Appendices

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Lake McDonald	***Landslide***	6.4	Lake Erosion at toe of slope / Place large rip rap at lake level, place 3 rows erosion log, clean silt fence (800 LF Excelsior Log / 200 CY rip pap with 60 hrs crane)
		9.1	Identified slide in progress has been monitored / Continue monitoring - possible tie back fix when limits identified
	Lake McDonald Lodge	10.86	Snyder Creek Bridge / See FHWA report
	Lake McDonald Falls	12.7	Stone retaining wall / See FHWA report
	Sacred Dancing Cascades	13.16	Stone retaining wall / See FHWA report
	McDonald Creek Overlook	14.6	Stone retaining wall / See FHWA report
West Tunnel	***Avalanche Campground***	16.4	Avalanche Creek Bridge / See FHWA report
	Red Rock Point	17.45	Dry stack wall, erosion problems at base, river scour / Need to place rip rap in void areas and grout (80 hrs crane / 80 hr grout crew)
		17.61	Damaged ends of walls, minor degradation of grout / Point and patch
		17.67	Minor grout deterioration / Point and patch
		17.8	200' of riverside slump - Riverbank erosion likely cause / Some rip rap and reveg has been done, more needed (200 CY 3-5' rip rap)
		18.34	CMP with stone headwall - erosion at headwall / rebuild headwall (75 SF / double CMP)
	Roadway at Creek Bridge	19.8	Roadway approach to bridge settling due to saturation / Over exc 5' place geotextile place 3' washed rock, more geotextile, then R59 (150 LF excavation)
	Logan Creek Bridge	20.9	Logan Creek Bridge scour along footer / Install scour protection while dredging - rip rap 2' -3' (220 CY)
		20.9	Logan Creek Bridge high bed loading / Use cofferdam to move water to one cell - clean out and use good material (2500 CY)
	Haystack Creek Bridge	21.5	Haystack Creek Bridge - high bed Loading, washout frequently, undersized / Rem 1 cottonwood create another channel at 20 deg skew 8x6 CBC+C48 (75 LF armor plate)
	Alder Creek Culverts	22.6	Alder Creek Box grout loss and separation of headwall - bottom scoured / Repair head and wingwalls, Attach abrasion plate to bottom, rip rap outlet (60 SF of wall repair)
		22.6	Drainage against walls / Concrete pan to drop inlet, 60lf pipe down hill (150 LF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
West Tunnel	*West Tunnel Approach*	23.08	Concrete retaining wall non crash tested, non-historical / Cut concrete at road level, build core wall and face with stone both sides (135 LF)
		23.11	Stone retaining wall impact damage, grout damage, settlement inside wall / Point & patch, template rehab, 4' sub ex (90 LF)
		23.2	Tipping guardwall / Remove and replace on 4' slab with drop inlet (70 LF)
		23.25	Concrete culvert pipe and inlet in disrepair / Replace inlet with Type C corten close mesh (1 EA)
		23.29	Road settlement and creeping / 8' Slab with anchors - keyed with toe wall (200 LF)
		23.3	Uphill soil cut erosion due to steepness / Wire mesh biomat (500 SY)
Alpine	*West Tunnel*	23.5	Uphill soil cut erosion due to steepness / Wire mesh biomat (400 SY)
		23.62	Concrete box trench drain erosion at outlet / Rip rap rundown (20 CY)
		23.64	West Tunnel with some large slabs above view area / Spot bolts both locations (300 LF)
		23.65	West Tunnel uphill portal is missing curb at waterfall / Install curb (20 LF)
		23.65	West Tunnel broken stones, grout cracking / Replace 120 SY concrete pavement, stones to be 7.5x12 (120 SY)
		23.66	West Tunnel uphill portal missing rock masonry / Replace, patch and point (120 SY)
		23.68	20' guardwall missing to allow drainage / Remove existing, install new trench drain, build new guardwall on 4' slab (20 LF wall / 35 LF trench drain)
		23.74	Stone retaining wall with broken stones, grout cracking / Point and patch (800 SF)
		23.75	Stone retaining wall moving, grout failing / FHWA has design slated for construction 2001
		23.77	Stone retaining wall with some cracked grout and stones, road subsidence inside wall / Point and patch, template rehab (300 LF)
		23.85	Stone retaining wall tilting - moving / FHWA has design slated for construction 2004
		23.88	Rock face above road with loose rock / Scaling, crane and hand (50 hr scaling)
		23.9	Drainage against walls / Concrete valley pan, 3 outlets with flat stone rundowns (300 LF)
		23.9	Stone retaining wall with erosion at toe / Rip rap toe of retaining wall (30 CY) See FHWA Report
		23.95	Stone retaining wall failing / Rebuild wall on footer (300 SF wall - See FHWA Report)
		23.97	Stone retaining wall settlement and erosion at footing / FHWA has design slated for construction 2004 (see FHWA Report)
		23.98	Rock face above road with loose rock / Scaling, crane and hand (30 hr scaling)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	***The Loop***	24.07	Asphalt curb in disrepair, shoulder raveling, but 13' lane here from centerline / Remove curb, cut 2' of asphalt from edge and shoulder with Class 7 (250 LF)
		24.1	Blasted rock is possible source of guard and retaining wall rock / Use slusher to recover 200-300 CY Ashlar stone and rubble (300 CY)
		24.2	Loop Parking Lot has impact damage to wall / Install parking stops to prevent vehicles from hitting wall (20 EA)
		24.2	Loop Parking Lot has guardwall undermined for 200 LF / Grout repair needed under wall (200 LF)
		24.5	Low Guard Wall / Lower roadway 6 in. (500 SY)
		24.5	Concrete pipe with stone headwall broken at outlet / Replace 30" RCP (16 LF)
Alpine	***Crystal Point Arch***	24.6	Road shows subsidence cracking, wall doesn't / Roadway template rehab - 4 ft sub exc. (100 LF)
		24.66	Ashlar guardwall is low and tipping / Remove and replace on 8' slab, 2 scuppers also needed (300 LF)
		24.7	Stone retaining wall is low and tipping / Remove guardwall portion and place on 8' slab (125 LF)
		24.8	Roadway damage due to drainage against walls / Install drop inlet and weepholes (1 EA)
		24.8	Crystal Point Arch Failed / FHWA has design
		24.8	Pullout guardwall at Crystal Point shows low wall / Safety concerns -lower roadway template 8" for 150 LF (500 SY)
		24.9	Roadway damage due to no drainage across road / Install trench drain with pipe through wall (1 EA)
		24.9	Stone and concrete retaining wall has veneer peeling from concrete, removable barrier not crash tested / Remove and replace veneer with compatible stone, replace removable barrier - replace with removable ARG (45 LF)
		25	Damaged concrete pavement and drainage pan, cracking & spalling / Replace 630SF concrete after subexc, stone size 9 x 7, replace 100 LF of pan - 30" hillside pan, seal joints (630 SF)+D79
		25	Stone retaining wall - guardwall portion failing, impact damage / Repair guardwall for full length 80' - See FHWA Report (240 SF)
		25	Guardwall subsidence due to raveling below wall / Install a 30’w x 4'H drystack wall below this guardwall in raveled area (120 SF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	*Crystal Point Arch*	25	CMP headwall damaged causing erosion into lane / Repair headwall to regain lane width, also install bollard (1 EA)
		25	Random rubble guardwall foundation problems and low wall / Repair foundation for 30', lower template 4-8" (100 LF)
		25.1	Several locations this area will require milling before overlay to prevent low guardwall
		25.1	CMP with stone headwall plugged, no grate on inlet / Clean pipe, install bollard (1 EA)
		25.1	Rock face above road has loose rock / Scaling, crane and hand (10 hr)
		25.1	Stone and concrete retaining wall - concrete portion stable, rock portions have foundation problems / In rock area rebuild top 4' of wall on 8' slab w/anchors (30 LF)
		25.2	CMP with stone headwall -hillside Inlet is blocked, small diameter pipe / Rebuild headwall on skew to ditch, install 30” new RCP on skew - headwall repair + 60' pipe w rip rap (60 LF - 10 CY rip rap)
		25.2	Ashlar guardwall tipping, road shows movement / Roadway rehab and guardwall on 8' slab (70 LF)
		25.2	CMP with stone headwall failing, pipe damaged / Repair headwall, remove existing inlets and install drop inlet Type C - new inlet drop into single pipe (60 SF)
		25.2	CMP with stone headwall failing, pipe damaged / Repair headwall, replace 2-24' CMP with 24" RCP, install bollard (80 LF pipe, 60 SF)
		25.3	Stone retaining wall - top 2' damaged for 20', some tipping / Repair top 2 ft (20 LF)
		25.3	Rock face above road has loose rock / Scaling, crane and hand (20 hr)
		25.3	Roadway drainage problem with water running against guard wall / Install concrete pan (100 LF)
Alpine	*Alder Creek*	25.4	Trash rack catching all material -plugging / Install new rack on 45 deg angle with bars on 8" centers - excv clean out hole above trash rack - blasting required (1 EA)
		25.5	Uphill soil cut erosion due to steepness / Wire mesh biomat (5600 SF)
		25.5	Localized roadway subsidence caused by drainage problems / Install 30" RCP on a 45 degree skew across the roadway - remove and replace fill in subsidence area (75 LF- 100 CY)
		25.5	Slope creep enhanced by water / Roadway template rehab - include pullout at 913+50 (400 LF)
		25.5	Saturation of uphill ditch / Install 30" RCP on a 45 deg. skew across the D95roadway (75 LF rip rap)
		25.5	Vertical roadway movement / Install 8" anchored slab (170 LF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	*Alder Creek*	25.5	Road and guard all moving downhill / Remove and replace wall on 8' slab with piles & anchors (60 LF)
		25.5	Drainage against guardwalls / 2 inlet collection with 1 outlet (2 EA)
		25.5	Stone retaining wall footer undermining, guardwall needs repair / Footing repair, point and patch - See FHWA Report (80 hr)
		25.6	Roadway fines washed out under asphalt, pavement failing / When trenching for collection system (below) fill with flowfill (25 CY)
		25.6	Drainage against walls / Install 4 inlet collection system with one outlet onto rock formation (4 EA, 180 LF 24" RCP)
		25.6	CMP with stone headwall plugged with sediment / Clean, enlarge basin uphill side, install trash rack with 12" gaps
		25.6	Stone retaining wall - guardwall in bad repair / Rebuild guardwall on top of retaining wall (113 LF)
		25.7	Rock face above road with loose rock / Scaling, crane and hand - need staining on rock and wall (30 HR)
		25.7	Missing guardwall / Rebuild on 4' footer - rock source downhill (100 LF)
		25.7	Tipping guardwall / Remove and replace on 4'Footer (70 LF)
		25.7	Guardwall tipping, road shows movement / Remove and replace on 8'slab w/anchors without piles - 20' spacing (100 LF)
		25.8	Open mesh inlet not functioning / Remove and replace with Type C corten close mesh grate, 80'- 24"RCP (1 EA)
		25.8	Material to back top of guardwall / Remove, some salvageable rock (30 CY)
		25.8	Tipping guardwall / Remove and replace on 4' footer (75 LF)
		26	Drainage to wall no outlet/Add a two inlet collection system with 1 outfall, 100 lf 18", rip rap (20 CY)
		26	Stone retaining wall grout cracking and spalling top 8-10' - guardwall damage / Point and patch (2000 SF) repair guardwall (50 LF)
		26.1	Tipping guardwall / Remove and replace on 4' footer (125 LF)
		26.1	No grate on inlet / Install bollard (1 EA)
		26.1	Rock face above road with loose rock / Scaling, crane and hand (40 hr)
		26.1	Low guardwall with super and road problems / Lower template 1' add inlet (100 LF)
		26.1	Missing section of guardwall / Install new section of ARG guardwall (100 LF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	***Alder Creek***	26.2	Low guardwall / Lower roadway template 4-6" (120 SY)
Alpine	***Haystack Creek***	26.9	Road Settlement / Roadway template rehab (300 LF)
		27	Stone retaining wall impact damage and cracking of guardwall portion / Repair existing wall See FHWA Report (225 LF)
		27	Rock face above road with loose rock / Scale, crane and hand (50 hr)
		27	CMP rotted out / Line or replace (75 LF)
		27	Subsidence behind stone retaining wall / Road rehab without disturbing wall See FHWA Report (110 LF)
		27	Super to wall with no outlet / Install scupper (1 EA)
		27	Rock face above road with loose rock / Scaling, crane and hand (150 hr)
		27	Impact damage and cracking, 70' missing random rubble guardwall / Replace top 4' with ARG (100 LF)
		27.1	Avalanche damage to retaining wall, seeping water / Rehab template with french drain - Replace top 4' with ARG (73 LF)
		27.1	Avalanche damage to retaining wall, seeping water / Rehab template with french drain - Replace top 4' with ARG (169 LF)
		27.1	CBC X drain taper section undermined / Remove and replace w/ rip rap (20 CY)
		27.1	Rock face above road with loose rock / Scaling, crane and hand (150 hr)
		27.2	Missing guardwall / Rebuild on 15' on 4’ slab (15 LF)
		27.2	Damaged top 4" of retaining wall / Remove and replace with ARG (100 LF), patch and repoint (2200 SF)
		27.3	Impact Damage and Cracking to guardwall / Replace top 4' with ARG (40 LF)
		27.3	Non crash tested removable rail / Replace with FHWA crash tested removable on 8' Slab (125 LF)
		27.3	Concrete walls at Haystack does not match historic / Either demo and rebuild with suitable or face with stone (150 LF)
		27.4	Non crash tested removable rail / Replace with FHWA crash tested removable on 8' Slab (100 LF)
		27.4	Stone retaining wall subsidence and leaning / Remove top 4' of wall, roadway rehab, 12' slab w/piles & anchor, rebuild wall (150 LF)
		27.4	Tipping guardwall / Remove and replace on 4' footer - Salvageable rock here (140 LF guard+D147wall)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	*Haystack Creek*	27.4	Water hitting CMP headwall at angle / Remove and replace headwall at 20 deg. angle, replace pipe (30 SY - 80' 24" RCP)
		27.5	Tipping guardwall /
		27.6	Rock face above road with loose rock / Scaling, crane and hand (40 hr)
		27.6	Low guardwall / Lower roadway template 10" (1300 SY)
		27.6	No grate on inlet / Install bollard (1 EA)
		27.7	Concrete End Taper Undermined / Demo concrete add rip rap end treatment (20 CY grouted rip rap)
		27.7	Low guardwall / Add rock to raise (25 LF)
		27.7	Non crash tested removable rail / Replace with guardwall on 4' slab (100 LF)
		27.7	No drainage across road / Drop inlet with 75' of pipe (1 EA)
		27.7	Non crash tested removable rail / Replace with ARG (100 LF)
		27.9	Non crash tested removable rail / Replace with stone guardwall on 4' slab (200 LF)
		27.9	Low guardwall / Replace with guardwall on 4' slab (100 LF)
		27.9	No grate on inlet / Install bollard (4 EA)
Alpine	*Weeping Wall*	28	Non crash tested removable rail / Replace with stone guardwall on 4' footer (150 LF)
		28.25	Stone masonry wall / See FHWA report
		28.8	No grate on concrete box trench drain inlet / Install bollard (1 EA)
	Big Bend	28.9	Leaning guardwall / Remove wall and footer, roadway rehab, replace 4' footer and rebuild guardwall (100 LF)
		28.9	Water damage to guardwall / Remove and replace on new concrete pavement, Rebuild half at a time (100 LF)
		28.9	Water washing out under slab - cracking and moving slab / Remove all concrete, rehab roadway, and replace with concrete slab after installing 6 inlets with corten 10 grates (1200 SY)
		29	Grout cracking and spalling throughout stone retaining wall / Point and patch See FHWA Report (1800 SF)
		29	Impact damage and cracking to guardwall / Rebuild guardwall on 4' footer (330 LF)
		29.1	Exposed concrete on backside of guardwall / Bush hammer and stain (75 LF)
		29.1	Missing Castellations on guardwall / Place castellations (50 LF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	*Big Bend*	29.3	Large amount of rock for recovery / Use slusher for retrieval (220 CY)
		29.3	No grate on inlet / Install bollard (1 EA)
		29.4	Guardwall subsidence and tipping / Remove wall and footer, roadway rehab, replace 4' footer and rebuild guardwall (200 LF)
		29.5	No grate on inlet / Install bollard (1 EA)
		29.5	Guardwall subsidence and tipping / Remove wall and footer, roadway rehab, replace 4' footer and rebuild guardwall (125 LF)
		29.6	No grate on inlet / Install bollard (1 EA)
		29.6	Guardwall rock color does not match / Apply stain (8 hr)
		29.6	Rock face above road with loose rock / Scale, crane and hand (20 hr)
		29.7	Super elev. Forces water to wall with no outlet / Install 3 inlet system with one outlet, rock arch over pipe at penetration and rip rap end treatment (3 EA)
		29.7	Stone masonry wall is leaning, road is moving / Remove top 4', roadway rehab, 12' slab w/ piles and anchors, rebuild wall (107 LF) drainage needs end treatment and rip rap D182 (20 CY rip rap)
		29.7	Tipping guardwall / Combo roadway template rehab and remove and replace (125 LF)
		29.7	Rock face above road with loose rock / Scaling, crane and hand (100 hr)
		29.7	Shallow guardwall footing showing - outside edge / Bury it (75 LF)
		29.82	CMP with stone headwall - no grate on Inlet / Install Bollard (1 EA)
		29.88	Tipping guardwall / Remove and replace on 8' moment slab (60 LF)
		29.9	Modern concrete guardwall D186inner and top surfaces incompatible rock -outside has none / Replace stone with compatible or roughen and stain faces (125 LF)
		29.9	Rock face above road with loose rock / Scaling, crane and hand (75 hr)
Alpine	*Triple Arches*	29.9	Reinforced concrete tieback wall - wall missing stone face - concrete barrier portion too high / Remove stone and reinstall to historic spec - cut barrier off pour core wall and face with rock (660 SY)
		30	Bedrock spalling below pillar of arches / Temporary repair made / See FHWA Report
		30	Removable rail is non crash tested / Remove existing removable - install ARG - no anchor - See FHWA plans (170 LF)
		30.1	No grate on inlet / Install bollard (1 EA)
		30.1	Triple Arches - stone masonry retaining wall - Low guardwall / Full width roadway template lowering - See FHWA report (450 SY)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	*Triple Arches*	30.1	Triple Arches - stone masonry retaining wall -voids in grout, minor foundation erosion / Point an patch, grout foundation repair See FHWA report (45 LF)
		30.15	Uphill road cut slope erosion / Try Macafarri Wire Mesh - Biomat (800 SY)
		30.15	Low guardwall with some subsidence / 12' Slab with anchors and piles (150 LF)
		30.18	Guardwall tipped and low some subsidence / Roadway template rehab, plus 4'footer under rebuild (150 LF)
		30.3	Concrete pipe with stone headwall broken at outlet / Need bollard (1EA)
		30.3	Guardwall low / Remove and replace on 4' footer (400 LF)
		30.4	Super elev causes drainage to wall with no outlet / Add pipe, drop inlet, rip rap (1 EA)
		30.4	Roadway localized settling, subgrade problem / Remove and replace subgrade with suitable material (25 CY)
		30.4	Guardwall low / Lower roadway 4-6" (450 SY)
		30.5	Guardwall subsidence and tipping / Remove and replace on 8' moment slab - may need anchors (220 LF)
		30.5	Guardwall tipped and low some subsidence / Roadway template rehab, plus 4'footer under rebuild (75 LF)
		30.5	Trench drain end concrete section - Outfall undermined / Remove taper section, add rock rundown (10 CY)
			Drainage against walls / Every 100 LF where super drains to wall, add drop inlet (15 EA)
		30.6	Roadway drainage against guardwall / Install drop inlet (1 EA) and rip rap (2 CY)
			Material to back top of guardwall / Leave dirt down 6"
		30.7	Roadway settlement, movement / 12' Slab with anchors and piles (250 LF)
		30.7	Removable rail is non crash tested / Remove existing removable (160 LF)
		30.78	Roadway settlement, sag in asphalt / Remove and replace subgrade - full width - leave wall in place - excv behind wall (150 LF)
		30.8	Guardwall settling, tipping / Rebuild wall on 8' slab (130 LF)
		30.8	Stone retaining wall erosion, under drainage, loose stones, foundation undermined / Point and patch - rebuild wall under drainage - See FHWA Report (100 LF)
		30.84	Stone retaining wall erosion under footing / Grout - concrete under footing - See FHWA Report (10 CY)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	***Triple Arches***	30.85	Drainage pipe failing, erosion problems / Install new 30" RCP - rip rap run down - leave arch in wall above new pipe (50 LF)
		30.89	Guardwall subsidence / Remove and replace on 4' slab (150 LF)
		30.9	Guardwall grout spalling, cracking / Extensive point and patch (28 LF)
		31	Guardwall stone different color than adjacent original wall / Stain stone and bury exposed footing (150 LF)
		31.1	Drainage crossing outfall undermined / Remove outfall chute - install rip rap energy dissipater - need bollard at inlet (20 CY)
		31.18	Guard rock area - slope erosion and subsidence / Install 12' slab anchored with micropiles and tiebacks (200 LF)
		31.2	Drainage crossing plugging and erosion / Install 30 " pipe diagonally across road (90 LF) rip rap (10 CY) corten trash grate
		31.2	Trench drain plugged / Clean (5 hr)
		31.2	Guardwall rock and snow damage also low / Install removable w/anchors (500 LF) lower template (130 LF)
		31.3	Loose material on rock face above road / Hang mesh on high wall during construction - close trail (700 SY)
		31.3	Roadway drainage running along walls / Install concrete pan (200 LF) to drop inlet, pipe downhill (100 LF) rip rap (10 CY)
		31.3	Guardwall damage and tipping /Remove and replace with removable rail on 12' slab with anchors - no piles (1650 LF)
		31.4	Stone masonry retaining wall undermining causing outward deflection / See FHWA Task Order 6
Alpine	***Oberlin Bend***	31.8	Rock face above road with loose rock / Scaling, crane and hand (50 hr) good rock
		31.9	Random rubble guardwall isolated damage / Install 4' slab repair (100 LF)
		32.4	Guardwall low / Add guardwall (100 LF)
		32.4	Edge of roadway eroded, losing shoulder / Removable guardrail on 12' slab - piles and anchors (210 LF)
		32.5	Low guardwall / Remove 4-6" asphalt (300 LF)
		32.7	Extensive guardwall damage / Core wall with slab (150 LF)
	East Tunnel	32.9	Roadway settlement / Roadway template rehab (300 LF)
		32.9	Guardwall tipping / Rebuild on 4' footer (100 LF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
Alpine	***East Tunnel***	33	Grout cracking and spalling throughout stone retaining wall / Point and patch, spot section rebuild See FHWA Report (80 SY)
		33	Stone masonry wall height low by 6-8" / Lower template 550 LF (1100 SY)
		33.2	Top portion of stone masonry wall damaged / Rebuild top portion - point and patch (200 LF)
		33.2	Heavy damage stone guardwall / Rebuild on 4' footer (250 LF)
		33.3	Guardwall tipping, undercut, some missing / Pull wall, pull in towards CL 2 (200 LF)
		33.3	Rock face above road with loose rock / Scaling, crane and hand (100 hr)
		33.4	Avalanche zone taking guardwall / Install ARG on slab with piles (200 LF)
		33.4	No drainage across road / Drop inlet with 50' of 24" RCP, rip rap outfall (1 LS)
Baring Creek	***Siyeh Bend***	34.75	Roadway super - drainage problem / Remove 4-6" asphalt (300 LF)
		34.78	Rundown erosion, invert damage, spalling, rebar exposed / Abrasion plating - rip rap (20 CY)
		34.82	High sediment flow causing headwall damage and plugging from masonry smooth rundown / Add small catch dam above masonry rundown
		35	Side slope erosion, sediment wash over roadway / Realign roadway - install catch ditch or wall
	Jackson Glacier	36.7	Sediment flow plugging culvert -erosion problem / Install rock drop - flat spot - replace 30" RCP (75 LF) rip rap (30 CY)
		37.4	High sediment and erosion debris flow / Install bollard type trash guard above road
		37.4	High sediment and erosion debris flow / Install 30" RCP (75 LF) rip rap rock rundown (20 CY)
	Baring Creek Bridge	39.45	Stone masonry wall under construction / See FHWA report (75 LF)
	Dead Horse Point	41.1	Guardwall settling / Add to wall height (200 LF)
		41.1	Rock face above road with loose rock / Scaling, crane and hand (50 hr) good rock
		41.5	Top 4' of wall in need of repair Rebuild top 4' - See FHWA report (218 LF)
		41.5	Low guardwall / Rebuild guardwall on 4’ footing (200 LF) and mill WB lane (400 SY)
		41.5	Moving subsiding guardwall / Install 8' slab with micropiles rebuild guardwall (130 LF)
	Wild Goose	43	Ped xing with short sight distance / Realign roadway slightly (1500 LF) add signing
St. Mary	***Golden Stairs***	43.35	Stone masonry retaining wall east end 75' sagging, tipping / Subex (100 CY) slab w/ core wall w/piles (75 LF)
		43.3	Low guardwall / Add rock to raise (200 LF)

Appendix A: Going-to-the-Sun Road Deficiencies and Repairs

Section	Segment	Mile Post	Identified Problem/Potential Solution (Magnitude)
St. Mary	***Golden Stairs***	43.3	Rock face above road with loose rock / Scaling, crane and hand (75 hr)
		43.3	No drainage crossing / Add inlets (3 EA) 24" RCP (200 LF) with I outlet - provide arched outfall
	St. Mary Slump	48.2	Roadway slump area / Monitor shore erosion - add rip rap protection (75 CY) to toe - tiebacks if necessary
	Divide Creek Bridge	49.3	High bed loading of Divide Creek Bridge / Add additional capacity - cells

APPENDIX B

SOCIOECONOMIC IMPACT METHODS FOR ANALYSIS AND SUPPORTING DATA

Methods for Socioeconomic Analysis

In order to assess the full economic impact to the local area from road rehabilitation, BBC Research & Consulting (BBC) projected the total socioeconomic impacts that could result from changes in visitation patterns, construction activity, and Park operations. Effects of mitigation strategies to reduce impacts on visitors and visitation levels (described in Chapter 2) were also analyzed. The socioeconomic impacts resulting from changes in visitation patterns are expected to be the largest followed by those resulting from construction activity and finally those resulting from changes in Park operations. The methodology employed for estimating these impacts is summarized below.

Visitation Effects

Visitor Experience

There is no direct means of measuring and quantifying the quality of the visitor experience at GNP. It is logical to presume that visitors prefer to be able to access all points along the GTSR from either direction and avoid traffic delays. This presumption is borne out by the results of the 2000 Survey of Visitors and the comparable survey performed in the summer of 2002, which indicated that a substantial portion of visitors would reconsider visiting the Park if access to Logan Pass was limited or lengthy delays were experienced along the GTSR. These projected responses to changes in the visitor experience are embodied in the impact analysis in this EIS in terms of projected changes in visitation levels under the various alternatives, as described in more detail elsewhere.

It is also logical to presume that at least some portion of the impact on visitor experience due to road rehabilitation can be mitigated by providing or enhancing other attractions at the Park, such as adding interpretive exhibits. Again this presumption is borne out by visitor's responses in the 2000 and 2002 visitor surveys, which indicated that a portion of the visitors who would avoid coming to the Park due to anticipated traffic disruption during rehabilitation would change their minds if more exhibits and interpretive services were provided. The effects of this mitigation strategy on the visitor experience at GNP are embodied in the projected effects of mitigation on visitation levels under Alternative 3 and Alternative 4.

Whether the presence of visible road rehabilitation activity, by itself, would significantly impact the visitor experience at GNP is unclear. While the primary purpose of most visits to GNP is undoubtedly to enjoy the relatively pristine environment of the Park, community leaders suggested during previous studies that the opportunity to observe the unique efforts to rehabilitate the historic road may be a potential tourist attraction in itself, at least for some visitors (WIS 2001).

Reductions in Direct Visitor Spending

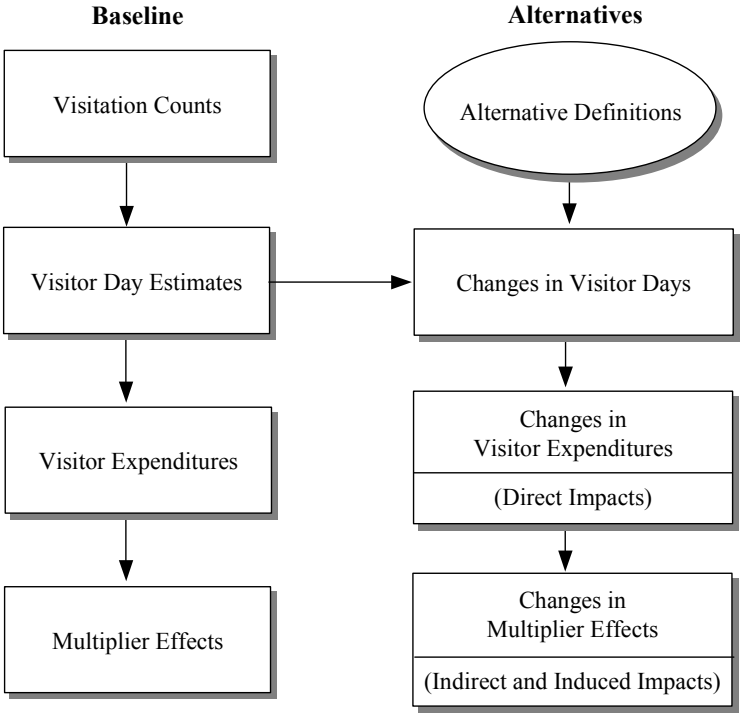
Reductions in Park visitation due to rehabilitation would directly impact the economy of the local study area, both in terms of declines in visitor spending in tourist related sectors and the resulting employment losses in those sectors. The level of direct impacts experienced by each region within the local impact area would depend on the following key factors:

- The baseline level of visitation to the Park,
- Road rehabilitation alternative characteristics and the traffic disruptions along the Road that these definitions imply,
- Visitor responses to the traffic disruptions,
- Existing visitor spending patterns within the study area,

- Visitor travel patterns and the ability of local communities to attract visitor expenditures.

To estimate the direct economic impacts from reductions in visitor spending, it is necessary to quantify each of these key factors. To achieve this, BBC used the Alternative definitions described in Chapter 2 combined with existing NPS recreation visitation estimates and analysis of data collected in the 2000 and 2002 visitor surveys. An overview of the methodology employed for estimating the direct impacts from reductions in visitor spending within the local impact area under each of the alternatives is graphically presented in Figure B-1 below.

Figure B-1. Overview of Methodology for Estimating Visitation Impacts



Source: BBC 2003

The first column in Figure B-1 depicts the relationship between baseline visitation levels and the associated economic effects that this visitation has within the local impact area. Economic effects from visitation include direct economic flows from baseline visitor expenditures and indirect economic flows that result from multiplier effects.

For Alternatives 2, 3, and 4, there is a parallel relationship, depicted in the second column of Figure B-1. Alternative specific definitions are combined with baseline visitation estimates to produce estimates of reductions in visitation. These reductions imply changes in both the direct economic flows from visitor expenditures and the indirect economic flows resulting from multiplier effects. The methodology for estimating each of these components is discussed in more detail below.

Estimation of Baseline Recreation Visits

The first step for estimating direct visitation impacts was to calculate existing baseline visitation and corresponding visitor expenditure levels. To accurately capture visitor expenditure patterns, it was necessary to segment the visitor population into visitor types. This is because visitor spending depends not only on the number of visitors, but also on the types of visitors. Day visitors have different spending patterns than visitors staying overnight in the area, and spending also varies among overnight visitors, depending on their lodging type (motel, campground, backcountry camping). Additionally, since GNP estimates visitation through vehicle (party) counts and because how much a visitor spends in the area also depends on how long the visitor stays in the area, not just how much time they spend in the park, a party day was selected as the spending unit of analysis. (Street, pers. comm. 2002.)

In order to convert NPS baseline recreation visit estimates to party days in the area, the study team employed NPSCONVERT.XLS software developed by recreation researchers at Michigan State University for the NPS. Required data inputs include estimates of recreation visits and overnight stays as well as estimates of parameters including average party size, length of stay in the park, nights spent in the park, number of Park entries made per trip. The first two inputs were NPS estimates, while all other required parameter estimates were calculated using data collected from the 2000 and 2002 visitor surveys.

The software produces estimates of party trips to the area by seven lodging segments as well as estimates of segment shares. Lodging segments included 1) day visitors living in the local impact area, 2) non local day visitors not staying overnight in the impact area, 3) visitors staying in motels or lodges inside the Park, 4) campers staying inside the Park, 5) visitors staying in motels outside the Park, 6) campers staying outside the Park, and 7) visitors staying overnight in the area in owned seasonal homes or with relatives or friends. Baseline party trips were then converted to party days by multiplying through by the average number of days spent in the area for each visitor type (assuming one for local and non-local day visitors).

During the completion of the *Socioeconomic Study*, concerns were raised by some members of the Advisory Committee concerning the number of recreational visits reported by NPS. In particular, the question was raised about potential double counting of parties that enter the Park more than once in any particular day. The NPS estimates are, however, the best data available regarding visitor use of GNP. The study team contacted Park staff and confirmed that they do ask visitors whether they have been in the Park earlier in the day in order to minimize or eliminate double counting (Street, pers. comm. 2002).

Estimations of Alternative-Specific Visitor Reductions

The second step for calculating direct visitation impacts was to estimate alternative specific reductions in party days. Reductions in party days may happen in two ways: parties that decide to completely cancel their trip to the Park as a result of road rehabilitation, and parties that decide to reduce the length of stay in the area because of the traffic disruption on the road. The actual number of party days reduced varies by alternative, depending upon the level of traffic disruption associated with the alternative.

For each road rehabilitation alternative, visitor response estimates were initially estimated using data from the 2000 visitor survey and subsequently revised based on the 2002 visitor survey. Response frequencies to specific questions were associated with different behavioral responses (trip cancellation versus trip length reduction) for road rehabilitation alternatives, using the alternative definitions provided in Chapter 2. Applying behavioral response frequencies to

baseline party day estimates allowed the study team to estimate reductions in party days that would result from implementation of specific road rehabilitation alternatives.

For Alternatives 3 and 4, it may be possible for the Park to offset a portion of the negative visitor impacts associated with road rehabilitation through visitor service mitigation efforts, and thus recover some of the potential reductions in party days (and associated visitor expenditures) for the local impact area. Response frequencies to relevant questions from the 2002 visitor survey were used to estimate the mitigating impacts of visitor service improvements. In this manner, the study team calculated alternative specific estimated reductions in party days, both with and without the mitigating impacts of proposed visitor service improvements.

Estimation of Visitor Expenditure Reductions

The third step in calculating direct visitation impacts was to calculate estimated reductions in visitor expenditures. This was achieved by applying the visitor spending profiles to the estimated reductions in party days on a party type basis. This allowed the study team to estimate reductions in visitor expenditures, by party type and by expenditure sector, associated with each road rehabilitation alternative. These totals were aggregated to obtain overall estimates of visitor expenditure reductions for each alternative.

Statistical analysis determined that Canadian visitors had significantly different spending profiles than other visitors to the Park. For this reason, separate expenditure profiles were developed and applied appropriately for Canadian visitors and Non-Canadian visitors.

Aggregate expenditure totals are net of estimated expenditure totals calculated for local Montanans under each alternative scenario. While construction activity associated with road rehabilitation might induce local Montanans to also visit the Park fewer times, any money this group saves by not visiting the Park may still ultimately be spent in the study area on other items. Such changes in local spending patterns were excluded from the impact analysis.

Allocation of Expenditure Reductions Within the Local Impact Area

The final step in calculating direct visitation impacts is to estimate the geographic distribution of expenditure reductions among the counties within the local impact area. The study team developed an allocation methodology based on two factors: 1) visitor travel patterns to and from the Park and 2) the relative ability of the economy in each study area county (and southwest Alberta) to capture visitor expenditures.

The 2000 and 2002 visitor surveys asked respondents what route they took in traveling both to and from the Park. Responses to these questions were used to estimate the proportion of visitors that traveled through Flathead, Glacier, and Lake Counties in Montana and southwest Alberta. In general, seven main routes are used in driving through the local impact area to reach the Park. In many cases, travel routes to and from the Park pass through more than one county. For example, visitors traveling on US 93 must drive through both Lake and Flathead counties in order to reach the Park. Each potential route combination was linked to the appropriate counties (and southwest Alberta), and travel frequencies for each combination were calculated using responses from the 2000 and 2002 visitor surveys.

For travel routes that passed through more than one county, a capture factor was applied to calculate route frequencies reflecting the relative ability of the county (or provincial area) to attract visitor expenditures. Some counties are better able to capture visitor expenditures than others because they offer a more diverse and complete set of the goods and services (lodging, restaurants, gift shops, recreation activities) that visitors purchase. To represent the percent of a visitor's daily expenditures that local businesses were able to capture, the study team used capture

rates developed for the Road *Socioeconomic Study* (August 2001) — 100 percent for Flathead County, 60 percent for Lake County and 25 percent each for Glacier County and southwest Alberta.

Combining calculated travel route frequencies with the capture factors resulted in the following estimated distribution of visitor expenditures and expenditure reduction: Flathead County – 42 percent, Glacier County – 28 percent, Lake County – 16 percent and southwest Alberta –14 percent.

During completion of the *Socioeconomic Study*, some Citizen Advisory Committee members indicated concerns that the previous estimates of annual visitor expenditures in the study area were too high based on data on bed tax revenues in the study area counties. In analyzing effects for this EIS, the study team returned to the original data from the 2000 visitor survey and developed an independent analysis of impacts on visitation and visitor spending. The estimates presented herein are lower than prior estimates in the *Socioeconomic Study*, but of similar general magnitude. Comparison of estimated baseline GNP visitor expenditures to IMPLAN model estimates of overall economic activity in key sectors such as lodging implies that about half of all annual lodging revenues in the study area would be attributable to visitors to GNP. Interviews with economic developers in the study area suggest that this figure is reasonable (Edgar pers. comm. 2002; Stewart, pers. comm. 2002).

Construction Effects

How spending and employment for Road rehabilitation construction would directly affect socioeconomic conditions in the study area depends on these key characteristics:

- The duration and total cost of each alternative
- Total costs for the three main categories of expenditure — labor, equipment, and materials
- Employment associated with labor expenditures
- Other issues affecting local participation in employment and contracting
- The following sections describe the methodology used to estimate the direct construction spending and employment effects associated with each rehabilitation alternative.

Duration and Funding

The Going-to the-Sun Road *Engineering Study* established benchmark estimates of duration and spending on the Road rehabilitation project. As modified to reflect current alternative descriptions, these cost estimates are the basis for the direct spending and employment effects used in this analysis (WIS 2001). The cost estimates were updated for inflation to year 2002 dollars, assuming an annual inflation rate of four percent.

Since the project durations for Alternative 3 (Shared Use) and Alternative 4 (Accelerated Completion) ranges of seven to eight years and six to eight years, respectively, Alternative 3's duration was simply fixed at eight years and Alternative 4's at seven years to render the analysis more straightforward. Similarly, costs for road rehabilitation were fixed at $112 million for Alternative 1, $102 million for Alternative 2, $98 million for Alternative 3, and $81 million for Alternative 4. These numbers represent the average of the lowest and highest costs in the cost range for each alternative.

The total costs for Alternatives 3 and 4 reflect an additional year of construction in this analysis compared to the schedule presented in the *Engineering Study*.

In addition, to the construction related costs for Road rehabilitation, Alternatives 2, 3, and 4 include costs for transit service and visitor use improvements. These costs range from about $6 million for Alternative 2 to about $19 million for Alternatives 3 and 4. Alternatives 3 and 4 also include expenditures of about $17.7 million for visitor development mitigation. Following Road rehabilitation, Alternatives 2, 3, and 4 anticipate annual operation and maintenance costs of about $1.5 to $1.9 million.

Labor, Equipment and Materials Costs

The analysis of direct socioeconomic costs carries forward the distribution of costs originally determined in the *Engineering Study*. Costs are distributed both across the key expenditure categories and over time.

First, road rehabilitation costs were reduced by 41 percent to separate contingency, design, and engineering costs, based on data from Appendix B of the *Engineering Study*. Then using data from the *Engineering Study*, the labor share of costs was estimated at 37 percent to 38 percent of the sum of labor, equipment, and materials costs. The remainder was apportioned between equipment and materials in proportion to shares represented in the *Engineering Study* data.

Distribution of costs over time follows annual patterns specified and described in the *Engineering Study*. Alternatives 1 and 2 assume level annual spending as a matter of policy. For Alternatives 3 and 4, spending was distributed over time in response to scheduling considerations such as efficient grouping of the work, the seasonal workability of job sites, when and where it is feasible to do night work, expectations about the weather, workforce availability, accommodating visitors, and funding expectations.

Employment

The *Engineering Study* did not estimate direct employment for road rehabilitation. The estimates of direct employment effects presented in this analysis are derived from assumptions about the labor share of costs, the duration of the construction season, and average labor cost per worker.

Based on information from the *Engineering Study*, the construction season was assumed to be 18 weeks for Alternatives 1, 2, and 4, and 21 weeks for Alternative 3. Initial estimates of the labor cost per worker were accessed from the Montana Davis-Bacon prevailing wage report for the year 2001 (Research and Analysis Bureau 2001). An interview with the lead author of the *Engineering Study* (Kracum, pers. comm. 2002) indicated that prevailing wages might be too low for a project of this type, assuming several factors would contribute to a higher overall labor cost.

First, the project would demand operators, crafts, and laborers with mountain road skills and experience that would command compensation at the high end of the range for every category. Second, some specialized occupations would be recruited from other, higher wage areas. Finally, attracting workers to work on a seasonal job may require higher pay rates.

Therefore, a premium of 10 percent over prevailing wages was applied to base assumptions, leading to a weighted average labor cost per worker of $1,349 per week as the overall labor cost assumption for this analysis. Using this value, the number of employees required is estimated by dividing total labor costs by the duration of the alternative in weeks and by the average weekly labor cost per worker.

Location Distributions

The direct socioeconomic effects of Road rehabilitation were distributed to various locations within the study area based on the following key factors: local labor employed on the project, the

residential location of non-local labor, and the location of project activity resulting in expenditures on equipment and materials.

Empirical research on the local composition of construction workforces has shown that the number of local workers supplied by a community increases with the population of the community and the numbers employed by the project and decreases with the distance of the community from the project and with the number of employees supplied by other communities. A preliminary estimate of local hiring based upon a standard version of this model (Mountain West Research) predicted 60 percent of the local hiring from communities and unincorporated areas of Flathead, Glacier and Lake counties and assumed there would be no hiring of residents of Canada. Interviews with the Job Service Division of the Montana Department of Labor and Industry (Lybbert, pers. comm. 2002) indicated that several factors, including transportation, competing job opportunities, and preferences for job location, would tend to decrease local hiring in parts of the study area. Therefore, the local hiring rate was set at 50 percent for this analysis.

The residency distribution of local residents working on the project and of non-local workers who re-locate to the study area during the construction season is assumed to be as follows: 60 percent in Glacier County, 30 percent in Flathead County, and 10 percent in Lake County. All residency is assumed to be outside the Park in accommodations drawn from market housing and lodging resources. This distribution is based on a field reconnaissance of housing resources in the study area and interviews with Job Service personnel familiar with residency patterns associated with past road construction projects at GNP (Baker, pers. comm. 2002).

Work sites for the Road rehabilitation project are distributed across the 50-mile length of the highway. Montana's transportation construction industry is relatively small, and most places where construction establishments are located are more than two hour's drive from GNP. There is, however, a construction firm in Kalispell that has been involved in previous Going-to-the-Sun Road work. The *Engineering Study* identified the most feasible staging sites for the Road project, including two on the west side of Logan Pass and one on the east side. Based on a review of these sources of information, two-thirds of spending on equipment and materials is assumed to occur in Flathead County and one-third in Glacier County.

Local Participation Issues

Although none of the documents describing the project sets forth specific occupational detail for the project, the *Engineering Study* indicates that the Going-to-the-Sun Road work force would need special skills and experience in mountain corridor road construction. According to the Study, this would include craftsmen able to fulfill historic rehabilitation requirements and contractors whose capabilities include handling tiebacks, micropiles, polyurethane injection and high rock scaling. Implementation of training and prequalification programs for local workers and contractors could potentially increase local participation.

An interview with the Job Service Division of the Montana Department of Labor and Industry indicates that there are typically numerous qualified active applicants in the skilled and unskilled construction activities (Lybbert, pers. comm. 2002). The Division maintains a high profile in communities, registers a high proportion of the unemployed, and can provide comprehensive personnel services to incoming employers.

Highway construction projects in GNP are designed, awarded, and administered by the Western Federal Lands Highway Division of the Federal Highway Administration, and they are subject to affirmative action requirements to ensure equal employment opportunity (Parsons, pers. comm. 2002). Assuming the contract is configured like past GNP road projects, contractors on the Road rehabilitation project would be required to implement hiring goals for minority and female

utilization in terms of percentages of the total hours of employment and training for the target groups.

Park project contracts also have typically included an enhancement for minority employment for laborers and all construction trades. Because the projects are near the Blackfeet and Flathead Indian Reservations, solicitations for construction work in GNP encourage prospective bidders to meet this intent by giving employment preference to Native Americans through contact with the Tribal Employment Rights Offices on each reservation.

Park Operations

Any large-scale changes in Park operations, particularly staffing and expenditures for locally procured goods and services, could have an impact on socioeconomic conditions in the study area. To assess potential changes in Park operations, the study team gathered and reviewed data from the Park regarding current revenues, expenditures, staffing, and staff residency. Interviews were conducted with Park staff to understand how each of these variables might change under the rehabilitation alternatives.

As described later in this section, affects of rehabilitation on Park revenues, expenditures, and staffing are expected to be somewhat offsetting. Since overall net effects on park operations are expected to be negligible from a socioeconomic standpoint, and the Park does not anticipate specific overall changes in operations under the alternatives, quantitative estimates of changes in Park operations and corresponding socioeconomic impacts were not developed.

Mitigation Effects

As noted in Chapter 2, potential strategies to mitigate socioeconomic impacts of Road rehabilitation were identified via working sessions with local economic development and tourism development specialists, a survey of local businesses in the local impact area, and work with the Citizens Advisory Committee. Essentially, the resulting socioeconomic mitigation strategies can be divided into four categories: construction management, transportation improvements, park facility/service improvements, and marketing measures.

Construction management and transportation mitigation measures consist of scheduling and planning rehabilitation activities to minimize traffic disruption, particularly during peak visitation periods, and adding transit services to further reduce disruption. Such measures are embodied, to varying degrees, in the design of each of the rehabilitation alternatives. Consequently, the socioeconomic effects of these mitigation strategies are built into the projected changes in visitation and visitor expenditures under each of the alternatives.

Park facility and service improvements can help mitigate socioeconomic effects by reducing the impacts on the number of visitors and/or the length of visitor stays at GNP during rehabilitation. The study team analyzed visitor responses to questions in the 2000 and 2002 visitor surveys regarding the impact of such improvements on their decision to come to the Park and on the activities they would undertake while visiting the Park. Based on survey responses, a proportion of visitors who would not come to the Park or would shorten their stay given anticipated traffic disruptions under some of the alternatives would change those decisions if more exhibits and interpretive services were offered. This proportion was used, in conjunction with the methodology for estimating impacts of visitation reductions described previously, to calculate the partly offsetting impact of facility and service improvement mitigation measures on visitation levels, length of visitor stays in the study area, and associated socioeconomic effects.

Effects of mitigation strategies based on marketing measures are more difficult to quantify. The study team interviewed local economic development representatives within the study area and

researched proactive marketing efforts in other communities highly dependent on nearby national park visitation, as well as statewide tourism marketing efforts. Essentially, proactive public relations by the Park during rehabilitation (as described in Chapter 2) is believed to be essential in avoiding a public perception that the effect of Road rehabilitation on the visitor experience at GNP is worse than it actually would be. For example, it is essential that the message be conveyed that the Park is not closed and that a variety of attractions for visitors remains. In other words, these efforts are believed necessary to confine visitation impacts to the projected levels based on responses to the 2000 and 2002 visitor surveys.

Under Alternatives 3 and 4, the Park also plans to participate in business planning efforts to coordinate with local economic development and tourism agencies and to provide funding that such agencies can apply for and use in marketing GNP and their communities (as described in Chapter 2). Such efforts can undoubtedly have an impact on visitation levels to the Park, but there is too much uncertainty regarding what will ultimately be done and how effective it would be to specifically quantify the effects of such measures.

Indirect and Induced Impacts

Secondary economic impacts result from "ripple" or "multiplier" effects throughout the local economy in response to direct impacts. In this case, they are the changes in economic activity that result from subsequent rounds of re-spending tourism dollars or direct road construction expenditures.

Definition of Indirect and Induced Impacts

Secondary impacts are often further divided into two categories: indirect impacts and induced impacts. Indirect impacts refer to changes in sales, income or employment within the local region in industries that supply goods and services to directly affected businesses. For example, in the case where the direct impact is reductions in visitor spending, indirect impacts may include a decrease in sales for the firms that supply linen to motels or lodges in the local area.

As a result of both the direct and indirect impacts, the number of jobs and income in the affected sectors will also change. This change in household spending capability can then affect the revenues of local businesses that cater to household needs, and the receipts of local governments. These secondary effects are known as "induced" impacts. In our case, induced impacts would be the changes in sales within the local impact region that result from changes in local household spending of income (on housing, utilities, groceries, etc.) earned in the tourism, construction and other supporting industries. Both indirect and induced impacts may be expressed either in terms of changes in expenditures (i.e., sales, output or income) or in terms of changes in the numbers of jobs required to produce a given volume of sales/production within the affected industries.

Overview of Input-Output Modeling for This Analysis

Input-Output (IO) analysis is a common method used to measure secondary socioeconomic impacts. This type of analysis usually employs an IO model tailored to the specific impact region of interest, which characterizes the flows of economic activity between sectors within that impact region. The model captures what each business or sector must purchase from every other sector in order to produce a dollar's worth of goods or services. In this way, flows of economic activity may be traced throughout both the local impact region and more generally, throughout the economy as a whole.

To conduct its analysis of the secondary impacts from changes in visitor spending, construction activity and park operations associated with each alternative for the United States portion of the impact region, the study team used the IMPLAN model originally developed by the United States

Forest Service. IMPLAN (IMpact analysis for PLANing) is a micro-computer based input-output modeling system that can estimate impacts for up to 528 sectors for any region in the United States defined at either the county or state level. To assess the secondary impacts for both the Province of Alberta and for the portion of Alberta within the local impact area (Census District 3) the study team retained Dr. Atif Kubursi of Econometric Research Limited and McMaster University in Hamilton, Ontario. Dr. Kubursi has developed a Canadian input-output model and has used it extensively to analyze the economic implications of tourism activity in Alberta. Kubursi's model is a less detailed model than IMPLAN, with only 57 commodities and 37 sectors represented (IMPLAN 2002; Econometric Research Limited 2002).

Fiscal and Community Impacts

To evaluate potential direct and indirect fiscal and community service impacts, budgets and other supporting documentation for local governments and infrastructure in the study area were obtained from county and provincial staff and the 2000 Census. Revenue sources were analyzed for sensitivity to changes in retail sales and other anticipated effects of the alternatives. Telephone interviews were conducted with local government staff in other communities adjacent to national parks that had experienced reductions in visitation due to construction projects and/or wildfires, particularly communities near Yellowstone National Park and Yosemite National Park. Finally, personal visits were made to county commissioners, county staff members, regional Job Service staff and local economic development officials to discuss any potential fiscal and community service effects from the alternatives.

Cumulative Impacts

As described at the outset of this chapter, cumulative effects refer to the impacts that result when the incremental impact of the action being analyzed is added to the impacts of other past, present or reasonably foreseeable future actions. While the effects of these actions can be relatively minor on an individual basis, collectively, their effects may be significant.

The study team evaluated a number of other events that are currently planned for the local impact area that could potentially have significant cumulative socioeconomic effects. These include a variety of highway and transportation projects currently planned for the local impact area, national forest activities, planned celebrations of the Lewis and Clark Bicentennial and the Glacier Park Centennial, and increases in regional population.

In order to evaluate these impacts, the study team analyzed information on anticipated events and conducted numerous on-site interviews. Interviewees included representatives for each of the three counties in the Montana portion of the study area, representatives of local economic development organizations, and representatives of both the Salish-Kootenai Confederated tribes and the Blackfeet tribe.

Table B-1. Visitors to geographic areas in GNP outside of the Road corridor.

Area	Percent of Respondents Who Stopped	Most Frequent Response for Duration of Stop	Percent of Respondents Who Did Not Stop Due to Lack of Parking	Average Estimated Time Spent for Daily Recreation
Polebridge/ Northfork	8%	28% 1 – 4 hours	6%	30 hours, 50 minutes
Many Glacier/ Swiftcurrent	39%	59% 4 hours – 1 day	6%	4 hours, 20 minutes
Two Medicine	18%	36% 1 – 4 hours	7%	3 hours, 5 minutes
Chief Mountain	14%	66% < 1 hour	6%	1 hour, 20 minutes
Camas Road	8%	42% 1 – 4 hours	5%	2 hours, 50 minutes
Waterton, Canada	25%	63% 4 hours – 1 day	4%	4 hours, 35 minutes

Source: WIS 2001.

Table B-2. Average daily expenditures per party during GNP visit (2002 $), all visitors.

Expenditures	Day Visitors		Motel Stay		Campers		Visited Friends or Relatives
	Local	Non-Local	In Park	Outside Park	In Park	Outside Park	
Groceries	$11.22	$26.42	$15.69	$18.72	$17.27	$19.13	$29.81
Restaurant/Bar	$11.58	$14.96	$52.84	$52.42	$20.44	$23.93	$43.84
Gas/Auto	$11.03	$27.46	$18.60	$24.24	$15.49	$21.11	$28.24
Lodging/Camping	$1.03	$37.89	$122.82	$138.32	$28.33	$41.84	$17.24
Recreation	$4.57	$6.81	$19.13	$23.98	$12.21	$10.25	$16.08
Gifts	$7.95	$19.90	$27.87	$26.20	$15.71	$29.98	$27.28
Other†	$1.41	$2.24	$12.86	$11.31	$9.85	$3.21	$4.87
Total	$48.78	$135.68	$269.82	$295.18	$119.30	$149.45	$167.35

†Excluding airfare.

Source: WIS 2001 and Coley-Forrest 2002.

Table B-3. Average daily expenditures per party during GNP visit (2002 $), Canadians only.

Expenditures	Day Visitors	Motel Stay		Campers		Visited Friends or Relatives
	Non-Local	In Park	Outside Park	In Park	Outside Park	
Groceries	$10.06	$6.19	$25.27	$12.60	$14.69	$9.29
Restaurant/Bar	$11.35	$47.18	$39.18	$7.58	$21.31	$5.90
Gas/Auto	$14.83	$2.33	$18.79	$10.71	$20.55	$6.67
Lodging/Camping	$9.33	$79.71	$103.00	$14.67	$28.08	$0.00
Recreation	$1.24	$40.96	$41.69	$12.24	$12.99	$0.00
Gifts	$15.82	$27.58	$19.99	$4.37	$30.66	$4.24
Other†	$4.00	$0.00	$20.71	$0.00	$3.27	$20.00
Total	$66.63	$203.95	$268.63	$62.17	$131.55	$46.09

†Excluding airfare.

Source: WIS 2001 and Coley-Forrest 2002.

Table B-4. Share of employment by key industry sector in the Montana study area.

Employment in 1999 by Key Sector	Montana	Flathead	Glacier	Lake
Farm and Agricultural Services	7.4%	3.9%	9.5%	10.8%
Annual change since 1990	1.1%	2.2%	0.2%	-0.3%
Construction	6.3%	8.2%	4.8%	6.6%
Change from 1990	6.6%	7.7%	4.2%	6.2%
Manufacturing	5.3%	10.2%	1.2%	11.4%
Annual change since 1990	1.2%	1.6%	-6.6%	7.4%
Trade and Services	53.2%	54.8%	52.3%	52.1%
Annual change since 1990	1.2%	1.6%	0.1%	1.1%
Other Private	12.8%	13.2%	10.0%	8.5%
Annual change since 1990	0.3%	0.8%	-0.6%	1.3%
Government	15.1%	9.7%	22.3%	10.6%
Annual change since 1990	0.4%	1.1%	0.3%	0.9%

Source: Bureau of Economic Analysis 2001.

Table B-5. Percentage of full and part time employees by industry— three county region.

Industry	1980	1990	1999	1980 to 1999 Change (in percentage points)
Farm Employment	7.1%	5.9%	4.2%	(2.9)
Agricultural Services, Forestry and Fishing	1.2%	1.5%	1.6%	0.4
Mining	1.9%	0.7%	0.6%	(1.3)
Construction	6.2%	5.5%	7.6%	1.4
Manufacturing	13.1%	10.6%	9.7%	(3.4)
Transportation, Communications and Utilities	6.4%	4.7%	4.1%	(2.2)
Wholesale Trade	3.0%	2.6%	2.2%	(0.9)
Retail Trade	17.5%	18.7%	19.5%	2.0
Finance, Insurance and Real Estate	6.3%	6.5%	7.2%	1.0
Services	22.0%	29.3%	32.3%	10.3
Government	15.4%	14.1%	11.0%	(4.3)

Source: Bureau of Economic Analysis 2001.

Table B-6. Distribution of transportation construction employment and business establishments in Montana, 1999.

	Employees	Establishments		
		All	With <50 Employees	With 50+ Employees
State of Montana	1,529	113	105	8
Billings MSA	454	12	9	3
Missoula MSA	370	20	18	2
Great Falls MSA	206	8	7	1
Gallatin Co. (Bozeman)	92	11	10	1
Silver Bow Co. (Butte)	60	3	3	0
Lewis & Clark Co. (Helena)	21	5	5	0
Balance of State	326	54	53	1

Note: Data are for the highway, street, bridge and tunnel construction sector, NAICS 2341.
MSA Metropolitan Statistical Area.

Source: U.S. Census Bureau 2000.

Table B-7. Selected demographic indicators in the Montana study area.

	Montana	Flathead	Glacier	Lake	Three-County Region
Persons under 18 years old in 2000	25.5%	25.9%	34.9%	28.1%	27.4%
Persons 65 years old and over in 2000	13.4%	13.0%	9.2%	14.5%	12.9%
White population in 2000	90.6%	96.3%	35.4%	71.4%	83.4%
American Indian population in 2000	6.2%	1.1%	61.8%	23.8%	13.4%
Persons in poverty in 1998	15.7%	14.6%	35.6%	21.5%	18.8%
Median household income in 1998, as percent of statewide level	100	109	70	88	NA

Note: All data available from Census and Economic Information Center, Montana Department of Commerce (ceis.commerce.state.mt.us).

Source: U.S. Census Bureau 2000.

Table B-8. Housing units by county.

	Flathead County		Glacier County		Lake County	
	Units	Percent	Units	Percent	Units	Percent
Total	34,773		5,243		13,605	
Owner Occupied	21,678	62%	2,670	51%	7,278	53%
Renter Occupied	7,910	23%	1,634	31%	2,914	21%
Vacant	5,183	15%	939	18%	3,413	25%
Total Vacant	5,183		939		3,413	
Owner	375	7%	44	5%	144	4%
Renter	595	11%	215	23%	217	6%
Rented/Sold Not Occupied	185	4%	32	3%	79	2%
Seasonal	3,570	69%	386	41%	2,690	79%
Other	458	9%	262	28%	283	8%

Source: U.S. Census Bureau 2000.

Table B-9. Alternative 1 (baseline) visitor expenditures and resulting total economic output (thousands of year 2002 dollars).

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	$115,756	$167,872	$56,177	$79,326	$38,275	$46,975	$21,303	$28,910	$18,065	$25,171
2005	$116,130	$168,415	$56,359	$79,583	$38,399	$47,127	$21,372	$29,004	$18,123	$25,252
2006	$116,318	$168,686	$56,450	$79,711	$38,461	$47,203	$21,406	$29,050	$18,152	$25,293
2007	$116,442	$168,867	$56,510	$79,796	$38,502	$47,254	$21,429	$29,081	$18,172	$25,320
2008	$116,505	$168,958	$56,540	$79,839	$38,523	$47,279	$21,441	$29,097	$181,181	$25,333
2009	$116,567	$169,048	$56,571	$79,882	$38,543	$47,304	$21,452	$29,113	$18,191	$25,347
2010	$116,567	$169,048	$56,571	$79,882	$38,543	$47,304	$21,452	$29,113	$18,191	$25,347
2011	$116,567	$169,048	$56,571	$79,882	$38,543	$47,304	$21,452	$29,113	$18,191	$25,347
2012-2023 (Annual Impacts)	$116,567	$169,048	$56,571	$79,882	$38,543	$47,304	$21,452	$29,113	$18,191	$25,347
2024-2053 (Annual Impacts)	$116,567	$169,048	$56,571	$79,882	$38,543	$47,304	$21,452	$29,113	$18,191	$25,347
Baseline Totals	$5,826,677	$8,449,980	$2,827,717	$3,992,942	$1,926,605	$2,364,527	$1,072,305	$1,455,209	$909,293	$1,266,981

Source: BBC 2003.

Table B-10. Jobs supported by visitor expenditures for Alternative 1.

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	3,351	4,241	1,626	2,011	1,054	1,204	671	801	298	478
2005	3,362	4,255	1,631	2,018	1,057	1,208	673	804	299	479
2006	3,367	4,262	1,634	2,021	1,059	1,210	674	805	299	480
2007	3,371	4,266	1,636	2,023	1,060	1,211	675	806	300	480
2008	3,373	4,268	1,637	2,024	1,061	1,212	675	806	300	481
2009	3,374	4,271	1,637	2,025	1,061	1,212	676	807	300	481
2010	3,374	4,271	1,637	2,025	1,061	1,212	676	807	300	481
2011	3,374	4,271	1,637	2,025	1,061	1,212	676	807	300	481
2012-2023 (Annual Impacts)	3,374	4,271	1,637	2,025	1,061	1,212	676	807	300	481
2024-2053 (Annual Impacts)	3,374	4,271	1,637	2,025	1,061	1,212	676	807	300	481

Source: BBC 2003.

Table B-11. Projected impacts on visitor expenditures and economic output for Alternative 2 (thousands of year 2002 dollars).

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	-$4,847	-$7,027	-$2,352	-$3,321	-$1,603	-$1,967	-$892	-$1,210	-$781	-$1,912
2005	-$4,863	-$7,050	-$2,360	-$3,332	-$1,608	-$1,973	-$895	-$1,214	-$783	-$1,918
2006	-$4,871	-$7,061	-$2,363	-$3,337	-$1,611	-$1,977	-$896	-$1,216	-$785	-$1,921
2007	-$4,876	-$7,069	-$2,366	-$3,341	-$1,613	-$1,979	-$897	-$1,217	-$786	-$1,923
2008	-$4,878	-$7,072	-$2,367	-$3,342	-$1,613	-$1,980	-$898	-$1,218	-$786	-$1,924
2009	-$4,881	-$7,076	-$2,368	-$3,344	-$1,614	-$1,981	-$898	-$1,218	-$786	-$1,925
2010	-$4,881	-$7,076	-$2,368	-$3,344	-$1,614	-$1,981	-$898	-$1,218	-$786	-$1,925
2011	-$4,881	-$7,076	-$2,368	-$3,344	-$1,614	-$1,981	-$898	-$1,218	-$786	-$1,925
2012-2023 (Annual Impacts)	-$4,881	-$7,076	-$2,368	-$3,344	-$1,614	-$1,981	-$898	-$1,218	-$786	-$1,925
2024-2053 (Annual Impacts)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative 2 Total	-$97,549	-$141,423	-$47,335	-$66,837	-$32,261	-$39,587	-$17,952	-$24,352	-$15,716	-$38,473

Source: BBC 2003.

Table B-12. Projected effects on jobs for Alternative 2.

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	-140	-177	-68	-84	-44	-50	-28	-34	-12	-24
2005	-140	-178	-68	-84	-44	-50	-28	-34	-12	-24
2006	-141	-178	-68	-84	-44	-50	-28	-34	-12	-24
2007	-141	-178	-68	-84	-44	-50	-28	-34	-12	-25
2008	-141	-178	-68	-85	-44	-50	-28	-34	-12	-25
2009	-141	-178	-68	-85	-44	-50	-28	-34	-12	-25
2010	-141	-178	-68	-85	-44	-50	-28	-34	-12	-25
2011	-141	-178	-68	-85	-44	-50	-28	-34	-12	-25
2012-2023 (Annual Impacts)	-141	-178	-68	-85	-44	-50	-28	-34	-12	-25
2024-2053 (Annual Impacts)	0	0	0	0	0	0	0	0	0	-25

Source: BBC 2003.

Table B-13. Projected effects on visitor expenditures and economic output for Alternative 3 (thousands of year 2002 dollars).

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	-$7,721	-$11,193	-$3,747	-$5,290	-$2,553	-$3.132	-$1,421	-$1,928	-$1,244	-$3,042
2005	-$7,746	-$11,229	-$3,759	-$5,307	-$2,561	-$3.142	-$1,426	-$1,934	-$1,248	-$3,052
2006	-$7,758	-$11,247	-$3,765	-$5,316	-$2,565	-$3,147	-$1,428	-$1,937	-$1,250	-$3,057
2007	-$7,767	-$11,259	-$3,769	-$5,321	-$2,568	-$3,151	-$1,429	-$1,939	-$1,251	-$3,060
2008	-$7,771	-$11,265	-$3,771	-$5,324	-$2,570	-$3,152	-$1,430	-$1,940	-$1,252	-$3,062
2009	-$7,775	-$11,271	-$3,773	-$5,327	-$2,571	-$3,154	-$1,431	-$1,942	-$1,253	-$3,063
2010	-$7,775	-$11,271	-$3,773	-$5,327	-$2,571	-$3,154	-$1,431	-$1,942	-$1,253	-$3,063
2011	-$7,775	-$11,271	-$3,773	-$5,327	-$2,571	-$3,154	-$1,431	-$1,942	-$1,253	-$3,063
2012-2023 (Annual Impacts)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2024-2053 (Annual Impacts)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative 3 Total	-$62,088	-$90,009	-$30,132	-$42,540	-$20,530	-$25,186	-$11,427	-$15,504	-$10,002	-$24,463

Source: BBC 2003.

Table B-14. Projected effects on jobs for Alternative 3.

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	-223	-282	-108	-134	-70	-80	-45	-53	-21	-42
2005	-224	-283	-108	-134	-70	-80	-45	-53	-21	-42
2006	-224	-283	-109	-135	-70	-80	-45	-53	-21	-42
2007	-224	-284	-109	-135	-70	-81	-45	-53	-21	-42
2008	-224	-284	-109	-135	-70	-81	-45	-53	-21	-42
2009	-225	-284	-109	-135	-70	-81	-45	-53	-21	-42
2010	-225	-284	-109	-135	-70	-81	-45	-53	-21	-42
2011	-225	-284	-109	-135	-70	-81	-45	-53	-21	-42
2012-2023 (Annual Impacts)	0	0	0	0	0	0	0	0	0	0
2024-2053 (Annual Impacts)	0	0	0	0	0	0	0	0	0	0

Source: BBC 2003.

Table B-15. Projected effects on visitor expenditures and economic output for Alternative 4 (thousands of year 2002 dollars).

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	-$13,903	-$20,160	-$6,747	-$9,528	-$4,597	-$5,641	-$2,559	-$3,472	-$1,882	-$4,605
2005	-$13,978	-$20,269	-$6,784	-$9,580	-$4,622	-$5,672	-$2,573	-$3,491	-$1,892	-$4,630
2006	-$14,024	-$20,335	-$6,806	-$9,611	-$4,637	-$5,690	-$2,581	-$3,502	-$1,898	-$4,645
2007	-$14,046	-$20,368	-$6,816	-$9,626	-$4,644	-$5,699	-$2,585	-$3,508	-$1,901	-$4,652
2008	-$14,061	-$20,389	-$6,824	-$9,636	-$4,649	-$5,705	-$2,588	-$3,512	-$1,903	-$4,657
2009	-$14,069	-$20,400	-$6,827	-$9,642	-$4,652	-$5,708	-$2,590	-$3,513	-$1,904	-$4,660
2010	-$14,076	-$20,411	-$6,831	-$9,647	-$4,654	-$5,711	-$2,591	-$3,515	-$1,905	-$4,662
2011	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2012-2023 (Annual Impacts)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2024-2053 (Annual Impacts)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative 4 Total	-$98,157	-$142,333	-$47,635	-$67,269	-$32,456	-$39,826	-$18,067	-$24,513	-$13,284	-$32,511

Source: BBC 2003.

Table B-16. Projected Local Impacts from Visitation Changes Due to Alternative 4 GTSR Rehabilitation: Jobs

	State of Montana		Flathead County		Glacier County		Lake County		SW Alberta (CD-3)	
Year	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2004	-402	-508	-195	-241	-126	-144	-81	-96	-38	-85
2005	-403	-510	-196	-242	-126	-144	-81	-96	-38	-85
2006	-404	-510	-196	-242	-127	-145	-81	-96	-38	-85
2007	-404	-511	-196	-242	-127	-145	-81	-97	-38	-85
2008	-405	-511	-196	-243	-127	-145	-82	-97	-38	-86
2009	-405	-512	-196	-243	-127	-145	-82	-97	-38	-86
2010	-405	-512	-196	-243	-127	-145	-82	-97	-38	-86
2011	0	0	0	0	0	0	0	0	0	0
2012-2023 (Annual Impacts)	0	0	0	0	0	0	0	0	0	0
2024-2053 (Annual Impacts)	0	0	0	0	0	0	0	0	0	0

Source: BBC 2003.

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APPENDIX C:
WILDLIFE AND PLANT SPECIES OF CONCERN

The wildlife species of concern found in Glacier National Park are described in Table C-1. This list includes species that are listed as "species of special concern" by the Montana Natural Heritage Program, "priority species" by Partners in Flight, and "sensitive species" by the U.S. Forest Service. Aquatic species are listed as species of concern by the Montana National Heritage Program.

WILDLIFE SPECIES OF CONCERN

Table C-1. Wildlife species of concern in the Going-to-the-Sun Road corridor.

Common Name	Scientific Name	Habitat	Potential for Occurrence near the GTSR
MAMMALS			
Fisher	*Martes pennanti*	Coniferous forest and riparian areas	Present, McDonald and St. Mary drainages
Hoary bat	*Lasiurus cinereus*	Mature subalpine, montane and riparian forest edges	Suitable habitat, rare occurrence east and west sides of GNP
Northern bog lemming	*Synaptomys borealis*	Wet meadows, bogs, and marshes	Present McDonald Creek drainage, rare resident, breeding confirmed
Rocky mountain bighorn sheep	*Ovis canadensis*	Subalpine and alpine rocky steep terrain	Present along Continental Divide to St. Mary
Silver-haired bat	*Lasionycteris noctivagans*	Mature subalpine, montane and riparian woodland	Present, both east and west sides of GNP, including McDonald Valley
Swift fox	*Vulpes velox*	Low elevation grasslands	Present in grassland habitat near St. Mary
Townsend's big-eared bat	*Corynorhinus townsedii*	Montane to subalpine forest, shrubland and riparian	Suitable habitat, but no records from GNP
Wolverine	*Gulo luscus*	Subalpine forest and alpine meadows	Present McDonald and St. Mary drainages, rare resident, breeding documented
BIRDS			
American white pelican	*Pelecanus erythrorhynochos*	Near water bodies	Present, rare in summer at Lake McDonald and St. Mary Lake, no breeding evidence
Barrow's goldeneye	*Bucephala islandica*	Small lakes where cavity trees for nesting are available	Present, common spring to fall, both sides of GNP
Black swift	*Cypseloides niger*	Rock cliffs near waterfalls	Present, rare spring and summer, McDonald and St. Mary Valleys
Black tern	*Chlidonias niger*	Large wet meadows, montane	Possible, records in North Fork, observations on east side of GNP
Black-backed woodpecker	*Nattallornis borealis*	Mature subalpine and montane forest, riparian woodlands	Present in McDonald Creek drainage, nesting documented

Common Name	Scientific Name	Habitat	Potential for Occurrence near the GTSR
Black-crowned night heron	*Nycticorax nycticorax*	Shallow water bodies, wetlands, marshes	Possible, accidental visitor to west side of GNP
Boreal owl	*Aegolius funereus*	Subalpine dense mature forest	Present in McDonald drainage, nesting documented
Brewer's sparrow	*Spizella breweri*	Shrubby subalpine habitat	Present, uncommon spring to fall
Brown creeper	*Certhia americana*	Coniferous forest montane to subalpine	Present, common year-round
Calliope hummingbird	*Stellula calliope*	Montane and subalpine forest clearings, alpine meadows	Present, common spring and summer, both sides of GNP
Caspian tern	*Sterna caspia*	Lakes and streams	Possible, rare in fall east side of GNP
Chestnut-collard longspur	*Calcarius ornatus*	Grassland prairie	Possible, uncommon spring, both sides of GNP
Clark's nutcracker	*Nucifraga columbiana*	Coniferous forest	Present, common year-round
Common loon	*Gavia immer*	Large and small lakes with emergent vegetation	Present, common spring to fall in Lake McDonald, St. Mary Lake
Common tern	*Sterna hirundo*	Marshes, lakes, and rivers	Possible, rare spring and fall migrant on east side of GNP
Cordilleran flycatcher	*Empidonax difficilis*	Woodlands	Possible, uncommon North Fork area
Ferruginous hawk	*Buteo regalis*	Plains and grasslands	Present, rare in grasslands on the east side of GNP
Forster's tern	*Sterna fosteri*	Marshes near open shallow water	Possible, accidental visitor on east side of GNP
Franklin's gull	*Larus pipixcan*	Open country near lakes	Possible, uncommon both sides of GNP spring and summer
Golden eagle	*Aquila chrysaetos*	Nests in cliffs and trees in a variety of habitats	Present, several nest sites between Avalanche and Logan Pass; GNP is important migration corridor
Great gray owl	*Strix nebulosa*	Dense conifer forest with meadows	Present, rare resident with documented nesting
Hammond's flycatcher	*Empidonax hammondii*	Mature coniferous forest with open understory	Present, common spring and summer, both sides of GNP
Harlequin duck	*Histrionicus histrionicus*	Primarily fast moving streams, occasionally lakes	Present, breeding habitat along upper McDonald, Avalanche Snyder, and Reynolds Creeks, and St. Mary
Hooded merganser	*Lophodytes cucullatus*	Ponds surrounded by forest	Present, uncommon spring to fall, both sides of GNP
Horned grebe	*Podiceps auritus*	Small lakes and ponds	Present, common spring and summer, both sides of GNP
Lark bunting	*Calamospiza melanocorys*	Grassland prairie	Possible, rare summer, both sides of GNP
Lazuli bunting	*Passerina amoena*	Foothills and riparian shrubland	Present, common spring and summer, both sides of GNP

Common Name	Scientific Name	Habitat	Potential for Occurrence near the GTSR
LeConte's sparrow	*Ammodramus leconteii*	Wet meadows	Present, rare spring to fall on west side of GNP
Lewis's woodpecker	*Melanerpes lewis*	Open pine forest	Present, uncommon spring and summer, both sides of GNP
Loggerhead shrike	*Lanius ludovicianus*	Plains, low valleys, open country	Present, uncommon spring and fall, both sides of GNP
Long-billed curlew	*Numenius americanus*	Open areas near water	Present, uncommon in spring, both sides of GNP
Marbled godwit	*Limosa fedoa*	Prairie grasslands and meadows near lakes	Possible, rare spring, both sides of GNP
McCown's longspur	*Calcarius mccownii*	Grassland prairie	Possible, rare spring, both sides of GNP
Northern goshawk	*Accipiter gentiles*	Mature dense coniferous forest	Present, uncommon spring to fall, rare nesting, sightings in McDonald and St. Mary Valleys
Northern hawk owl	*Surnia uluta*	Burned forested areas, large snags	Present, rare resident and migrant, nesting in North Fork area
Olive-sided flycatcher	*Contopus borealis*	Coniferous forest, bogs, recent burned forest	Present, uncommon spring to fall in McDonald and St. Mary Valleys, documented breeding
Peregrine falcon	*Falco peregrinus*	Foothills to montane, nest generally in cliffs	Present, rare migrant, no known nesting
Pileated woodpecker	*Dryocopus pileatus*	Mature forest montane to subalpine and riparian	Present, fairly common, nesting documented
Red-eyed vireo	*Vireo olivaceus*	Riparian deciduous forest	Present, uncommon spring and summer, both sides of GNP
Ruffed grouse	*Bonasa umbellus*	Deciduous woodland, coniferous forest edges	Present, abundant year-round
Three-toed woodpecker	*Picoides tridactylus*	Coniferous forest and burned areas	Present, common year-round throughout GNP
Trumpeter swan	*Cygnus buccinator*	Lakes, ponds, and rivers	Present, spring and fall migrant, Lake McDonald
Vaux's swift	*Chaetura vauxi*	Coniferous and deciduous forest	Present, common spring and summer both sides of GNP
Veery	*Catharus fuscescens*	Deciduous woodlands and shrubland	Present, uncommon spring to fall, both sides of GNP
White-tailed ptarmigan	*Lagopus leucurus*	Tundra and riparian areas	Present, common in alpine areas
Williamson's sapsucker	*Sphyrapicus thyroideus*	Coniferous and aspen forests	Possible, uncommon spring and summer, both sides of GNP
Willow flycatcher	*Empidonax traillii*	Riparian thickets, mountain parks	Present, common spring and summer, both sides of GNP
Winter wren	*Troglodytes troglodytes*	Coniferous shrubby understory	Present, common spring and summer, both sides of GNP

Common Name	Scientific Name	Habitat	Potential for Occurrence near the GTSR
AMPHIBIANS AND FISH			
Boreal toad	*Bufo boreas*	Breeds in shallow, permanent water bodies above 8,500 feet; adults use upland habitat	Present, aquatic habitat
Rocky Mountain capshell	*Acroloxus coloradensis*	Lakes and ponds	Present in the St. Mary drainage
Shorthead sculpin	*Cottus confussus*	Streams and lakes	Present in the St. Mary drainage
Spoonhead sculpin	*Cottus ricei*	Streams and lakes	Present in the McDonald Creek drainage
Tailed frog	*Ascaphus truei*	Turbulent headwater streams with cobble substrates	Present in McDonald Valley, breeding confirmed
Trout-perch	*Percopsis omiscomaycus*	Streams and lakes	Present, rare in St. Mary Lake
Western cutthroat trout	*Oncorhynchus clarki lewisi*	Streams and lakes	Present in east and west side water bodies

PLANT SPECIES OF CONCERN

Tables C-2, C-3, and C-4 list plant, moss, and lichen species of concern for Glacier National Park according to species listed as plant "species of special concern" listed by the Montana Natural Heritage Program. The rank for these species includes the state rank by the Natural Heritage Program, unless the plant is also globally rare, in which case its global rank is also listed.

Table Code Definitions

G = global status; S = state-wide status; T = rank for subspecific taxon; Q = taxonomic questions involved; H = historically known only from records before 1925; may be rediscovered.

1 = Critically imperiled (<5 occurrences) because of extreme rarity or because of some factor of its biology making it especially vulnerable to extinction.

2 = Has demonstrable factors making it vulnerable to extinction throughout its range (6 to 20 occurrences).

3 = Either very rare or local throughout its restricted range (21 to 100 occurrences) or vulnerable to extinction because of other factors.

4 = Apparently secure, through it may be quite rare in parts of its range, especially at the periphery.

5 = Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

Table C-2. Plant species of concern in the Going-to-the-Sun Road geographic corridor.

Common Name	Scientific Name	Habitat	Rank
Lyre-leaf rockcress	*Arabis lyrata var. kamchatica***	Open, rocky slopes in montane and subalpine zones	G5T5/S2
Mountain moonwort	*Botrychium montanum*	Deep litter of springy, mature forests; also in riparian thickets, mesic meadows, and grassy trail edges where there is little vegetated cover	G3/S3
Creeping sedge	*Carex chordorhiza*	Sphagnum bogs at low elevations	G5/S2
Maritime sedge	*Carex incurviformis var. incurviformis*	Wet rock ledges and small streams above treeline	G4G5T4T5/S1
Lens-fruited sedge	*Carex lenticularis var. dolia***	Wet meadows and boggy ground, along ponds and shallow streams	G5T3Q/S2
Pale sedge	*Carex livida****	Cold, calcareous, poorly drained lowlands and wet peaty ground at low elevations in foothill and submontane zones, shade intolerant.	G5/S3
Beaked sedge	*Carex rostrata***	Organic soils of fens and floating peat mats	G5/S1
Pink corydalis	*Corydalis sempervirens**	Rocky, dry soils of eroding or disturbed slopes, frequently after a burn	G4G5/S1
Mountain bladder fern	*Cystopteris montana***	Moist areas in the mountains at mid to high elevations	G5/SH
Alaskan clubmoss	*Diphasiastrum sitchense*	Meadows and open rocky places at mid to high elevations	G5/S3
Dense-leaf draba	*Draba densifolia*	Gravelly and stony, open soil of rocky slopes and exposed ridges from the mid-montane to alpine zones	G5/S2
Macoun's draba	*Draba macounii***	Moist to wet areas of cool, slopes, outcrops and streams above treeline	G3G4/S1

Common Name	Scientific Name	Habitat	Rank
English sundew	*Drosera anglica*	With moss in wet, organic soils of fens, swamps and bogs in the montane zone	G5/S2
Giant helleborine	*Epipactis gigantea*	Open, wet sites, and in mossy shady areas along rivers, streams, meadows, seeps, and hanging gardens from warm desert shrub to spruce communities	G4/S2
Slender cottongrass	*Eriophorum gracile*	In wet, organic soil of fens at mid to high elevations	G5/S2
Northern eyebright	*Euphrasia arctica var. disjuncta*	In alpine bogs, moist peaty soil, streambanks, and other wet places	G5/S1
Viviparous fescue	*Festuca vivipara***	Moist to wet alpine turf often on slopes between 7,000-8,000 feet	G4G5Q/S2
Glaucous gentian	*Gentiana glauca***	Wet to boggy soils of rock ledges at or above treeline	G4G5/S1
Three-flowered rush	*Juncus albescens*	Peatlands and moist, well-developed turf and gravelly soils along streams and seeps in the alpine zone	G5/S2
Pale laurel	*Kalmia polifolia*	In peat-lands, including spruce forest and outer lake margins in the montane zone	G5/S1
Simple kobresia	*Kobresia simpliciuscula*	Moist, organic soils in alpine turf on exposed slopes	G5/S2
Ground pine	*Lycopodium dendroideum*	Low elevations in moist, montane forest	G5/S1
Running pine	*Lycopodium lagopus***	Turf along moist slopes at mid to high elevations	G?/S1
Adder's tongue	*Ophioglossum pusillum*	Wet meadows, margins of fens, and gravelly moist soil at low to mid elevations	G5/S2
Alpine glacier poppy	*Papaver pygmaeum*	Rocky, open slopes at high elevations	G3/S3
Banff loose-flowered bluegrass	*Poa laxa ssp. banffiana***	Mudstone slopes and alpine turf at high elevations	G5?T1/S1
Five-leaf cinquefoil	*Potentilla quinquefolia*	Dry, gravelly soil of windswept ridges and slopes in the alpine zone	G5T4/S2
Northern buttercup	*Ranunculus pedatifidus*	Moist meadows, grasslands, alpine tundra, or open, rocky soil on windswept ridges; grows best in calcareous regions	G5/S1
Timberline buttercup	*Ranunculus verecundus*	Meadows, moraines, open slopes and ridges, often in gravelly areas at treeline	G5/S2
Barratt's willow	*Salix barrattiana*	Boggy meadows, moist open hillsides in mountains, and along lakeshores and streambanks	G5/S1
Pod grass	*Scheuchzeria palustris*	Wet, organic soil of fens and bogs at low to mid elevations	G5/S2
Tufted club-rush	*Scirpus cespitosus*	Wet meadows and bogs at low to high elevations	G5/S2
Hudson's Bay bulrush	*Scirpus hudsonianus**	Wet meadows and springs at low to mid elevations	G5/S1
Water bulrush	*Scirpus subterminalis*	Submerged in rivers, ponds, lakes, streams, and standing water up to 3 or 4 feet deep at low elevations	G4G5/S2
Northern beechfern	*Thelypteris phegopteris*	Boreal, wet temperate, cool mesothermal climates on moist, calcareous cliff crevices or moist banks in rich, damp forest floors	G5/S2

Common Name	Scientific Name	Habitat	Rank
Little false asphodel	*Tofieldia pusilla***	Moist, often shallow soils in alpine areas	G5/S2
Cushion townsendia	*Townsendia condensata*	Open, rocky, soil of exposed slopes and ridge tops at mid to high elevations	G4/S2
Flat-leaved bladderwort	*Utricularia intermedia*	Shallow, standing, or slow-moving water	G5/S1
Velvetleaf blueberry	*Vaccinium myrtilloides*	Moist to rather dry forests in the montane zone	G5/S1

* only locations in the western US

** only location(s) in Montana

*** only location for the northern Rocky Mountains

Table C-3. Mosses of concern in the Going-to-the-Sun Road corridor.

Scientific Name	Habitat	Rank
Brachythecium turgidum	Partially submerged in pond on tundra	G4/S1
Bryum lonchocaulon	Moist, peaty soils	G5?/S1
Bryum pallens	On soil or rocks	G4G5/S1
Bryum schleicheri	Wet rock surfaces	G5?/S1
Dichodontium olympicum	Wet rock surfaces and soil	GU/S1
Dicranella grevilleana	Moist shaded banks	G2G4/S1
Dicranella heteromalla	Moist peaty slight slopes	G5?/S1
Dicranum fragilifolium	Moist shaded banks and slopes and on rotting wood	G4G5/S1
Distichium inclinatum	Rock surfaces	G4G5/S1
Grimmia mollis	Rock and occasionally tundra	G3G5/S1
Kiaeria blyttii	Rock at mid to high elevations	G5/S1
Kiaeria starkei	Peaty soils, stream edges, ledges and banks	G5/S1
Meesia longiseta	In swamps and sphagnum bogs	G4?/S1
Meesia triquetra	Moist to wet soils	G5/S2
Meesia uliginosa	Peaty or calcareous soils, fens, and in wet depressions at high elevations.	G4/S1
Myurella tenerrima	Soil, cliffs, banks and overhangs; fens at mid elevations	G3G4/S1
Neckera douglasii	Lakeshore	G4/S1
Paludella squarrosa	Fens, springs, meadows and seeps in tundra at high elevations	G3G5/S1
Paraleucobryum enerve	Acidic tundra, often in depressions and at the top of rock outcrops at high elevations	G5?/S1
Paraleucobryum longifolium	Acidic tundra and on rock outcrops at high elevations	G5/S1
Plagiobryum zierii	Wet rock	G3G4/S1
Pohlia drummondii	Wet to moist soils including clay at mid to high elevations	G3G4/S1
Pohlia obtusifolia	Cold, wet soil such as the edge of snowfields	G2G4/S1
Pseudocalliergon turgescens	Wet rock in alpine zone	G3G5/S1
Schistostega pennata	Moist to wet dark places such as caves and overturned bases of trees	G4/S1
Sphagnum centrale	Fens and bogs at low to high elevations	G5/S1
Sphagnum contortum	Fens and bogs at low to high elevations	G5/S1
Sphagnum girgensohnii	Fens and bogs at low to high elevations	G5/S1
Stegonia latifolia	Dry soil	G3G5/S1
Tayloria lingulata	Fens, preferably slightly acidic, at high elevations	G3G5/S1
Tayloria serrata	Dung, decomposing wood, and soil	G4/S1
Thamnobryum neckeroides	Rock in the alpine zone	G?/SH
Tortula norvegica	Wet soils and rocks in the alpine zone	G5/S1

Table C-4. Lichens of concern in the Going-to-the-Sun Road corridor.

Scientific Name	Habitat	Rank
Bryoria subdivergens	Alpine sod at high elevations	G2/S2
Collema curtisporum	Bark of *Populus* species	G3/S2