



# Table of Contents

## VOLUME 1

EXECUTIVE SUMMARY .....	T-4
<b>1. PURPOSE OF AND NEED FOR THE ACTION</b>	
<b>1.1 Assumptions and Report Organization .....</b>	<b>1.1-1</b>
1.1.1 Assumptions and Definitions .....	1.1-1
<i>1.1.1.1 Alternatives Analyzed .....</i>	<i>1.1-1</i>
<i>1.1.1.2 Federal Grant and State Lease .....</i>	<i>1.1-1</i>
<i>1.1.1.3 Definition of Pipeline System .....</i>	<i>1.1-2</i>
<i>1.1.1.4 Affected Environment .....</i>	<i>1.1-3</i>
<i>1.1.1.5 Analysis of Effects .....</i>	<i>1.1-3</i>
1.1.2 How to Use This Report .....	1.1-5
<b>1.2 Purpose and Need.....</b>	<b>1.2-1</b>
<b>1.3 History of Trans Alaska Pipeline System .....</b>	<b>1.3-1</b>
<b>2. ALTERNATIVES INCLUDING THE PROPOSED ACTION</b>	
<b>2.1 Description of Proposed Action: Renewal of Right-of-Way .....</b>	<b>2.1-1</b>
2.1.1 Trans Alaska Pipeline System .....	2.1-1
<i>2.1.1.1 Description by Major Component.....</i>	<i>2.1-1</i>
<i>2.1.1.2 Projected Use .....</i>	<i>2.1-9</i>
2.1.2 Pipeline-Associated Marine Transportation.....	2.1-14
<i>2.1.2.1 Tanker Traffic .....</i>	<i>2.1-14</i>
<i>2.1.2.2 Ship Escort/Response Vessel System .....</i>	<i>2.1-17</i>
<b>2.2 No Action Alternative: Right-of-Way Not Renewed .....</b>	<b>2.2-1</b>
2.2.1 Completion of Use .....	2.2-1
2.2.2 Major Physical DR&R Assumptions .....	2.2-1
2.2.3 Description of No-Action Alternative .....	2.2-2
<b>2.3 Alternatives and Issues Considered but Eliminated from Detailed Analysis .....</b>	<b>2.3-1</b>
<b>3. AFFECTED ENVIRONMENT</b>	
<b>3.1 Physical Characteristics .....</b>	<b>3.1-1</b>
3.1.1 Terrestrial Environment .....	3.1-1
<i>3.1.1.1 Physiography and Geology .....</i>	<i>3.1-1</i>
<i>3.1.1.2 Paleontological Resources .....</i>	<i>3.1-4</i>
<i>3.1.1.3 Soils and Permafrost .....</i>	<i>3.1-5</i>



3.1.1.4	<i>Sand, Gravel and Rock</i> .....	3.1-6
3.1.1.5	<i>Hazardous Materials</i> .....	3.1-6
3.1.1.6	<i>Hydrology/River Characteristics</i> .....	3.1-7
3.1.1.7	<i>Seismicity</i> .....	3.1-16
3.1.2	Water Resources .....	3.1-18
3.1.2.1	<i>Fresh Water Quality</i> .....	3.1-18
3.1.2.2	<i>Port Valdez Marine Waters</i> .....	3.1-19
3.1.3	Atmospheric Environment .....	3.1-21
3.1.3.1	<i>North of Brooks Range</i> .....	3.1-21
3.1.3.2	<i>South of Brooks Range to North of Alaska Range</i> .....	3.1-23
3.1.3.3	<i>South of Alaska Range</i> .....	3.1-26
<b>3.2</b>	<b>Biological Resources .....</b>	<b>3.2-1</b>
3.2.1	Special Areas, Special Management Zones, and Zones of Restricted Activity .....	3.2-1
3.2.2	Vegetation and Wetlands .....	3.2-1
3.2.2.1	<i>Arctic Coastal Plain</i> .....	3.2-3
3.2.2.2	<i>Arctic Foothills</i> .....	3.2-6
3.2.2.3	<i>Brooks Range</i> .....	3.2-8
3.2.2.4	<i>Interior Forests</i> .....	3.2-8
3.2.2.5	<i>The Alaska Range</i> .....	3.2-9
3.2.2.6	<i>Copper Plateau</i> .....	3.2-10
3.2.2.7	<i>Pacific Coastal Mountains</i> .....	3.2-10
3.2.2.8	<i>Coastal Western Hemlock-Sitka Spruce Forest</i> .....	3.2-10
3.2.3	Fish .....	3.2-11
3.2.3.1	<i>Arctic Slope Drainage</i> .....	3.2-11
3.2.3.2	<i>Yukon Drainage</i> .....	3.2-16
3.2.3.3	<i>Copper River Drainage</i> .....	3.2-17
3.2.3.4	<i>Prince William Sound and Tanker Routes</i> .....	3.2-18
3.2.4	Birds .....	3.2-19
3.2.4.1	<i>Waterfowl</i> .....	3.2-19
3.2.4.2	<i>Raptors</i> .....	3.2-26
3.2.4.3	<i>Shorebirds</i> .....	3.2-27
3.2.4.4	<i>Seabirds</i> .....	3.2-29
3.2.4.5	<i>Passerines and Other Birds</i> .....	3.2-29
3.2.5	Terrestrial Mammals .....	3.2-32
3.2.5.1	<i>Moose</i> .....	3.2-38
3.2.5.2	<i>Caribou</i> .....	3.2-42
3.2.5.3	<i>Muskoxen</i> .....	3.2-48
3.2.5.4	<i>Bison</i> .....	3.2-50
3.2.5.5	<i>Dall Sheep</i> .....	3.2-52
3.2.5.6	<i>Deer</i> .....	3.2-54
3.2.5.7	<i>Mountain Goats</i> .....	3.2-55
3.2.5.8	<i>Brown (Grizzly) Bear</i> .....	3.2-57
3.2.5.9	<i>Black Bear</i> .....	3.2-61
3.2.5.10	<i>Wolf</i> .....	3.2-64
3.2.5.11	<i>Furbearers and Small Mammals</i> .....	3.2-66
3.2.6	Marine Mammals .....	3.2-72
3.2.6.1	<i>North Slope/Beaufort Sea</i> .....	3.2-72
3.2.6.2	<i>Prince William Sound Tanker Routes</i> .....	3.2-78



3.2.7 Threatened and Endangered Species .....	3.2-82
3.2.7.1 <i>Birds</i> .....	3.2-82
3.2.7.2 <i>Plants</i> .....	3.2-86
3.2.7.3 <i>Mammals</i> .....	3.2-86
<b>3.3 Social Systems.....</b>	<b>3.3-1</b>
3.3.1 Economy .....	3.3-1
3.3.1.1 <i>Importance of ANS/TAPS to the National Economy</i> .....	3.3-1
3.3.1.2 <i>Importance of ANS/TAPS to the State Economies</i> .....	3.3-5
3.3.1.3 <i>Importance of ANS/TAPS to Regional Economies in Alaska</i> .....	3.3-19
3.3.1.4 <i>Alaska Native Community</i> .....	3.3-22
3.3.1.5 <i>Other Historical TAPS/ANS Impacts</i> .....	3.3-23
3.3.2 Sociocultural Systems .....	3.3-29
3.3.2.1 <i>Introduction and Definition</i> .....	3.3-29
3.3.2.2 <i>Description of Sociocultural Systems Past and Present</i> .....	3.3-29
3.3.3 Subsistence .....	3.3-49
3.3.3.1 <i>Definition of Subsistence</i> .....	3.3-49
3.3.3.2 <i>Sociocultural Significance of Subsistence</i> .....	3.3-49
3.3.3.3 <i>Activities That Make Up Subsistence</i> .....	3.3-50
3.3.3.4 <i>Subsistence Harvest Patterns</i> .....	3.3-54
3.3.3.5 <i>Access to Subsistence Resources</i> .....	3.3-64
3.3.4 Cultural Resources .....	3.3-65
3.3.4.1 <i>Introduction</i> .....	3.3-65
3.3.4.2 <i>Cultural History of TAPS Route</i> .....	3.3-66
3.3.5 Land Ownership and Land Uses .....	3.3-71
3.3.5.1 <i>Introduction</i> .....	3.3-71
3.3.5.2 <i>Land Ownership</i> .....	3.3-71
3.3.5.3 <i>Land Use</i> .....	3.3-72
3.3.6 Recreation and Visual Resources .....	3.3-75
3.3.6.1 <i>Introduction</i> .....	3.3-75
3.3.6.2 <i>Recreation</i> .....	3.3-75
3.3.6.3 <i>Visual Resources</i> .....	3.3-76
3.3.7 Wilderness .....	3.3-77
3.3.7.1 <i>Federal- or State-Designated Wilderness</i> .....	3.3-77
3.3.7.2 <i>Description of Wilderness Character of Remaining Access</i> .....	3.3-78
3.3.8 Transportation .....	3.3-78
3.3.8.1 <i>Introduction and History</i> .....	3.3-78
3.3.8.2 <i>Transportation Systems</i> .....	3.3-79

## 4. ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION AND ALTERNATIVES

<b>4.1 Mechanisms of Impact .....</b>	<b>4.1-1</b>
4.1.1 Ground-Impacting Maintenance Actions .....	4.1-1
4.1.1.1 <i>Corrosion Repair of Below-Ground Mainline Pipeline</i> .....	4.1-1
4.1.1.2 <i>Slope/Workpad Maintenance</i> .....	4.1-2
4.1.1.3 <i>Potential Pipeline Replacement</i> .....	4.1-2
4.1.1.4 <i>Mainline Below-Ground Valve Inspections</i> .....	4.1-2
4.1.1.5 <i>Remediation of Mainline Cathodic Protection</i> .....	4.1-3
4.1.1.6 <i>River Crossings and River Training Structure Repairs</i> .....	4.1-3
4.1.1.7 <i>Surveillance Actions</i> .....	4.1-4



4.1.1.8	<i>Fuel Gas Line Maintenance and Repair</i> .....	4.1-4
4.1.1.9	<i>New Material Sites/Rock Quarries</i> .....	4.1-4
4.1.2	<i>Spill Analysis</i> .....	4.1-4
4.1.2.1	<i>Data Sources and Compilation</i> .....	4.1-5
4.1.2.2	<i>Data Analysis</i> .....	4.1-5
4.1.2.3	<i>Projections of Future Spill Volumes</i> .....	4.1-10
<b>4.2</b>	<b>Existing Mitigation Measures</b> .....	<b>4.2-1</b>
4.2.1	<i>Design Features</i> .....	4.2-2
4.2.1.1	<i>Special Foundation Designs for Permafrost Soils</i> .....	4.2-2
4.2.1.2	<i>Design Features to Mitigate Earthquake Effects</i> .....	4.2-4
4.2.1.3	<i>Mitigation of Effects of Stream Crossings and Instream Alignments</i> .....	4.2-5
4.2.1.4	<i>Hydrocarbon Emissions Control</i> .....	4.2-8
4.2.1.5	<i>Ballast Water Treatment</i> .....	4.2-8
4.2.1.6	<i>Pipeline Spill Control</i> .....	4.2-10
4.2.1.7	<i>Designated Big Game Crossings</i> .....	4.2-11
4.2.2	<i>TAPS Monitoring, Surveillance, and Maintenance Programs</i> .....	4.2-11
4.2.2.1	<i>Integrity Monitoring Programs</i> .....	4.2-12
4.2.2.2	<i>Surveillance and Maintenance Programs</i> .....	4.2-19
4.2.2.3	<i>Environmental Monitoring</i> .....	4.2-19
4.2.3	<i>Spill Prevention and Response</i> .....	4.2-24
4.2.3.1	<i>Pipeline</i> .....	4.2-25
4.2.3.2	<i>Valdez Marine Terminal</i> .....	4.2-26
4.2.3.3	<i>Tanker Trade</i> .....	4.2-27
4.2.3.4	<i>North Slope Oil Fields</i> .....	4.2-33
4.2.4	<i>Social Mitigation Measures</i> .....	4.2-33
4.2.4.1	<i>Original ROW Stipulations</i> .....	4.2-34
4.2.4.2	<i>Stipulations Contained in Other Lease Agreements</i> .....	4.2-34
4.2.4.3	<i>Specific Commitments by TAPS Owners or Alyeska</i> .....	4.2-35
4.2.4.4	<i>Economic/Demographic Factors</i> .....	4.2-35
4.2.4.5	<i>Federal and State Laws and Implementing Regulations</i> .....	4.2-35
<b>4.3</b>	<b>Impacts of Proposed Action</b> .....	<b>4.3-1</b>
4.3.1	<i>Physical Characteristics</i> .....	4.3-1
4.3.1.1	<i>Terrestrial Environment</i> .....	4.3-1
4.3.1.2	<i>Water Resources</i> .....	4.3-12
4.3.1.3	<i>Atmospheric Environment</i> .....	4.3-22
4.3.1.4	<i>Global Climate Change</i> .....	4.3-33
4.3.2	<i>Biological Resources</i> .....	4.3-34
4.3.2.1	<i>Special Areas, Special Management Zones, and Zones of Restricted Activity</i> .....	4.3-35
4.3.2.2	<i>Vegetation and Wetlands</i> .....	4.3-36
4.3.2.3	<i>Fish</i> .....	4.3-44
4.3.2.4	<i>Birds</i> .....	4.3-46
4.3.2.5	<i>Terrestrial Mammals</i> .....	4.3-50
4.3.2.6	<i>Threatened and Endangered Species</i> .....	4.3-67
4.3.2.7	<i>Effects of Treated Ballast-Water Effects on Benthos in Port Valdez</i> .....	4.3-70
4.3.3	<i>Social Systems</i> .....	4.3-70
4.3.3.1	<i>Economy</i> .....	4.3-70
4.3.3.2	<i>Sociocultural Systems</i> .....	4.3-81
4.3.3.3	<i>Subsistence</i> .....	4.3-82



4.3.3.4 <i>Cultural Resources</i> .....	4.3-83
4.3.3.5 <i>Land Ownership</i> .....	4.3-85
4.3.3.6 <i>Land Use</i> .....	4.3-85
4.3.3.7 <i>Coastal Management</i> .....	4.3-85
4.3.3.8 <i>Recreation</i> .....	4.3-86
4.3.3.9 <i>Visual Resources</i> .....	4.3-86
4.3.3.10 <i>Wilderness</i> .....	4.3-86
4.3.3.11 <i>Transportation</i> .....	4.3-86
<b>4.4 Impacts of No-Action Alternative .....</b>	<b>4.4-1</b>
4.4.1 Physical Characteristics .....	4.4-1
4.4.1.1 <i>Terrestrial Environment</i> .....	4.4-1
4.4.1.2 <i>Water Resources</i> .....	4.4-3
4.4.1.3 <i>Atmospheric Environment</i> .....	4.4-4
4.4.1.4 <i>Global Climate Change</i> .....	4.4-5
4.4.2 Biological Resources .....	4.4-5
4.4.2.1 <i>Special Areas, Special Management Zones, and Zones of Restricted Activity</i> .....	4.4-5
4.4.2.2 <i>Vegetation and Wetlands</i> .....	4.4-6
4.4.2.3 <i>Fish</i> .....	4.4-7
4.4.2.4 <i>Birds</i> .....	4.4-8
4.4.2.5 <i>Terrestrial Mammals</i> .....	4.4-11
4.4.2.6 <i>Threatened and Endangered Species</i> .....	4.4-20
4.4.3 Social Systems .....	4.4-22
4.4.3.1 <i>Economy</i> .....	4.4-22
4.4.3.2 <i>Sociocultural Systems</i> .....	4.4-40
4.4.3.3 <i>Subsistence</i> .....	4.4-40
4.4.3.4 <i>Cultural Resources</i> .....	4.4-41
4.4.3.5 <i>Land Ownership</i> .....	4.4-42
4.4.3.6 <i>Land Use</i> .....	4.4-42
4.4.3.7 <i>Coastal Management</i> .....	4.4-42
4.4.3.8 <i>Recreation</i> .....	4.4-42
4.4.3.9 <i>Visual Resources</i> .....	4.4-42
4.4.3.10 <i>Wilderness</i> .....	4.4-42
4.4.3.11 <i>Transportation</i> .....	4.4-42
<b>4.5 Cumulative Impacts .....</b>	<b>4.5-1</b>
4.5.1 Methodology .....	4.5-2
4.5.1.1 <i>Sequence of Analysis</i> .....	4.5-2
4.5.1.2 <i>Detailed Discussion of Methods for Evaluating Cumulative Impacts</i> .....	4.5-8
4.5.2 Other Past, Present, and Reasonably Foreseeable Future Actions and Associated Environmental Issues .....	4-5-10
4.5.2.1 <i>Other Actions</i> .....	4.5-10
4.5.2.2 <i>Types of Issues Creating the Potential for Cumulative Effects</i> .....	4.5-19
4.5.3 Results: Proposed Action .....	4.5-19
4.5.3.1 <i>Proposed Action: Physical Resources</i> .....	4.5-20
4.5.3.2 <i>Proposed Action: Biological Resources</i> .....	4.5-26
4.5.3.3 <i>Proposed Action: Social Resources</i> .....	4.5-49
4.5.4 Results: No-Action Alternative .....	4.5-66
4.5.4.1 <i>No-Action Alternative: Physical Resources</i> .....	4.5-66
4.5.4.2 <i>No-Action Alternative: Biological Resources</i> .....	4.5-68



4.5.4.3 No-Action Alternative: Social Issues .....	4.5-76
4.5.5 Summary and Conclusions .....	4.5-84
<b>4.6 Unavoidable Adverse Effects of Proposed Action .....</b>	<b>4.6-1</b>
<b>4.7 Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity .....</b>	<b>4.7-1</b>
4.7.1 Physical Resources .....	4.7-1
4.7.2 Biological Resources .....	4.7-1
4.7.3 Cultural/Paleontological Resources .....	4.7-2
4.7.4 Visual Resources .....	4.7-2
4.7.5 Socioeconomic Effects .....	4.7-2
<b>4.8 Irreversible and Irretrievable Commitment of Resources.....</b>	<b>4.8-1</b>
4.8.1 Crude Oil and Gas .....	4.8-1
4.8.2 Physical Environment .....	4.8-2
4.8.2.1 Water Resources .....	4.8-2
4.8.2.2 Water Quality .....	4.8-2
4.8.2.3 Air Quality .....	4.8-2
4.8.3 Biological Environment .....	4.8-2
4.8.3.1 Vegetation .....	4.8-2
4.8.3.2 Fish .....	4.8-2
4.8.3.3 Birds .....	4.8-3
4.8.3.4 Mammals .....	4.8-3
4.8.3.5 Endangered and Threatened Species .....	4.8-3
4.8.4 Social Systems .....	4.8-3
4.8.4.1 Economy .....	4.8-3
4.8.4.2 Cultural Resources .....	4.8-3
4.8.4.3 Recreational and Visual Resources .....	4.8-3
4.8.4.4 Subsistence Harvest Patterns .....	4.8-3
4.8.4.5 Sociocultural Systems .....	4.8-4
4.8.5 Resources Used in Construction and Operations .....	4.8-4
<b>4.9 Energy Requirements and Conservation Potential .....</b>	<b>4.9-1</b>
4.9.1 TAPS Energy Usage .....	4.9-1
4.9.2 Energy Intensity .....	4.9-1
4.9.3 Marine Transportation .....	4.9-3
4.9.4 Synthesis .....	4.9-5
<b>4.10 Environmental Justice .....</b>	<b>4.10-1</b>
4.10.1 Proposed Action .....	4.10-1
4.10.2 No-Action Alternative .....	4.10-1
4.10.3 Cumulative Effects .....	4.10-2
<b>4.11 Impact on Sacred Sites .....</b>	<b>4.11-1</b>
<b>4.12 Invasive Species .....</b>	<b>4.12-1</b>
4.12.1 Tanker Traffic .....	4.12-1
4.12.2 Revegetation .....	4.12-1
<b>4.13 Impact on Wetlands .....</b>	<b>4.13-1</b>
4.13.1 Vegetation and Wetlands .....	4.13-1
4.13.2 No-Action Alternative .....	4.13-1



## **VOLUME 2**

<b>5. LIST OF PREPARERS .....</b>	<b>5-1</b>
<b>6. INDEX .....</b>	<b>6-1</b>
<b>7. LIST OF ACRONYMS .....</b>	<b>7-1</b>
<b>8. LITERATURE CITED .....</b>	<b>8-1</b>

## **APPENDICES**

<b>A. Trans Alaska Pipeline System Throughput Analysis .....</b>	<b>A-1</b>
<b>B. Oil Spill Analysis for North Slope Oil Production and Transportation Operations .....</b>	<b>B-1</b>
<b>C. Trans Alaska Pipeline System Right-of-Way Map Atlas .....</b>	<b>C-1</b>
<b>D. Historical Overview of North Slope Petroleum Development and <i>Exxon Valdez</i> Oil Spill .....</b>	<b>D-1</b>
<b>E. Federal Agreement and Grant Right-of-Way for the Trans-Alaska Pipeline .....</b>	<b>E-1</b>



# List of Figures

Figure 1	General study areas used in preparation of this Environmental Report .....	vi
Figure 1.1-1	General study areas used in preparation of this Environmental Report .....	1.1-4
Figure 2-1	State of Alaska map showing place names and trans-Alaska pipeline route .....	after p. 2-2
Figure 2.1-1	Trans Alaska Pipeline System .....	after p. 2.1-2
Figure 2.1-2	Pipeline construction modes for Trans Alaska Pipeline System .....	2.1-3
Figure 2.1-3	TAPS gate valve and check valve .....	2.1-4
Figure 2.1-4	Pump Station 1 at TAPS Milepost 0 .....	2.1-6
Figure 2.1-5	Layout of Valdez Marine Terminal .....	2.1-7
Figure 2.1-6	Daily average TAPS throughput since startup .....	2.1-9
Figure 2.1-7	Sample hydraulic gradient graph .....	2.1-10
Figure 2.1-8	Average incoming crude-oil temperature at Valdez .....	2.1-12
Figure 2.1-9	Routes from Valdez for tankers carrying Alaska North Slope crude .....	2.1-15
Figure 2.1-10	Planned phaseout for existing TAPS-related tankers .....	2.1-16
Figure 2.1-11	Tanker projections .....	2.1-16
Figure 3-1	General study areas used in preparation of this Environmental Report .....	3-2
Figure 3.1-1	Physiographic units along the Trans Alaska Pipeline System .....	after p. 3.1-2
Figure 3.1-2	Hypothetical example of typical temperature profile and thickness of permafrost in central Alaska .....	3.1-6
Figure 3.1-3	Braided river — Dietrich River, MP 185.8. Characteristics and changes over time .....	3.1-8
Figure 3.1-4	Floodplain in a braided North Slope river — Sagavanirktok River, MP 63.0. Characteristics and changes over time .....	3.1-9
Figure 3.1-5	Split channel and sharp bend — Middle Fork Koyukuk River, MP 218.5. Characteristics and changes over time .....	3.1-10
Figure 3.1-6	Single incised channel — Tazlina River, MP 687.0. Characteristics and changes over time .....	3.1-11
Figure 3.1-7	Alluvial fan — Miller Creek, MP 599.6. Characteristics and changes over time .....	3.1-12
Figure 3.1-8	Monthly flow data for streams crossed by the trans-Alaska pipeline .....	3.1-15
Figure 3.1-9	Peak flow hydrographs for representative streams crossed by the pipeline .....	3.1-16
Figure 3.1-10	Map showing seismic zones and fault crossings along TAPS and earthquakes greater than magnitude 5.5 that have occurred near TAPS since startup. ....	3.1-17
Figure 3.1-11	Field water-quality data from selected TAPS route locations (May-September 1972) .....	3.1-18
Figure 3.1-12	Water quality in Sagavanirktok River basin, average values along watercourse, June and August 1969 .....	3.1-19
Figure 3.1-13	Groundwater quality at Alyeska Pipeline Service Company facilities .....	3.1-20
Figure 3.1-14	Vertical distribution of temperature, salinity, and density in Port Valdez .....	3.1-21
Figure 3.1-15	Mean temperature for six weather stations .....	3.1- 22
Figure 3.1-16	Normal monthly accumulation of precipitation for six weather stations .....	3.1-22



Figure 3.1-17	Average monthly snowfall for six weather stations .....	3.1-23
Figure 3.1-18	Mean number of clear days for six weather stations .....	3.1-23
Figure 3.1-19	Average hours of daylight for six weather stations .....	3.1-24
Figure 3.1-20	Windroses for five weather stations .....	3.1-25
Figure 3.2-1	Major vegetational zones along TAPS .....	after p. 3.2-2
Figure 3.2-2	Major drainages along the TAPS ROW .....	3.2-12
Figure 3.2-3	Locations of seabird colonies in North Gulf Coast/Prince William Sound region .....	3.2-30
Figure 3.2-4	State of Alaska game management unit map .....	3.2-34
Figure 3.2-5	Game management unit map for moose along TAPS .....	3.2-39
Figure 3.2-6	Moose mortality chart for GMU 13 .....	3.2-40
Figure 3.2-7	Moose hunter numbers for GMU 13 .....	3.2-40
Figure 3.2-8	ADF&G caribou herd map with population estimates .....	after p. 3.2-44
Figure 3.2-9	Nelchina Caribou Herd population estimates .....	3.2-43
Figure 3.2-10	Delta Caribou Herd population estimates .....	3.2-43
Figure 3.2-11	Central Arctic Herd population estimates .....	3.2-44
Figure 3.2-12	Nelchina Caribou Herd mortality causes and harvest permits issued .....	3.2-45
Figure 3.2-13	Game management unit map for muskoxen along TAPS .....	3.2-49
Figure 3.2-14	Game management unit map for bison along TAPS .....	3.2-50
Figure 3.2-15	Game Management Unit map for Dall sheep along TAPS .....	3.2-52
Figure 3.2-16	Game management unit map for deer along TAPS .....	3.2-54
Figure 3.2-17	Game management unit map for mountain goats along TAPS .....	3.2-55
Figure 3.2-18	Game management unit map for brown bears along TAPS .....	3.2-57
Figure 3.2-19	Game management unit map for black bears along TAPS .....	3.2-62
Figure 3.2-20	Game management unit map for wolves along TAPS .....	3.2-64
Figure 3.2-21	Fall wolf-population estimates/harvests, GMU 13 .....	3.2-64
Figure 3.2-22	Abundance patterns of Spectacled Eiders across the North Slope .....	3.2-84
Figure 3.3-1	ANS and other Alaska crude oil as a percentage domestic crude production, 1977-1998 .....	3.3-2
Figure 3.3-2	U.S. net balance-of-trade in crude oil as reported and estimated assuming no ANS/TAPS outputs .....	3.3-2
Figure 3.3-3	Federal royalties and income taxes from Alaska North Slope and TAPS operations 1977-1998 .....	3.3-3
Figure 3.3-4	Estimates of the full-time equivalent and total number of tankers engaged in the Alaska North Slope trade .....	3.3-4
Figure 3.3-5	Alaska gross state product by sector .....	3.3-6
Figure 3.3-6	Alaska North Slope oil employment (left axis) and wages in money of day and 1998 dollars (right axis) .....	3.3-7
Figure 3.3-7	Average annual wages by industry in Alaska, 1997 .....	3.3-8
Figure 3.3-8	Twenty states listed in descending order of combined state and local expenditures per capita, 1996 .....	3.3-14
Figure 3.3-9	Twenty states listed in descending order of debt per capita, 1996 .....	3.3-14
Figure 3.3-10	Permanent Fund Dividend in dollars per person and as percent of per-capita income .....	3.3-15
Figure 3.3-11	State revenues from the petroleum industry as a percentage of unrestricted General Fund revenues, 1965-1999 .....	3.3-17
Figure 3.3-12	Communities in North Slope, Central TAPS, and Valdez/Prince William Sound study areas .....	3.3-30
Figure 3.3-13	Population trends for the State of Alaska, North Slope Borough, and Barrow ....	3.3-32



Figure 3.3-14	Population and ethnicity data, North Slope study area communities, 1999 .....	3.3-33
Figure 3.3-15	Major employers of residents of the North Slope Borough in 1998 .....	3.3-34
Figure 3.3-16	Median household income of North Slope communities, Alaska, and the United States in 1990 .....	3.3-35
Figure 3.3-17	Population and ethnicity data, Central TAPS study area communities, 1999 .....	3.3-36
Figure 3.3-18	Median household income of TAPS study area communities, 1990 .....	3.3-42
Figure 3.3-19	Distribution of Fairbanks North Star Borough employment by sector, 1997 .....	3.3-43
Figure 3.3-20	Population and ethnicity data for Valdez/Prince William Sound communities, 1999 .....	3.3-44
Figure 3.3-21	Median household income of Valdez/Prince William Sound communities, 1990 .....	3.3-47
Figure 3.3-22	Annual subsistence cycle for North Slope communities .....	3.3-52
Figure 3.3-23	Selected summary quantitative subsistence harvest data, Barrow .....	3.3-56
Figure 3.3-24	Selected summary quantitative subsistence harvest data, Kaktovik .....	3.3-56
Figure 3.3-25	Selected summary quantitative subsistence harvest data, Nuiqsut .....	3.3-57
Figure 3.3-26	Documented annual bowhead whale harvest for Barrow, Kaktovik, and Nuiqsut, 1964-1997 .....	3.3-57
Figure 3.3-27	Harvest data for rural communities in the Central TAPS study area, 1987 .....	3.3-58
Figure 3.3-28	Per-capita harvests of wild resources by resource category, Valdez .....	3.3-61
Figure 3.3-29	Per-capita harvests of wild resources by resource category, Tatitlek .....	3.3-62
Figure 3.3-30	Per-capita harvests of wild resources by category, Cordova .....	3.3-62
Figure 3.3-31	Per-capita harvests of wild resources by category, Chenega Bay .....	3.3-63
Figure 3.3-32	Percent of respondents reporting eating any wild foods the day before, PWS communities, 1992 .....	3.3-63
Figure 3.3-33	Cultural chronology of the TAPS study area.....	3.3-67
Figure 3.3-34	Fluted projectile points and lanceolate points .....	3.3-67
Figure 3.3-35	Artist's conception of microblade and core .....	3.3-69
Figure 3.3-36	Sample land ownership map from Appendix C .....	after p. 3.3-72
Figure 3.3-37	Conservation system units in the vicinity of TAPS .....	3.3-73
Figure 3.3-38	Transportation assets of Alaska .....	3.3-80
Figure 3.3-39	Number of general aviation aircraft per 10,000 residents .....	3.3-81
Figure 3.3-40	Number of licensed pilots per 1,000 persons .....	3.3-81
Figure 3.3-41	Top ten states ranked in descending order of land areas per mile of road .....	3.3-82
Figure 3.3-42	Common carrier pipelines on the Alaskan North Slope .....	3.3-84
Figure 4.1-1	TAPS corrosion investigation projects for underground mainline pipe .....	4.1-2
Figure 4.1-2	Distribution of total spill volume by segment for both crude and product spills (1977-1999) .....	4.1-6
Figure 4.1-3	Distribution of total number of spills by segment for both crude and product spills (1977-1999) .....	4.1-6
Figure 4.1-4	Number of spills by volume category (1977-1999) .....	4.1-7
Figure 4.1-5	Fraction of total volume (crude and product) spilled accounted for by largest spills .....	4.1-7
Figure 4.1-6	Number of large (>1,000 bbl) spills per billion bbl throughput for Operations segments compared to MMS data .....	4.1-9
Figure 4.1-7	Cumulative distribution function for E&P spills (1977-1999) .....	4.1-9
Figure 4.1-8	Cumulative distribution function for pipeline spills (1977-1999) .....	4.1-9
Figure 4.1-9	Cumulative distribution function for VMT spills (1977-1999).....	4.1-10
Figure 4.1-10	Cumulative distribution function for marine transportation spills (1977-1999) ...	4.1-10
Figure 4.1-11	Volumetric spill rate for ANS E&P operations (1977-1999) .....	4.1-10



Figure 4.1-12	Volumetric spill rate for pipeline (1977-1999) .....	4.1-11
Figure 4.1-13	Volumetric spill rate for VMT (1977-1999).....	4.1-11
Figure 4.1-14	Volumetric spill rate for marine transportation (1977-1999) .....	4.1-12
Figure 4.1-15	Probability distribution of number of large spills in ROW renewal period (2004-2034) .....	4.1-13
Figure 4.1-16	Volumetric spill rate (crude and product) for marine transportation spills <1,000 bbl .....	4.1-14
Figure 4.2-1	Below-ground thaw bulb .....	4.2-2
Figure 4.2-2	Typical pipeline details for conventional burial .....	4.2-2
Figure 4.2-3	Typical pipeline details for special burial .....	4.2-3
Figure 4.2-4	Typical insulated box .....	4.2-3
Figure 4.2-5	Potential VSM movement .....	4.2-3
Figure 4.2-6	Typical thermal VSM .....	4.2-4
Figure 4.2-7	Typical cross-section of fuel gas line .....	4.2-4
Figure 4.2-8	Comparison of maximum annual peak flows .....	4.2-7
Figure 4.2-9	Comparison of maximum flood since startup to 200-year return or design flood ..	4.2-8
Figure 4.2-10	Timeline of the major repairs and new structures for river training structures, 1991-1999 .....	4.2-9
Figure 4.2-11	Middle Fork Koyukuk River, MP 218.5 .....	4.2-15
Figure 4.2-12	Middle Fork Koyukuk River, MP 217 .....	4.2-16
Figure 4.2-13	Tazlina River Bridge, MP 686.7 .....	4.2-17
Figure 4.2-14	Prince William Sound spill prevention and preparedness .....	after p. 4.2-28
Figure 4.3-1	Conceptual maximum thaw-bulb development for above-ground pipe .....	4.3-2
Figure 4.3-2	Example of localized workpad impact on ice-rich permafrost .....	4.3-2
Figure 4.3-3	VSM tilt resulting from frost heave on slopes .....	4.3-3
Figure 4.3-4	Conceptual thaw-bulb development for refrigerated burial .....	4.3-4
Figure 4.3-5	Guidebanks to align flow at major bridges .....	4.3-6
Figure 4.3-6	Elevated crossings on vertical support members .....	4.3-7
Figure 4.3-7	Revetments to limit riverbank erosion or movements .....	4.3-8
Figure 4.3-8	Spurs to deflect main channel flow from the pipeline .....	4.3-9
Figure 4.3-9	Armoring at valve sites .....	4.3-10
Figure 4.3-10	Structures that protect transitions and elevated lines .....	4.3-11
Figure 4.3-11	Water use at TAPS facilities, 1994-1999 .....	4.3-13
Figure 4.3-12	Discharges from excavation dewatering .....	4.3-15
Figure 4.3-13	Simplified VMT BWTF flow schematic .....	4.3-18
Figure 4.3-14	Annual flow and levels of BTEX and TSS for VMT treated ballast water discharge .....	4.3-20
Figure 4.3-15	Historical and projected BWTF flows and TAPS throughput .....	4.3-22
Figure 4.3-16	Ambient air monitoring stations in the Prudhoe Bay oil field in the vicinity of Pump Station 1 .....	4.3-28
Figure 4.3-17	Prudhoe Bay air quality, 10-year trends .....	4.3-30
Figure 4.3-18	Mean annual air temperature at Fairbanks .....	4.3-34
Figure 4.3-19	ANS output as percent of domestic crude production or consumption under the proposed action .....	4.3-73
Figure 4.3-20	Proposed action, state oil revenues and share of total General Fund revenues, 2004 to 2033 .....	4.3-76
Figure 4.3-21	Property tax revenues for proposed action for several communities, 2004 to 2033 .....	4.3-76
Figure 4.4-1	Channel migration along workpad .....	4.4-2



Figure 4.4-2	Revegetation example of abandoned access road .....	4.4-3
Figure 4.4-3	Direct annual employment impact of the no-action alternative, 2002 to 2010 ....	4.4-26
Figure 4.4-4	Cumulative lost revenues associated with the no-action alternative, 2004 to 2034 .....	4.4-27
Figure 4.4-5	Cumulative loss of property tax revenues for the no-action alternative, 2004 to 2033 .....	4.4-28
Figure 4.4-6	Projected statewide employment for proposed and no-action alternatives and percent difference, 2000 to 2015 .....	4.4-28
Figure 4.4-7	Projected state total personal income for the proposed and no-action alternatives and percent difference, 2000 to 2015 .....	4.4-29
Figure 4.4-8	Projected disposable personal income for the proposed and no-action alternatives and percent difference, 2000 to 2015 .....	4.4-29
Figure 4.4-9	Projected non-oil gross state product for the proposed and no-action alternatives and percent difference, 2000 to 2015 .....	4.4-29
Figure 4.4-10	Projected state population for the proposed and no-action alternatives and percent difference, 2000 to 2015 .....	4.4-30
Figure 4.4-11	No-action alternative impact on composition of state revenues, 2000 to 2015 ....	4.4-31
Figure 4.4-12	No-action alternative impact on composition of local revenues, 2000 to 2015 ....	4.4-31
Figure 4.4-13	Per-capita impact of the no-action alternative, 2000 to 2015 .....	4.4-32
Figure 4.4-14	Employment projections for the no-action alternative compared with the recessions of 1976 and 1985 .....	4.4-32
Figure 4.4-15	Direct employment impacts of the no-action alternative, 2000 to 2010 .....	4.4-34
Figure 4.4-16	Impact of no-action alternative on total wage and salary employment by region, 2000 to 2010 .....	4.4-35
Figure 4.4-17	Impact of no-action alternative on total wage and salary employment by region in 2015 .....	4.4-35
Figure 4.4-18	Impact of no-action alternative on resident employment by region in 2015 .....	4.4-35
Figure 4.4-19	Impact of no-action alternative on real per-capita income for North Slope, 2000 to 2015 .....	4.4-35
Figure 4.4-20	Impact of no-action alternative on real per-capita income in 2015 by region .....	4.4-36
Figure 4.4-21	Impact of no-action alternative on real per-capita income for Fairbanks, 2000 to 2015 .....	4.4-36
Figure 4.4-22	Impact of no-action alternative on population by region/community in 2015 .....	4.4-36
Figure 4.4-23	Impact of no-action alternative on real per-capita income for Valdez/Cordova, 2000 to 2015 .....	4.4-38
Figure 4.4-24	Impact of no-action alternative on real per-capita income for Anchorage, 2000 to 2015 .....	4.4-38
Figure 4.4-25	Impact of no-action alternative on real per-capita income for Kenai Peninsula Borough, 2000 to 2015 .....	4.4-39
Figure 4.5-1	Use of a simple matrix to show the distribution of potential cumulative effects when ranked by intensity and probability .....	4.5-5
Figure 4.5-2	Graphic summary of the steps in the cumulative effects analysis .....	4.5-7
Figure 4.5-3	Muhlbauer's hazard-consequence-likelihood matrix .....	4.5-9
Figure 4.5-4	Estimated liquid production rate as a function of assumed natural gas reserves and production period .....	4.5-16
Figure 4.5-5	Net natural gas imports and net imports as a percentage of domestic consumption .....	4.5-17
Figure 4.5-6	Ranking matrix of potential cumulative impacts on physical environment (proposed action) .....	4.5-22



Figure 4.5-7	Ranking matrix of potential cumulative impacts on biological environment (proposed action) .....	4.5-29
Figure 4.5-8	Ranking matrix of potential cumulative impacts on social environment (proposed action) .....	4.5-51
Figure 4.5-9	Historical and projected tanker loadings at Valdez, 1977-2020 .....	4.5-60
Figure 4.5-10	Ranking matrix of cumulative impacts on physical environment (no action alternative) .....	4.5-67
Figure 4.5-11	Ranking matrix of cumulative impacts on biological environment (no action alternative) .....	4.5-69
Figure 4.5-12	Ranking matrix of cumulative impacts on social environment (no action alternative) .....	4.5-78
Figure 4.5-13	Revenue losses to state .....	4.5-78
Figure 4.5-14	State employment .....	4.5-79
Figure 4.5-15	Employment as percent of base level .....	4.5-79
Figure 4.5-16	Regional revenue losses .....	4.5-80
Figure 4.5-17	Revenue .....	4.5-80
Figure 4.5-18	Resident employment impact .....	4.5-80
Figure 4.5-19	Average monthly earnings .....	4.5-81
Figure 4.5-20	Average household income .....	4.5-84
Figure 4.5-21	Persons per household .....	4.5-84
Figure 4.9-1	Energy intensity for freight shipments, 1997 .....	4.9-2
Figure 4.9-2	Crude oil and product shipments in the United States by mode .....	4.9-2
Figure 4.9-3	The trends in energy intensity for rail and waterborne commerce .....	4.9-3
Figure A-1	Alaska North Slope oil production projections .....	A-2
Figure A-2	Baseline throughput assumption used in this analysis .....	A-3
Figure B-1	Tankers loaded at VMT by year, 1977 to November 1, 1999 .....	B-8
Figure B-2	Tankers loaded at VMT as a function of the volume of crude shipped, 1977-1999 .....	B-8
Figure B-3	Average load per tanker by year (1977-1999) for the ANS trade .....	B-8
Figure B-4	Distribution of total spill volume among segments for both crude and product spills (1977-1999) .....	B-10
Figure B-5	Distribution of total number of spills among segments for both crude and product spills (1977-1999) .....	B-10
Figure B-6	A hypothetical Lorenz diagram .....	B-12
Figure B-7	Lorenz curve for E&P spills (1977-1999) .....	B-12
Figure B-8	Cumulative distribution function of ANS E&P spills less than 2 bbl (1977-1999) .....	B-13
Figure B-9	Lorenz curve for pipeline spills (1977-1999) .....	B-13
Figure B-10	Cumulative distribution function for pipeline spills less than 2 bbl (1977-1999) ..	B-13
Figure B-11	Cumulative distribution function for VMT spills less than 2 bbl (1977-1999) ..	B-14
Figure B-12	Cumulative distribution function for tanker spills less than 2 bbl (1977-1999) ..	B-14
Figure B-13	Number of large spills per billion bbl throughput for Operations compared to MMS data .....	B-15
Figure B-14	Histogram of E&P crude spills and fitted normal distribution, and normal probability plot of same data .....	B-18
Figure B-15	Histogram of pipeline crude spills and fitted normal distribution, and normal probability plot of same data .....	B-18



Figure B-16	Volumetric spill rate for E&P activities (1977-1999) .....	B-19
Figure B-17	Volumetric spill rate for pipeline and ordinary-least-squares trend (1977-1999), and same data with five largest pipeline spills removed .....	B-20
Figure B-18	Volumetric spill rate for VMT (1977-1999) .....	B-20
Figure B-19	Volumetric spill rate for marine transportation (1977-1999) .....	B-21
Figure B-20	Projected total and annual spill volumes .....	B-21
Figure B-21	Probability distribution of number of large spills in ROW renewal period (2004-2034) for various improvement factors .....	B-28
Figure B-22	Volumetric spill rate (crude and product) for marine transportation spills <1,000 bbl .....	B-28
Figure C-1	Atlas Maps .....	after p. C-6
Figure D-1	The Alaska North Slope in the oil field region .....	D-2
Figure D-2	Alaska North Slope oil fields .....	D-6
Figure D-3	Alaska North Slope oil field development footprint in 1968 .....	D-7
Figure D-4	Alaska North Slope oil field development footprint in 1973 .....	D-8
Figure D-5	Alaska North Slope oil field development footprint in 1983 .....	D-9
Figure D-6	Alaska North Slope oil field development footprint in 1990 .....	D-10
Figure D-7	Alaska North Slope oil field development footprint in 1999 .....	D-11
Figure D-8	The Trans Alaska Pipeline System .....	D-13



# List of Tables

Table 1.3-1	Facts about construction of TAPS, 1974-1977 .....	1.3-2
Table 1.3-2	Key events in the history of the Trans Alaska Pipeline System .....	1.3-3
Table 2.1-1	Summary of major features of the Trans Alaska Pipeline System .....	2.1-2
Table 2.1-2	Trans Alaska Pipeline System pump station summary .....	2.1-6
Table 2.1-3	Valdez Marine Terminal facility summary .....	2.1-8
Table 2.2-1	Disposition of TAPS facilities for DR&R .....	2.2-3
Table 2.3-1	Alternatives considered in the original final environmental impact statement for TAPS .....	2.3-1
Table 3.1-1	Physiographic units along the Trans Alaska Pipeline System .....	3.1-2
Table 3.1-2	Flow data record for streams crossed by the pipeline .....	3.1-14
Table 3.2-1	Active and historical special areas, special management zones, and zones of restricted activity .....	3.2-2
Table 3.2-2	Vegetation types and associated landforms found in each ecoregion crossed by the TAPS ROW .....	3.2-4
Table 3.2-3	Scientific and common names of dominant plant species found along the TAPS ROW .....	3.2-7
Table 3.2-4	Fish species by major drainages along TAPS route .....	3.2-13
Table 3.2-5	Common and scientific names and status of bird species found along the TAPS ROW, on the North Slope, and in Prince William Sound .....	3.2-20
Table 3.2-6	Relative abundance of shorebirds (birds/route) by ecoregion .....	3.2-28
Table 3.2-7	Seabird breeding populations in the vicinity of tanker routes in the North Gulf of Alaska Coast/Prince William Sound region .....	3.2-31
Table 3.2-8	Priority bird species and their status by biogeographic regions .....	3.2-32
Table 3.2-9	Terrestrial mammal species, game management unit or herd, and recent population/herd status near TAPS ROW .....	3.2-33
Table 3.2-10	Species observations within the TAPS ROW as recorded during Alyeska Security flight surveillance .....	3.2-36
Table 3.2-11	Moose observations along the TAPS ROW by month and year as recorded during Alyeska Security flight surveillance .....	3.2-36
Table 3.2-12	Caribou observations along the TAPS ROW by month and year as recorded during Alyeska Security flight surveillance .....	3.2-36
Table 3.2-13	Bison observations along the TAPS ROW by month and year as recorded during Alyeska Security flight surveillance .....	3.2-37
Table 3.2-14	Wolf observations along the TAPS ROW by month and year as recorded during Alyeska Security flight surveillance .....	3.2-37
Table 3.2-15	Black bear observations along the TAPS ROW by month and year as recorded during Alyeska Security flight surveillance .....	3.2-37
Table 3.2-16	Brown (grizzly) bear observations along the TAPS ROW by month and year as recorded during Alyeska Security flight surveillance .....	3.2-38
Table 3.2-17	Furbearers and small mammals that have been recorded in Alaska .....	3.2-67



Table 3.2-18	Alaska hunting and trapping seasons for furbearers and small mammals .....	3.2-69
Table 3.2-19	Marine mammal species of the Beaufort Sea and Prince William Sound .....	3.2-73
Table 3.2-20	Status and distribution of threatened and endangered species in Alaska .....	3.2-83
Table 3.3-1	Alaska gross state product by sector .....	3.3-5
Table 3.3-2	Alaska North Slope investment through 1998 .....	3.3-6
Table 3.3-3	Pipeline-related employment and wages .....	3.3-7
Table 3.3-4	Alyeska Pipeline Service Company TAPS expenditures .....	3.3-8
Table 3.3-5	State revenues, North Slope oil production and pipeline operations, 1978-1998 ...	3.3-9
Table 3.3-6	Property tax revenues, 1975-1998 .....	3.3-9
Table 3.3-7	Annual average employment .....	3.3-10
Table 3.3-8	Place of residence of North Slope oil workers.....	3.3-16
Table 3.3-9	Local government for 1998 .....	3.3-18
Table 3.3-10	Full- and part-time employment by place of work, 1977 .....	3.3-20
Table 3.3-11	Economic and demographic indicators .....	3.3-20
Table 3.3-12	Summary comparison of land ownership of TAPS ROW from 1972 to 1999 .....	3.3-72
Table 3.3-13	Visual resources along TAPS .....	3.3-77
Table 4.1-1	North Slope production and transportation system segments employed in oil spill analysis .....	4.1-5
Table 4.1-2	Crude or product spills >1,000 bbl for Operations (1977-99) .....	4.1-8
Table 4.1-3	Potential benefits of double-hull tankers .....	4.1-13
Table 4.1-4	Estimates of future oil spills based on historical data only .....	4.1-15
Table 4.1-5	Estimates of future marine transportation spills based on allowance for mitigating measures .....	4.1-15
Table 4.2-1	Requirements of the VMT NPDES permit .....	4.2-20
Table 4.2-2	Requirements of line-wide NPDES permit .....	4.2-20
Table 4.2-3	NPDES multi-sector permit requirements for operations material sites .....	4.2-21
Table 4.2-4	State of Alaska drinking-water monitoring requirements .....	4.2-21
Table 4.2-5	Some key TAPS federal and state air-quality monitoring requirements .....	4.2-22
Table 4.2-6	TAPS oil spill contingency equipment .....	4.2-26
Table 4.2-7	Prince William Sound spill prevention and response .....	4.2-28
Table 4.2-8	Summary of Alyeska SERVS spill response equipment .....	4.2-29
Table 4.3-1	Summary of wastewater discharges from pump stations and MCCFs .....	4.3-14
Table 4.3-2	Discharges addressed in 1998 line-wide NPDES permit application .....	4.3-16
Table 4.3-3	Potential annual air emission rates for TAPS facilities .....	4.3-23
Table 4.3-4	Permitted stationary emission sources at TAPS pump stations .....	4.3-24
Table 4.3-5	Permitted Valdez Marine Terminal emission sources .....	4.3-25
Table 4.3-6	Monitoring and modeling data for TAPS air-quality impacts .....	4.3-28
Table 4.3-7	Prudhoe Bay Unit, 10-year ambient-air-impact trend .....	4.3-29
Table 4.3-8	Impacts on visibility from VMT tanker vapor recovery .....	4.3-30
Table 4.3-9	Six crude oil spills monitored by BLM along TAPS ROW .....	4.3-41
Table 4.3-10	Numbers of graminoid and forb “weeds” and/or introduced vascular plant species found at each of 52 locations along the TAPS ROW during July-September 1999 survey .....	4.3-42
Table 4.3-11	Means and standard errors from 49 locations along TAPS (July-September 1999) from within the ROW and adjacent control sites .....	4.3-43
Table 4.3-12	Causes of human-induced mean annual animal mortality by species in Alaska ...	4.3-60
Table 4.3-13	Caribou and reindeer killed in Alaska for wildlife management and research ....	4.3-61
Table 4.3-14	Moose killed by trains in Alaska .....	4.3-61
Table 4.3-15	Moose killed by documented collisions with motor vehicles in Southcentral Alaska .....	4.3-61



Table 4.3-16	Basic-sector employment and projected growth rates for the proposed action .....	4.3-72
Table 4.3-17	Direct full-time employment from pipeline and North Slope-related activity associated with the proposed action .....	4.3-76
Table 4.3-18	Annual average growth rates for economic indicators under the proposed action .....	4.3-77
Table 4.3-19	Total wage and salary employment by region for the proposed action .....	4.3-78
Table 4.3-20	Total resident employment by region for the proposed action .....	4.3-78
Table 4.3-21	Real per-capita income by region for the proposed action .....	4.3-79
Table 4.3-22	Population by region for the proposed action .....	4.3-79
Table 4.4-1	Prudhoe Bay area annual background levels .....	4.4-5
Table 4.4-2	Valdez area background levels .....	4.4-5
Table 4.4-3	No-action alternative impact on direct annual average employment of pipeline operations including special projects .....	4.4-23
Table 4.4-4	No-action alternative impact on direct annual average employment of pipeline DR&R .....	4.4-23
Table 4.4-5	No-action alternative impact on direct annual average employment of total pipeline-related activity .....	4.4-24
Table 4.4-6	No-action alternative impact on North Slope oil field construction and operations direct annual average employment .....	4.4-24
Table 4.4-7	No-action alternative impact on direct annual average employment of North Slope oil facilities .....	4.4-25
Table 4.4-8	No-action alternative impact on direct annual average employment of North Slope oil-related activity .....	4.4-25
Table 4.5-1	CEQ principles of cumulative effects analysis .....	4.5-3
Table 4.5-2	Procedure for cumulative effects analysis in this report .....	4.5-4
Table 4.5-3	Past, present, and reasonably foreseeable future actions .....	4.5-11
Table 4.5-4	Past and potential future crude oil production from North Slope fields. ....	4.5-13
Table 4.5-5	Basic elements of the proposed Trans Alaska Gas System .....	4.5-15
Table 4.5-6	Additional features of the proposed Trans Alaska Gas System .....	4.5-15
Table 4.5-7	Overview of ANGTS project .....	4.5-18
Table 4.5-8	Criteria for ranking potential cumulative effects on physical resources .....	4.5-21
Table 4.5-9	Physical cumulative effects summary: Proposed Action .....	after p. 4.5-20
Table 4.5-10	Criteria for ranking potential cumulative effects on biological resources .....	4.5-28
Table 4.5-11	Biological cumulative effects summary: Proposed Action .....	after p. 4.5-28
Table 4.5-12	Criteria for ranking potential cumulative effects on social resources .....	4.5-50
Table 4.5-13	Social resource cumulative effects summary: Proposed Action .....	after p. 4.5-50
Table 4.5-14	Alyeska Native employment goals .....	4.5-57
Table 4.5-15	North Slope oil fields .....	4.5-61
Table 4.5-16	Biological cumulative effects summary: No-action alternative .....	after p. 4.5-68
Table 4.5-17	Social resource cumulative effects summary: No-action alternative .....	after p. 4.5-78
Table 4.6-1	Unavoidable adverse effects of proposed action .....	4.6-2
Table 4.9-1	Energy intensity for TAPS, 1999 .....	4.9-2
Table 4.9-2a	Calculation of energy intensity for oil tankers based on data published by the National Research Council .....	4.9-4
Table 4.9-2b	Calculation of energy intensity for oil tankers based on data published by the U.S. Department of Energy .....	4.9-4
Table 4.9-3	Energy requirements as percentage of energy shipped .....	4.9-5
Table A-1	Baseline throughput assumption and constant decline model compared .....	A-2
Table A-2	Alaska oil production in 2020: Sensitivity results .....	A-3
Table B-1	Operations spill data sources and data utilization .....	B-4



Table B-2	Prior knowledge tested/incorporated in present spill analysis .....	B-5
Table B-3	Operations segments employed in oil spill analysis.....	B-6
Table B-4	The ten largest oil spills (1977-1999) .....	B-9
Table B-5	More exact calculation of original EIS estimates of spill volumes .....	B-11
Table B-6	Number of crude spills greater than or equal to specific spill threshold (1977-1999) by Operations segment and comparison with MMS estimates .....	B-15
Table B-7	Characteristics of TAPS crude and product spills (1977-1999) .....	B-16
Table B-8	Wide applicability of the lognormal distribution .....	B-17
Table B-9	Spill projections based on different data sets .....	B-22
Table B-10	Prince William Sound spill prevention and response .....	B-23
Table B-11	Potential benefits of double-hull tankers .....	B-24
Table B-12	Discharge history of all spills greater than 55 gallons from either VMT or the marine transportation link .....	B-26
Table B-13	Probability calculations for future marine spills over ROW renewal period .....	B-27
Table B-14	Annual and total volumes from marine spills less than 1,000 bbl by material spilled, spill rate, and projected future small spills .....	B-29
Table B-15	The <i>American Trader</i> crude spill; several comments on the protective effect of double hulls .....	B-30
Table B-16	Risk-related estimates .....	B-31
Table B-17	Comparison of spill rates by Operations segment .....	B-32
Table B-18	Estimates of future Operations oil spills based on historical data only .....	B-33
Table B-19	Estimate of future marine transportation spills based on allowance for mitigating measures .....	B-33
Table C-1	Active TAPS operations material sites on public lands .....	C-2
Table C-2	Major and minor river and creek crossings and instream and floodplain segments .	C-4
Table D-1	Average rate of increase in ANS oil field development footprint, 1968-99 .....	D-12
Table D-2	Scientific studies during ANS oil-field development phases .....	D-12



# List of Photos

Photo 2-1	Vertical support members elevate the trans-Alaska pipeline in areas of thaw-unstable permafrost .....	2-2
Photo 2.1-1	Examples of TAPS bridges .....	2.1-4
Photo 2.1-2	Valdez Marine Terminal .....	2.1-7
Photo 2.1-3	Operations Control Center at Valdez .....	2.1-9
Photo 2.1-4	Drag-reducing agent .....	2.1-11
Photo 2.1-5	Escort vessels accompany a tanker through Prince William Sound .....	2.1-14
Photo 2.2-1	Isabel Camp in 1976 during pipeline construction .....	2.2-2
Photo 2.2-2	Isabel Camp site following removal and restoration .....	2.2-2
Photo 3.2-1	Arctic grayling .....	3.2-14
Photo 3.2-2	Sockeye salmon .....	3.2-17
Photo 3.2-3	Red-throated Loon .....	3.2-24
Photo 3.2-4	Tundra Swans .....	3.2-24
Photo 3.2-5	Brant pair .....	3.2-25
Photo 3.2-6	Harlequin Duck .....	3.2-26
Photo 3.2-7	Red-necked Phalarope .....	3.2-27
Photo 3.2-8	Sabine's Gull .....	3.2-29
Photo 3.2-9	Common Raven .....	3.2-30
Photo 3.2-10	Cow moose .....	3.2-38
Photo 3.2-11	CAH caribou in North Slope oil field .....	3.2-44
Photo 3.2-12	Caribou on North Slope .....	3.2-47
Photo 3.2-13	Muskoxen .....	3.2-48
Photo 3.2-14	Bison .....	3.2-50
Photo 3.2-15	Dall sheep .....	3.2-52
Photo 3.2-16	Sitka black-tailed deer .....	3.2-54
Photo 3.2-17	Brown bear .....	3.2-57
Photo 3.2-18	Black bear .....	3.2-62
Photo 3.2-19	Wolf .....	3.2-64
Photo 3.2-20	Arctic fox .....	3.2-71
Photo 3.2-21	Polar bear .....	3.2-75
Photo 3.2-22	Steller sea lions with pups .....	3.2-79
Photo 3.2-23	Spectacled Eider .....	3.2-82
Photo 3.2-24	Steller's Eider .....	3.2-85
Photo 3.2-25	Arctic Peregrine Falcon .....	3.2-86
Photo 3.3-1	Production facility at Prudhoe Bay for separating water and gas from the crude oil .....	3.3-1
Photo 3.3-2	Tanker with escort vessels in Prince William Sound .....	3.3-6
Photo 3.3-3	Pipe is wrapped and placed in trench during TAPS construction .....	3.3-24
Photo 3.3-4	Shoreline cleanup work during <i>Exxon Valdez</i> spill .....	3.3-28
Photo 3.3-5	Barrow is the largest North Slope Borough community .....	3.3-33



Photo 3.3-6	The North Slope community of Nuiqsut .....	3.3-35
Photo 3.3-7	Kaktovik on the coast near the Canadian border .....	3.3-36
Photo 3.3-8	Wiseman .....	3.3-37
Photo 3.3-9	Coldfoot .....	3.3-37
Photo 3.3-10	Stevens Village .....	3.3-38
Photo 3.3-11	Rampart .....	3.3-38
Photo 3.3-12	Fairbanks .....	3.3-39
Photo 3.3-13	The community of Delta Junction .....	3.3-40
Photo 3.3-14	Glennallen .....	3.3-41
Photo 3.3-15	Copper Center .....	3.3-42
Photo 3.3-16	The Prince William Sound community of Chenega Bay .....	3.3-46
Photo 3.3-17	The Valdez boat harbor is home to numerous fishing vessels .....	3.3-47
Photo 3.3-18	The community of Tatitlek .....	3.3-48
Photo 3.3-19	Valdez .....	3.3-48
Photo 3.3-20	The boat harbor at Cordova .....	3.3-49
Photo 3.3-21	Butchering a whale at Barrow .....	3.3-56
Photo 3.3-22	Fish wheel on the Yukon River .....	3.3-59
Photo 3.3-23	Snow machine and baleen in Nuiqsut .....	3.3-64
Photo 3.3-24	Broken Mammoth Site, one of the oldest documented sites in Alaska .....	3.3-66
Photo 3.3-25	Excavation of the Gallagher Flint Station archeological site during TAPS construction .....	3.3-66
Photo 3.3-26	Photo of historical site (LIV-299), a building associated with a mine operating from the 1930s to the 1940s in Vault Creek valley .....	3.3-68
Photo 3.3-27	Splitting adze from the PWS region .....	3.3-71
Photo 3.3-28	TAPS visitor site at pipeline visitors center near Fairbanks .....	3.3-75
Photo 3.3-29	Dalton Highway .....	3.3-82
Photo 4.1-1	Typical TAPS corrosion investigation project .....	4.1-1
Photo 4.1-2	Coating mainline pipe .....	4.1-3
Photo 4.2-1	Pipeline crossing of Denali Fault showing beams embedded in a gravel berm to allow large pipe movements .....	4.2-5
Photo 4.2-2	Settlement monitoring rods along buried section of TAPS .....	4.2-12
Photo 4.2-3	Smart pig .....	4.2-12