downloaded separately from

www.westernakaccess.com

Western Alaska Access Planning Study
Planning Level Cost Estimates
Refined Alternatives Road Cost Estimates
Refined alternatives presented in Chapter 5 of report

Road Construction Costs in 2009 Dollars		
Corridor Alternatives	Route 1	Route 2b
Total Miles	450	500
Slope 0-5% (mi)	365	300
Cost per mile (\$M/mi)	\$2.2	\$2.2
Slope 5-10% (mi)	60	135
Cost per mile (\$M/mi)	\$3.1	\$3.1
Slope >10% (mi)	25	65
Cost per mile (\$M/mi)	\$4.7	\$4.7
Base Road Construction Cost (\$M)	\$1,107	\$1,384
+ Contingency @ 20%	\$1,328	\$1,661
+ Mobilization @ 10%	\$1,461	\$1,827
+ Engineering/Envt/ROW @ 15%	\$1,680	\$2,101
+ ICAP @ 4.88%	\$1,762	\$2,203
2009 Road Construction Costs (\$M)	\$1,762	\$2,203
Average Cost per Mile (\$M/mi)	\$3.9	\$4.4

Notes

1. Mileage through each terrain range based on 8/17/09 ArcGIS analysis from Allied GIS, Inc. (see page D8).
2. • \$2.2M/mi for flat terrain (0-5%) derived from calculated cost estimates for a conservative typical section (see page D2).
 - \$3.1M/mi for rolling terrain (5-10%) and \$4.7M/mi for mountainous terrain (>10%) derived from higher average per-mile costs for similar projects through more difficult terrain and published studies comparing construction costs in flat, rolling, and mountainous terrain.
3. Flat terrain assumed to be predominantly wetland areas; the typical section and cost estimates reflect this assumption.
4. Typical roadway section assumed to have 8" crushed aggregate surface course, 64" subbase, 24" unclassified excavation, 4:1 side slopes, and a geogrid.
5. Assumed clearing area 78 feet wide (30-foot roadway surface with side slopes extending 24 feet beyond each shoulder).
6. Contingencies based on STIP Phase 4 Funding Template and discussions with Northern Region design/engineering staff.

Western Alaska Access Planning Study
Planning Level Cost Estimates
Refined Alternatives Cost Estimates Summary - Roads, Bridges, and Maintenance Facility Capital Costs
Refined alternatives presented in Chapter 5 of report

Construction Costs in 2009 Dollars			
Corridor Alternative		Route 1	Route 2b
ROAD	Proposed New Length (mi)	450	500
	Road Costs (\$M) ¹	\$1,762	\$2,203
BRIDGES	Major River Crossings	Koyukuk	Yukon + Koyukuk
	Cost - Major Crossings (\$M) ²	\$28	\$140
	Number of Minor River Crossings ³	11	12
	Cost - Minor Crossings (\$M) ²	\$35	\$38
	Number of Stream Crossings ³	90	131
	Cost - Stream Crossings (\$M) ²	\$152	\$222
	Total Water Crossings Cost (\$M)	\$215	\$399
Road & Bridge Construction Costs (\$M)		\$1,977	\$2,603
M&O	Number of Maintenance Stations	8	9
	Maintenance Facility Capital Costs (\$M) ⁴	\$124	\$140
TOTAL CONSTRUCTION COST (\$M)⁵		\$2,101	\$2,742
Average Inclusive Cost per Mile (\$M/mi)		\$4.7	\$5.5

Notes

1. Road construction cost estimates are detailed on pages D2 and D6.
2. Water crossing construction cost estimates are detailed on page D3.
3. Number of minor river and stream crossings derived from an atlas overlay created with ArcGIS software using a USGS Quad at a scale of 1:250,000.
 Minor crossings were assumed to be those named as rivers or listed as anadromous.
 Stream crossings were assumed to be those named as creeks or unnamed streams shown on the USGS Quads.
4. Maintenance Facility Capital cost estimates are detailed on page D4.
5. All cost estimates presented in 2009 dollars.