4. Environmental Consequences

4.1 Existing Mitigation Measures

4.1.1 JPO Oversight

The member agencies that make up the JPO cooperatively monitor TAPS and TAPS activities. Table 4.1-1 lists the federal and state agencies that compose the JPO and their primary areas of responsibility. The JPO now exercises comprehensive oversight of all aspects of TAPS operations covered by the Federal Grant and the State Lease. Aspects include those covered by technical, environmental, and general stipulations as well as by the requirements of the 41 sections of the Federal Grant and the 42 sections of the State Lease.

The fundamental objective of all JPO oversight is to ensure that APSC, as the Permittees' common agent, complies with all expectations delineated in provisions of the Federal Grant and State Lease. Specifically, APSC must:

- Know all of the applicable requirements that derive from the Federal Grant and State Lease stipulations, state and federal regulations, permit conditions, and other government directives;
- Obtain all the necessary permits and authorizations to operate the TAPS;
- Take reasonable and prudent actions to detect operational or design deficiencies (the expected result of stipulations related to surveillance programs, safety programs, quality programs, and abatement requirements); and
- Correct observed deficiencies in a timely manner according to risk-based priorities.

JPO member agencies have clear and direct regulatory authority over various TAPS activities. Essentially, JPO member agencies perform five compliance activities:

1. Issue necessary permits and authorizations to operate the TAPS;
2. Monitor the TAPS and TAPS activities to identify situations requiring corrective action;
3. Approve construction or other actions;
4. Direct compliance or remediation actions, as necessary, to protect public safety and health, the environment, and pipeline integrity; and
5. Ensure immediate response to oil spills and other abnormal conditions.

Once the JPO directs APSC to conduct a corrective action (including compliance or remediation activities) through the appropriate governmental process, APSC must comply. APSC's failure to comply in a sufficient and timely manner may result in civil or criminal penalties levied by regulatory agencies or in termination or civil penalties under the Federal Grant, using the process described in Federal Grant Section 31.

Before construction or certain other actions can occur, APSC must conduct reviews mandated in the Alaska Coastal Management Program, when appropriate, and it must obtain permits and other authorizations from JPO agencies. These include Notice to Proceed decisions from the BLM and ADNR that are based on the requirements of the Federal Grant and State Lease, as well as regulatory required authorizations, such as wetlands permits from the U.S. Army Corps of Engineers (USACE) and fish passage permits from the ADF&G. Through these permitting processes, federal and state agencies can require coordinated measures designed to avoid or mitigate harmful impacts that might result from TAPS actions.

TABLE 4.1-1 Federal and State Agencies within the Joint Pipeline Office

Federal Agency	State Agency
U.S. Department of the Interior/Bureau of Land Management Issues and administers ROWs and permits for land use and material sales related to pipeline use on federal land.	*Alaska Department of Natural Resources* Administers state-owned land and administers rights granted in land-use leases, permits, material sales, water rights, and water use.
U.S. Department of Transportation/Office of Pipeline Safety Regulates the transportation of hazardous liquids and gases by pipeline, regulates drug testing related to pipeline safety, and conducts inspections of the TAPS.	*Alaska Department of Environmental Conservation* Issues permits to operate facilities that could affect air quality, generate waste, and treat, store, and dispose of hazardous material; regulates these facilities; and approves oil spill contingency plans.
U.S. Environmental Protection Agency Works in partnership with the ADEC to administer regulatory programs of the Clean Air Act, Clean Water Act, and Oil Pollution Act.	*Alaska Department of Fish and Game* Regulates activities affecting fish passage, anadromous fish streams, and hazing of wildlife in connection with oil spills.
U.S. Coast Guard Issues permits for structures over navigable waters and oversees vessels, marine oil spills, and terminal safety.	*Alaska Department of Labor* Reviews practices and procedures pertaining to occupational safety and health; mechanical, electrical, and pressure systems; and wage and hour codes to protect employees working on the TAPS.
U.S. Army Corps of Engineers Issues approvals of structures or activities in navigable waters and approvals of placement of dredged or fill material in U.S. waters, including wetlands.	*Alaska Division of Governmental Coordination* Coordinates the review of projects under the Alaska Coastal Management Program and consolidates state comments on NEPA issues.
U.S. Department of the Interior/Minerals Management Service Manages the nation’s natural gas, oil, and other mineral resources on the Outer Continental Shelf. Assists BLM with financial capability and liability reviews.	*State Fire Marshal’s Office* Conducts fire and safety inspections, reviews plans, investigates fires, and provides safety education to the public.
	Alaska Department of Transportation/ Public Facilities Designs, constructs, and maintains primary and secondary land and marine highways and airports.

Source: JPO (2002a).

4.1.1.1 Compliance Requirements and the Role of the Government and the JPO

Compliance requirements derive from many sources. TAPS-specific requirements are found in the following:

- The Federal Grant contains sections and stipulations under the authority of the MLA, the TAPAA, and the contractual terms of the Agreement between the Permittees (TAPS Owners) and the DOI.
- The State Lease contains sections and stipulations under the authority of Alaska Statute 38.35. These sections and stipulations often are identical to those of the Federal Grant.
- The Federal Grant and State Lease also require the Permittees to comply with regulations based on numerous laws, each with its own enforcement protocol.
- In addition, certain permits and authorizations are required for specific activities (e.g., ADF&G Title 16 permits are required for activities that could affect fish habitats), for specific programs (e.g., Oil Spill Contingency Plans approved by the BLM and by the ADEC, among other agencies, are required), and for specific land uses (e.g., federal temporary use permits, mineral material site permits, or state land use permits may be required).

4.1.1.2 Adaptive Nature of the Grant in Compliance Monitoring

The two “landlord” agencies, the BLM and ADNR, have additional broad management authority stemming from the basic landlord-tenant relationship. The TAPAA gives the DOI/BLM broad powers to add requirements related to the construction, operation, maintenance, and termination of the TAPS in order to protect the public interest. The Federal Grant and State Lease stipulations — specifically Stipulations 1.3.2, 1.8, and 3.2.1.2 — reflect the scope of that broad authority.

Since the beginning of TAPS operations, the BLM has exercised its authority under Stipulations 1.3.2 and/or 3.2.1.2 on 11 separate occasions by issuing interpretive letters that either clarify existing technical requirements contained in the Federal Grant or introduce new technical requirements deemed appropriate as a result of the JPO’s review of operating and empirical data. The topics addressed in these interpretive letters include earthquake, fault, and glacier surge monitoring; vegetation clearing and management; depth of cover at buried main-line pipe crossings; zones of restricted activities for peregrine falcons and other raptors; performance standards for aboveground (structural) systems for seismic and hydraulic events; performance standards for restoration; pipe curvature standards; and zones of restricted activities for key fish areas (JPO 2002b).

4.1.1.3 Risk-Based Compliance Monitoring

All aspects of TAPS operations are subject to JPO monitoring. However, activities having the greatest potential impacts on public safety and health, the environment, or pipeline integrity are examined more often and more closely. Similarly, prior problem areas usually warrant periodic reviews with regard to their recurrence. The JPO’s compliance oversight is not a single event but rather an ongoing process within which the JPO continually monitors TAPS operations and engages TAPS representatives in developing and implementing solutions to observed “deficiencies” and “noncompliance conditions.” These deficiencies and noncompliance conditions are tracked in JPO databases as “findings.” Maintaining these databases provides the impetus for tracking and follow-up on any open or unresolved findings. The databases can also highlight recurring problems that might be indicative of systemic design or programmatic weaknesses.

4.1.1.4 JPO Comprehensive Monitoring Program

The comprehensive monitoring program was established in 1994 to provide structured monitoring and reporting mechanisms to support enforcement of the Federal Grant and State Lease requirements. Prior to 1994, monitoring focused on protection of surface resources, oil spill contingency capabilities, corrosion abatement, and land use permitting issues. The ROW was the primary area of the JPO's attention. However, audits conducted in 1993 and thereafter found many problems within the pump stations and the Valdez Marine Terminal (see JPO Annual Reports for 1994–1996 [JPO 1995, 1996, 1997]). As a result, the JPO has recognized that risk can exist in all facets of TAPS operations and can originate anywhere within the TAPS infrastructure. Consequently, the JPO's oversight has moved toward a broader, more comprehensive oversight and audit program that evaluates not only APSC's performance with regard to promises it made to the U.S. Congress, but also the overall effectiveness of APSC's efforts to address employee concerns and maintain program quality. The Audit Action Item Closure procedures developed by the JPO provide a valuable tool for supporting this broader oversight objective and for keeping the efforts to resolve problems made by all parties in focus and on schedule.

As a result of the JPO's broadened monitoring scope, its technical staff has developed considerable expertise in pipeline operations in general and APSC processes in particular. The JPO monitors have the ability to evaluate not only the compliant status of the TAPS but also the effectiveness of the processes by which compliance is being pursued and maintained.

The comprehensive monitoring program is a three-tiered process for monitoring TAPS activities that involves surveillance, assessment, and reporting. Surveillance is the most frequent and routine monitoring function and normally involves physical inspections as well as reviews of critical operating and monitoring data. The JPO has access to all APSC monitoring data, and some data are formally reported to the JPO by APSC. In addition, JPO surveillance also verifies that APSC has adhered to its own internal procedures in its conduct of operations, especially with respect to the collection of monitoring data. (Additional discussions on APSC procedures are provided in Section 4.1.3.) Surveillance is the JPO's primary mechanism for verifying compliance with Federal Grant and State Lease requirements.

Surveillance actions take limited-scope "snapshots" of compliance issues. The subsequent surveillance reports separate observations into measurable parts called "attributes." Each attribute specifies the requirement; documents how it was measured or observed; and judges whether the observation was satisfactory, unsatisfactory, or corrected on the spot. If the unsatisfactory condition is individually significant or represents a serious compliance deficiency, then a finding is formally issued to APSC. Otherwise, information on the unsatisfactory conditions is entered into a database for analysis at the assessment or technical report level. To date, the JPO has accumulated a significant cache of information from more than 1,300 surveillances that can be used in a variety of ways. Data from surveillance actions can be used for trend analyses or can directly result in a decision to conduct more in-depth technical studies that will contribute to the issuance of a technical report.

Assessment reports are broader in scope than surveillance reports. An assessment report usually combines the results of several related surveillance actions and of related and independently conducted engineering surveys to identify discrete compliance deficiencies as well as trends. Assessment reports are the primary tool used to formally issue findings to APSC for corrective action. Most assessment reports are highly technical. They identify problems and their causal factors in sufficient engineering detail to allow APSC to develop corrective action programs of equivalent detail and sophistication. These correction action plans, as well as their proposed implementation schedules, are formally approved by the JPO. The status of a JPO-approved corrective action is evaluated during subsequent surveillance or assessment actions as a way of "closing" the finding.

Technical or engineering reports are also completed; they constitute the most flexible tool in the comprehensive monitoring program tool kit. These reports address issues of a highly technical nature, for which scientific or engineering judgment and documentation of calculations or rationale for professional opinion are required. Some of these reports also include or are accompanied by surveillance reports that document aspects of the issue that were addressed by verification, observation, or documentation. Many engineering reports provide the technical basis for assessment reports. However, engineering reports can also be used independently to identify findings and compel corrective action. Engineering reports are available for review by JPO stakeholders; because they are highly technical, however, they are normally not widely distributed.

The culmination of JPO oversight is the periodic issuance of a full comprehensive monitoring program (CMP) report. These reports focus on providing summary information to TAPS stakeholders (i.e., federal and state policymakers, the public, and Congress). The reports incorporate the findings and conclusions of previous assessments (including information on any follow-up actions) and previous comprehensive monitoring program reports, thus providing a more comprehensive description of the status of particular items or systems over a longer time period.

To date, 11 CMP Reports have been issued. The latest CMP report, *A Comprehensive Monitoring Program Report Examining Grant and Lease Compliance*, OMP Report 11, was issued in April 2002 (JPO 2002c). The CMP Report 11 provided a comprehensive overview of JPO's oversight activities to determine APSC's conformance with Federal Grant and State Lease provisions and compliance with general, environmental, and technical stipulations of the Federal Grant. In addition, Report 11 provided summaries of unplanned events and incidents, including the following: pipe movements at MP 170 and Check Valve 50, three fire safety incidents occurring at the Valdez Marine Terminal in 2000, and three crude oil spills associated with shutdown/start-up activities at PS 3, 4, and 5.

4.1.1.5 Corrective Actions Requiring Memoranda

Occasionally a large or longer-term corrective action is identified (e.g., evaluating "leak through"[1] on some main-line valves). Such large or potentially expensive repair issues may be addressed through a specific MOA between the JPO and APSC. The MOA will address time frames for correction and other aspects of the corrective action effort arrived at through negotiation (JPO 2002a).

4.1.1.6 The JPO's Interpretation of "Compliance"

The terms "noncompliance," "aspects of noncompliance," and "stipulation deficiency" are used virtually interchangeably in various JPO reports to describe an existing condition that needs to be modified to fully comply with the Federal Grant or State Lease. As applied, these terms may imply, but are not necessarily, a substantial or immediate threat to human health or safety or to the environment.

The JPO's use of these terms should not be confused with the level of noncompliance (including a refusal to comply upon notifications of noncompliance — see Section 18 and Stipulation 1.3.2 of the Federal Grant) that would be needed to reach the stage of formal Federal Grant or State Lease termination or unilateral modification available under law to the DOI and the ADNR. Rather, these are convenient terms used to inform government policymakers and the public about the issues the JPO is working on with APSC and how the issues relate to the Federal Grant and State Lease. The JPO publishes comprehensive monitoring program reports that summarize APSC's overall compliance status in specified program areas (JPO 1998a,b; 1999a,b; 2001a,b,c).

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1 As used here, "leak through" means the incomplete sealing of a valve that results in fluid continuing to flow through the valve after it is closed.

TAPS compliance verification is an ongoing process that involves the following activities:

- Establishing clearly defined requirements related to design specification or operations;
- Making field checks with the aid of comprehensive surveillance checklists;
- Where needed, providing notifications of immediate safety, environment, or integrity issues to APSC for corrective action;
- Reviewing and authorizing actions proposed by APSC;
- Tracking activities and facilities' surveillance observations over time to establish trends;
- Conveying these trends to APSC through assessment reports and compelling corrective actions, where necessary; and
- Summarizing overall compliance status through comprehensive monitoring program reports to stakeholders.

4.1.1.7 Reliability-Centered Maintenance — JPO Oversight into the Future

The JPO recognizes that the TAPS has thousands of moving parts and operates under critical internal and external influences. If not operated and maintained properly, catastrophic injury to people and damage to the environment could result. Because the JPO believes that the useful life of the TAPS (i.e., how long it can operate safely) is directly related to the quality and effectiveness of system monitoring and maintenance, it asked APSC to review its asset maintenance management (AMM) program and to conduct a series of reliability-centered maintenance (RCM) analyses. The JPO and APSC have entered into a Memorandum of Agreement regarding APSC's use of RCM methodologies to underpin its maintenance activities (BLM et al. 2001, 2002).

The RCM analyses identify maintenance activities necessary to preserve operational safety and reliability. On the basis of this information, a customized preventive/ predictive maintenance strategy is designed. The goal is to identify potential maintenance issues and focus maintenance efforts on the systems and subsystems associated with the highest risks and biggest consequences.

The RCM initiatives provide a very strong maintenance-based methodology for evaluating current maintenance strategies and the resulting useful life of the TAPS.

The RCM process describes actions necessary to prevent a particular failure or reduce the likelihood and consequences of its occurrence. For example, slope stability and its effects on the integrity of VSMs are currently being studied under the RCM process. The JPO has issued a special requirement for slope stability monitoring that formally incorporates static and dynamic factor performance standards into acceptable safety criteria. APSC's incorporation of this requirement into its monitoring and maintenance protocols will ensure that the safety criteria are always satisfied.

In some situations, a failure management policy cannot be identified for a particular failure mode. In these cases, if the consequences of the failure affect safety or the environment, then the default decision is as follows: "Redesign is compulsory." Compulsory redesign recommendations fall into three categories: modify hardware, modify procedures, or modify training. The JPO is most concerned with implementing the tasks identified by APSC as addressing failures classified as hidden, safety. or environmental. The JPO will also review the manner in which APSC has addressed the compulsory redesign recommendations. This procedure adds a great deal to the government's confidence in the long-term operational viability of the TAPS.

The JPO intends for the TAPS RCM process to be fully transparent. The RCM methodologies have already been made available to the PWS RCAC for review and comment. The JPO received comments from RCAC and has formally responded to those comments (PetroTech Alaska 2002; Brossia and Kerrigan 2002). In addition the JPO sought outside review of both

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Seven analytical questions form the core of the RCM process:

- What are the functions of an item of equipment?
- How can it fail?
- What causes it to fail?
- What happens when it fails?
- Does it matter if it fails?
- Can anything be done to predict or prevent the failure?
- What should be done if the failure cannot be predicted or prevented?

Failure modes and the ramifications of a failure are further defined by asking:

- Have failures historically occurred?
- Are they likely to occur?
- Are current maintenance activities preventing failures?
- Are there significant safety or environmental consequences associated with the failure that have not yet occurred but that require proactive measures to be avoided?

The potential effects and consequences of failures are enumerated in detail. The RCM analyses classify failures according to their consequences, as follows:

- Hidden: Has no direct impact; the failure remains unknown until another failure occurs, but it exposes the organization to serious, often catastrophic, consequences if multiple failures were to occur.
- Safety and environmental: Has safety consequences if it could injure or kill someone; has environmental consequences if it could breach an environmental standard.
- Operational: Affects operations by impacting output, product quality, customer service, or operating costs, in addition to affecting the direct cost of repair.
- Nonoperational: Affects neither safety nor production; involves only the direct cost of repair.

The RCM process describes tasks needed to prevent a particular failure or reduce its likelihood of occurring. In some situations, a failure management policy cannot be identified for a particular failure mode. If, in these cases, the consequences of the failure would affect safety or the environment, the default decision is “redesign is compulsory.” Compulsory redesign recommendations fall into three categories: modify hardware, modify procedures, and modify training.

The JPO is most concerned with tasks identified to address failure modes when the consequences of failure are classified as hidden, safety, or environmental, and will track implementation of those tasks. The JPO will also track the resolution of the compulsory redesign recommendations. Application of the RCM methodology as a maintenance strategy substantially increases the government’s confidence in the long-term operational safety of the TAPS.

Suggested Reading:*

Moubray, J.M., 1997, *Reliability-Centered Maintenance*, 2nd Ed., Industrial Press, Inc., New York, N.Y.

NAVAIR 00-25-403 Guidelines for the Naval Aviation Reliability-Centered Maintenance Process, published by Direction of Commander, Naval Air Systems Command, Feb. 2000, available at http://www.nalda.navy.mil/rcm/403manual.pdf.

The following web sites:

http://www.reliability-centered-maintenance.com/
http://www.aladon.co.uk/
http://www.wara.com/AssetManagement/Asset.html
http://www.nalda.navy.mil/rcm

the RCM methodology and the RCAC comments received from recognized experts in RCM (Netherton 2002). This outside review was initiated to further ensure that the process is in full conformance with applicable industry standards. Except for matters involving confidential business information or relating to national security, the JPO intends to continue to make the RCM decisionmaking process open to public review.

4.1.1.8 Coordinated Planning and Response to Abnormal Incidents

The final JPO focus area relates to the JPO's responsibility to ensure a coordinated and effective response by APSC and all government entities to unplanned incidents that could result in a release of crude oil, refined petroleum product, or hazardous materials into the environment. Since the incident when crude oil spilled from the Exxon Valdez into Prince William Sound, the JPO approach to spill response preparedness has been comprehensive and holistic. It has involved all JPO member agencies in myriad comprehensive planning activities that have resulted in a unified spill preparedness and response plan for the TAPS. In accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (commonly referred to as the National Contingency Plan or NCP; 40 CFR Part 300) and Alaska State statutes and regulations (principally 18 AAC Part 75), the EPA and ADEC are the lead federal and state oil spill response agencies. However, depending on the resources affected or threatened by the spill, numerous other federal and state agencies can have authorities with regard to oil spill prevention (including leak detection and safe conduct of operations) and preparedness (including both equipment and trained personnel), as well as authorities with regard to overseeing the cleanup of spilled oil or hazardous materials and the restoration of affected resources. These agencies include the BLM, U.S. Department of Transportation Office of Pipeline Safety (DOT/OPS), ADF&G, and ADNR. In addition, other agencies that may be potentially involved include the U.S. Coast Guard (USCG) Marine Safety Office in Valdez; USFWS; and two Alaska state agencies, the Division of Governmental Coordination and the Department of Labor and Workforce Development.

The common goal unifying these agencies is to prevent spills to the greatest degree possible while ensuring the highest possible levels of spill response preparedness and capability within APSC with participating federal and state government agencies. Because of the many federal and state requirements, only a coordinated approach involving all agencies can guarantee effective and efficient spill prevention, planning, and response. The JPO formed an internal standing committee, the Oil Spill Prevention, Preparedness, and Response (OSPPR) Coordination Team, that was charged with coordinating all agency activities to prevent duplication, promote efficiency, and improve the overall capability to meet the common goal.

The scope of the OSPPR Team's charter is broad and includes the continuous review, updating, and refinement of the government's unified spill response plan; review of APSC's spill response plans for its conformance with applicable federal and state substantive requirements; oversight of APSC spill prevention efforts (including leak detection and preventative maintenance programs); oversight of APSC's level of preparedness (including inspections of spill response equipment and reviews of exercises, drills, and personnel training); and continuous reviews of spill response technology developments and of evolving response strategies with regard to their possible incorporation into JPO and/or APSC response plans.

In addition to conducting periodic reviews of contingency planning, after a significant response incident, key response agencies may prepare an after-action report to document the significant lessons learned in order to improve future responses. Following the October 4, 2001, incident 80 mi north of Fairbanks near the community of Livengood, when a shot from a high-powered rifle punctured the TAPS, staff from APSC, ADEC, ADF&G, Alaskan Labor and Workforce Development, ADNR, Alaska Department of Public Safety (ADPS), the EPA, the JPO, U.S. Department of Transportation-Office of Pipeline Safety (DOT-OPS), and DOI-BLM collaborated on the *Joint After-Action*

Report for the TAPS Bullet Hole Response (February 8, 2002) (Joint Report) (JPO et al. 2002). A progress update, responding to recommendations contained in the Joint Report, was issued by the JPO on October 3, 2002 (JPO 2002d). On October 14, 2002, APSC issued a 3rd quarter update report. The salient points of the Joint Report and the corresponding responses are summarized in a text box beginning on the next page.

4.1.2 Design Features as Mitigation

4.1.2.1 Design Elements

Numerous TAPS design features actually serve as mitigation measures and were incorporated into the TAPS to mitigate anticipated impacts. Others were initiated by JPO directives or in recognition of applicable standards or regulations. Major mitigating design features include special installation techniques and foundations; corrosion control features; earthquake mitigation measures; special design considerations for river crossings; volatile organic chemical control; ballast water treatment at the Valdez Marine Terminal; TAPS valves (RGVs and check valves) as mitigation features; main-line TAPS Leak Detection Systems; and special designs for designated big game crossings (DBGCs). Each of these design features is discussed in the sections below.

4.1.2.2 Special Installation Techniques and Foundations

The construction and operation of a buried warm-oil pipeline could induce thaw in permafrost soils. Such thawing might degrade system integrity. Different soil types vary widely in response to thawing. Granular soils with little excess ice are considered "thaw-stable" because they do not lose significant volume or strength when thawed. Fine-grained, ice-rich permafrost, however, may decrease in volume a great deal upon thawing and have a very low shear strength during and after thaw. Subsidence of the ground surface, downslope movement of the thawed mass, and susceptibility to liquefaction can result. These soils are considered "thaw-unstable."

Warm oil flowing through a buried pipeline results in thawing of permafrost and creation of a "thaw bulb" around the pipe. The thaw bulb grows with time at a rate affected primarily by the temperature of the pipe, the temperature and water content of the surrounding soils, and the climate, but eventually it stabilizes. Special designs were developed to deal with the problems imposed by the subsurface conditions and climate. Stipulation 3.3.1 sets criteria that govern which construction mode is used at any given location.

4.1.2.2.1 Conventional Buried Pipe. In areas where the ice content of the permafrost is very low or absent, or where no permafrost exists, the pipe is buried in a conventional belowground mode (see Figure 4.1-1). The 376 miles of TAPS pipe are buried in this manner.

4.1.2.2.2 Buried-Pipe Animal Crossings. As required by Stipulation 2.5.4.1 of the Federal Grant, to ensure free passage of big game animals, buried-pipe animal crossings are provided where there would otherwise be long uninterrupted sections of aboveground pipe. The animal crossings typically consist of about 50 ft of buried pipe in thaw-unstable soils. The buried pipe has an insulated jacket and is installed in an insulation-lined trench. In some instances, refrigeration systems cool the surrounding soil to prevent thawing.

4.1.2.2.3 Special Burial. At three locations, sections of the pipeline are buried in a "special burial" (refrigerated) mode for a total of about 4 mi. This mode involves insulation as well as active refrigeration of the soils in thaw-unstable permafrost. Refrigerated brine lines are installed under the pipe to keep the underlying ice-rich soils from thawing (see Figure 4.1-2).

4.1.2.2.4 Insulated Box. In a few places, at locations where the underlying soils are thaw-unstable, the pipe is installed in an

Joint After-Action Report for the TAPS Bullet Hole Response (February 8, 2002)

On October 4, 2001, a 285,600-gal oil spill occurred when the TAPS was shot with a high-powered rifle near the community of Livengood, Alaska. The APSC Fairbanks Emergency Operations Center (FEOC) was activated and the Unified Command was formed to direct incident management operations. The affected section of the pipeline was isolated by control valves; however, the residual oil in the pipeline was still under pressure, and crude oil sprayed from the bullet hole for an extended period of time. Steps were taken to reduce the pressure within the section of the pipeline. Oil remaining in the section of pipeline was pumped around Remote Gate Valve (RGV) 65 into the segment north of the isolation valve as a method to reduce segment pressure. The high pressure also created a serious hazard for responders. A hydraulic clamp, designed, built, and tested for such a leak, was lifted by crane into place within 36 hours after the release. By the next morning the bullet hole had been permanently plugged, North Slope oil production resumed, and the flow through the pipeline was restored. Recovered oil was reinjected into the pipeline at PS 7. Approximately 175,793 gal (of the estimated 285,600 gal of spilled product) has been recovered, and removal of the contaminated soils and vegetation has been completed.

The Joint After-Action Report for the TAPS Bullet Hole Response (issued February 8, 2002 (Joint Report; JPO et al. 2002) concluded the overall response went well (due to the efforts of the responders) — spilled oil was contained in a limited area, environmental damage was limited, no one was injured, and pipeline throughput was restored with minimal disruption to the public. The Joint Report reviewed and addressed the following elements, each compared to the implementation of the existing APSC Oil Spill Contingency Plan (CPlan). Each element is described and the corresponding recommendations and progress updates are summarized below:

- Incident Command System (ICS)/Unified Command (UC) — APSC activated the Fairbanks Business Unit Incident Management Team, which opened the Fairbanks Emergency Operations Center (FEOC). The Federal On-Scene Coordinator (FOSC) (EPA) and the State OSC (SOSC) sent representatives to the FEOC and the spill site. A BLM representative from the JPO functioned as a BLM/ADNR Liaison/alternate Field OSC in the UC. A representative of DOT-OPS worked with APSC's pipeline repair unit.

    - ❑ Recommendations — included improving the integration of JPO senior management (e.g., Authorized Officer [AO] and State Pipeline Coordinator [SPC]) and technical specialists into the Incident Management Team, improving communication between off-site agency specialists and the IMT, between the on-site field command center and the FEOC, and between the UC and the Operations Section. The Joint Report found no fault with the implementation of the CPlan incident command system.

    - ❑ Progress Updates — APSC will provide workspace for agency personnel in the ICS General Staff sections and units. In addition, a mobile command post (trailer) has been constructed and is currently being outfitted with appropriate electrical and communication gear. APSC will develop a "go team" of field support operations support personnel capable of providing relief and expanded capacity to the on-scene command organization.

- TAPS Leak Detection — There are three leak detection systems in place: (1) deviation alarms, (2) line volume balance (LVB), and (3) transient volume balance (TVB). Although the on-line leak detection systems were functioning as designed, there are system limitations, and none of the systems alarmed before the leak was discovered during routine aerial security surveillance. The October 4, 2001, leak was too small to trigger the deviation alarms, and the time interval between visual detection and pipeline shutdown was less than the time interval required for LVB to detect and trigger an alarm. Only the TVB had a theoretical chance of detecting and alarming for a leak of this magnitude in the 30-minute time window between the onset of the leak and pipeline shutdown. The TVB system did detect a volume imbalance, however, because the imbalance did not meet necessary validation conditions due to flow measurement shifts following the recent passage of a cleaning pig through PS 6, which reduced the TVB system's effective sensitivity.

Continued

- Recommendations — The current leak detection sensitivities are within the 1% of throughput and are consistent with best available technology, per ADEC regulatory requirements. The Joint Report recommended APSC continue on-going efforts to improve current lead detection systems. In addition, the CPlan should be revised to more thoroughly describe the TAPS leak detection system and delineate specifications and limitations of the system more completely, including leak detection thresholds and time required to detect a leak.

- Progress Update — APSE has a Pipeline Leak Detection Improvement Project underway to improve leak detection capabilities. A performance test was completed in August 2002, and the results are being reviewed. The current project is scheduled to be completed in 2003.

- Source Control — The TAPS has more than 177 pipeline valves that can stop the flow of oil. Each pair of valves can enclose a segment of pipeline. The ultimate size of the spill is limited to the TAPS design volume in that segment. One minute after receiving notification of a leak on the pipeline, controllers initiated a pipeline shutdown designed to minimize oil pressure at the leak location. The upstream pump stations were idled five minutes after the leak was detected. The sequence of shutdown was found to be appropriate for the information provided, and the Joint Report found no indication that training or procedures need improvement. However, the pressure within the leaking segment was too high for safe application for the Plidco Smith+ Clamp (also know as the Bullet Clamp). It was determined that installation of the clamp against the jet stream pressure in the hazardous vapor environment was unsafe for the workers who would have to do the work. The pressure at the leak was also higher than the pressure that had been used during testing and training for the application for the Team Clamp. The Hydraulic Clamp, several Plidco Smith+ sleeve clamps, and several bullet clamps were on-site and available for use once the personnel hazard was reduced. The mobilization of the pump-around skid, required to reduce pressure at the site of the leak, required approximately 29 hours. In addition, on October 5, 2001, significant reverse flow associated with source control activities caused failure of Check Valve 50, moving the valve and nine pipeline anchors 13 in. upstream.

  - Recommendations — Investigate modification to the pump skid, increasing pump capacity, and developing a planning tool to determine allowable pump-around parameters. In addition, scenarios, procedures, and training should be developed to use the Hydraulic Clamp and the Bullet Clamp under extreme conditions. Furthermore, conditions and limits to the tools and methodologies should be defined and additional methods, tools, and safety plans should possibly be developed. In addition, modification of the mainline relief valve maintenance procedures should be considered to eliminate potentially damaging reserve pipeline flow conditions. The Joint Report found the CPlan implementation for pipeline shutdown was appropriate. However, the CPlan should be revised to describe in more detail the considerations and possible consequences should the option to backflow oil to an upstream pump station be taken. It should include information about use of the pump-around skid as a method of pressure reduction related to source control. The CPlan also should be revised to include the safety limitations for each device (clamps) listed in the CPlan when applied in an uncontrolled vapor environment. Although the devises were listed in the CPlan, their use was described as the preferred method to repair damaged pipe (a permanent repair practice) rather than a source control device. In addition, changes to procedures for maintenance of relief valves and for operations while check valves are locked open should be included in the CPlan.

  - Progress update — A facility has been fabricated in Fairbanks to aid in developing, testing, and training for source control methods. A new bullet hole clamp has been purchased and modified on the basis of experiences of other pipelines that have had leaks due to bullet holes. The modifications are believed to allow application of the manual clamp under higher pressure. Additional testing will be conducted. APSC has issued a Request for Contract for design of a lightweight hydraulic clamp for source control and temporary repair. APSC has modified the existing pump-around skid to reduce mobilization time and improve pumping capacity. These modifications were completed in 2001. APSC is creating a project to design and construct new drain down/pump-around skids to be pre-positioned on the basis of risk and mobilization times. Acquisition has been targeted for completion in 2003.

Continued

- Safety — Significant health and safety threats exist while working around an oil spill. Personal protective equipment (PPE), including air filters, self-contained breathing apparatus, and protective clothing, can protect workers from respiratory exposure or skin contact, but other dangers include slips, trips, and falls, and reduced visibility and sight lines. Vapors from a crude oil spill can ignite in much the same manner as vapors from a gasoline release. In the presence of flammable vapors in the outdoors, any ignition source could start a fire. If the vapor concentrations are high enough, an explosion could occur.

    - Recommendations — There were few recommendations concerning safety procedures during the incident, other than to ensure all responders have received appropriate respirator fit testing and HAZWOPER training (records of training could not be produced for three responders) and to encourage the participation of community fire departments in future exercise and preparedness training. In addition, in-state and out-of-state resources that could enhance fire prevention and fire suppression capabilities should be identified. It was recommended that the CPlan be updated to reflect the lessons learned during this incident regarding fire prevention, control, and suppression in such situations.

    - Progress update — Specifications for a fire foam skid are nearly finalized. APSC has developed generic safety plans to address emergency response activities involving insulation removal, pump-around skid use, temporary patching, and plugging.

- Containment and Cleanup Actions — ADEC regulations contain eight criteria to be applied to determine the adequacy of containment and cleanup. The Joint Report concluded the response, both as to containment and cleanup, met all eight criteria. Because of the problems with source control, a decision was made at the FEOC to concentrate resources on containment rather than source control. The footprint of this spill did not significantly increase after about 7-1/2 hours. Innovative tactics were applied, such as the creation of a number of shallow trenches in a linked chevron pattern cut into the vegetative mat to drain oil into existing collection pits. The release posed a low risk to fish and wildlife in the immediate area, since the spill-impacted area was limited. Shorty Creek and Tolovana River are located approximately 1/2 and 1 mile from the spill site, respectively. Wildlife exclusionary fencing installed during the cleanup phase will minimize accidental contact with contaminants.

    - Recommendations — A checklist should be developed to focus on critical response information such as determining the location of predetermined containment sites and the rate of advance of the oil spill, and containment actions should be developed. In addition, innovated tactics should be memorialized in response tactic manuals and the CPlan. The CPlan should be amended to include various techniques to estimate oil recovery and to track the volume of oil recovered (e.g., use of recovered oil-filtering skid with a metering system). The CPlan should also list any environmental permits already in place and identify and investigate preauthorization for certain key permits.

    - Progress update — APSC is evaluating additional tanks and oil transfer equipment to efficiently transport oil captures at a spill site to a reasonable transfer point. Draft internal amendments to the CPlan have been completed. They will be reviewed with agency personnel prior to being submitted as formal plan amendments. APSC is also developing specifications to design and construct an oil metering and filter skid.

- Return to Service — A standard pipeline fitting (known as a threaded O-ring), was installed by using previously approved welding procedures. This installation met all APSC's operating requirements and satisfied all regulatory requirements. Restart of the pipeline was conducted using established procedures and approval protocols. The Joint Report had no recommendations other than to continue current practices.

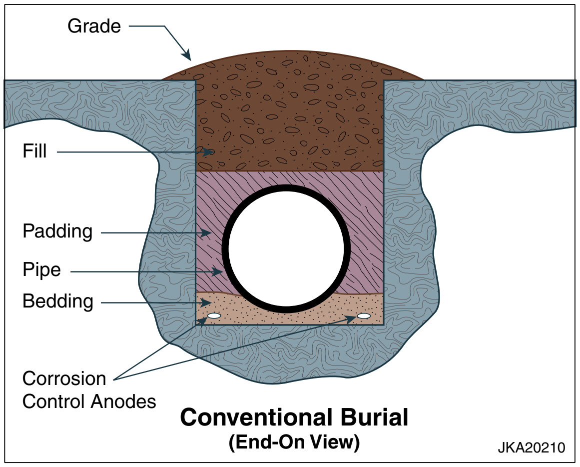

FIGURE 4.1-1 Typical Pipeline Details for Conventional Burial (Source: TAPS Owners 2001a, Figure 4.2-2)

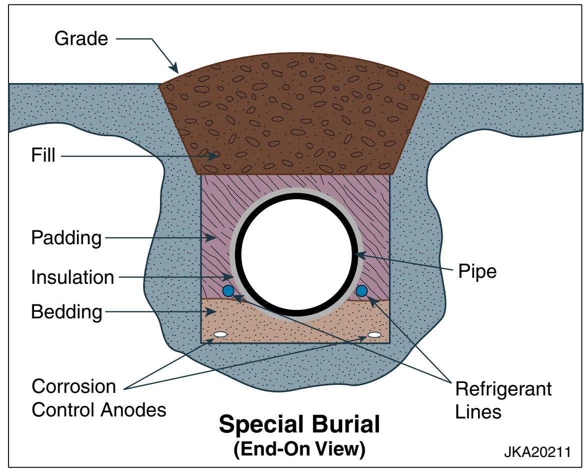

FIGURE 4.1-2 Typical Pipeline Details for Special Burial (Source: TAPS Owners 2001a, Figure 4.2-3)

insulated box. This mode is used primarily where avalanches would threaten the pipe if it were aboveground.

4.1.2.2.5 Conventional Elevated Pipe. In areas where soils are typically thaw-unstable and thus unfavorable for conventional burial, the pipe is elevated on crossbeams attached to VSMs. Figure 4.1-3 displays a typical VSM installation. The VSMs consist of 18-in.-diameter steel pipe embedded deep enough to support the loading and resist frost heave. Several types of VSMs are used; each is designed for extant soil and loading conditions.

South of the Brooks Range, designers expected a high potential for thawing of the permafrost around the VSMs, thus leading to potential instability. Movement of VSMs caused by settling or jacking can cause the crossbeam to tilt or to move up or down at one support relative to adjacent supports (see Figure 4.1-3). Either movement may cause nonuniform loading of the pipeline. Tilting of VSMs because of settling or lateral earth pressures may also cause the crossbeam to move (relative to the pipeline axis), preventing the shoe from being evenly supported by the crossbeam. To avoid this instability, many VSMs are equipped with thermal devices called heat pipes (or thermo-siphons), which use nonmechanical circulation of ammonia in a pressurized tube to remove heat from the soil during winter when the air is colder

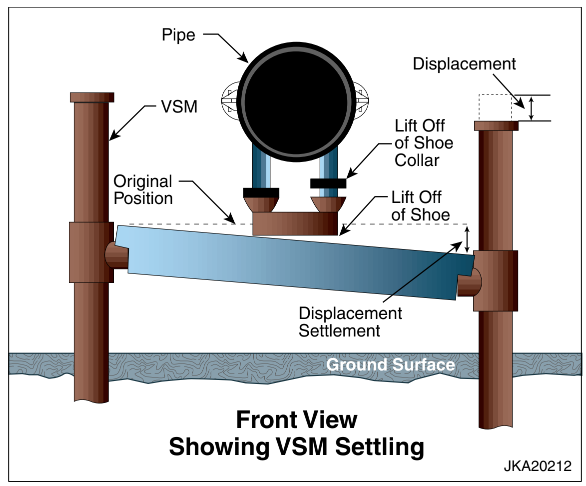

FIGURE 4.1-3 Potential Vertical Support Member Movement (Source: TAPS Owners 2001a, Figure 4.2-5)

than the soil. Figure 4.1-4 shows a typical heat pipe cross section.

4.1.2.2.6 Other Facilities. Numerous other facilities associated with the TAPS have foundations in permafrost. These include refrigeration plants, the fuel gas line, pump station facilities, storage buildings communications sites, and others. As required

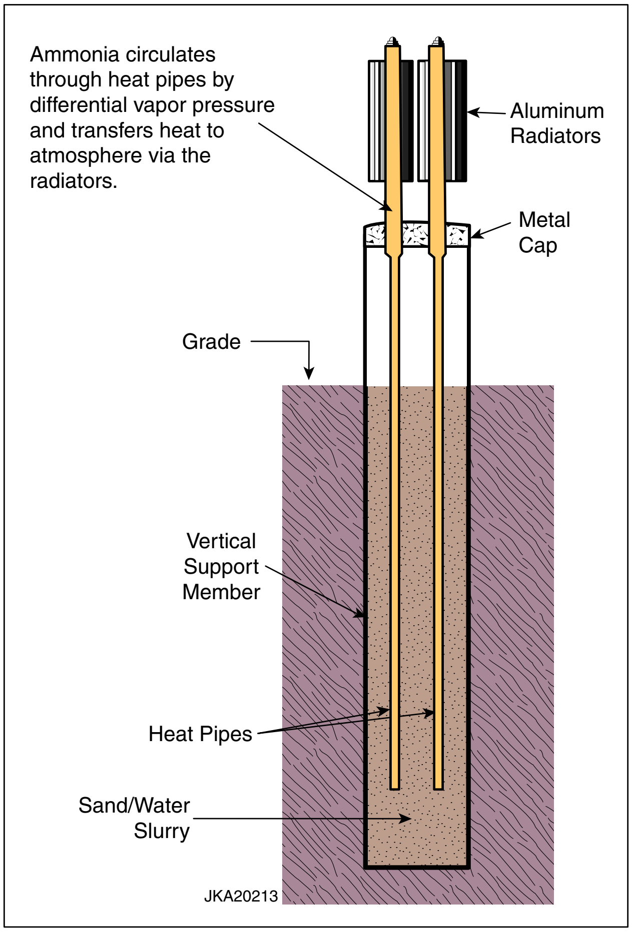

FIGURE 4.1-4 Typical Thermal Vertical Support Member (Source: APSC 2001j as cited in TAPS Owners 2001a, Figure 4.2-6)

by Stipulation 3.9.1 of the Federal Grant, foundation designs for these structures include active and passive refrigeration in thaw-unstable soils and more conventional designs in thaw-stable soils. The fuel gas line is buried in cold permafrost throughout its length, and the temperature of the gas is regulated to keep it below freezing. (Gas discharged to the line at PS 1 is approximately 20°F.) The gas temperature equilibrates to the temperatures of soils surrounding the pipe as it travels south. Soil temperatures along the gas line vary between –20°F to +32°F annually. The line was constructed in winter from a snow pad, and there is no associated gravel workpad.

Heat Pipes

The heat pipes operate in accordance with basic laws of thermodynamics. The anhydrous ammonia inside the sealed heat pipe absorbs heat from the subsurface soils. The ammonia boils, and the vapors rise to the aboveground portions of the heat tube by differential pressure. There, heat is transferred to the ambient atmosphere and radiated into space. Fins on the uppermost portion of the heat pipes increase the efficiency of this heat exchange. Once the ammonia has released sufficient heat, it condenses and returns back to the bottom of the heat pipe as a liquid, where it is again available for the next heat transfer cycle. Because the heat pipes are sealed, their function does not result in any release to the environment other than heat. Heat pipes can function with limited maintenance or refurbishment. However, in some heat pipes, the buildup of hydrogen gas from the chemical reduction of residual cutting oils by the ammonia forms a noncondensible blockage in the uppermost portion of the heat pipe fins, ultimately reducing the efficiency of the heat pipe to a degree to which it must be repaired or maintained. On those occasions, repair and refurbishment procedures call for venting the hydrogen to the atmosphere and recharging the heat pipe with anhydrous ammonia to bring the heat pipe back to full operation and heat transfer capability. However, amounts of ammonia in each heat pipe are small — on the order of 14 ounces (Sweeney 2002).

4.1.2.3 Corrosion Control Features

Cathodic protection technologies are employed to mitigate corrosion of buried main-line pipe. Both impressed-current and sacrificial galvanic anode technologies are used. Cathodic protection systems are also installed at each pump station and are used to also provide protection to adjacent segments of buried pipe. APSC monitors cathodic protection by “coupon”

Corrosion Control

All metallic objects are subject to corrosion when exposed to the elements. Corrosion is an electrochemical reaction in which metal atoms loose electrons to form stable ions; that is, they oxidize. The metal acts as the anode (a source of electrons) in a galvanic cell. (A galvanic cell is a device in which electricity is produced through chemical reactions.) In the case of the pipeline, the iron pipe changes chemically from the metallic state, Fe^{0}, to Fe^{+2} or Fe^{+3} ions that combine with available oxygen atoms to form stable oxides of iron, ferrous oxide (FeO), and ferric oxide (Fe_2O_3), commonly referred to as rust. If left unchecked, this oxidation will continue until so much of the iron in the pipe oxidizes that the pipe's integrity is compromised. All efforts to control the oxidation of the iron in the pipe are generally referred to as "corrosion control" or "cathodic protection." These efforts can involve coating the iron with a material that will isolate it from water and oxygen, or the use of techniques designed to prevent or slow the metal's oxidation reactions. Two such common techniques include the use of a "sacrificial anode" or the application of "impressed electrical current." Sacrificial anodes composed of twin zinc-ribbon anodes are buried with the buried pipeline over 376 miles and electrically "bonded" to the pipeline. Zinc oxidizes more readily than iron and will oxidize completely before the more resistant steel pipe begins to oxidize. That is, the zinc anode is "sacrificed" to save the pipe." Normally, sacrificial anodes will last decades before they need to be replaced. A second way to stem oxidation of the pipe is to apply an electrical current to the pipe that is at least equal to the current that would result from the iron's oxidation, commonly referred to as an "impressed current" cathodic protection system.

testing,[2] close interval survey, and test stations positioned along the ROW. Inhibitors are used to control corrosion in isolated and low-flow or seldom-flow piping in pump stations and valves. Monitoring of cathodic system performance is discussed in Section 4.1.3.2.1.

Impressed current systems are utilized in those buried pipeline segments where electrical power is readily available. At remote sites, where commercial power is not available, a generator is used to provide electrical current to the impressed current system, or, alternatively, a sacrificial anode system is employed.

Impressed current systems also involve the installation and maintenance of deep-well anodes (also known as vertical anodes), linear anodes, or horizontally distributed anode beds that serve as electrical ground paths. Deep-well ground beds consist of electrically conductive metal rods that were installed vertically from the surface and may be several hundred feet deep. Vertical ground beds are necessary in areas where the electrical resistivity of surface and near-surface soils is high. Because of existing soil conditions in the ROW, some deep-well ground beds were originally installed in locations remote from the pipeline (i.e., off the ROW). Linear anodes were placed near the pipeline at relatively shallow depths. Trenching near the pipeline was required for initial installation, although linear anodes were installed in the main pipe trench. Horizontally distributed anode ground beds were installed at pump stations; they support not only pump station equipment but also pipeline segments on either side of the station. Horizontal anodes are buried relatively near the surface in proximity to the pipe; they usually have a longer linear extent and proximity to the pipe in order to ensure an adequate electrical ground path. Regardless of the anode type employed, all impressed current systems also require an electrical power rectifier and rheostat to control current output.

4.1.2.4 Earthquake Mitigation Measures

The TAPS ROW crosses five seismically active zones having Richter magnitudes from 5.5 to 8.5. Section 3.4 provides a description of

[2] As used in the context of the TAPS, corrosion coupons are small pieces of metal with the same metallurgical properties as the pipeline. They are buried with the pipeline, but do not themselves prohibit corrosion. They do allow for precise measurement of pipe-to-soil potential, important for establishing the correct level of corrosion protection provided to the pipeline.

earthquake potential along the TAPS route and the Valdez Marine Terminal and includes a detailed discussion of the potential impacts of seismic activity on the integrity of the pipeline and Valdez Marine Terminal. Stipulation 3.4.1.1 of the Federal Grant sets criteria governing the design features to mitigate the effects of earthquakes and fault displacement. A design earthquake magnitude has been established for each seismic zone, resulting in unique design parameters (i.e., ground motions and design response spectra) for each zone (APSC 1973).

The pipeline, pump stations, terminal facilities, RGV facilities, and control and communication systems were originally designed to withstand the effects of earthquake ground shaking and permanent ground deformation. In addition, the tanker loading berths at the Valdez Marine Terminal have been designed for estimated maximum tsunami wave and wave run-up conditions that can be expected at Jackson Point (Stipulation 3.7). Where possible, the pipeline was routed to avoid areas having significant potential for large amounts of ground displacement; otherwise, the pipeline was engineered to accommodate permanent ground movements without rupture. At the three fault crossings — Denali, McGinnis Glacier, and Donnelly Dome — the pipeline was placed above ground with oversize pipe shoes and support beams to accommodate design movements. To accommodate extraordinarily large design movements of 20-ft horizontal slip and 5-ft vertical slip at the Denali Fault crossing, the pipeline was placed on beams embedded in a gravel berm. The designs of these fault crossings have been reevaluated and have been confirmed as adequate.

4.1.2.5 Special Design Considerations for River Crossings

The pipeline crosses 80 major rivers in either buried or aboveground mode and is in or adjacent and parallel to a number of river valleys. In accordance with Federal Grant Stipulation 3.6.1.1, these crossings were designed to accommodate foreseeable erosion, scour, ice conditions, and river meanders. Pipeline design at river crossings and in floodplains was based on quantitative assessments of flow and scour and a qualitative analysis of potential channel changes over the life of the system. In addition, the pipeline was designed for the pipeline design flood, a theoretical flood magnitude computed for every significant river and creek crossing in satisfaction of Federal Grant Stipulation 3.6.1.1.1.2.

To mitigate the effects of natural events, channel flow and flood data are incorporated into the initial design of river crossing structures, and flood remediation and contingency plans are developed. Gravel bags are placed on the left bank of the SAG River at MP 47, and riprap is stockpiled at a number of locations along the ROW, and constant monitoring and inspections of the river crossings are carried out, as are extensive postflood inspections. Also, river training structures are installed and maintained to control the effects of natural bank scouring or the impacts of channel migration on the integrity of buried pipeline segments and pipeline structural support systems.

4.1.2.6 Volatile Organic Emission Control

Certain crude oil handling activities have the potential to release volatile organic compounds (VOCs). Storage tanks and equipment are vented for fire and overpressure safety reasons, and the VOCs released could be emitted to the atmosphere. Major sources of crude oil vapor emissions are controlled through vapor recovery systems at PS 1 and the Valdez Marine Terminal. At PS 1, a vapor recovery system routes displacement vapors from the two receiving tanks (tanks 110 and 111) to a vapor incineration flare. The tanks receive crude from the various North Slope production areas. The tanks also function as crude breakout or pressure-relief (surge) tanks when crude has to be diverted during pipeline upsets or slowdowns. The vapors are collected in a common vapor header and routed to the tank-vapor incineration flare. During 1994 to 1995, APSC installed a new flare tip and a gas-assist combustion system. This upgrade helped improve the combustion characteristics of the flare in all cases except during full tank in-rush situations, when exceedances of the permitted opacity limit still occasionally occurred. In September 2001, APSC installed additional improvements that allowed the flare to accept a full in-rush of volatiles and destroy them without exceedances of opacity limits. ADEC officials witnessed the testing (Montgomery 2002).

The Valdez Marine Terminal is equipped with a system that controls the crude oil vapors from both the onshore tank farm and the marine loading operations. Crude vapors are generated when fresh crude enters the tanks and displaces an equal volume of the internal tank vapor space. The tank displacement vapors are controlled by low-pressure vapor collection lines and are primarily used for vapor balancing to replace tank vapors when tanks are being emptied. Excess tank vapors are used as fuel gas in the Valdez Marine Terminal power boilers. Excess vapors that are not used as fuel are incinerated in one of the three vapor incinerators.

The tanker vapor control system operates in a similar fashion to capture vapors during tanker loading operations at two of the four existing tanker berths. It was built and tied in with the existing system in 1997.

4.1.2.7 Ballast Water Treatment at the Valdez Marine Terminal

Oily ballast water from tankers and other wastewaters from the Valdez Marine Terminal are treated at the BWTF. When it was originally built in 1976, as required by Section 23B of the Federal Grant, the BWTF used three 18,000,000-gal steel primary gravity-separator tanks and six 240,000-gal secondary dissolved-air-flotation cells to remove oil before discharging the saline ballast water to Port Valdez under the terms of a NPDES permit. The waste discharge limitations imposed on the BWTF in the NPDES permit were later revised to include a limit on BTEX. In response, two aerated impound basins were replaced in 1990 by a permanent biological treatment facility consisting of two 5,500,000-gal concrete aeration tanks equipped with a submerged-jet aeration and mixing system (Rutz et al. 1991).

BTEX Fraction

Benzene, toluene, ethyl benzene, and xylene are all discrete polar organic compounds routinely present in crude oil as well as refined petroleum products. Collectively, these four compounds make up what is referred to as the BTEX fraction of the petroleum substance. The BTEX fraction normally exhibits the greatest mobility in the environment. Consequently, environmental media are often sampled for the presence of BTEX as an indication of the extent to which spilled petroleum has migrated from the spill site. Potential carcinogenic and other health effects from exposures to BTEX compounds are addressed in Sections 3.17.2.4 and 4.3.13.2.2.

To provide additional reliability, a polishing air stripper was installed downstream of the aeration tanks to remove occasional spikes of BTEX in the event of biological upset (Rutz et al. 1992). The entire BWTF is controlled by a computerized supervisory control and data acquisition (SCADA) system in a centralized control room. Additional discussions regarding wastewaters delivered to the BWTF and the amount and character of discharges from the BWTF to Prince William Sound are provided in Section 3.16.

4.1.2.8 TAPS Main-Line and Pump Station Valves as Mitigation Features

Valves controlling the operational functions of the TAPS are located on the main line, in pump stations, and at the Valdez Marine Terminal. Main-line pipeline and pump station valves have three purposes: minimize spills in the event of a leak in the main line, prevent overpressurization of the pipeline, and isolate pump station and terminal facilities. Valve placement along the ROW was dictated by a number of factors in addition to operational demands, including these two: the locations of sensitive environmental receptors and the adoption of a design specification that no more than 50,000 bbl of crude oil (static volume — the amount of crude oil spilled after all the pumps upstream are shut down and all the valves are closed) would be released in the event of a guillotine break anywhere along the main line.[3] Current performance standards for main-line valves limit valve "leaks through" to a rate that would not result in an increase over the initial design spill volume (Weber and Malvick 2000; Aus et al. 2000.).

The main-line pipeline valve system of 177 valves includes 63 RGVs[4] and 81 check valves. Where the oil flows uphill, check valves prevent backflow if oil pumping stops, as would occur in response to a known or suspected rupture or break. RGVs prevent flow in either direction. (Check valves are preferred over RGVs on uphill slopes. They serve the same purpose as RGVs but are more economical and, more important, they are less complicated and require less maintenance.)

Nine manual gate valves have been placed near check valve sites to provide more positive isolation when required. They are included for pipeline maintenance and secondary spill response. Battery limit valves make up the final 24 pipeline valves. These gate valves are located on either side of each pump station and ahead of the Valdez Marine Terminal to isolate the station or the terminal from the pipeline in the event of a pump station fire or other emergency.

All main-line valves are subject to annual preventive maintenance to refurbish lubricants and ensure mechanical functionality. In addition, all main-line valves are subject to performance testing to ensure that they maintain their ability to seal off flow (minimum "leak through") (Jackson and White 2000). This function is the key to minimizing the amount of oil that could theoretically leak from any pipeline segment (Stipulation 3.2.2.1) (TAPS Owners 2001a).

4.1.2.9 TAPS Leak Detection Systems

The TAPS leak detection systems include deviation alarms for pressure and flow rate, line volume balance (LVB) leak detection, and transient volume balance (TVB) leak detection. Each system capitalizes on unique leak characteristics. The intent is to detect leaks as early as possible and when they are as small as possible to minimize environmental damage. To supplement leak detection systems, regular and frequent visual field observations are performed from both the air and the ground.

4.1.2.9.1 Deviation Alarms. Two types of deviation alarms are used: pressure and flow rate. The leak detection system looks for deviations from preset values or sudden changes in flow or pressure. This tool has been in service since 1977 to rapidly detect large leaks. The leak-loss sensitivity threshold is about 10,000 bbl/d (1% of flow), with a response time of 1 to 5 minutes.

Pressure deviation alarms are based on pump station suction and discharge pressure readings. Approximately every 3 to 4 seconds, the SCADA host computer retrieves pressure readings at each pump station. The current pressure reading is compared with the previous one. A drop in pressure greater than 1% of range generates a deviation alarm, as does a value outside the acceptable range of pressures. This method can detect large leaks between adjacent pump stations and between PS 12 and the Valdez Marine Terminal.

Flow rate deviation alarms are based on readings from each pump station's leading-edge flow meter (LEFM) and the incoming meters at

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3 A maximum of approximately 54,000 bbl was calculated as potentially lost due to a spill from a postulated quillotine break in the pipeline. This amount includes both the dynamic volume (the quantity forced through the break due to pumping action) and the static volume. The static volume is less than the 50,000 bbl limit. See Section 4.4 for detailed discussions of spill scenarios and Table 4.4.1-5 for anticipated spill volumes.

4 One ball valve, at PS 11, performs the same function as the RGVs and is included in the count of 63 RGVs used throughout this report. Some valve reconfigurations also occurred during the rampdown actions for PS 2, 6, 8, and 10. A check valve was installed at PS 6. A battery limit valve was installed in PS 10, but it performs the same function as an RGV.

the Valdez Marine Terminal, all of which are scanned approximately every 10 seconds by the SCADA system. Each new reading is compared with the previous one. Any deviation greater than 1% of range causes an alarm to sound. Flow rates outside preset limits also generate an alarm. This method can detect large leaks between adjacent pump stations and between PS 12 and the Valdez Marine Terminal.

4.1.2.9.2 Line Volume Balance. LVB leak detection is based on readings from the custody-transfer meter at PS 1 and incoming meters at the Valdez Marine Terminal. The SCADA computer gathers LEFM readings approximately every 3 to 4 seconds and calculates a real-time average flow rate at each end of the pipeline. With these data, every 30 minutes, the LVB system calculates the average oil volume entering the pipeline at PS 1, the average volume leaving the pipeline at the Valdez Marine Terminal, the changes to the oil inventory in all breakout tanks at the pump stations, and the volumes of oil diverted to and returned from refineries at the North Pole and Valdez.

LVB leak detection compares the relative volumes of oil in and out of the pipeline to detect a leak. If more oil is entering the pipeline than exiting, a leak is declared. LVB is a long-term leak detection system that works well for finding smaller leaks. Given optimal steady-state conditions, leak-loss sensitivity thresholds may be as low as 2,000 bbl/d with response time of 6 to 24 hours. The threshold can be much higher with non-steady-state conditions. The TVB system, discussed in Section 4.1.2.9.3, provides better leak detection under non-steady-state conditions.

4.1.2.9.3 Transient Volume Balance. A 1998 enhancement to TAPS leak detection capabilities, the TVB system is a computerized method that uses mathematical models to detect leaks on the basis of field measurements. Every 60 seconds, the TVB system calculates flow characteristics derived from actual field pressures, temperatures, flow rates, and crude oil properties. On the basis of this information, the TVB system can produce a reliable flow-rate model. This information is compared with the actual line flow rates measured by the LEFMs. Deviations between the modeled flow and measured flow indicate potential leaks. This method takes just minutes to detect a spill that the LVB system would take hours to detect. The leak-loss sensitivity threshold is about 4,000 bbl/d (0.4 % of flow). The response time is about 30 minutes, depending on leak size. The system is also used to identify the approximate location of the leak. TVB has become APSC's primary leak detection system.

4.1.2.10 Special Designs for Designated Big Game Crossings

Several Federal Grant stipulations pertain to the conservation of terrestrial mammals and require mitigation of impacts to wildlife associated with TAPS construction, operation, and maintenance. Concern for potential obstruction to the migration patterns and local movements of caribou, moose, and bison resulted in construction of DBGCs (TAPS Owners 2001a). DBGCs constructed as elevated pipes were a minimum of 10 ft high and 60 ft long. Also, many were built as short buried sections (i.e., sagbend crossings) or as long, refrigerated, buried sections. A total of 554 DBGCs were designated along the pipeline in areas known by state and federal biologists to be regularly used by bison, moose, and/or caribou on the basis of traditional use and/or habitat characteristics.[5] Pipeline installation designs in these areas meet the requirements of the DBGCs. Studies in the 1970s and 1980s did not show any indication that large mammals were selectively crossing in these areas; however, it was hypothesized that the DBGCs would be necessary for big game movement during winters with severely deep snow (Carruthers and Jakimchuk 1987; Eide et al. 1986; Sopuck and Vernam 1986a,b; Van Ballenberghe 1978).

5 The Environmental Atlas locates resources and habitats to be protected (APSC 1993).

4.1.3 Mitigation through TAPS Operational Controls

4.1.3.1 Administrative Controls

In addition to the intrinsic design features discussed above, numerous routine TAPS operations provide mitigation against potential impacts or provide reliable data upon which mitigation decisions are based. Stipulation 1.18 requires APSC to conduct surveillance and maintenance of TAPS sufficient to (1) provide for public health and safety, (2) prevent damage to natural resources, (3) prevent erosion, and (4) maintain pipeline system integrity. Stipulations 1.20 and 1.21 require APSC to take all measures necessary to protect the health and safety of all persons affected in connection with TAPS construction, operation, maintenance, or termination and to operate the TAPS in a safe manner so as to ensure the safety and integrity of the pipeline system. In response to these stipulations, as well as in recognition of the overall program quality objectives of Section 9 of the Federal Grant and Section 16 of the State Lease, APSC has developed numerous formal procedures and operating manuals to control the critical aspects of TAPS operations. Among the operations manuals that have the potential to mitigate impacts are the following:

- Procedure Manual for Operations, Maintenance, and Emergencies (OM-1): Provides procedures for operating and maintaining the pipeline during normal and critical conditions. A similar manual, FG-78, addresses operation of the fuel gas line.
- Quality Program Manual (QA-36): Provides overall policy and guidance for ensuring quality in critical TAPS systems (APSC 1999a).
- Section 9 of the Federal Grant: Requires that JPO review and approve the substantive elements of the Quality Assurance Program displayed in the Quality Program Manual. The JPO's review extends to such matters as compliance with environmental regulations and Federal Grant stipulations, procedures for change (to TAPS infrastructure, planned surveillance, and monitoring activities), and effective corrective action procedures.
- Inspection Services Manual (IP-218): Provides inspection procedures for modification or addition to critical TAPS systems.
- TAPS Engineering Manual (PM-2001): Provides overall policy and guidance to engineers who produce project designs for modifications or additions to critical TAPS systems (APSC 2001a).
- APSC Design Basis Update (DB-180): Requires that changes to critical TAPS systems receive prior approval of the APSC engineering standards manager (APSC 2001b).
- System Integrity Monitoring Program Procedures Manual (MP-166): Establishes the manner in which system monitoring data will be collected and interpreted to serve as the basis for maintenance intervention.
- Maintenance System Manual (MP-167): Provides maintenance procedures and detailed checklists for planning and scheduling work, monitoring conditions, measuring maintenance effectiveness, and analyzing equipment reliability (APSC 2001c).
- APSC Surveillance Manual (MS-31): Provides pipeline surveillance procedures for the TAPS.
- Trans-Alaska Pipeline Maintenance and Repair Manual (MR-48): Provides detailed procedures for performing specific maintenance and operation (APSC 2001j).

In addition to the above manuals that address TAPS operations primarily from an engineering perspective, other manuals that incorporate health and safety and environmental protection considerations have been developed. These include:

- Environmental Management System Compliance Manual: Defines corporate environmental compliance policies, establishes business models for each compliance program area, and assigns responsibilities for compliance (APSC 2000b).

- Environmental Protection Manual (EN-43-1): Defines the scopes of various environmental protection programs, assigns responsibilities within those programs, and provides references to implementing procedures and training requirement matrices (APSC 2000a).

- Trans Alaska Pipeline System Environmental Protection Manual, Waste Management (EN-43-2): Provides detailed systemwide guidance for the identification and management of wastes routinely resulting from TAPS operations (APSC 2001d).

- TAPS Corporate Safety Manual (SA-38): Provides guidance and assigns responsibilities for the TAPS safety programs (APSC 2001e).

- Guide for Packaging and Transporting Hazardous Materials/Dangerous Goods by Highway and by Aircraft (HZ-134): Provides a reference guide for the safe and proper procedures for identifying, packaging, marking, labeling, documenting, and transporting hazardous materials/dangerous goods in accordance with DOT regulations (APSC 2001f).

- Environmental Atlas of the Trans-Alaska Pipeline System: Provides information on important fish and wildlife resources and considerations (APSC 1993).

Numerous other programs within APSC also provide mechanisms for identifying and mitigating or preempting potential impacts of planned actions. For example, the centralized control of hazardous material purchases allows potential environmental and safety and health impacts from the use of hazardous materials to be identified and provides the opportunity to identify less problematic alternatives. Section 3.16 provides additional details on this hazardous material control program. Likewise, numerous proposed actions require the input and review of APSC's field environmental generalists and environmental subject matter experts to ensure that environmental impacts of proposed actions are clearly understood and that less disruptive alternatives are identified, evaluated, and selected when feasible.

4.1.3.2 Monitoring, Surveillance, and Maintenance

Numerous routine monitoring, surveillance, and maintenance activities are performed for the purpose of preserving system integrity. Although monitoring and surveillance activities do not themselves constitute mitigation, they do produce reliable data on the current condition of critical TAPS equipment relative to predetermined adequate levels of performance. These data, in turn, support mitigation decisions. Over time, the data can also support trend analyses. Collectively, monitoring data are utilized to predict failures and direct preemptive maintenance or replacement actions. TAPS monitoring, surveillance, and preventive maintenance efforts focus on the following areas: main-line pipeline integrity, corrosion control, bridge monitoring, river and floodplain monitoring, seismic (earthquake) activity, slope stability, glacier surge, fuel gas line, and buildings and structures.

Monitoring and Surveillance

The terms "monitoring" and "surveillance" have distinct meanings. Monitoring implies a measurement and comparison against a predetermined value. Surveillance involves simply a visual observation and interpretation of a system component or existing condition by trained individuals. Both activities have the ability to direct mitigation. However, that distinction notwithstanding, the two terms are used interchangeably within the context of discussions related to mitigation.

4.1.3.2.1 Main-Line Pipeline Integrity Monitoring. APSC conducts systematic monitoring of the pipeline for movements that may jeopardize pipeline integrity. Aboveground segments are monitored by field crews who inspect and rebalance pipe loading on VSMs and perform maintenance on heat pipes when warranted. Belowground monitoring is implemented by field observations, elevation surveys of monitoring rods attached to the pipe, and periodic inspections inside the pipeline with devices called “smart pigs,” which travel through the pipe with the flow of the oil (Figure 4.1-5). Belowground pipeline segments are monitored for curvature, deformation, and corrosion.

Smart pigs have been in service since 1989 and have become the primary mechanism for collecting monitoring data on pipeline integrity. Depending on what instrumentation is installed, smart pigs can inspect for wall thinning caused by corrosion, curvature and settlement, deformation, dents, or other anomalies. Large quantities of data are recorded by the smart pigs and used to identify pipeline status and changes in pipeline condition over time and provide the basis for focused, preventative maintenance decisions. Since their introduction in 1989, as the quality of pig data (especially wall thickness measurements that are primary indicators of corrosion) has steadily improved, the use of smart pigs has dramatically reduced the number of exploratory corrosion digs. Corrosion pigs were used to inspect the full length of the pipeline in 1994, 1996, 1997, 1998, and 2001 (Cederquist 1999; Shoaf 2002). Currently, corrosion pigs are run on a triennial schedule, followed by one curvature pig run in the following year, and one deformation pig run in the next year. Corrosion pigs are also used in the fuel gas line at least once every 10 years. Since start-up, 56 corrosion, curvature, and deformation pigs have been run through the pipeline (TAPS Owners 2001a).

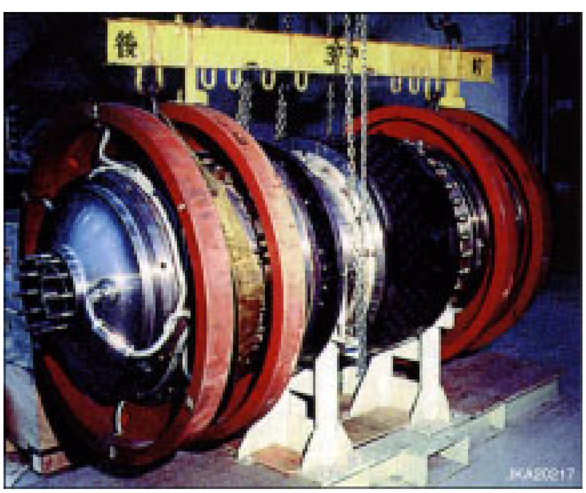

FIGURE 4.1-5 Smart Pig (Source: TAPS Owners 2001a, Photo 4.2-2)

Structural Support Monitoring, Adjustment, and Repair. About 424 mi of the pipeline is above ground. Structural support of the pipeline is provided by horizontal cross beams attached to vertical support members (VSMs) installed in the ground. Not only do these structural members support the weight of the pipe and the oil, they also are designed and positioned to allow for thermal expansion and contraction of the pipe, as well as to control the movement of the pipeline in response to seismic events. The pipeline is supported on intermediate supports (bents) spaced at about 60-ft intervals and anchored by specially designed supports at intervals of about 800 to 1,800 ft. At intermediate support locations, clamps around the pipe connect it to “shoes” resting on the horizontal cross beam that is supported by a pair of VSMs. A third VSM is sometimes used at intermediate supports where abnormal lateral soil loadings are possible. The shoes are not attached to the cross beam and are allowed to move both longitudinally and laterally. The bottoms of the shoes are composed of tetrafluoroethylene (TFE) (Teflon®) to facilitate their movements along the cross beam, albeit with predictable resistance. At anchoring locations, the pipe clamps are rigidly attached to the horizontal cross beams that are supported by four VSMs. A third type of structural support is used to support the 80 main-line valves in aboveground pipeline segments. A typical intermediate support (on a slope) is shown in Figure 4.1-6. The figure shows how shoe design can be used to support the pipeline on sloped terrain.

As many as 11 types of VSMs are used, depending on circumstantial factors such as soil

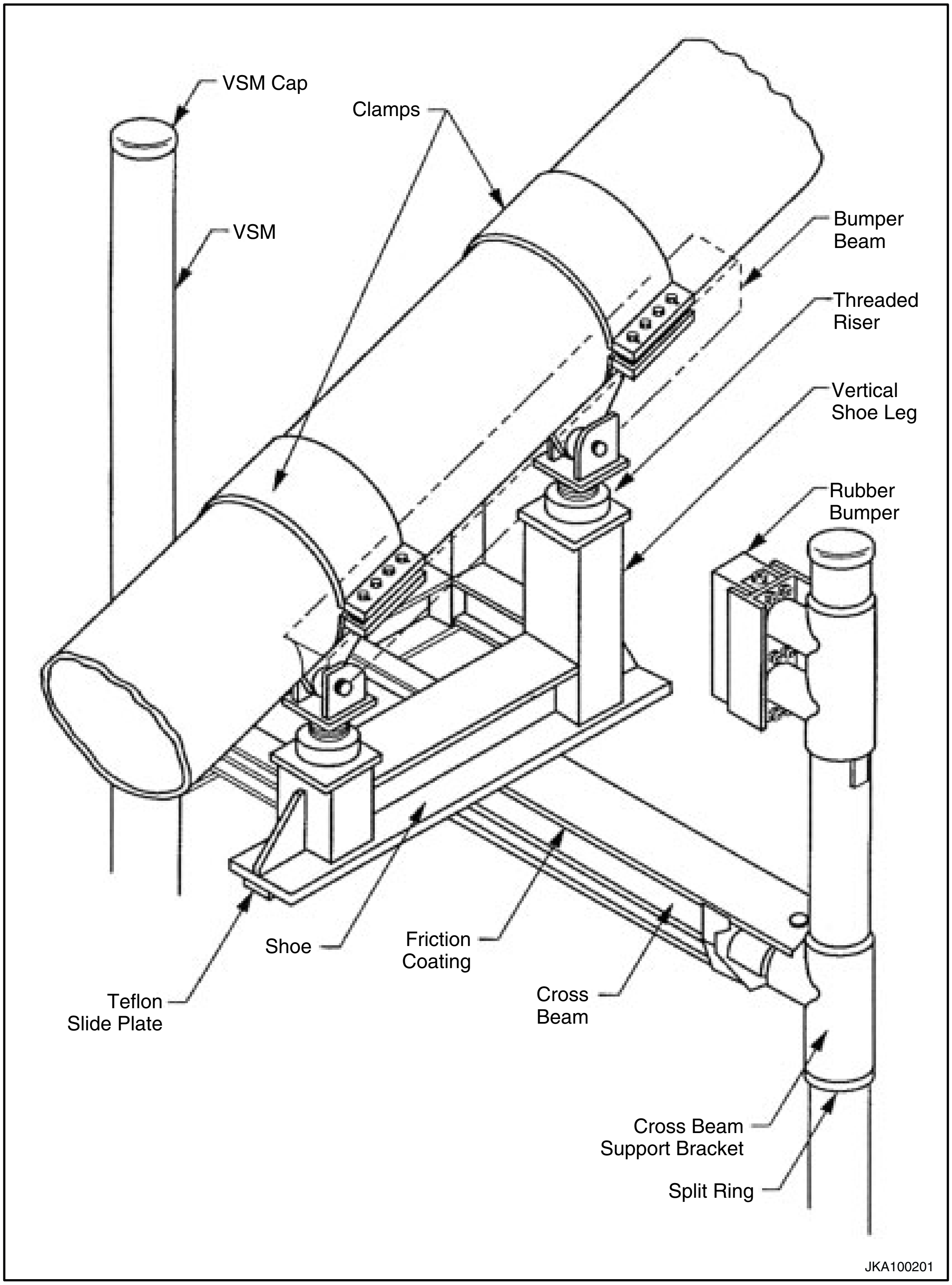

FIGURE 4.1-6 Typical Intermediate Support Assembly (Shown is a support installed on sloped terrain.) (Source: Modified from APSC 2001j)

type and grade (or slope) and whether they are providing intermediate support or anchoring the pipeline. Six of the 11 types of VSMs are equipped with heat pipes. (See Section 4.1.2.2.5 for a discussion of how heat pipes help address heat that can be transferred from the warm oil to the soil through the structural support members.) Likewise, there are 15 basic shoe designs. These assemblies differ in the lengths of their legs, creating the ability to support the pipe within a given range of slope. Eight different cross-beam designs are utilized, depending on the amount of lateral pipeline movement that can be anticipated at each location.

Various adjustment capabilities are incorporated into the designs of the structural support members to ensure that the load of the pipeline can be balanced and that no destructive tension or compression forces are applied to the pipeline. For example, as much as 3 in. of adjustment is possible in the horizontal cross beam's anchoring brackets, and these anchoring brackets connect to support brackets that are connected to the VSMs by means of split rings that can be raised or lowered on the VSM to account for vertical VSM movements. Shims and adjustment screws are also incorporated into the structural components to allow for adjustment when necessary. In seismically active zones, VSMs on intermediate supports are equipped with seismic bumpers composed of stiff rubber blocks, attached at the same elevation on the VSM as the centerline of the pipe and/or rubber bumper beams positioned between the pipe and its horizontal support beam. There are 4,400 bumpers and bumper beams installed on the aboveground pipeline segments (see Figure 4.1-6). Their function is to limit lateral or vertical motion of the pipe during an earthquake, providing a "crush zone" support against which the pipe can safely expend kinetic energy imparted by earthquakes.

Monitoring of the structural support system is extensive and done for the purpose of verifying that all of the components are stable and the pipeline load is balanced. Monitoring includes measuring loads as well as geometries and alignments. Alignments that are monitored include departures of the cross beam and the shoes from horizontal, the "cocking" of the shoes on the cross beam, and the vertical up or down movement of the VSM due to frost heaving or settlement jacking, as well as the "tilt" of each VSM from vertical that may be caused by soil movements or lateral forces on the VSM brought about by slope movement, as well as by fundamental changes to soil conditions in response to climate changes (e.g., potential changes to the permafrost horizons due to climate warming). APSC has calculated the amount of departure from perfect alignment of the structural support components that can be tolerated without introducing forces that can destabilize the support or compromise pipeline integrity. The tolerances have been established as "action levels" within APSC's Maintenance and Repair Manual (APSC 2001j). If monitoring or inspection reveal that any of the tolerances have been exceeded, action is initiated to adjust, repair, or replace the appropriate component or undertake reconstruction of the structural member. Standard operating procedures also call for certain adjustments to be automatically made annually (e.g., centering pipeline shoes on their horizontal support members). In most instances, simple adjustment has been sufficient to correct the observed problem. However, APSC has developed procedures that allow for the complete reconstruction of structural support members if necessary (including replacement or reconstruction of the VSMs) without interruption of oil flow.

Corrosion Control System Monitoring. All activities related to corrosion system monitoring and maintenance are outlined in APSC's Corrosion Control Management Plan (APSC 1999b). Monitoring of corrosion control systems involves a number of activities, including data gathering by smart pigs, field inspections and monitoring of impressed current systems, measurements of soil resistivity and other geophysical characteristics and pipe-to-soil potential, and monitoring of corrosion coupons.[6] Resulting data are incorporated into the Corrosion Data Management System, a

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[6] The rates of corrosion of the coupons are routinely monitored in order to measure the effects of circumstantial factors, such as telluric currents established by the earth's magnetic fields, on pipe-to-soil potential.

relational database that is used to ensure adequate corrosion system performance, direct maintenance and repair actions, and identify segments where supplemental cathodic protection is required.

Cathodic protection monitoring of the mainline pipeline takes place annually. Data are gathered from test stations, over-the-line (electrical) potential surveys, inline corrosion coupons, cased road crossings, the Atigun reroute, and the fuel gas pipeline (Stears et al. 1998). Gathering of cathodic protection data also occurs at buried propane tanks, pump stations, and the Valdez Marine Terminal. Rectifiers that are present in each impressed current system are checked six times a year. Interpretation of data is performance based rather than being a simple comparison with federal DOT standards. The corrosion control system's performance is judged to be adequate on the basis of its ability to control corrosion, not simply because it meets the DOT standard for amount of current imparted to the pipe. The system routinely exceeds the minimum voltage specified in applicable DOT regulations.

APSC performs a forward looking infrared (FLIR) survey of the heat pipes a minimum of once every two years. The surveys can involve a winter (usually February or March) flyover of the aboveground pipe with a helicopter equipped with an infrared camera and recorder; hand-held infrared survey equipment is also available for use in these surveys. The camera is pointed at the mainline pipe and the heat pipes. If the heat pipes are fully functioning, the radiator section appears to "glow" (because of the heat being released). If the heat pipes are not functioning at all, the radiators appear dark. If the heat pipe is partially functioning (because of blockage in the form of light gases, such as hydrogen, stratified at the top radiator section), a dark section appears at the top of the radiator and a lighter section appears underneath. The recorded images are then graded in terms of a rough percentage of radiator surface shown as blocked. Since only the exceptions are of interest, the grading focuses only on the blocked or partially blocked heat pipes. This information is used to assess the need for corrective action on heat pipes to vent hydrogen, to perform possible recharge of anhydrous ammonia, or to replace the heat pipes.

It has been estimated that 84% of all heat pipes along the TAPS have some degree of blockage, potentially causing diminished heat transfer performance. In response to these concerns, APSC began an experimental program in the fall of 2000 to measure the heat transfer performance of blocked heat pipes. This program was implemented because of the large number of heat pipes and the increasing number of heat pipes with blockage; it is important to identify those actually needing repair. The test program did obtain the data necessary to determine TAPS heat pipe thermal degradation as a function of hydrogen blockage, and these data are being used to identify heat pipes needing repair to meet design requirements. The test results indicate that the loss of heat transfer functionality as a result of hydrogen blockage is less serious than anticipated. For example, from Fairbanks south to Thompson Pass along the southern part of the TAPS, it was originally thought that 6,500 heat pipes out 62,000 installed in the VSMs in that area might need repair. Instead, it was found that only 2,000 were functioning so poorly as to need maintenance. (See also Section 4.1.2.2.5 and the associated text box for a discussion on heat pipe functions.)

Bridge Monitoring. Bridges for the pipeline, access roads, and workpads provide access for oil spill response, routine maintenance, and equipment for upgrade projects. Professional engineers periodically inspect the bridges for structural integrity and safety. Workpad and access road vehicular bridges are maintained to state highway secondary road standards, and load limits for bridges are posted. Recently, a program to evaluate all vehicular bridges required for oil spill response access was completed. Several bridges were reinforced for projected loads, and several workpad bridges were raised to allow for increased flood flow.

Pipeline bridges were designed to accommodate static and dynamic loadings that include the weight of the pipe, crude oil, insulation, snow and ice, wind, thermal expansion and contraction, and earthquakes.

Pipeline bridges are located to provide adequate clearance between the bridge's low chord and the pipeline design flood level and clearance for ice ride-up, aufeis buildup (see text box), and navigational traffic.

Aufeis

Aufeis is a seasonal accumulation of ice that is superimposed on the frozen surface of a stream or landscape. Aufeis accumulation is common in areas of continuous or discontinuous permafrost. Both surface water and groundwater can be sources of aufeis. Aufeis accumulation constitutes a major management problem for roadways, culverts, and structures that have been located in areas susceptible to ice accumulation, or whose construction impedes water movement in the soil mantle or in surficial channels. Accumulation of aufeis can affect the hydrologic characteristics of river basins (e.g., stream flows and spring melt runoff patterns) and can have localized consequences for water quality, fluvial geomorphology, and ecological systems (Slaughter 1990).

The relatively few modifications that have occurred on pipeline bridges have been engineered and documented. APSC monitors pipeline bridge performance through routine surveillance as well as third-party inspections. Currently, there are no known conditions that represent a concern or threat to the integrity of pipeline bridges.

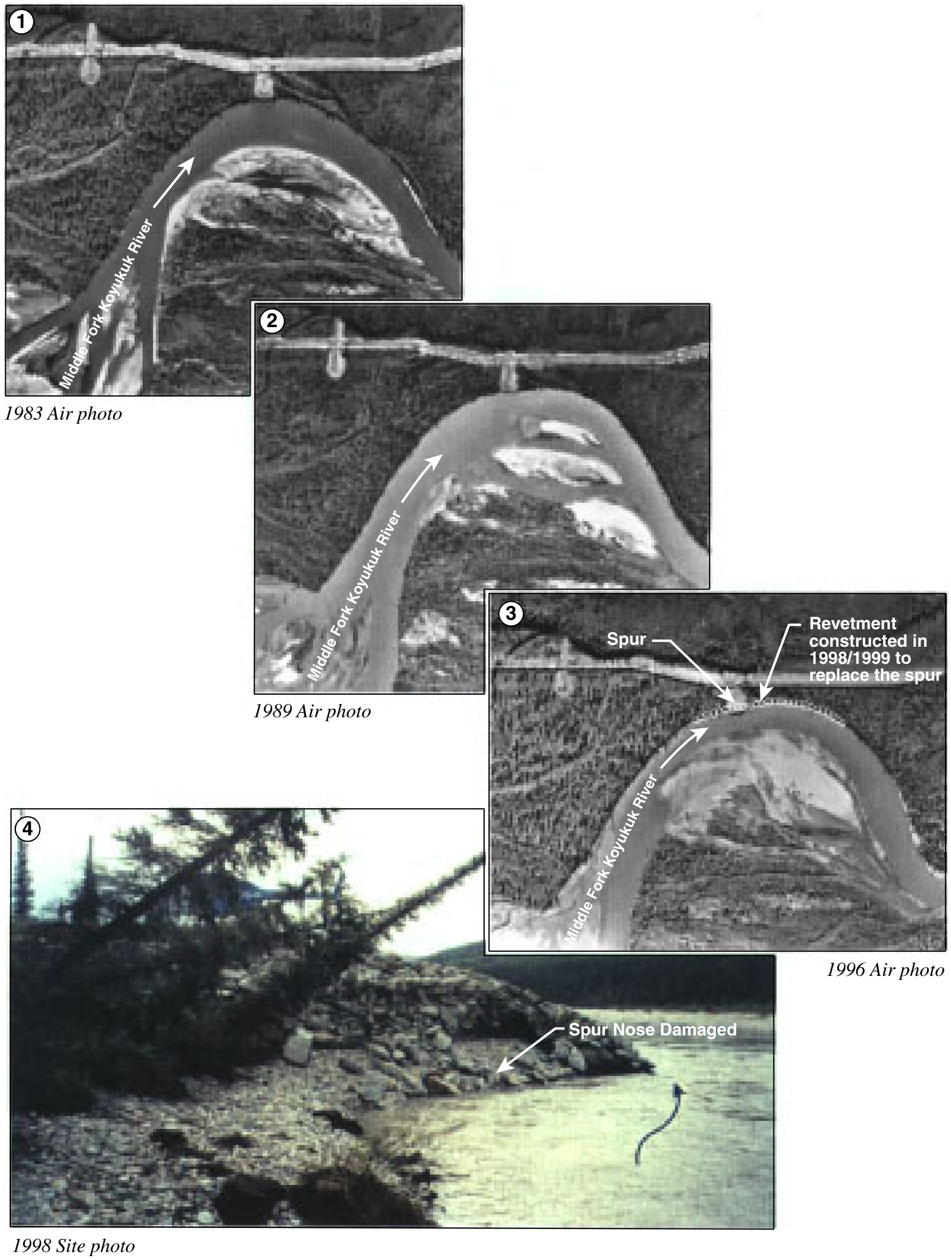
Pipeline bridges are inspected annually in accordance with APSC bridge inspection manuals. To evaluate their integrity, a professional engineer registered in the State of Alaska inspects pipeline bridges at intervals not exceeding five years. The purpose of these inspections is to verify that each structure is performing as expected, to note needed maintenance, to notify appropriate personnel of needed improvements, and to serve as an independent monitor to verify the effect of maintenance, design, and construction procedures. Future annual inspections of abutments and piers and five-year inspections of the pipeline superstructure are expected to remain at current levels. Inspection results are reviewed by the U.S. Coast Guard.

During 1997, inspections were performed on each plate-girder bridge and the Gulkana River Bridge. No significant discrepancies were noted. Because of the lack of access at the Gulkana River Bridge during the 1997 professional engineer's inspection, a full reinspection was conducted in 1999. The Tazlina River suspension bridge was also inspected in 1999. The Tanana River Bridge was inspected in 2001.

Rivers and Floodplains Monitoring. The rivers and floodplains along the TAPS are monitored annually by engineering personnel using aerial photography and on-site evaluations, complemented by weekly surveillance flights by TAPS observers. These observations identify erosion areas and other anomalies or regime changes that may require continued observation and preventative maintenance (see Figures 4.1-7 and 4.1-8). Survey markers have been installed at a number of key locations so that aerial or ground reconnaissance can detect changes (see Figure 4.1-9).

In addition to scheduled annual river surveillance, monitoring occurs during and after floods. In addition, comparative aerial photos are assessed. River engineers use this information to assess the need for preventative maintenance. Detailed river-engineering assessments are undertaken to determine the need for and scope of remedial measures or new structures as a result of major floods. Examples of this are the detailed studies and designs conducted following high flows in 1992 on the Sagavanirktok, in 1994 and 1998 on the Middle Fork Koyukuk, and in 1999 at Marion Creek and in the PS 4 area.

In some instances during high flows, immediate protection measures are taken, such as reinforcing or adding to existing river training structures. More substantial and permanent works, such as new revetments or additional spurs, may also be built. For streams where erosion could potentially impact the TAPS, innovative technologies, such as the Rosgen (1994) technique, are being used to train the streams. The Rosgen technique allows control of river or stream erosion with minimal construction

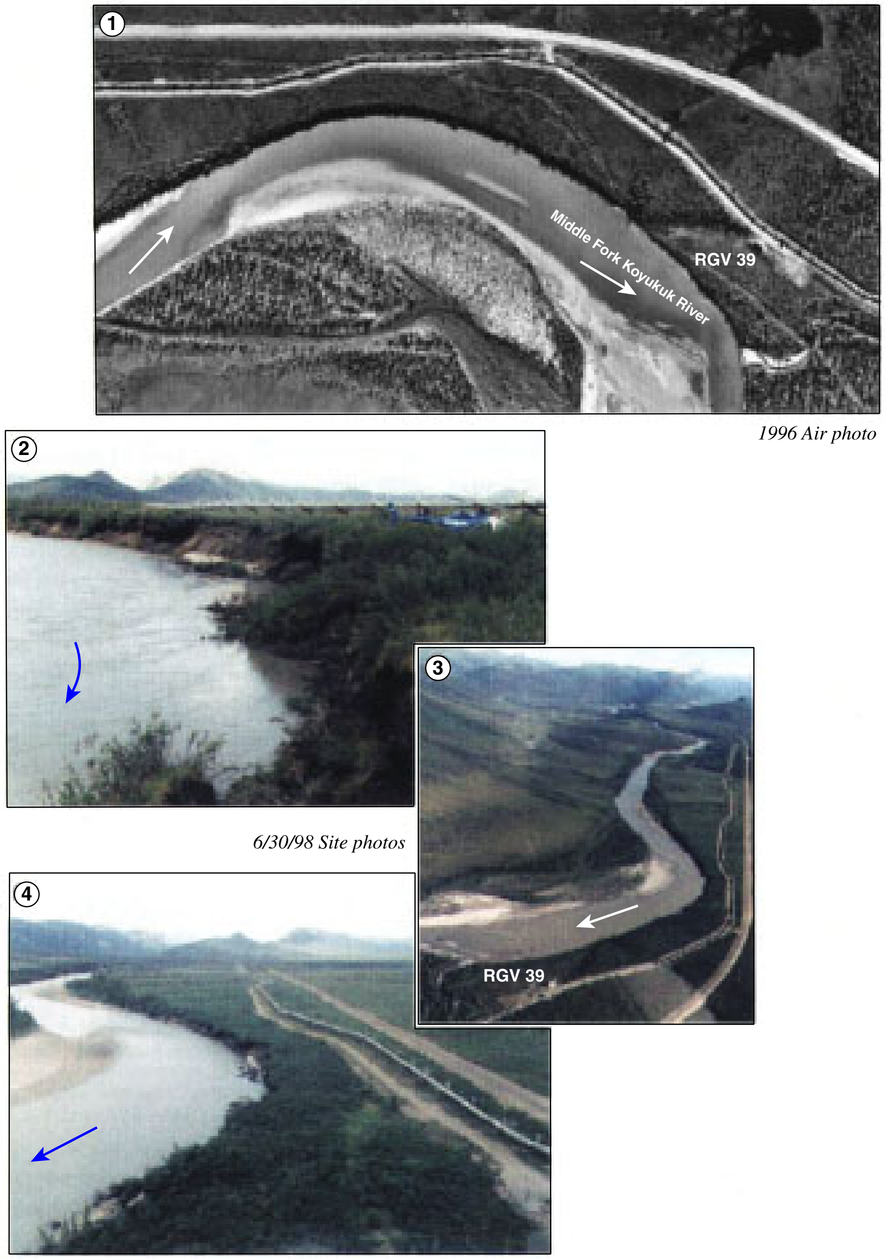


At this location, bank erosion towards the spur and elevated pipeline was minor until 1994. A major flood in 1994 necessitated repair of the spur, and high flows in 1998 necessitated construction of a new revetment in the winter of 1998/99. (Compare conditions in Photos 1, 2, and 3). Although the minimum pipeline-to-bank buffer was still about 80 feet in 1998 and the spur (Photo 4) was still partially effective in controlling the rate of and location of the erosion, delaying the work while more erosion occurred would have resulted in minimal pipeline-to-bank buffer and thus would have required "moving" the river (an extensive undertaking) rather than armoring the existing bank.

CONCLUSION: Routine, annual, and event-driven monitoring and follow-up engineering assessments are effective means to establish the need for additional structures and to ensure they are constructed in a timely manner.

JKA20214

FIGURE 4.1-7 Middle Fork Koyukuk River, MP 218, Where Monitoring Led to Follow-up Remedial Action Consisting of Bank Armoring (Source: TAPS Owners 2001a, Figure 4.2-11)

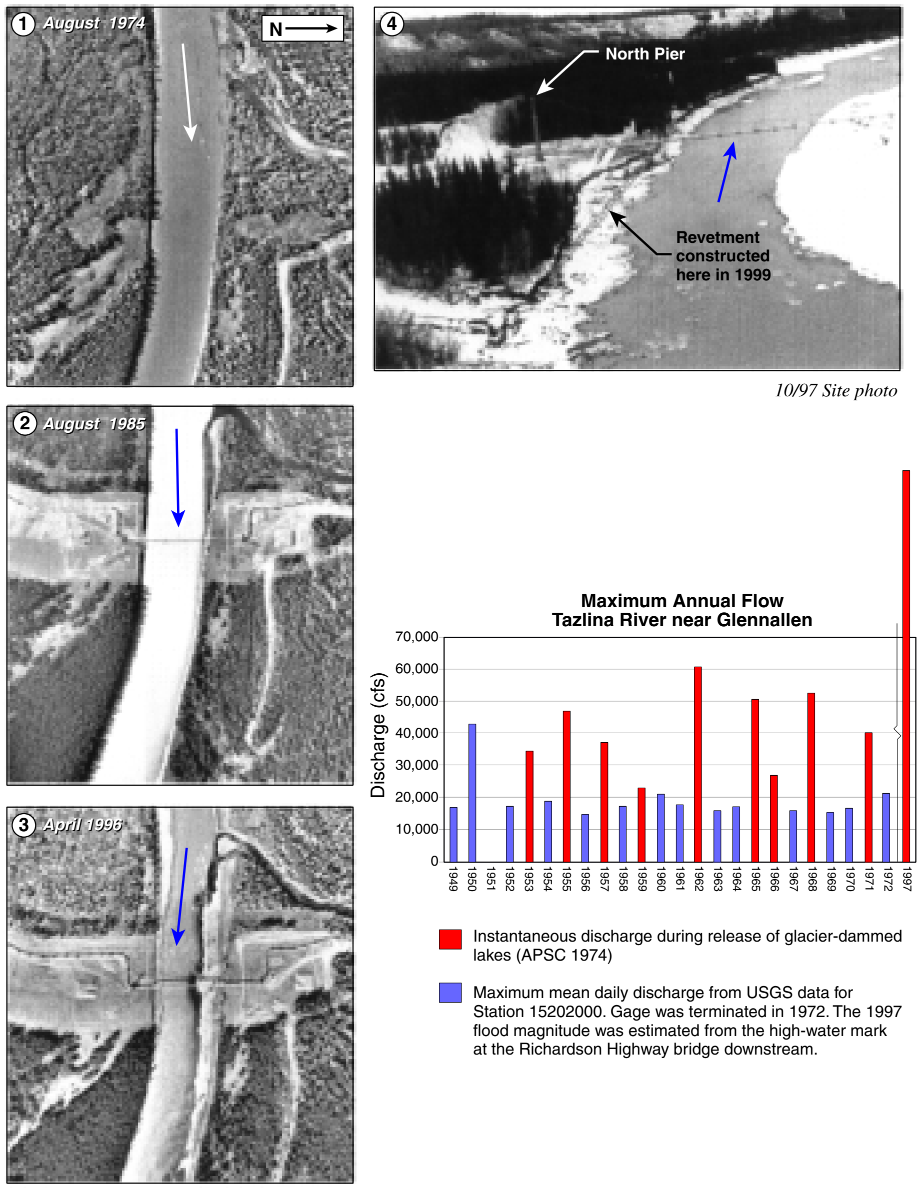


The bank at this large bend is eroding towards the pipeline and RGV 39. The bank was 25 to 30 feet high with a minimum buffer of about 155 feet in 1998. The rate of erosion of the bank, even during major floods, compared to the remaining buffer, did not warrant armoring of the bank at the time of the assessment in 1998. Depending on the timing of the next major flood (the majority of bank erosion is caused during high-flow periods), a revetment may need to be constructed within 5 years, or nothing may be required for 10 to 20 years.

CONCLUSION: Monitoring and assessments can track long-term river changes that may not require immediate remedial measures but warrant close attention on an ongoing basis.

JKA20215

FIGURE 4.1-8 Middle Fork Koyukuk River, MP 217, where Monitoring Did Not Lead to Immediate Follow-up Action (Source: TAPS Owners 2001a, Figure 4.2-12)



Major river crossings such as the 650-foot-long Tazlina River bridge undergo extra monitoring – a video camera on site relays images to a nearby security station. The flood magnitude and potential for river changes on the Tazlina River are related to the release of glacier-dammed lakes, which typically produce flows two times as large as normal peak summer runoff. The flood of record, estimated to be about two times the size of the previous record in 1962, occurred in October 1997 as a result of heavy rains that triggered the release of all four lakes impounded by the Nelchina and Tazlina glaciers. At the centerline of the bridge, a buffer of about 150 feet remained on the north bank after the 1997 flood. Although this buffer would have been adequate for a considerable period of time and probably even the next major flood, and it is considerably more than the total erosion experienced since startup, the potential consequences of another large flood on this major structure resulted in the decision to armor the bank in early 1999.

JKA20216

FIGURE 4.1-9 Tazlina River Bridge, MP 686, Where Monitoring Led to Bank Armoring to Prevent Further Erosion (Source: TAPS Owners 2001a, Figure 4.2-13)

and does not require the placement of large dikes or revetments; however, a substantial amount of in-stream activity is often required. Preventative measures are performed as necessary to protect the integrity of the pipeline within or near the major river systems as natural channel changes occur.

Seismic/Earthquake Monitoring. An earthquake monitoring system has been part of the pipeline control system since start-up in 1977 (Stipulation 3.4.1.2). The monitoring system consists of 11 remote digital strong motion accelerograph (DSMA) stations located at PS 1, PS 4 through 12 (including the PS 11 site), and the Valdez Marine Terminal. The system processes seismic data to evaluate the severity of earthquake ground shaking and to delineate areas of the TAPS for inspection. Reviews of reports of ground motion caused by the seismic event determines whether the pipeline is shut down and delineates inspection requirements for the affected portion of the route.

The original earthquake monitoring hardware and software were replaced in 1998 with a second generation system. Each station consists of ground-motion-sensing instrumentation (accelerometers) and a computer that provides data acquisition, processing, recording, network communications, and output of alarms to the OCC at Valdez. The pipeline controller determines the need for pipeline shutdown and field inspection by reviewing alarm displays from the earthquake monitoring system and other control system information. If the pipeline controller fails to acknowledge seismic alarms within 10 minutes, automatic shutdown of the pipeline will commence. This automatic shutdown process is intended to guard against the possibility that the operator is unable to respond to the seismic alarm conditions. The JPO required extensive testing of this shutdown procedure. Deficiencies were identified during these tests and were corrected (Lalla 2001).

Slope Stability Monitoring. About 50 slopes along the ROW were identified during construction as having some potential for mass movements that could damage pipeline facilities. In accordance with Stipulation 3.5.1, these slopes are periodically monitored so that preemptive measures can be taken to prevent the occurrence of, or protect the pipeline against, the effects of such movements. The monitoring includes aerial observations and photography, site inspection, and direct measurements using a variety of instruments. The monitoring results are analyzed and documented, and additional monitoring, instrumentation, maintenance, or repair work is completed as needed.

Glacier Surge Monitoring. In accordance with Stipulation 3.8 of the Federal Grant, glaciers near the pipeline are monitored by aerial photography for movement to ensure adequate notice is provided if a glacier approaches the pipeline or if outburst floods could occur from glacially dammed lakes. Steady movement of a glacier toward the pipeline would result in pipeline relocation. Five glaciers are monitored on a five-year schedule: Worthington, Canwell, Fels, Castner, and Black Rapids. The last monitoring work was completed in 1999 (EMCON Alaska, Inc. 1999). None of the glaciers has advanced since the TAPS was built. Surveillance monitoring continues (Johnson 2000).

Fuel Gas Line Monitoring. Monitoring is performed to verify adequate depth of cover, movement from frost heave, erosion, or ground disturbance. Maintenance or repair is conducted as necessary to restore depth of cover when frost heaves occur. Smart pigs are also used at 5- to 10-year intervals to detect corrosion. As per a DOT/OPS determination, APSC was not required to install corrosion protection on the gas line at the time of installation. However, corrosion has been detected on the pipe near PS 4. APSC is addressing this by repairing the corrosion damage and installing an impressed current corrosion control system at this location. Under a MOA (JPO 2001d), DOT/OPS has provided training to JPO personnel who can then conduct field inspections of the gas line for compliance with DOT regulations (Dygas and Keyes 2002). A smart pig run is scheduled for calendar year 2002. Results will support determination of whether additional gas line segments also need corrosion control.

Buildings and Structures. Buildings and structures at the pump stations and at the Valdez Marine Terminal are monitored to identify movements from permafrost thaw or ground subsidence. The information is used to develop maintenance programs and to arrest ground movement before foundation damage. Some building foundations are equipped with refrigeration systems to prevent heat transfer into the permafrost.

4.1.3.3 Biological Considerations for Operations and Maintenance Activities

Numerous stipulations in the Federal Grant deal with mitigating or preempting impacts on biological systems. These stipulations contain either prescriptive requirements or performance standards that must be met by APSC in the planning, design, construction, operation, maintenance, and eventual decommissioning of the TAPS. Because these stipulations are concerned with impacts on highly dynamic natural systems, they are often written in a manner that requires case-by-case approvals or permits by the appropriate JPO member agency, thereby allowing the agency to fully consider all circumstantial factors existing at the time of the proposed actions. However, when the impacts of proposed actions on biological systems are predictable with reasonable precision, these stipulations either contain specific requirements or defer to the application of relevant rules promulgated by JPO member agencies. Table 4.1-2 lists the relevant stipulations, the topics they address, and their respective requirements and controls.

APSC's response to Federal Grant stipulations that control impacts on biological resources involves numerous initiatives, including (1) development and distribution of corporate policies on interacting with and protecting biological resources; (2) issuance of explicit directives, guidance, and prohibitions to APSC personnel and TAPS contractors; (3) training of APSC personnel about potential impacts on biological resources, including appropriate behavior toward wildlife; (4) posting at facilities or distribution of relevant permits and the TAPS environmental atlas delineating sensitive areas; (5) development of contingency plans that include special consideration for biological resources; and (6) development and implementation of internal administrative controls and procedures. APSC program initiatives that apply to biological resource protection are contained in Section 5 of the TAPS Environmental Protection Manual (APSC 1998b).

APSC's corporate policies[7] with respect to interactions with biological resources are reflected in the following three policy statements in the TAPS Environmental Protection Manual:

- "Alyeska personnel will make all attempts to avoid harming or disturbing wildlife, wildlife habitats, archaeological sites, and fish-containing waterbodies."
- "Feeding, attracting, or unnecessarily disturbing any animal (fish, bird, or mammal) is prohibited at Alyeska facilities and work sites."
- Feeding wildlife may result in disciplinary action, including termination of employment."

APSC has issued the following specific prohibitions to APSC personnel and TAPS contractors:

- Feeding, attracting, or unnecessarily disturbing any animal (fish, bird, or mammal) is prohibited at APSC facilities and work sites.
- APSC personnel may not camp within or hunt, fish, trap, or discharge firearms from the pipeline ROW. The ROW includes related facilities defined as the workpad, pump stations and associated buildings, valves, the fuel gas line, bridges, dikes, the terminal, and all other structures and facilities necessary to operate and maintain the pipeline.

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[7] APSC has indicated that the Environmental Protection Manual, EN-43-1 (APSC 1998b) has been amended and that corporate "policy statements" are now referred to as "environmental work practices." However, there were no substantive changes (Sweeney 2002).

TABLE 4.1-2 Federal Grant Stipulations Related to the Mitigation of Impacts on Biological Systems

Stipulation	Topic	Summary of Requirements or Controls
1.14	Camping, hunting, fishing, and trapping	• Post signage prohibiting camping, hunting, fishing, trapping, and shooting within the ROW. • Prohibit such activities by APSC personnel and TAPS contractors. • Notify employees of applicable regulatory controls over such activities.
2.2	Pollution control	• Do not use mobile ground equipment in or on lakes, streams, or rivers unless specifically approved.
2.23	Thermal pollution	• Comply with thermal pollution standards in Alaska Water Quality Standards.
2.25	Pesticides	• Use only nonpersistent and immobile pesticides, herbicides, and other chemicals. • Obtain written approval from the JPO Authorized Officer for all pesticide usage.
2.4.1	Erosion control	• Conduct all operations in a way that will avoid or minimize disturbances to vegetation. • Ensure that the facility design minimizes erosion.
2.4.2	Stabilization	• Stockpile surface materials taken from disturbed areas and use them during restoration. • Stabilize the site, which can include, but may not be limited to, seeding, planting, mulching, and the placement of mat binders, soil binders, rock or gravel blankets, or structures, as dictated by site-specific conditions and needs.
2.4.3	Erosion control/crossing of streams, rivers, or floodplains	• Prevent or minimize erosion at stream or river crossings or in floodplains. • Ensure that temporary access over stream banks is by means of fill ramps rather than stream bank cutting, unless otherwise approved.
2.4.4	Seeding and planting	• Seed and plant disturbed areas as soon as practicable and, if necessary, repeat until vegetation is successful.
2.5.1	Passage of fish	• Provide for uninterrupted movement and safe passage of fish. • Ensure that any artificial structure or stream channel change includes fish passage features. • Screen (water withdrawal) pump intakes. • Plug and stabilize abandoned water diversion structures to prevent trapping or stranding of fish. • Place levees, berms, or other suitable structures that protect fish and fish passage and prevent siltation at material sites adjacent to or in certain lakes, rivers, or streams.
2.5.2	Fish spawning beds (and fish rearing areas)	• Avoid channel changes in fish spawning beds or rearing areas when possible. • When necessary, construct new channels in accordance with written JPO standards. • Protect fish spawning beds and rearing areas from sediment; intercept any anticipated silt with settling basins before it reaches streams or lakes. • Repair damage to fish spawning beds and rearing areas caused by construction, operation, maintenance, or termination of the pipeline.

TABLE 4.1-2 (Cont.)

Stipulation	Topic	Summary of Requirements or Controls
2.5.3	Zones of restricted activity	• Adhere to restrictions of some activities imposed by the JPO in key fish and wildlife areas during periods of fish and wildlife breeding, nesting, spawning, lambing, or calving activity and during major migrations of fish and wildlife.
2.5.4	Big game movements	• Construct and maintain the pipeline, both buried and aboveground sections, to assure free passage and movement of big game animals.
2.6	Material sites	• Use existing material sites in preference to new sites. • Do not take gravel from stream beds, river beds, lake shores, or other outlets of lakes unless approval is granted by the JPO Authorized Officer. • Ensure that the design and operation of material sites prevents soil erosion and damage to vegetation.
2.7.2.5	Clearing	• Remove debris resulting from clearing operations that may block stream flow, delay fish passage, contribute to flood damage, or result in stream bed scour or erosion.
2.8.1	Disturbance of natural water	• Refrain from taking any action that may create new lakes, drain existing lakes, significantly divert natural drainages, permanently alter stream hydraulics, or disturb significant areas of stream beds (on state land) unless approval of such activities, along with necessary mitigation measures, is secured from the JPO.
2.9	Off-ROW traffic	• Do not operate mobile ground equipment off the ROW, access roads, state highways, or authorized areas unless specific written approval is provided by the JPO or unless such actions are necessary to prevent harm to any person.
2.11.2	Use of explosives	• Do not blast under water or within one-quarter mile of streams or lakes without permits from the ADF&G.
2.12	Restoration	• Restore disturbed areas to the satisfaction of the JPO Authorized Officer. • Leave cut and fill slopes in stable condition. • Dispose of materials from access roads, haul ramps, berms, dikes, and other earthen structures in accordance with directions from the JPO Authorized Officer. • Properly dispose of vegetation and overburden removed during clearing.
3.9.1	Construction and operation; thermal and environmental changes	• Conduct construction, operation, maintenance, and termination activities so as to avoid or minimize thermal and other environmental changes and provide maximum protection to people and to fish and wildlife and their habitats. • Plan and execute working platforms, pads, fills, and other surface modifications in such a way that any resulting degradation of permafrost will not jeopardize the pipeline foundations.

- Feeding bears or prompting actions that create unnecessary intrusion of wild animals at the job site is prohibited.

Finally, various operating plans and internal procedural controls in effect for the TAPS reflect special attention to the protection of biological resources. Successful execution of these procedures relies on the regular involvement of APSC subject matter experts or field environmental generalists. Subject matter experts are stationed at the Fairbanks Business Unit and the Valdez Marine Terminal. Field environmental generalists are stationed somewhere in the portion of the pipeline for which they have been assigned responsibility for environmental protection oversight. Both subject matter experts and field environmental generalists are highly trained in environmental protection tactics (including tactics directed at protecting biological resources) and very familiar with applicable regulations and requirements. They serve as consultants to the APSC work force and help to identify potential impacts on biological resources from planned activities and develop strategies to preempt or mitigate those impacts. Field environmental generalists or subject matter experts must review and approve all proposed actions that have environmental consequences or create compliance liability for APSC. Field environmental generalists and subject matter experts are also responsible for identifying occasions when permits or approvals from JPO agencies are required and for initiating the actions to secure them. Field environmental generalists are responsible for ensuring that internal procedures and controls are followed and for continuous surveillance for adverse impacts from TAPS activities. All planned activities that have the potential to affect biological resources are subject to (internal) environmental reviews. Necessary or appropriate actions for protection of biological resources are incorporated into detailed work plans for the activity. These reviews also identify the permits that may be required to support the activity.

4.1.4 Spill Prevention and Response

Many JPO agencies have authorities over spill prevention and response. DOT/OPS regulates pipeline safety and approves contingency plans. The JPO Authorized Officer monitors system integrity and approves spill contingency plans for the pipeline and terminal. ADEC also approves spill contingency plans for their conformance with state requirements.

The Oil Pollution Act of 1990 (OPA) amended the Clean Water Act (33 U.S.C. 1321(j)) to require that specific elements be included in federal contingency plans (see 40 CFR 300.210) and in response plans for certain facilities and vessels (see 40 CFR 300.211), specific contingency plans for onshore oil pipelines (see 49 CFR 194), and in periodic contingency plan drills (see 40 CFR 300.212). In addition to contingency planning and response strategies, the OPA also dictates the use of double-hulled tanker vessels in Prince William Sound. Under the OPA, states are not preempted from establishing additional laws governing oil spill prevention and response within such state. Alaska has established laws and regulations governing oil discharge prevention and contingency plans (AS 46.04.030; 18 AAC 75).

In 1990, after the Exxon Valdez spill, Alaska enacted legislation that significantly strengthened standards for oil tankers, terminals, pipelines, and oil exploration and production facilities. ADEC amended its regulations under 18 AAC 75, *Oil and Other Hazardous Substances Pollution Control*, accordingly. The new law required, among other things, that spill prevention requirements be added to spill contingency plan rules; that response planning standards be established for different types of facilities; and that ADEC review and approve oil discharge prevention and contingency plans.

Article 1 of 18 AAC 75 addresses pollution control requirements. These include the following:

- Leak detection, monitoring, and operating requirements for crude oil transmission pipelines;
- Oil storage tank requirements;
- Secondary containment requirements for aboveground oil storage and surge tanks;
- Facility piping requirements for oil terminal and crude oil transmission pipeline, exploration, and production facilities; and
- Recommended practices.

Article 4 of 18 AAC 75 addresses response action plan requirements. Article 4 requires that an oil discharge prevention and contingency plan be developed in a form that is usable as a working plan for oil discharge prevention, control, containment, cleanup, and disposal, and that this plan be submitted to ADEC. Article 4 prescribes that these plans have four parts. Part 1 is an emergency response plan in sufficient detail to clearly guide responders in an emergency event. An emergency response plan should include the following:

- *Emergency actions:* A short checklist of the immediate response and notification steps to be taken if an oil discharge occurs;
- *Reports and notification:* A description of the immediate spill reporting actions to be taken at any hour of the day;
- *Safety:* A description of the steps necessary to develop an incident-specific safety plan for conducting a response;
- *Communications: A* description of field communications procedures;
- *Deployment strategies:* A description of proposed initial response actions that may be taken, including procedures for the transport of equipment, personnel, and other resources to the spill site; and
- *Response strategies:* A description of the discharge containment, control, and cleanup actions to be taken.

In addition to these general response plan standards, there are specific standards for each type of facility or vessel to which Article 4 pertains (oil terminal facilities, exploration or production facilities, crude oil pipelines, crude oil tank vessels and barges, noncrude oil tank vessels and barges, and multiple operations).

An oil discharge prevention and contingency plan should also contain a prevention plan in Part 2 that meets the requirements of Article 1. A prevention plan should include the following:

- A description and schedule of regular pollution prevention, inspection, and maintenance programs in place at the facility or operation;
- A history and analysis of all known oil discharges of greater than 55 gal that have occurred at the facility;
- An analysis of potential oil discharges and a description of actions taken to prevent potential discharges;
- A description of any condition specific to the facility or operation that might increase the risk of a discharge and any measures that have been taken to reduce the risk of a discharge attributable to these conditions; and
- A description of the existing and proposed means for detecting discharges, including surveillance schedules, leak detection, observation wells, monitoring systems, and spill detection systems.

Part 3 of the plan should contain supplemental information that provides background and verification information, including the following:

- A facility description and operational overview that contains a general description of the activities of the operation;

- A description of the receiving environment (for a land-based facility or operation, the potential paths of oil discharges from the facility or operation to open water);
- A description of the command system used to respond to a discharge that must be compatible with the state's response structure;
- A description of realistic maximum response operating limitations;
- A description of logistical support that might be used to transport equipment and personnel during a discharge response;
- A complete list of oil discharge containment, control, cleanup, storage, transfer, lightering, and related response equipment;
- A detailed description of the training program for discharge response personnel; and
- Mapped predictions of discharge movement, spreading, and probable points of contact with environmentally sensitive areas and areas of public concern.

Part 4 of an oil discharge prevention and contingency plan must provide for the use of the best available technology consistent with the state's best available technology review and approval criteria (18 AAC 75.445(k)). In addition, Part 4 of the plan should identify technologies applicable to the facility or operation that are not subject to the state's best available technology review and include a separate written justification that the technology proposed to be used is the best available for the applicant's operation.

On February 2, 2002, the Supreme Court of the State of Alaska entered an order declaring the state's best available technology approval criteria invalid. ADEC adopted a three-tiered approach for determining whether a contingency plan provides for the use of the best available technology. The first tier of the definition requires cleanup and containment technologies to meet the oil spill response performance standards mandated by Alaska statutes. The second tier of the definition requires that oil pollution prevention technologies, with limited exceptions, be capable of meeting the performance standard of the applicable oil spill prevention regulations. Under ADEC regulations, the technology is considered the best available if it is appropriate and reliable for the intended use, as well as for the magnitude of the applicable response planning standard. The third tier of the definition, which covers remaining technologies not subject to either the cleanup or prevention performance standards, requires each technology to be reviewed on a case-by-case basis using specific criteria. The criteria include whether the technology is the best in use in a similar situation, is available for use by the application, is transferable to the applicant's operations, and that there is a reasonable expectation the technology will provide increased spill prevention or other environmental benefits. The court found that the first two tiers of the definition were inconsistent with the statutory requirement to have the best available technology, because the regulations would allow any technology that meets the performance criteria and is appropriate and reliable, rather than the "best available technology." The matter was remanded to the Alaska Superior Court.

In response to the Alaska Supreme Court ruling, the Alaska Legislature enacted Senate Bill 343, which explicitly approves the existing ADEC regulations, as described above, for making the determination whether the best available technology is included in oil spill prevention and response contingency plans. The bill was signed into law on April 17, 2002 (amending AS 46.04.030(e)). In Senate Bill 343, the Alaska Legislature found that the ADEC 1997 regulations meet the Legislature's intent with respect to application of best available technology through reliance on proven, appropriate, and reliable technology meeting the response planning standards in AS 46.04.030(k) and the use of performance standards set in regulations or other specific criteria for determining best available technology. It specifically amended the prior statute to read that the ADEC may find that any technology meeting the response planning standards in AS 46.04.030(k) or a prevention performance standard established under AS 46.04.070 is the best available technology. Under the new statute, the ADEC may maintain a list of those technologies that are considered the best available. The ADEC is setting up a series of public meetings to solicit suggestions for new equipment or systems. Promising new technologies will be reviewed by ADEC contractors. Then new technologies selected as best available will be used as guidelines when the ADEC reviews oil spill prevention and response contingency plans (Alaska Oil & Gas Reporter 2002).

Pursuant to 18 AAC 75 and federal regulations, several such plans have been developed. The *Trans-Alaska Pipeline System Oil Discharge Prevention and Contingency Plan* (CP-35-1) (APSC 2001g) covers the main TAPS pipeline and pump facilities. The *Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan* (CP-35-2) (APSC 2001h) covers the Valdez Marine Terminal. The *Prince William Sound Oil Discharge Prevention and Contingency Plan* (Prince William Sound Tanker Plan Holders 2002) covers Prince William Sound. Another relevant document is the *Alaska Clean Seas Technical Manual* (Alaska Clean Seas [ACS] 1999). To ensure coordinated response by regulatory agencies, a consolidated spill plan was developed by the Alaska Regional Response Team (ARRT), a coalition of government agencies responsible for spill response (ARRT et al. 1999).

4.1.4.1 Pipeline

Operation of the main TAPS pipeline and pump station facilities, beginning at the incoming producer pipeline block valve and ending at the Valdez Marine Terminal property fence, is governed by the *TAPS Oil Discharge Prevention and Contingency Plan* (APSC 2001g). It provides detailed information for reconnaissance, response, and containment actions in the event of an oil spill.

This TAPS Contingency Plan, which is reviewed annually by the BLM, every three years by ADEC, and every five years by DOT, divides the 800-mi pipeline into five regions. (Region 1 extends from MP 0 to 206, Region 2 extends from MP 206 to 357, Region 3 extends from MP 357 to 496, Region 4 extends from MP 496 to 648, and Region 5 extends from MP 648 to 800.) It contains an oil discharge prevention and contingency plan for each region. To facilitate response, the pipeline regions are further divided into contingency areas. Contingency areas are subdivided into segments for containment actions, access, and detailed environmental information. Contingency plans with season-dependent instructions on how to respond to a spill have been developed for segments of contingency areas. Map 4.1-1 identifies specific sites and equipment for spill prevention and response activities along the pipeline. In addition to BLM, ADEC, and DOT review, the EPA has jurisdiction for facility response plans (pump stations).

In the prevention program in place, the oil transportation and storage facilities and operational systems have been designed to help prevent and minimize oil spills (APSC 2001g). The equipment used to prevent oil release includes these items and features:

- Control system interlocks,
- Main-line valves,
- Redundant system design,
- Secondary containment systems,
- Level gauges, and
- Abnormal condition alarms.

Operational systems in place to prevent and minimize oil spills include these:

- Safe operating procedures;
- Operator training programs;
- Corrosion monitoring and prevention programs;
- Periodic oil spill exercises that range from unannounced, quarterly notification of qualified individuals to triennial entire plan exercises;
- Preventive maintenance programs; and
- Quality assurance programs.

Control of an oil spill can be viewed in four distinct phases: leak detection, source control, containment and recovery, and restoration. The plan provides for the following:

- Routine surveillance along the entire route of the pipeline;
- Security systems at each of the pump stations;
- Equipment and resources and field training for spill responders;
- Electronic leak-detection capabilities;
- Improved leak detection and leak prevention alarm systems for pump station tanks;
- More than 220 sites along the ROW that are designated as staging and deployment areas for oil spill equipment, and dedicated oil-spill-contingency-plan buildings and equipment at each of the pump stations;
- Service contract with Rampart and Stevens Village to provide local guides with Yukon River expertise;
- Thirteen spill scenarios that cover a variety of terrains, oil products, spill volumes, and seasonal conditions; and
- Aerial photographs of the pipeline to aid in spill response planning.

For example, the contingency plan suggests the following tactics in a response to a spill occurring during the summer in Segment 2 (MP 144) of the Atigun River Contingency Area. A spill in this area would occur over land, with subsequent overland flow to the nearby river. Specifics of the contingency plan include:

- Confining the spill to the workpad by constructing berms and barriers from materials from the pump station pad;
- Constructing berms or barriers in front of the leading edge of the spill to prevent oil from reaching flowing water;
- Deploying booms to contain the oil in the ponds, if the oil reaches a pond or ponds west of the pump station, and constructing an underflow dam at CS3-31 (a small drainage at the confluence with the Atigun River west of PS 4) to prevent oil from reaching the Atigun River; and
- Deploying a series of diversion booms downstream from the Dalton Highway Bridge to divert oil to the south bank, if oil reaches the Atigun River.

Any oil that escapes containment by the booms is assumed to form patches of sheen. These sheens would follow river currents downstream. They would evaporate, dissolve in the water column, bind with inorganic silt particles, and be removed from surface water quickly because of vertical mixing.

In addition to detailed response tactics, the TAPS Contingency Plan also describes detailed response strategies for 13 hypothetical spills. These spills are assumed to occur along various sections of the TAPS ROW. The scenarios illustrate the implementation of a range of response strategies within the framework of the response organization and demonstrate how resources will be allocated in the event of a spill. Each scenario addresses the following:

- The discharge itself, including a description of its location, environmental conditions, source, cause, quantity, and environmental sensitivities;
- The notification process, starting with the discovery of the spill;
- The emergency actions taken to stem the discharge;
- Tracking of the discharge;
- Safety measures, including the identification of potential hazards, specification of personal protective equipment requirements, establishment of decontamination (if appropriate), and precautions to be taken to minimize the risk of fire;
- The Incident Commander, who issues the incident objectives;
- Initial response actions, including the resources (persons, equipment, material) needed to accomplish these actions and the estimated time of arrival of the resources;
- Reevaluation of the objectives during the course of the response;

- Longer-term response actions that might be needed to repair the source of the spill, recover free oil, and decontaminate the environment;
- The logistics needed to transport persons, equipment, and materials to the site of the spill; and
- The communications systems needed.

4.1.4.2 Valdez Marine Terminal

Spill prevention and response measures at the Valdez Marine Terminal are explained in the *Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan* (CP-35-2) (APSC 2001h), which has been approved by ADEC. Part 2 of this plan addresses the prevention programs, procedures, requirements, and equipment in place at the Valdez Marine Terminal. These include the following:

- *Preventive training programs.* Oil spill prevention training is given to staff at the terminal (facility operators, maintenance, support services, and project personnel, including contractors) who have direct control or maintenance responsibilities over the oil handling portions of the facility.
- *Substance abuse programs.* Persons at the Valdez Marine Terminal who perform operations, maintenance, or emergency functions at oil handling or transfer facilities, or those who are engaged on board a vessel under USCG jurisdiction, or those who operate a commercial motor vehicle, are subject to a drug testing program designed to meet DOT pipeline safety standards and USCG standards.
- *Medical monitoring programs.* APSC maintains a program of preplacement physical exams and continuing mandatory medical monitoring.
- *Security program.* A security program prevents unauthorized access through measures that include fencing, security guard force patrols, visual inspections and camera surveillance of grounds and equipment, and safety inspections by Valdez Marine Terminal personnel. Additional security and access control features are also in place.
- *Transfer procedures.* A number of safe operating procedures have been developed to control transfer and help reduce the risk and size of a spill during transfer operations, such as during the loading or off-loading of fuel and trucks, fueling of tugs and escort vessels, loading and off-loading of tank vessels, and tank-to-tank transfers.
- *Oil storage tanks.* Measures in place to prevent oil spills from oil storage tanks include maintenance and inspection programs, cathodic protection systems, leak detection systems, overfill prevention measures during transfer events, and appropriate oil storage tank designs.
- *Secondary containment.* Secondary containment, consisting of dikes, berms, and walls, has been built around tanks to contain a spill that might result from a spill or rupture in the tanks or connective piping. The area within secondary containment is subject to an integrity maintenance program, is kept free of debris, and is drained of water accumulation.
- *Steel piping corrosion control.* Pipeline integrity is monitored between the metering facilities and the tank farms and between the metering facilities and the loading berth to detect potential leaks. There is also an inspection and cathodic protection program to prevent piping corrosion.

Part 1 of the Valdez Marine Terminal Contingency Plan addresses the terminal's response actions in the event of an oil spill there. It does not address the response to spills from tankers berthed at the terminal. Such spills are responded to in accordance with each tanker's plan and the *Prince William Sound Oil Discharge Prevention and Contingency Plan.* The most likely source of spills at the terminal would be those resulting from maintenance and system integrity problems, such as pinhole corrosion leaks in pipes, improperly installed fittings, leaking gaskets, or valve packings. Other sources of spills would be equipment failure and operator error.

Should an oil spill occur, the terminal has a two-stage response strategy. The first stage is the immediate response. Upon notification that a spill has occurred, the Initial Response Incident Commander would first determine whether any personnel are injured and whether conditions that are potentially harmful to response personnel exist. The commander would then attempt to determine the source of the spill and to control it. Then the Initial Response Incident Commander (or successors – the Initial Incident Commander or Incident Commander) would determine the quantity of oil spilled and the locations impacted. The spill would be reported in accordance with government requirements based on the quantity of the spill and its location. Eight types of positions (Initial Response Incident Commander, Safety Officer, Security Officer, Operations Sections Chief, Planning Section Chief, On Land/Water Containment and Recovery, Source Mitigation, and Logistics/Temporary Repairs) are involved in the initial response stage, each with a checklist of actions.

If a spill requires additional response activities beyond those required in the immediate response, the number of positions with checklists would be increased by 13 (Incident Commander, Operations Section Chief, Open-Water Group Supervisor, Near-Shore Group Supervisor, Shoreline Group Supervisor, Land Group Supervisor, Air Operations Branch Director, Staging Area Branch Director, Planning Section Chief, Environmental Unit Leader, Logistics Section Chief, Fishing Vessel Coordinator, and Finance Section Chief), and the lengths of the checklists are increased.

Several strategies could be used to respond to an oil spill. Each of these strategies for oil on open water has appropriate checklists. These strategies include:

- *Containment and control strategies:* For marine spills, strategies rely strongly on containment booms. When tankers are being loaded, a containment boom is prepositioned around the vessel and held together by a system of permanent and secondary anchors. Should an oil spill occur outside a boomed-off area, a prestaged boom at several locations could be deployed. Land spills are likely to be contained by secondary containment. Should an oil spill occur outside secondary containment or overwhelm it, several measures could be taken to contain the spill before it reached Port Valdez. These include blocking culverts, constructing berms or dams, or interposing fences, trenches, and sheet barriers.
- *Dispersants:* Using dispersants may be an appropriate strategy when the oil spill is heading toward sensitive shoreline areas. It would result in less overall environmental impact, and dispersant application is safe for personnel. Depending on where the dispersants are applied, approval must be obtained from either the Federal or State On-Scene Coordinator.[8]
- *In-situ burning:* This strategy can be used only in certain locations when meteorological conditions are appropriate. In-situ burning operations would be conducted in conformity with ARRT guidelines.

4.1.4.3 Prince William Sound

Spill prevention and response measures for oil spills originating from a tanker vessel at berth or traveling upon state waters of Prince William Sound are explained in the *Prince William Sound Oil Discharge Prevention and Contingency Plan* (Prince William Sound Tanker Plan Holders 2002). Spill prevention and response measures at the Valdez Marine Terminal are explained in the *Valdez Marine Terminal Oil Discharge Prevention and Contingency Plan* (APSC 2001h.)

In Prince William Sound, oil spills can occur while a tanker is in transit from causes such as collisions, groundings, striking floating objects, or impact with a fixed object. They can occur

[8] Both Federal and State On-Scene Coordinators must be notified of the intention to use disperants. The Federal On-Scene Coordinator (FOSC) must grant approval for dispersant use; however, depending on the location, the FOSC must also first obtain the approvals of the EPA representative to the Alaska Regional Response Team (ARRT) and the ADEC.

while a tanker is at berth from causes such as berthing or unberthing impact, mooring line failures, structural failure, or during crude oil or ballast water transfer operations.

An important prevention and response resource is the APSC SERVS. The mission of SERVS is to prevent oil spills by helping tankers safely navigate through Prince William Sound and to assist in spill response. The SERVS fleet currently consists of 10 vessels: 2 enhanced tractor tugs (ETTs); 3 prevention and response tugs (PRTs); 1 utility vessel; and 4 tugs.

Programs and procedures to prevent spills found in Part 2 of the *Prince William Sound Oil Discharge Prevention and Contingency Plan* include the following:

- *Vessel traffic lanes.* Tankers transiting Prince William Sound from the Valdez Marine Terminal to Cape Hinchinbrook are required by USCG regulations to participate in the USCG VTS. Tankers are required to notify the VTS, maintain communications with the VTS, and maintain vessel separation requirements while in the vessel traffic lanes. Special precautions must be taken when they are within the Valdez Narrows VTS Special Area.

- *Ice navigation procedures.* When glacial ice is observed in the vessel traffic lanes, tankers reduce speed. The VTS may impose custom routing measures to route vessel traffic around ice, as appropriate. If no safe routing exists, Port Valdez is closed to tank vessel traffic.

- *Industry ice management procedures.* When ice is observed or reported in the vicinity, a tanker transiting Prince William Sound in periods of darkness or reduced visibility must be escorted by a vessel with operational radar and searchlights.

- *Maximum transit speeds.* Speeds for laden tankers transiting Prince William Sound are limited by USCG regulations and are monitored.

- *Pilot and watch requirements.* While a tanker is navigating Prince William Sound, at least two licensed officers must be on watch on the bridge pursuant to USCG regulations. In certain areas, there must be a pilot on watch on the bridge.

- *Weather restrictions.* Weather restrictions on tanker traffic at several locations (Port Valdez, Valdez Narrows, Valdez Arm, Knowles Head Anchorage, and Hinchinbrook Entrance) may close traffic or require extra escorts, depending on wind speed and whether a tanker is laden.

The Prince William Sound spill prevention and preparedness program has the following elements. These are listed in order from the perspective of an inbound tanker entering Prince William Sound.

- An inbound tanker ballasted with seawater enters the VTS at Hinchinbrook Entrance. It transits the Sound in the east tanker lane, which provides separation from outbound, laden tankers.

- The inbound tanker is met by the Valdez harbor pilot at Bligh Reef light for transit of Valdez Narrows. Restrictions based on tanker size, wind speed, and sea state are in place. A holding area is specified at Knowles Head for tankers if weather closes the port or keeps outbound tankers from transiting Hinchinbrook Entrance.

- Berthed tankers are surrounded by an oil spill containment boom for the entire deballasting and loading process. Ballast water is pumped to the BWTF at the Valdez Marine Terminal, where it is treated before being discharged into Port Valdez. Oil recovered as a result of the treatment process is returned to product storage tanks at the Valdez Marine Terminal.

- A predeparture conference is held, and drug and alcohol testing of the tanker’s captain and crew are conducted as required. A harbor pilot boards the tanker. Two escorts accompany the departing tanker; one is tethered through the Narrows to Bligh Reef light.

- The SERVS base in Valdez provides escort vessels, response equipment, a response command center, and trained personnel.

- Prevention and response vessels maintain radio contact with inbound and outbound tankers and with the SERVS base. They also watch for icebergs from the Columbia Glacier.
- Each outbound tanker following the west tanker lane is accompanied by one or two escort vessels (with a sentinel vessel in the area) and is monitored by the VTS.
- Two barges with response equipment are stationed in the Sound, and two are stationed at Valdez.
- Two enhanced tractor tugs built for the Sound are used for tanker escort, ship handling, fire fighting, and emergency response.
- An ocean-going tug (one of the 10 SERVS vessels discussed above) on station at Hinchinbrook monitors outbound tankers until they are 17 mi beyond the entrance. It can provide assistance to tankers if needed.
- Response Centers with prestaged spill equipment are located at five locations throughout the Sound.
- APSC maintains contracts with more than 300 fishing vessels to provide assistance in the event of a spill. Its Valdez Star, the largest oil skimmer ever built in North America, was specifically designed for Prince William Sound.

Part 1 of the *Prince William Sound Oil Discharge Prevention and Contingency Plan* contains a Response Action Plan. This plan, as do other response plans, divides the response into an initial action and, if necessary, a broader, subsequent response, with checklists for the initial responders and for leaders in the broader response. Should an oil spill occur, either the SERVS Response Coordinator at the Valdez Marine Terminal or a Response Specialist onboard an escort vessel would automatically become the initial on-scene Incident Commander, who would provide the SERVS Duty Officer with sufficient information to brief the Initial Incident Commander. The Initial Incident Commander would make an immediate decision on the size and complexity of the incident and the need for additional resources. The initial response would continue until the source of the spill is determined, the flow of oil is stopped, and the personnel and equipment that have been mobilized are deemed sufficient to respond. The *Prince William Sound Oil Discharge Prevention and Contingency Plan* contains 19 initial response checklists.

If a spill requires additional response activities beyond the initial actions, the Initial Incident Commander would be replaced by the Incident Commander, and appropriate response strategies would be implemented. One response tactic is to use dispersants. The plan contains a checklist whose criteria should be satisfied before dispersants are applied. The considerations on the checklist include whether application of the dispersant would adversely affect the safety and operation of other vessels or shoreline protection and cleanup operations; whether chemical dispersants, spray units, and aircraft or vessels on which to mount the sprayers are available; and whether appropriate personnel are available. The FOSC must approve the use of disperants. Depending on the location of the spill, the FOSC must also receive approval from the EPA representative to the ARRT and from the ADEC before granting approval for disperant use.

Another response tactic is in-situ burning. The *Prince William Sound Oil Discharge Prevention and Contingency Plan* contains a checklist whose criteria must be satisfied before burning can begin. This checklist includes requirements to determine whether (1) the burn would impair safety and other operations, (2) appropriate equipment is available, (3) personnel capable of operating equipment safely and effectively are available, (4) personal protective equipment is provided, (5) heli-torches and their ignition systems are available, and (6) fire safety requirements are met. The suitability of in-situ burning depends on visibility, wind speed, the height and choppiness of the waves, the currents, and the thickness and water content of the oil slick.

4.1.4.4 North Slope

North Slope operators maintain oil spill contingency plans in accordance with state and federal laws. North Slope spill response plans are based on the operators' membership in ACS, an oil spill response cooperative. The *Alaska Clean Seas Technical Manual* (ACS 1999) provides ACS member companies with a unified response plan for spills in the North Slope oil fields, both onshore and offshore, and spills from PS 1 to PS 4 of the TAPS.

Volume 1, *Tactics Descriptions*, contains a list of response tactics arranged by subject matter (Safety, Containment, Recovery and Storage, Tracking and Surveillance, Burning, Shoreline Cleanup, Wildlife and Sensitive Areas, Disposal, Logistics and Equipment, and Administration). Each tactic consists of the following elements: a simplified diagram, a brief narrative description, an equipment and personnel table, a support equipment table, capacities for planning, and deployment considerations and limitations. These data give sufficient information to quickly determine how a tactic should be and which equipment and personnel should be used to implement the tactics.

Volume 2, *Map Atlas*, contains 11- by 17-in. maps and legend pages that cover the developed areas of the North Slope and provide operationally useful information. The maps give detailed geographical, biological, and civil information on the region. Each color map contains information on facilities, roads and pipelines, culvert locations, prestaged response equipment locations, priority protection sites, topography, hydrography (including drainage divides and flow directions), and shoreline types.

Volume 3, *Incident Management System*, describes the incident command system and unified organization used by ACS member companies for responding to spills and other incidents and crises on the North Slope.

4.1.5 Social, Cultural, and Economic Mitigation Features

Many of the mitigative measures discussed in the above sections have social or economic mitigation consequences as well. For example, measures designed to reduce the likelihood or consequences of oil spills also reduce the likelihood and/or severity of impacts on subsistence harvests. Adverse effects on subsistence resources have significant sociocultural implications because of the economic importance of subsistence to rural Alaskans and because of the economic, social, and cultural importance of subsistence to Alaska Natives. Therefore, measures that reduce subsistence impacts also lessen social impacts. As a second example, the pipeline has been designed with features to mitigate or preempt possible impacts on the free passage of terrestrial mammals. These measures also limit adverse impacts on subsistence harvests.

Both the Federal Grant and State Lease contain numerous provisions that identify mitigating measures and duties to abate/ rehabilitate damages relevant to possible social impacts. For example, several sections of the Federal Grant require measures that limit, mitigate, or require rehabilitation of potentially adverse TAPS impacts. These include:

- Section 9: Construction Plans and Quality Assurance Program;
- Section 10: Compliance with Notices to Proceed;
- Section 13: Damage to United States Property; Repair, Replacement or Claim for Damages (including requirements to rehabilitate any natural resource that shall be seriously damaged or destroyed);
- Section 16: Laws and Regulations;
- Section 23: Port Valdez Terminal Facility (including provisions to minimize environmental impacts);
- Section 24: Duty of Permittees to Abate;
- Section 29: Training of Alaska Natives; and
- Section 30: Native and Other Subsistence.

As another example, most stipulations associated with the Federal Grant are designed to prevent, mitigate, or rehabilitate potential impacts. Three categories of stipulations are included in the Federal Grant: general, environmental, and technical. For example, in the general category, Stipulation 1.9 (Antiquities and Historical Sites) requires that an archaeologist provide surveillance and inspection of the TAPS and its archaeological values, including an assessment of the protection measures to be undertaken by the Permittees if archeological resources are discovered. Stipulation 1.1.4.1 requires APSC to prohibit employees from camping, hunting, fishing, trapping, or shooting within the TAPS ROW while on duty or on shift. This reduces competition for subsistence resources. In the environmental category, nearly all stipulations serve to mitigate social impacts. For example, Stipulation 2.10 (Aesthetics) instructs the Permittees to consider aesthetic values in planning, construction, and operation of the TAPS. This stipulation includes specific provisions (e.g., limitations on the straight length of pipeline segments visible from highways) to limit aesthetic impacts. Stipulation 2.5 (Fish and Wildlife Protection), in turn, identifies measures that protect wildlife. In the technical category, many stipulations also mitigate possible social impacts. For example, Stipulation 3.6 (Stream and Flood Plain Crossings and Erosion) contains provisions to ensure that pipeline support structures are adequately protected from the effects of scour, channel migration, undercutting, ice forces, and degradation of permafrost.

Mitigation measures are also identified in specific commitments made by TAPS Owners and/or APSC. These measures appear in numerous documents, such as various oil spill contingency plans and consent agreements. For example, Section 29 of the Federal Grant requires permittees to enter into an agreement for recruitment, testing, training, placement, employment, and job counseling of Alaska Natives. The purposes of this section are to ensure that Alaska Natives share in economic benefits from TAPS operations and to help alleviate the chronic unemployment found in many Alaska Native communities throughout the state. A Native Utilization Agreement was put in place in 1995 (and is updated every 3 years) to define employment goals (expressed as the percentage of positions to be filled by Alaska Natives) by labor category by year.

From time to time, companies institute or modify internal policies that mitigate possible social impacts. For example, access to oil field lands is one of the subsistence issues on the North Slope. Traditionally, all access to the oil fields for subsistence hunting has been restricted for security and safety reasons. Phillips Petroleum has agreed to permit access for subsistence hunting and fishing purposes to its Alpine and Tarn developments, with certain security/safety-related exceptions. This increased hunting access serves as a mitigation measure for subsistence-related cumulative impacts.

Concerns for the potential adverse consequences of increased interaction between oil industry workers and local residents of North Slope villages are often addressed in EIS analyses of North Slope developments (e.g., BLM 1998). Specific impacts noted include the growth of racial tension between oil workers and residents, introduction of new values and ideas, and increased availability of drugs and alcohol (BLM 1998). Analysts (e.g., BLM 1998) claim that these effects could cause “some disruption to sociocultural systems” but concede that these impacts “would not displace existing institutions.” Because large impacts, either of the type examined for the North Slope or other sets of sociocultural effects, have not been documented for the TAPS, no special mitigation measures have been considered necessary.

The alignment of economic and other factors — which provides an impetus for enclave development — also creates a de facto mitigation measure. Potential social benefits of enclave development are acknowledged implicitly in the National Petroleum Reserve-Alaska (NPR-A) EIS (BLM 1998).

4.2 Impacting Factors

In the environmental report (ER) for the TAPS ROW renewal (TAPS Owners 2001a), APSC identified and described a number of activities related to pipeline operation and maintenance (O&M) that are either ongoing or reasonably anticipated over any period of continued TAPS operation. These O&M activities are necessary not only to preserve the integrity of TAPS, but also to comply with conditions contained in the Federal Grant of ROW and Stipulations (TAPS Owners 2001a). This section provides a qualitative discussion of the impacts associated with those routine or reasonably anticipated activities.

Also in the ER, APSC provided a brief description of the activities that would constitute termination of the TAPS operations (TAPS Owners 2001a). That description is based on more detailed engineering conceptual plans also developed by APSC (APSC 1983). The activities identified in Section 4.2.4 are derived from APSC's general descriptions of termination contained in the ER as well as the activities described in the APSC engineering study.

4.2.1 Factors Resulting from the Existence of TAPS Facilities

Notwithstanding the mitigating design features of the TAPS discussed in Section 4.1, the mere existence of TAPS facilities has a continuous impact on the environment and extant ecosystems. These impacts exist irrespective of TAPS operations. Both ROW facilities and off-ROW facilities have been and will continue to be sources of potential impact. Impacts from pump stations, river crossings, mainline refrigeration units, material sites, the workpad, and access roads, as well as the pipeline itself, have included alteration of localized surface water drainage and flood patterns and potential alteration of the behavior of subsurface waters, including groundwater in near-surface aquifers and suprapermafrost water. Support structures for river crossings have resulted in the alteration of river channels, changes to erosion patterns, and some bank scouring. In many instances, the slopes of river embankments have been highly modified in the vicinity of the TAPS crossing to ensure stability of TAPS structural support systems. Stream migrations, if they were to occur, may also impact the habitats of anadromous fish. Changes to thaw lakes, lakes, and wetlands may also result from the presence of TAPS facilities. Surface water drainage into Prince William Sound from the Valdez Marine Terminal, facilitated by substantial areas of paved or graveled land surfaces, also has a potential impact to the near-shore marine environment within the Sound. Workpads and land areas (either gravel or paved areas) at pump stations have potential continuous impacts on permafrost because of potential changes to the rates of absorption of solar insolation and water infiltration.

Other impacting factors include the potential alteration of animal habitats and migration patterns. Altered habitats and migration patterns may subsequently have continuing impacts on subsistence and on commercial and sport hunting and fishing. The workpad and access roads have also impacted mobility, and thus the range, of sport and subsistence hunters and animals. Off-ROW facilities, such as material sites and landfills and their associated access road systems, also may have similar impacts to the natural environment and ecosystems, regardless of whether active mining is occurring or waste is being disposed. These impacts are localized and include such factors as visible scarring, increased fugitive dust, altered surface water drainage patterns, altered rates of absorption of solar insulation due to removal of vegetative cover, and increased potential for siltation of nearby watercourses. Potential impacts to thermokarst can also be associated with the existence of material sites. Although no impacts on weather were identified from the mere existence of TAPS facilities, the workpad, access roads, and graveled areas around pump stations, as well as areas from which vegetative cover has been removed, have the potential to produce localized impacts to air quality by affecting fugitive dust generation. Impacting factors derived from facility existence have been incorporated into the analyses of impacts presented in Section 4.3.

4.2.2 Factors Associated with Routine TAPS Operations

Section 4.2.1 provides a discussion of impacts that result from the existence of TAPS facilities. In general, those impacts can be expected to continue throughout the period of continued operation defined by the proposed action. Additional impacting factors are associated exclusively with the operation and maintenance of the TAPS. These impacts result from routine operations, routine and preventive maintenance activities, repairs, and planned or potential TAPS upgrades, including rerouting pipeline. Those discrete O&M activities thought to have the greatest potential for impact are described below. Only actions that are known to be ongoing or that are reasonably foreseeable are addressed. Basic descriptions of the actions are provided and serve as the basis for the more detailed impact analyses in Section 4.3. Impacts discussed in Section 4.1 where mitigation has occurred through design features or operational controls are not discussed again here.

The potential impacting factors associated with each type of routine pipeline maintenance and repair activity are described in the sections below. However, some general observations can be made with respect to the potential impacts of those routine activities. Impacting factors fall into one of two broad categories: those associated with support of the workforce and those derived from the particular activity being performed. Impacting factors associated with workforce support routinely include the operation of vehicles and equipment, which results in air emissions and noise. Sustaining the workforce also can impact water resources because withdrawals are made for potable domestic and industrial use. These activities result in the generation of sanitary and/or domestic wastewaters, as well as industrial wastewaters. Domestic solid wastes can also be expected. In most instances, these impacts will occur at the nearest housing locations for the workforces involved rather than at the individual worksites. For major repair actions, however, temporary workforce quarters may need to be established at the work site.

The individual maintenance or repair activity can also have potential impact to local resources. Invariably, hydrostatic testing of repaired or replaced equipment will be required, resulting in impacts to water resources both from withdrawals of water used for such testing and from release of the test waters. Many of the routine activities also will result in ground surface disturbance (e.g., brush clearing, excavations, access road construction or modification, mining of gravel and rock at material sites, temporary staging of materials and equipment). Such ground surface disturbances can subsequently impact surface and groundwater resources, vegetation (including primary animal subsistence food resources), air quality (as a result of increased potential for fugitive dust generation), and cultural resources located at or close to the work sites (or the off-ROW material sites that are used to support the activity). The potential for these impacts exists regardless of whether the footprint of the activity is confined to the ROW or the areas adjacent to the ROW.

4.2.2.1 Routine Pump Station Operation

Section 3.1.2 provides an overview of the operational pump stations and their major features. Many impacting factors result from normal operations. Impacts to air quality result from the consumption of fossil fuels and the subsequent discharge of products of combustion. The pump turbines, electric power generators, comfort heating units, flare stacks, and solid waste incinerators are the major sources. The potential release of VOCs from overpressure vents (“pop valves”) on various process equipment, balance tanks at PS 1, and breakout tanks at other pump stations may also impact the air quality in the vicinity of the pump stations. Impacts to air quality can also result from nonroutine events such as fires, including the release of fire suppressing agents in response to such events. Finally, during extremely cold weather, the operation of internal combustion sources results in the formation of ice fog near the ground surface, which creates short periods of reduced visibility. The formation of ice fog also may indicate a buildup of other combustion products at near-surface elevations of the atmosphere. Water resources are impacted from the withdrawals of ground and surface waters for both domestic and industrial uses. Water resources are also impacted from the treatment and discharge of domestic wastewaters, including releases from septic systems used at some pump stations. Surface waters are also impacted from the discharge of storm waters from industrial areas, including secondary containment features at storage tanks. A wide range of additional activities result collectively in impacts from vehicular traffic, noise, and fugitive dust. Routine vegetative clearing (in accordance with the JPO Brushing Plan [Brossia and Britt 2001]) to maintain the work area also results in impacts to the terrestrial environment and potential impacts to nearby surface waters. Finally, operations at the pump stations result in impacts at remote locations. These include impacts to the terrestrial environment, surface waters, and groundwaters from the land disposal of pump station solid wastes.

4.2.2.2 Routine Valdez Marine Terminal Operation

Impacting factors from operations at the Valdez Marine Terminal are similar to those resulting from pump station operations. Consumption of large volumes of fossil fuels in various internal and external combustion sources results in the release of combustion products into the atmosphere. A waste gas incinerator, an “oily waste” incinerator, and an air stripper associated with the BWTF also contribute air pollutant emissions. Water resources are affected by the withdrawal of water from wells and surface streams for industrial uses. Water resources are also impacted by discharges to Port Valdez of treated sanitary wastewater and treated industrial wastewaters from the sewage treatment plant and the BWTF, respectively. Storm water runoff from the Valdez Marine Terminal also impacts waters of Port Valdez. However, storm water from industrial areas of the Valdez Marine Terminal is captured and sent to the BWTF before discharge. Finally, Port Valdez is also impacted from tanker traffic to and from the Valdez Marine Terminal, together with escort vessel traffic. The release of ballast water from tankers may also introduce nonindigenous biological species into Prince William Sound. See Section 4.7.7.2.1 for additional discussions on this cumulative impact. Valdez Marine Terminal operations also impact the environment as a result of solid waste generation and subsequent disposal in off-site landfills. Industrial solid waste generation at the Valdez Marine Terminal results in land impacts from disposal in area landfills. Although industrial hazardous wastes are treated and disposed of in out-of-state facilities, the transport of those wastes results in local impacts.

Operation of both the BWTF and the sanitary wastewater treatment plant results in impacts from the generation and subsequent management of sludge. Aeration of BWTF sludge results in nominal impacts to air quality. Sludge from the BWTF and the sanitary plant is delivered to the City of Valdez wastewater treatment plant for further treatment.

The routine transfer and storage of crude oil and refined petroleum products result in impacts to air quality through the release of VOCs. Loading of crude oil into tankers also results in the release of VOCs. However, impacts to air quality from these activities are mitigated by the capture and combustion of volatile organic releases. Finally, many operations at the Valdez Marine Terminal collectively contribute to increased traffic volumes and noise impacts.

4.2.2.3 Routine Operations of the Pipeline

Notwithstanding spills or accidental releases, routine operations of the pipeline result in nominal impacts. Various internal combustion power generators impact air quality from the release of combustion products and also are a source of noise. At some remote gate valve (RGV) locations, propane-fired generators are continuously operational and would also have nominal impacts to air quality and noise.

Three sections of the TAPS, approximately 4 mi in total length near Gulkana, are buried in thaw-unstable permafrost. These sites are mechanically refrigerated to prevent thawing of the soil surrounding the warm pipeline and possible settlement of the pipeline. Mechanical refrigeration systems may require replacement or upgrade for improved performance and durability during the ROW renewal period (TAPS Owners 2001a). Replacement or servicing will result in impacts typically associated with excavation, including impacts to water resources from excavation dewatering or vegetation clearing. Impacts may also result from the removal and disposition of the brine solution that acts as the heat transfer fluid in these refrigeration units. Noise and increased vehicle and construction equipment traffic can also be anticipated during removal or replacement activities. Typical routine servicing of the refrigeration units will have limited short-term and localized impacts, including vehicle traffic, noise, and possibly the generation of industrial wastes.

4.2.2.4 Routine and Preventive Maintenance Actions

4.2.2.4.1 Slope and Workpad Maintenance. Workpad repair activities normally include maintenance of safety of slopes and elevations, regrading, revegetation of adjacent areas, clearing of obstructed surface drainage pathways, adjustment of aboveground pipeline elevations, and the installation of passive thermal-transfer devices (heat pipes) to maintain slope stability when necessary. Impacting factors associated with these activities include increased vehicular traffic, increased noise levels during repair activities, and mining and transport of gravel or soils to the work site. In those instances where slope movements have resulted in movements of VSMs, VSM replacement or repair may be necessary. In such cases, additional heavy equipment would also be involved and excavation would be necessary. Although heat pipes contain a hazardous chemical (anhydrous ammonia), they are sealed, and impacts from their installation and subsequent operation will not be influenced by the presence of the ammonia. Slope and workpad repair actions are confined to the workpad and adjoining areas.

Finally, vehicular traffic on the workpad access roads can itself be an impacting factor, irrespective of the purpose for which the vehicle is being driven to the workpad. Many access roads cross small, low-volume and intermittent streams. Low-water crossings have been designed to prevent alteration of stream cross sections and subsequent impacts to water flow and fish habitats. Surveillance by both APSC personnel and state authorities extends to identifying maintenance needs for those crossings. Conducting work on the ROW during the winter months can also reduce such inadvertent impacts from vehicles. Vehicular traffic both on TAPS access roads and the Dalton Highway may also impact animal migration patterns.

4.2.2.4.2 Valve Maintenance and Repair. Main-line valves undergo extensive performance testing. When such testing indicates that applicable performance standards are not being met, valve inspection, maintenance, refurbishment or replacement is scheduled. Because adequate valve performance is essential to fundamental control of oil flow through the pipeline and the ability to successfully isolate pipeline segments to facilitate repairs as well as responses to accidental releases, valve maintenance receives high priority. The rate of valve inspection for corrosion, possible sealing problems, and other damage is currently about five valves per year (TAPS Owners 2001a). Since initial construction, four main-line valves have been replaced or repaired because of sealing-performance deficiencies — two aboveground gate valves and two belowground check valves (TAPS Owners 2001a). One RGV is scheduled for replacement in the 2002–2003 time frame (Norton 2002a). Although there are insufficient data regarding valve failure to predict the levels of future valve replacement activities, it is anticipated that general maintenance levels for all valves will increase in the future (Jackson and White 2000). Three RGVs removed from service as part of the Atigun Pass reroute completed in 1990 have been inspected for wear. These inspections have provided useful data for RGV maintenance and intervention schedules and criteria (Norton 2002a).

APSC initiated a program of installing vaults around buried main line check valves. JPO has concurred that vaulting is appropriate and beneficial (Wrabetz 2002). Ultimately, all below-ground valves will receive a vault. This installation program is expected to be completed by 2003. Once installed, the vaults will facilitate routine inspections and performance testing of valves and will reduce impacts of such activities, particularly when excavation is required (see Section 4.2.2.6.2 for additional discussion). However, the impacts of installing the vaults and replacing vaulted valves, when necessary, would be the same as current activities to replace buried valves.

Replacements of buried valves will involve excavating anywhere from 18 to 48 in. of compacted gravel (that portion of the workpad immediately above the valve) and soil overburden and pipeline backfill materials, extending to depths ranging from 4 to 20 ft below grade. Excavations are likely to extend a few tens of feet to either side of the valve location to provide an opportunity to inspect adjoining pipeline segments for corrosion and to facilitate reattachment of the repaired or replacement valve. A typical excavation can be expected to result in land disturbance of a surface area approximately 50 by 200 ft. All replacement valves undergo hydrostatic testing before installation. Valve replacements in buried sections of pipeline may also require dewatering of the excavation and the importing of additional backfill sands or gravels to reestablish the original grade and workpad once repairs or replacements have been completed. All work is expected to occur within the dimensions of the previously disturbed areas. However, excavated materials and support equipment may be temporarily staged on adjacent areas. Some vegetative clearing and repairs or modifications to access roads may also be necessary to support the work effort. Support equipment will include portable electric power generators and temporary fuel storage for excavation and lifting equipment. Valves are precoated with an epoxy or phenolic coating. After installation, there will be minor amounts of field dressing of the valve body and adjacent main-line pipe segments with phenolic corrosion control coatings.

Impacts associated with replacing buried valves include ground disturbance from excavation and temporary stockpiling of excavated fill; impacts to surface water from the discharge of excavation waters or from increased siltation potential because of ground disturbances; the generation of small amounts of waste from surface preparation and recoating of the adjoining pipeline segments; local and short-term impacts to air quality from the consumption of fossil fuels by vehicles and construction equipment, as well as the creation of fugitive dust; impacts to air quality from increased fugitive dust; impacts to the terrestrial environment not only from the excavation but also from the possible need to clear vegetation around the work site for vehicle and equipment access; and impacts from increased vehicle traffic, including the release of air pollutants, fugitive dust, and noise. Impacts may also result at off-site material sites for mining and hauling of additional fresh materials for bedding and padding the new valve and adjacent pipe. New materials may also be needed to repair or modify the access road to support heavy construction equipment. In most instances, it is not necessary to import additional overburden fill soils to reestablish the original grade at the completion of the project. In fact, on some occasions, excess fill materials may need to be removed from the work site because of the use of fresh bedding materials.

4.2.2.4.3 Surveillance and Monitoring Activities. Detailed descriptions of mitigative surveillance and monitoring activities are provided in Section 4.1. Monitoring and surveillance are conducted for the following: slope movement and deterioration, VSM movement, pipeline movement, glacier movement, earthquakes, internal and external corrosion in the pipe, and vandalism. Surveillance also extends to routine measurements of currents and resistivity in the "impressed current" cathodic protection systems installed on some portions of buried pipeline as well as monitoring of conditions in sacrificial anode protection systems. Surveillance uses conventional vehicles on established workpads and access roads. Helicopters provide year-round aerial surveillance. Light aircraft are used for aerial photography to measure glacier movement. Surveillance during winter months is conducted using four-wheel drive trucks, Tucker Snow Cats™, or snow machines. Impacts from routine surveillance activities are nominal and relate primarily to site access by inspectors, including increased vehicular traffic (including air reconnaissance) and noise. The surveillance and monitoring activities themselves have no notable impacts.

Surveillance for pipeline movement and corrosion is also performed remotely through the use of instrument pigs (also sometimes referred to as "smart pigs"). Pigs are "launched" into the main pipeline at PS 1 and 4 and carried along in the flow of oil. Pigs can be recovered at PS 4 or at the Valdez Marine Terminal. Earthquakes are monitored through an array of accelerometers located at pump stations and the Valdez Marine Terminal. The use of smart pigs and accelerometers does not impact the ROW per se; however, interpretation of the monitoring data may lead to additional excavations to facilitate visual inspections of suspect or potentially affected portions of the pipeline.

4.2.2.5 Repair Activities

4.2.2.5.1 Corrosion Digs. External corrosion investigations ("digs") of buried main-line pipe occur on the basis of the review of data gathered by smart pigs and annual close potential corrosion surveys. Historical corrosion data analyzed through the corrosion data management system database may also dictate corrosion digs (Norton 2002b). Main-line pipe sections where pipe-wall thinning is detected are excavated and examined. Pipe coatings and cathodic protection systems are repaired to stop additional wall thinning from corrosion. In some cases, full-encirclement pipe sleeves are installed to reinforce the pipe where anticipated hydraulic pressures require additional measures of safety.

Uncovering main-line buried pipe for examination and repair usually results in an engineered excavation of about 60 linear feet of pipe (Tart and Hughes 1998). The excavations usually disturb a surface area of about 50 by 200 ft within the previously disturbed area. Many digs occur in a sequence, so a number of such excavations may occur in a given winter construction season. Impacts from this series or "cluster" of corrosion digs will be proportionally greater than those for an individual corrosion dig. Depth of soil cover over the top of the pipe varies from 4 to 20 ft, with side slopes generally at a ratio of 2 to 1. For personnel safety, the slopes of the excavation are no steeper than 1.5 to 1. Excavations occurring in wet areas are more complex and are carried out in winter to reduce the need for dewatering; however, dewatering may be required at any time of the year. Water pumped from excavations is discharged in accordance with APSC's linewide NPDES permit. If required, excavation of pipe segments buried beneath rivers would have more far-ranging impacts and would likely also require extensive river training (redirection) over the period of the work. Conducting such actions in the winter months when flows are substantially reduced or even stopped can mitigate impacts to the river.

Impacts from these repair activities are localized and of short duration and include increased vehicular traffic, equipment noise, discharges of excavation waters to the land surface or nearby streams, possibly some vegetative clearing within the work area, and the possible importation of small volumes of additional fill materials. The work effort also involves minimal amounts of sandblasting to remove the original coating and surface rust and application of an epoxy coating. Cathodic protection systems (impressed current or sacrificial anodes) may also be upgraded or installed to prevent corrosion or reduce the rate of corrosion. An estimated 15 digs will occur each year, potentially increasing to 20 by the end of 2034 (Norton 2002b). Figure 4.2-1 shows the numbers of APSC corrosion investigation digs since 1989.

4.2.2.5.2 Maintenance, Repair, or Replacement of Main-Line Cathodic Protection Systems. Cathodic protection of the main-line pipe and various other TAPS facilities against corrosion is directed by the Corrosion Control Management Plan agreed to by the JPO and APSC (APSC 1999b). Cathodic protection systems are described in Section 4.1.2.3. Monitoring and surveillance actions are described in Section 4.1.3.2.1. Remedial action is taken if cathodic protection is determined to be inadequate or the installed

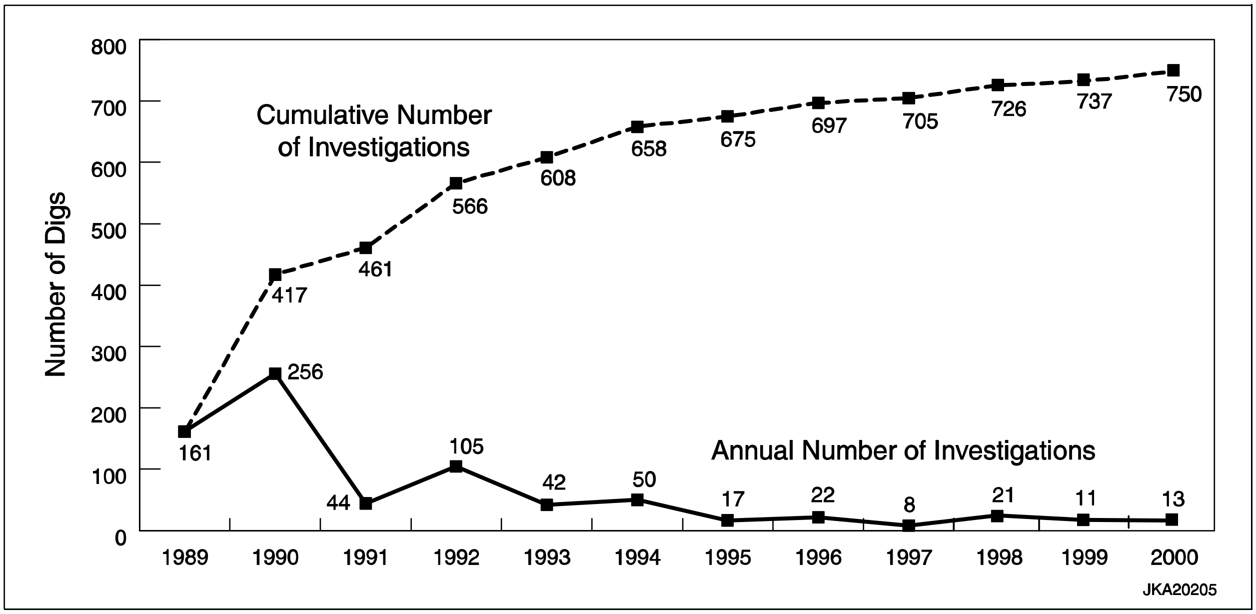

FIGURE 4.2-1 TAPS Corrosion Investigation Projects for Underground Main-Line Pipe (Source: TAPS Owners 2001a, Figure 4.1-1)

system is not meeting its performance requirements. Impacts from the surveillance of already installed cathodic protection systems are minimal and localized and include primarily noise and increased vehicular traffic associated with the physical surveillance of the system. However, testing, monitoring with instrument pigs, and corrosion histories of certain pipeline segments may indicate that existing ground beds need to be repaired, replaced, or improved, or that additional ground beds for impressed current cathodic protection systems need to be installed. As many as six to eight repairs or replacements of impressed current ground beds are expected from 2004 to 2034 (TAPS Owners 2001a).

Repairs, replacements, or new ground bed installations will have impacts similar to those encountered during initial installation. Those impacts include increased vehicular traffic, noise, vegetation clearing, and excavations. Equipment used will include excavation equipment, portable power generators, and possibly temporary storage facilities for vehicle and equipment fuels. Because installation or repair is expected to occur over relatively short time frames and because water accumulated in the excavation is not expected to seriously impede installation, minimal excavation dewatering is likely to occur. Horizontal ground beds at pump stations are likely to have been installed entirely beneath the graveled footprint. Repair or replacement of horizontal beds would therefore have only minimal impacts to the ground surface. While most repair actions are expected to occur within the existing ROW, replacement of remote vertical ground beds may also involve construction of temporary access roads and thus result in substantially greater areal extent of ground surface disturbance. Power rectifiers will also need periodic replacement. From 2004 to 2034, the addition of 20 to 30 new impressed-current rectifiers can be expected (TAPS Owners 2001a). Impacting factors associated with rectifier replacements include increased vehicular traffic and noise but not excavation. Removed rectifiers will be solid wastes and are likely to be sold as scrap.

Maintenance of sacrificial anode-type cathodic protection systems requires periodic excavation to replace the original zinc anode. Anode depths can generally be expected to be at or near the lowest elevation of the pipeline at that location. Impacting factors associated with sacrificial anode replacement will be similar to those encountered for the ground bed repairs or replacements discussed above. Expanded use of impressed current systems or distributed ground beds as replacements for sacrificial anodes can reduce the number of excavations for anode replacement. However, these alternative corrosion control systems are not, themselves, maintenance-free, and excavations associated with their repair or replacement could still occur.

As the pipeline ages, the coating degrades, more bare metal is exposed, and greater demands are placed on the cathodic protection system. The existing system may ultimately be unable to supply sufficient corrosion protection. At that point, either additional protection must be added or the coating must be refurbished. In those instances, excavation of the affected pipe segment will be required, and impacting factors similar to those discussed above for corrosion digs will result. It is estimated that rehabilitation of less than 5 mi of pipeline will occur during a 30-year renewal period (TAPS Owners 2001a).

4.2.2.5.3 River Crossing and River Training Structure Repairs. River training structures are required when changes to the natural course of rivers represent a threat of erosion of pipeline structures and thus a loss of pipeline integrity. Because river channels are subject to seasonal change, all locations requiring river training structures could not be identified during initial design and construction. While some locations requiring river training could be identified in the design phase, other locations could only be identified by monitoring changing river conditions over time or after major flood events. It was anticipated that maintenance of existing river training structures would be necessary and that new structures might be needed in response to major floods or stream migration. Historically, some repair to existing structures, as well as construction of new structures, has occurred almost every year. A typical repair may involve adding riprap to a washed-out spur nose or to a riverbank. All work is conducted in accordance with environmental permits. Emergency or temporary repair work is performed in accordance with methods practical at the time for the specific location, with oversight by regulatory agencies.

In addition to maintenance of river training structures to ensure pipeline integrity or to preempt problems from erosion, repairs or additions may also be made to facilitate ROW access. For example, a dike was constructed along McCallum Creek in 1999 to mitigate workpad overflows caused by icings. In the Atigun River floodplain, repairs to the workpad were necessary in the 1990s to maintain access to a check valve.

The scope of future maintenance needs depends primarily on the timing, location, and magnitude of high-flow events. The record, widely distributed floods on the Sagavanirktok River and Middle Fork Koyukuk River systems in 1992 and 1994, respectively, and the required response/maintenance plans, are probably representative of the scope of major maintenance initiatives that could be required in the future if record or near-record floods occur. Work will likely be required at a number of locations along the Middle Fork Koyukuk River in the future where pronounced, well-developed channel bends are moving toward the pipeline. (The migration of these bends is being closely monitored to be able to implement remedial measures in a timely and sound manner.) Future channel changes and possible additional works that might be required along the Sagavanirktok River are more difficult to estimate, as the multi-channeled braided nature of this river causes predictions to be largely speculative in nature. Dramatic and rare events such as the simultaneous release of the glacier-dammed lakes in the Tazlina River watershed are difficult to predict with accuracy. The north bank of the Tazlina River was armored in 1998 to 1999 as a protection measure for this type of event.

Impacts from maintenance or construction of river training structures are primarily noise, dust, gravel, and rock mining (either local or remote); increased siltation from disturbed land or newly placed gravel; and sediment generation from construction activities. Riparian habitats north of the Brooks Range can also be expected to be impacted by increased siltation in surface water drainage. It may also be necessary to place construction equipment directly in the watercourse. Thus, the potential exists for contamination of the watercourse by the various fluids present in the equipment. However, where possible, construction of the training structure is conducted in such a way to avoid contamination. Further, whenever possible, construction of training structures takes place in winter months when the flow in many rivers is reduced dramatically. However, low-flow conditions are themselves a high-risk period for fish that inhabit the river. Impacts on adjacent structures or on natural vegetation and flow patterns are also possible. Once completed, training structures can have local impacts, such as enhanced local bank erosions at the upstream end of the structure. In general, these structures are designed to minimize erosion impacts. However, overall erosion will still occur in certain areas. In some instances, river training structures can have more significant impacts on flow patterns in the downstream direction. Such impacts, however, may be significantly reduced in braided streams. Innovative techniques, such as the Rosgen technique, are being used along the TAPS to minimize the disturbance during construction and to minimize the types of impacts that are sometimes associated with larger structures used for river training. Although it is difficult to anticipate all the impacts resulting from river training activities, the historical record provides the following examples of potential impacts:

- Spurs such as the one at MP 47 can have a significant local impact on flow; however, even at this location, their impact is nominal compared with natural changes that can occur in the wide, braided Sagavanirktok River.

- The revetments along the Dietrich and Middle Fork Koyukuk Rivers since the major 1994 flood, and along the north bank of the Tazlina River bridge in response to the 1997 flood, were built along the post-flood bank alignments and thus had little impact on overall flow patterns.

- Along the Middle Fork Koyukuk River in the MP 243 area, the length of additional spurs, required because of channel changes induced by the 1994 flood, were significantly reduced compared with the original spurs to minimize their effect on vegetated islands.

- At small creeks, such as Vanish at MP 145, where high flows in 1999 could have resulted in significant VSM vertical movement or tilting, it was necessary to deflect the flow into its original location. By careful layout and construction of the transitions from the armored areas back to the original banks, the impact of the river training structures and pipeline structural members on creek behavior and flow patterns is very limited.

The impact of the river on structural support systems is also closely monitored. Erosion, channel scouring, and buildup of debris can destabilize some structural support members that are positioned in watercourses. Actions virtually identical to river training are then undertaken to reestablish the integrity of the pipeline system at those locations. Impacts from the repair of these structural members are similar to those encountered during construction of river training structures. The areal extent of the impacts, however, is likely to be smaller.

4.2.2.5.4 Fuel Gas Line Repairs. Annual maintenance of the soil cover over the fuel gas line is required because of seasonal temperature variations and water runoff. Sections of the line are subject to thermal uplifting (jacking) each year because of seasonal freezing in thaw ponds and wet areas. These sections are analyzed for stress and corrosion (by visual observation and by smart pigs) and evaluated using an integrity-based approach. Several hundred feet of the line are reburied each year to maintain the minimum cover requirements in DOT regulations (see 49 CFR 192) (TAPS Owners 2001a). Most of the fuel gas line was built from snowpads, and no permanent gravel workpad exists. However, the fuel gas line runs adjacent to either the oil pipeline workpad or the Dalton Highway, both of which provide access for surveillance or repairs. No notable impacts result from surveillance and monitoring activities, except nominal impacts associated with personnel access to any given location along the ROW. Impacts resulting from repairs are related to excavation and include ground disturbance (albeit at a much smaller scale than excavations that occur as part of TAPS maintenance or repairs), clearing of vegetation, localized impacts to surface water from ground surface disturbances, increased vehicular traffic, and noise. Air quality impacts result from the consumption of fossil fuels in vehicles and construction equipment and short-duration increases in fugitive dust resulting from ground disturbances. Air quality impacts may also result from importation of additional gravels or soils to reestablish original grades or to serve as pipe bedding material. After repairs are complete, the ROW is regraded and revegetated. Many of the above-noted impacts can be minimized by performing most gas line repair work in the winter.

Impressed current systems located at PS 1, 2, 3, and 4 and also at several remote impressed current rectifier sites provide cathodic protection for the fuel gas line. Continued adequacy of cathodic protection is determined by annually monitoring 74 test stations along the gas line. Maintenance and repair of the cathodic protection system is based on a risk assessment performed in accordance with DOT OPS requirements. Impacts are similar to those discussed in Section 4.2.2.5.2 for TAPS cathodic protection systems. However, the majority of the impacts may be realized at the pump stations rather than along the gas line ROW.

4.2.2.6 Planned and Potential Upgrades

4.2.2.6.1 Pipeline Replacement or Reroutes. Recurring corrosion problems or the continued potential for pipeline settlement are the primary reasons for segment replacement or reroute. Replacement of main-line pipe sections is rare since most pipe repair work can be accomplished by installing full-encirclement pipe sleeves over damaged sections. Replacements or reroutes are performed only when this method of repair is infeasible or when evidence suggests that settlement or corrosion will recur because of uncontrollable circumstantial factors. Ongoing refurbishment of pipeline coatings and cathodic protection systems reduces pipeline repairs or replacements. Four pipeline reroutes/ replacements have occurred since 1977: (1) 3,600 linear feet at MP 200 near the Dietrich River in 1985, (2) 234 linear feet at MP 166 at Atigun Pass in 1987, (3) 200 linear feet at PS 3 in 1990, and (4) 8.5 mi from MP 157 to MP 165 near the Atigun River in 1991.

Impacts from pipeline replacements are similar to impacts from corrosion digs but at a much greater scale. Pipeline replacements are major construction projects that approach original construction impacts in scale for a localized area. Costs range from $1 million to $10 million per mile. Because of pipeline integrity monitoring, major reroutes because of corrosion are not expected during a 30-year renewal period. If they were to occur, pipeline reroutes would invoke the controls and requirements of numerous grant stipulations in much the same manner as original construction. Any reroute would be preceded by extensive design and planning activities, all of which would be subject to JPO review and approval.

4.2.2.6.2 Valve Vaulting. APSC is currently engaged in a systemwide project to install vaults around all buried main-line valves. The vaults are intended to facilitate future inspection and maintenance of these valves. Valve vaulting involves excavation to expose the valve, deepening the pipeline trench immediately below the valve to allow for installation of pre-formed concrete slabs or corrugated metal pipe to serve as the walls and cover for the vault. While the valve is exposed, it is inspected for signs of external corrosion, and the surface is repaired and recoated with epoxy as necessary. Some nominal length of pipeline on either side of the valve is also exposed during excavation and also undergoes inspection and repair as necessary. No interruption of oil flow is required to accomplish valve vaulting. APSC estimates that vaulting will proceed at a rate of 5 per year, and that the project will be completed by 2003 (Malvick 2002).

Impacts from valve vaulting activities would be similar to those encountered during corrosion digs. However, the scale of a vaulting operation with respect to manpower, equipment, and material needs is slightly larger than that of an individual corrosion dig, and impacts have the potential to be proportionally larger. Most of the work is expected to take place on the established workpad; however, adjacent areas within the ROW may also be used for temporary staging. Excavation dewatering and increased potential for siltation because of ground disturbances can have temporary localized impacts on surface water resources. Air quality impacts can be anticipated as a result of the operation of portable internal combustion units on generators or air compressors as well as from the operation of lifting and excavation equipment. Air quality is also impacted by sandblasting that may occur to remove surface corrosion. However, such air impacts are local and of relatively short duration. Spent sand used in this blasting operation as well as the corrosion and original epoxy coating that is removed are left in the excavation as bedding material pursuant to ADEC approval (see Appendix C, Section C.6.8). Because the installed vault will occupy some space in the original excavation, no additional fill materials are anticipated to be necessary to reestablish the original grade at the end of the project. However, it may be necessary to import additional gravel to modify the access road and workpad to accommodate the heavy equipment used in lifting and positioning the pre-formed concrete or corrugated metal pipe. As with other construction activities along the ROW, vaulting will have impacts as a result of increased vehicular traffic and noise. Finally, once completed, the valve vaulting project will preempt or greatly reduce impacts from future monitoring and surveillance of buried valves as well as enhance APSC's ability to conduct these activities.

4.2.2.6.3 Planned Pump Station Upgrades and Valdez Marine Terminal Modifications. The potential for the TAPS system upgrades was identified in the ER for the TAPS ROW renewal (TAPS Owners 2001a). At the time that report was released (February 2001), numerous system upgrades or modifications had already been completed or were ongoing (e.g., rampdown of some pump stations and crude oil topping plants, enhanced communication systems, improved earthquake alarm and intervention systems, improved main-line leak detection capability, and vaulting of buried main-line valves). It is readily anticipated that upgrading the TAPS will continue to be a dynamic process that occurs throughout the operational period. Also, additional upgrades or modifications would likely occur over the period of the proposed 30-year renewal of the Federal Grant, precipitated by such factors as reduced North Slope crude oil production (and thus reduced TAPS throughput), JPO directives, technological advancements, or opportunities to enhance the overall efficiency and effectiveness of TAPS operations.

APSC has announced a conceptual engineering study of potential facility upgrades involving modifications to all but 1 of the 11 TAPS pump stations and to the Valdez Marine Terminal (APSC 2002a). The study primarily looked at altering the configurations of pump stations, including eliminating some stations, and increasing the levels of automation at which the remaining pump stations would continue to operate. Other modifications being considered included replacing existing turbine pump drivers with more fuel-efficient drivers, while also increasing overall efficiency of TAPS operations. Pump drivers can alternatively be replaced by electric motors when commercial power is available as a means of reducing overall fuel consumption (and thus operating costs). Finally, the study considers the removal of two of the four tanker berths at the Valdez Marine Terminal. No significant change is being considered for the pipeline itself.

It is important to note that the proposed system upgrade exists at this time only as a preliminary engineering conceptual design study. More extensive engineering and numerous logistical details still need to be developed and approved before the plan can be executed. Further, all aspects of the study must be reviewed and approved by appropriate JPO agencies before the Authorized Officer authorizes APSC to proceed. It is assumed that any authorization to proceed would be issued only after APSC had demonstrated to the JPO's satisfaction that the requirements of all applicable Federal Grant stipulations would be satisfied both during the modifications and thereafter. It is further assumed that the JPO would apply its broad management authority to impose additional special stipulations as it has done on 11 previous occasions to ensure that the full intent of the Federal Grant is met (see Section 4.1.1 for a discussion of the JPO's specific and broad authorities). It is also assumed that planned upgrades would not occur if the Federal Grant is not renewed.

Although preliminary, in its current stage of development, the study provides a sufficiently detailed reference point against which to develop at least a qualitative analysis of its attendant environmental impacts and to compare those impacts with the analogous impacts of the existing TAPS facilities being considered for modification. That qualitative impact analysis is provided below. Where warranted and possible, more extensive, quantitative analyses of environmental impacts are given (see Section 4.3). Because the conceptual study of upgrades is preliminary, many engineering decisions have yet to be made. In many instances, absence of these decisions precludes a quantitative analysis of the impacts of the change. For example, APSC has proposed substituting existing turbine pumps with more efficient pumps. It is easily anticipated that such a substitution will result in reduced air emissions and fuel consumption. However, until substitute pump and driver models are selected, quantitative comparative analyses against the impacts of existing pumps is not possible. In such instances, the end point of the upgrade action is not sufficiently defined at this stage to allow for more detailed analyses of both short- and long-term impacts.

Details of Proposed Changes. Infrastructure changes are being proposed for all pump stations except PS 5 and for the Valdez Marine Terminal. However, the extent of the modifications differs at each pump station. At some, only the crude oil main pumps and some minor equipment may be modified. At others, in addition to replacing crude oil pumps, additional infrastructure will be removed or modified, electrical service will be modified, and automated controls will be installed. Finally, at those pump stations currently in a ramped-down status, all of the pump station infrastructure may be removed and replaced with a simple pipe segment interconnecting the main-line pipe. RGVs may be installed in these new segments to preserve overall flow control and facilitate spill response. These stations would, therefore, cease to be pump stations. More specifically, infrastructure changes being considered by APSC include the following:

- Replacement of existing electric power systems and pumping systems at PS 1, 3, 4, 7, 9, and 12, including the installation of new fuel gas-fired turbine generators and electric driver pumps at PS 1, 3, and 4 and, because commercial electric power is potentially available, installation of new electric motor-driven pumps at PS 7, 9, and 12;
- Removal of most existing aboveground physical facilities at PS 3, 7, 9, and 12, converting these pump stations to fully automated operations;
- Removal of all pump-station-related infrastructures at currently ramped-down PS 2, 6, 8, and 10 and installation of interconnecting pipeline segments and RGVs; and,
- Removal of tanker Berths 1 and 3 at the Valdez Marine Terminal.

Table 4.2-1 displays the overall changes to power systems and equipment that would occur in this upgrade at PS 1, 3, 4, 7, 9, and 12.

The study anticipates that all of the above actions could begin within two to three years once a final workplan becomes available and that these actions would be completed over a period of several years (assuming all necessary approvals and permits could be secured without unanticipated delays). With appropriate planning and scheduling, APSC anticipates that physical modifications to the pump stations can be accomplished with minimal disruption to pipeline operations or oil flow. In essence, modifications to pump stations would result in stoppage of oil flow in approximately the same manner as maintenance shutdowns that already periodically occur.

The following additional assumptions are applied as bounding conditions for the identification and analysis of impacting factors from the proposed upgrades:

- Appropriately modified corrosion control systems and thermal control features will be installed and maintained at the modified pump stations to protect any remaining facilities or equipment.

TABLE 4.2-1 Planned Pump Station Upgrades

Pump Station	Power Sources		Facility Infrastructure	
	Existing	Upgraded	To Remain	To Be Added
1	8 operating fuel gas-fired turbines 8 spare fuel gas-fired turbines	Electric motors with 1 new gas turbine One spare power generation set and electric motors	Most existing equipment and structures	Nothing
3[a]	5 operating gas turbines 2 spare gas turbines	Electric motors with 2 new gas turbines	Main piping manifold, gas building, relief system, and booster pump	New electrical and instrumentation module for control and power distribution
4	4 operating gas turbines 3 spare gas turbines	Electric motors with 2 new gas turbines	Most existing equipment and structures	New electrical and instrumentation module for control and power distribution
7[a]	2 operating liquid-fuel turbines 2 spare liquid-fuel turbines	Electric motors with 1 liquid-fuel turbine	Main piping manifold, relief system, and booster pump	New electrical and instrumentation module for control and power distribution
9[a]	2 operating liquid-fuel turbines 2 spare liquid-fuel turbines	Electric motors with 1 liquid-fuel turbine Tie-in to commercial power or a secondary generator for standby power	Main piping manifold, relief system, and booster pump	New electrical and instrumentation module for control and power distribution
12[a]	1 operating liquid-fuel turbine 4 spare liquid-fuel turbines	Electric motors driven by commercial power One standby generator powered by liquid-fuel internal combustion engine	Main piping manifold, relief system, and booster pump	New electrical and instrumentation module for control and power distribution

[a] PS 3, 7, 9, and 12 will be converted to fully automated operations.

- Ancillary capabilities at pump stations would be preserved (e.g., smart pig capture and launching facilities at PS 4 would remain fully functional and facilities for the storage of refined fuels for vehicles and aircraft would remain in place at some pump stations).

- A separate contractor (or contractors) would perform the necessary physical alterations; work could occur simultaneously at more than one location.

- Razing of existing structures (if called for) will involve removal of all buildings and foundations and other engineered systems (e.g., foundation refrigeration systems) to a nominal depth of 2 ft below ground elevation.

- All work at the pump stations will be accomplished within the existing footprint (i.e., the paved or gravel roads and work pads at the pump stations) or adjacent to previously disturbed areas. Further, no new real estate parcels would be involved in the completion of this upgrade. Except for those minor disruptions to the workpad associated with structure removal, the gravel work pad and all access roads will remain undisturbed.

- Building components (e.g., structural elements, concrete, cinder block, and sheet metal) and infrastructure systems (e.g., heating, ventilation, and air-conditioning [HVAC]; plumbing; and electrical equipment) will be salvaged to the greatest extent practical; materials that cannot be recycled will be managed in generally the same manner as wastes from routine operations.

- The accumulation of dismantled equipment or structures will be kept to the minimum time periods necessary to accomplish efficient transport to salvage or disposal facilities.

- Existing TAPS or commercial housing facilities will be used to the extent practical to support the construction workforce. The contractor would construct and maintain temporary housing facilities and workforce support systems (e.g., cafeterias) when adequate housing is not available within a reasonable distance from the worksite.

- Work to remove the berths at the Valdez Marine Terminal will involve the use of both land- and water-based construction equipment.

- Work to remove the berths at the Valdez Marine Terminal will involve removal of the oil transfer arms, the VOC control, ballast water transfer plumbing, the piers, and all above- and below-water structural elements but will not involve dredging of sediments.

Although the physical modifications called for in the plan are extensive at the local level (i.e., at some of the pump stations), all of the proposed modifications collectively would not constitute a “reconfiguration” of the pipeline. Therefore, the proposed upgrade is considered to be a reasonably anticipated action within the context of the proposed action and is not sufficiently distinguishable from the proposed action to rise to the level of a separate alternative.

General Discussion of Impacting Factors Associated with Planned Upgrades and Modifications. Anticipated environmental impacting factors related to the execution of pump station upgrades and Valdez Marine Terminal modifications can be identified for both the short term (i.e., the “construction” periods during which physical modifications are taking place)[1] and the long term (i.e., from routine operation of the modified facilities thereafter). However, long-term impacts from modifications to pump stations that had been previously ramped-down will represent only marginal changes to the impacts those pump stations are now contributing during routine

1 Here, the term, “construction,” includes any or all of the following activities: dismantling of equipment and structures, reorientation of equipment, installation of new equipment, and installation of pipeline segments and RGVs, where necessary.

operation, since many of the impacts associated with operating pump stations had already ceased at these locations at the time of ramp-down. Over the short term, impacts will be equivalent to, or less than, those encountered during initial facility construction.

The most extensive impacts anticipated are localized, short-term impacts associated with the wholesale removal of existing equipment at pump stations that will be eliminated (PS 2, 6, 8, and 10) and the installation of pipeline segments and RGVs to interconnect the pipeline segments entering and leaving these former pump stations.[2] Similar impacts of generally smaller dimensions can be anticipated from the less extensive removal or reorientation of equipment contemplated at PS 3, 4, 7, 9, and 12. The least impact from dismantling and reconstruction will occur at PS 1 at which very little equipment changes will occur. Pump Station 5 is not included in this upgrade plan and will remain physically unaltered from its current condition. Similarly, at the Valdez Marine Terminal, the greatest impacts will be short term, occurring during berth and pier dismantlement. Long-term impacts associated with the use (or presence) of those piers will be very small.[3]

Changes to Short-term Impacting Factors Associated with Physical Modifications. Air pollution impacts during this period include increases in the amounts of air pollutants released (1) from the combustion of fossil fuels in various commuting and construction vehicles, portable power generators and heaters, incinerators used for the disposal of nonhazardous construction wastes and domestic solid wastes, and support equipment, and (2) from the operation of comfort heating and cooking equipment operated to support the construction workforce. Increased amounts of fugitive dust will result from increased vehicular traffic as a result of such activities as mobilization/demobilization of construction crews and equipment, commuting of construction personnel (when housing cannot be established at the work site), minor disturbances to the gravel work surface during building/foundation removals,[4] the transport of new TAPS equipment to the work sites, and the transport of dismantled equipment and building components to salvage or waste disposal locations. Localized noise impacts could also be associated with all of the above activities.

The access roads leading to the pump stations and the Valdez Marine Terminal are likely to be suitable for the conveyance of heavy construction equipment, new TAPS equipment, and dismantled equipment and structures, and no major road alterations are anticipated. Because the disruption to the gravel pad will be minimal, large amounts of fill or new gravel are not expected to be necessary, except at those locations where new pipeline segments will be installed below ground (i.e., where new gravel will be required as bedding material). In addition to installing new pipeline segments, minimal amounts of new gravel may be required to re-establish grade in those areas where foundations or subsurface structures (e.g., refrigeration systems) had been removed. It is assumed that any new gravel needed will be obtained from existing (and closest) material sites.

Potable water usage will increase due to consumption by construction personnel. Proportional increases in amounts of sanitary wastewater will also result. Potable water will also be required to clean equipment. Industrial wastewaters that result from this cleaning will likely need to be transported elsewhere for treatment and disposal. It is anticipated that all construction-related water demands can be satisfied by using existing wells or surface waters; however, modified water withdrawal permits may be required. Modifications to the line-wide EPA-issued NPDES permit which

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2 It is not clear at this time whether newly installed pipeline segments will be above or below ground.

3 In recent years, Berth 3 has been used only rarely to load oil tankers. Berth 1 had been used to berth tankers delivering diesel fuel for use at the Valdez Marine Terminal. However, those deliveries are now made by truck, and Berth 1 is no longer used (Edwards 2002).

4 However, where it is determined that new pipeline segments will be installed below ground, disturbance to the gravel pad will be more significant.

hydrostatic test waters are now discharged may also be necessary because of the anticipated increased volumes of hydrostatic test waters generated during equipment reconfiguration. Discharge of hydrostatic test water not covered by the EPA-issued permit is controlled on ADEC Wastewater General Permit (ADEC 1999) (see Section C.5).

Construction activities can be expected to impact local surface water because the amount of silt in storm water flowing over recently disturbed gravel is expected to increase. At those locations where new pipeline segments will be buried, excavation waters will be generated and discharged to surface waters. An amended linewide NPDES permit may be required. Hydrostatic test waters will be generated as equipment is installed or reassembled. It is anticipated that this water would be discharged under the existing linewide NPDES permit.

Increases in solid waste volumes (including putrescible wastes from cafeteria activities) can also be anticipated as a result of increases in workforce personnel (expected to be substantially greater than the number of pump station operating personnel routinely present), especially if the workforce is housed at the work site. Solid industrial wastes from the dismantlement of structures and equipment that has no salvage value will also be generated.

Emptying and cleaning of pump station equipment destined for removal or reorientation will result in the generation of wastes. Sludge, tank bottoms, and condensates removed from equipment may exhibit the characteristics of hazardous waste and will need to be transported to permitted out-of-state treatment, storage, and disposal facilities. It is possible that dismantled equipment will also require cursory cleaning to be eligible for salvage. Lightweight petroleum distillates (e.g., kerosene) may be used for such cleaning. However, it is possible that such rinsates as well as spent lubricating oils from various internal combustion equipment operated to support construction activities can be reintroduced into the crude oil product stream, provided no contaminants (e.g., chlorinated solvents) are introduced that would preclude the receipt of these rinsates at crude oil refineries. Other wastes that result from building dismantlement may require special handling because of the presence of chemicals or materials of special concern (e.g., asbestos-containing materials, PCBs, and mercury). The presence of such materials within the TAPS infrastructure, however, is limited, and only minor amounts of special wastes are expected.

Wildlife and fish habitats may also be impacted from increases in such factors as human presence; air pollution and noise; traffic; and levels of silt present in storm waters, excavation waters, or hydrostatic test waters being discharged from the construction zone. Little to no removal of vegetative cover is expected to be necessary; however, increased levels of traffic-related fugitive dust may nevertheless impact vegetation adjacent to the workpad, access roads, or the Dalton Highway. Worker health and safety impacts routinely associated with typical construction activities will also occur during facility modifications. Health and safety impacts outside the construction zones are not anticipated.

Cultural resources may also be impacted by ground-disturbing activities in previously undisturbed or only slightly disturbed soils in culturally sensitive areas and by the dismantling of equipment and structures should the TAPS be determined an eligible historic property.

With respect to modifications at the Valdez Marine Terminal, all of the impacting factors noted above that are intrinsically related to construction projects can also be expected to occur at the Valdez Marine Terminal. Normally encountered health and safety impacts can be anticipated. However, because the deconstruction activities occur on or near the water, additional unique worker health and safety impacts also will exist.

Changes to Long-term Impacting Factors Associated with Operation of Modified Facilities. The net results of the planned pump station upgrades are a simplification or, in some instances, a complete elimination of complex mechanical systems that comprise a typical pump station. As discussed below, while it can be clearly anticipated that the proposed upgrade project has the potential for substantial short-term, generally localized, impacts, the much simplified facilities that result can be expected to produce fewer and smaller impacts during subsequent routine operation than did their predecessors. Likely changes in operational impacts as a result of the proposed pump station modifications are provided below.

The berths proposed for removal at the Valdez Marine Terminal have been used only rarely or not at all in recent years, and the current and projected operational levels at the Valdez Marine Terminal (i.e., frequencies of tanker berthings or volumes of crude oil shipped per unit time) will not be influenced by the presence of these berths or encumbered by their absence (Edwards 2002). Consequently, no measurable changes to the operational impacts from the Valdez Marine Terminal can be attributable directly or solely to the berth removals being proposed, and no further discussion of operational impacts from the modified Valdez Marine Terminal is necessary.

Many operational impacts will change as a result of the modifications proposed for the pump stations, including air emissions, water and energy consumption, wastewater generation, solid and hazardous waste generation, and impacts to surrounding habitats. Currently, the pump stations have multiple air emission sources, including the main turbine-driven pumps, generators, transfer pumps, flare stacks, steam boilers, comfort heating boilers, and waste incinerators. The largest single sources of air pollution at any pump station, however, are the turbine-driven pumps. Although some of the incidental sources of air pollution will remain unchanged, air pollution impacts from upgraded pump stations will still be reduced because the replacement drivers at PS 1, 3, and 4 are more efficient.[5] At PS 7, 9, and 12, criteria air pollutant emissions from main turbine-driven pumps will be totally eliminated because drivers at these stations will be run by electric motors powered by commercial electricity. PS 2, 6, 8, and 10 will be completely eliminated, and only small electric generators will remain as air pollution sources directly related to the TAPS operations. Air impacting factors, such as the incineration of solid wastes that now occurs at some pump stations, would be eliminated or greatly limited if the resident workforce were reduced or eliminated. In addition to reductions in air impacts from the introduction of modified equipment, additional reductions in air impacts can be anticipated because of the reduced frequencies of deliveries of fuels, replacement equipment, and provisions that are likely to be necessary to support simplified facilities and/or reduced workforces. However, these reductions are partially offset by the fact that the individuals who perform periodic maintenance on automated pump stations will be traveling to, rather than residing at, those pump stations.

In addition to the water used for consumptive or sanitary purposes, pump station water is also used to clean equipment and perform hydrostatic testing activities. Water used for industrial purposes will be dramatically reduced at those pump stations where equipment is removed and will be eliminated entirely at PS 2, 6, 8, and 10. Potable water usage at pump stations is primarily related to the size of the workforce, especially when the workforce resides on site. Increased levels of automation introduced at PS 3, 7, 9, and 12 may result in the complete elimination of the operating workforce at those locations.[6] Reduced workforce levels can also be expected at PS 4 and 5.[7] Potable water usage at ramped-down PS 2, 6, 8, and 10 is already limited to that which is necessary to support certain maintenance activities. Once all pump-station-related equipment is removed, water usage will be reduced to zero.

Domestic solid waste generation is also primarily a function of workforce size and depends further on whether all or part of the workforce resides at the work site. Therefore, proportional reductions in solid waste volumes can be anticipated at those pump stations where the workforce is either reduced or eliminated.

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5 Replacement drivers at PS 1, 3, and 4 will burn fuel gas like the original pumps. However, higher operating efficiencies will result in more power delivered and less pollutants emitted per Btu of energy consumed, thus resulting in both a fuel savings and a reduction in air pollution.

6 A small security force is expected to still be present at these fully automated pump stations, but security personnel will likely not reside at those pump stations.

7 The APSC upgrade proposal also involves automating PS 4 and 5 to an extent that operating personnel may not be required. However, spill response personnel may still reside at these locations.

However, industrial solid waste is not related to workforce size, but rather the complexity and maintenance requirements of the equipment at each facility. Although automated and greatly simplified, modified pump stations will still use equipment that requires periodic maintenance, one inevitable consequence of which will be industrial solid and/or hazardous wastes. Such maintenance activities will also use potable water and generate hydrostatic test water. At pump stations that have been eliminated (PS 2, 6, 8, and 10), only a newly installed pipeline segment and gate valve and communication infrastructure will remain, the maintenance requirements of which will be no different than those for any other pipeline segment or gate valve. If the pipeline segment and gate valve at these locations are buried, maintenance-related activities will also result in impacts from excavations similar to those already resulting from the maintenance of buried pipeline segments. (Sections 4.2.2.4.2 and 4.2.2.5.1 discuss the impacts related to maintenance and repair activities on valves and buried pipeline segments.)

All of the modified pump stations will continue to have nominal impacts on surrounding ecosystems by virtue of the continued existence of the gravel pads and access roads. These features will continue to impact surface water drainage and nearby fish habitats and may have an impact on permafrost due to increased rates of absorption of solar insolation. However, many of the impacting factors associated with pump station operations will be reduced or eliminated. Impacts to ground waters and surface waters from potable water withdrawals and on-site sanitary wastewater and storm water management activities will be greatly reduced as a result of both reduced maintenance requirements of remaining simplified mechanical systems and reduced or completely eliminated workforces. Reduced human presence, reduced air pollution (including fugitive dust) and reduced noise levels can also be expected at modified, simplified, or eliminated pump stations.[8]

Other Changes to Impacting Factors from Planned Upgrades and Modifications. As noted in the preceding sections, the planned upgrades may result in the reduction or elimination of the workforces at some pump stations. Together with the changes to environmental and ecosystem impacting factors discussed above, these workforce changes will also have social and economic consequences. In addition to the obvious economic consequences for those whose jobs are eliminated, the lesser amounts of turbine fuels that will be required will impact the economics of commercial fuel suppliers. Simultaneously, there may be an opposite economic impact to those industries supplying commercial electric power, the demand for which will rise at those pump stations where the replacement pumps will be driven by electric motors.

Finally, modifications to the pump stations and the concomitant reductions or eliminations of the workforces at some pump stations will require a fundamental restructuring of the TAPS spill contingency plan with respect to its basic response strategy and logistical issues such as deployment of personnel and equipment for response. At the present time, APSC's first response to spills at certain locations involves members of pump station workforces. Where those pump station workforces change as a result of pump station modifications, new strategies will be required. APSC has indicated its intent to explore development of a spill response strategy that involves the development of regional response centers. However, many of the necessary details of spill response plan changes have yet to be determined. JPO review and approval of any changes to the contingency plans must also be secured.

8 It can be reliably anticipated that replacement turbine drivers will generate less air pollution per unit of power delivered because energy savings is one of the primary motivations of these modifications. It is less easily assumed that any replacement driver selected will have a noise signature dramatically different than the current drivers. However, turbine drivers powered by electric motors are likely to be quieter than current fuel-gas-fired or liquid-fuel-fired drivers.

4.2.2.6.4 New Material Sites/Rock Quarries. Continued O&M of the TAPS will require sand, gravel, and quarry rock to support workpad and access road repairs, flood damage control, and river training projects. From 1995 to 1999, APSC's annual usage ranged from approximately 30,000 to 97,000 yd^3 (TAPS Owners 2001a). It is thus conservatively estimated that APSC would need approximately 100,000 yd^3 of these materials per year of operation covered by a 30-year Federal Grant renewal. Most of these materials would likely be obtained from the 69 material sites on public lands for which APSC currently has mining permits. Many of these sites have existing stockpiles (TAPS Owners 2001a).[9]

Additional mineral extraction will result in the development of previously undeveloped portions of some existing material sites. Development of new material sites or reopening of previously closed material sites may also be required when existing mineral resources have been depleted. Within the footprint of the newly developed areas and access roads, this activity will result in modifications to the topography, loss of existing vegetation, land scarring, alteration of natural drainage patterns, and impacts to surface waters because of increased siltation potentials. Impacts to air quality from fugitive dusting off the exposed gravel are also likely. Impacts to cultural resources may also occur if newly developed areas are not first evaluated for the presence of those resources. The extent of surface disturbance from future material-site development is unknown but is likely to be limited to a few acres at each of the existing material sites. The size of possible new material sites will likely be significantly less than the typical 20- to 40-acre sites opened during construction. The construction-era material sites were used to construct extensive sections of the workpad, access roads, pump station pads, and the Haul Road (now the Dalton Highway). This required approximately 41 million yd^3 of mineral materials for the workpad and access roads and an additional 40 million yd^3 for the Haul Road. Future earthwork materials will be primarily for maintenance and will be minimal by comparison, approximately 3 million yd^3 over a 30-year renewal period.

Soil erosion and siltation may occur temporarily during mining and before stabilization of the disturbed surfaces. The material sites used as sources of riprap will likely require blasting of rock faces, leaving an enduring visible rock face over a small area. Additional impacting factors include increased vehicular traffic, noise, and fugitive dust. Traffic and noise are short-term impacting factors, extending over the period of active mining and removal of materials. Fugitive dust represents both a short- and a long-term impacting factor and will continue until vegetative cover is reestablished at the end of the life of the material site. However, most of these sites are in remote locations, and the impacts discussed above are expected to be localized.

4.2.2.7 Health and Safety Impacts Associated with the Proposed Action

Health and safety impacts are associated with every aspect of routine TAPS operations, including routine and nonroutine monitoring, surveillance, and repairs. The TAPS is a complex mechanical system, the operation of which results in many health and safety impacts. The activities or principal aspects of TAPS operation that create potential health and safety impacts include trip or fall hazards; work from ladders or elevated platforms; work in high noise areas; areas of high fire risk; equipment operating at elevated temperatures or pressures; electrical hazards (especially for "hot" work, i.e., work that must be performed on energized circuits or equipment); operation of construction or industrial equipment; overhead lifting and manipulation of heavy objects; welding and open flame operations; confined space entries; use of power tools; work over water; excavations; travel in aircraft and ground vehicles; avalanche hazards; and potential exposures to hazardous chemicals, including crude oil, refined petroleum products, corrosive agents, organic solvents, asbestos, and PCBs (in electrical equipment). (See Appendix C for further details on the presence and distribution of hazardous or toxic

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9 APSC and the Alaska Department of Transportation both maintain material sites north of the Brooks Range, with such sites available for use by either party.

substances in the TAPS.) Impacts from weather extremes, as well as encounters with wildlife are also superimposed on virtually every aspect of TAPS operations. While a majority of these hazards are present at the pump stations and the Valdez Marine Terminal, many also exist along the main-line in conjunction with routine maintenance or repairs. TAPS personnel represent the primary category of impacted individuals. However, impacts may also extend to other receptors, including the public and the environment.

Various JPO agencies exercise regulatory authority over TAPS operations and require APSC's identification and response to health and safety impacts. APSC's compliance with relevant regulatory requirements has resulted in the development of numerous engineering controls and administrative procedures as well as the use of personal protective equipment and safety devices. TAPS health and safety program elements are contained principally in the TAPS Safety Manual (APSC 2001e). The APSC Risk Management Program, developed to satisfy the objectives of the APSC Integrated Management System provides the principal mechanism by which hazards are identified and addressed. The Process Hazard Assessment required by the Risk Management Program results in the development of detailed work plans that govern all routine and nonroutine operations. The review and approval of these work plans guarantee that health and safety impacts to TAPS personnel are identified and that appropriate controls are established.

4.2.3 Impacting Factors Associated with Routine TAPS Operations during the Less-Than-30-Year Grant Renewal Alternative

Section 4.2.2 discusses impacting factors associated with the proposed action — a renewal of the grant for 30 years. This section discusses the impacting factors associated with a renewal of the grant for less than 30 years. The same assumptions underlying the identification of impacting factors from the proposed action would apply to the less-than-30-year renewal alternative. Notwithstanding the incorporation of technological advancements, it is assumed that TAPS would continue to operate in virtually the same manner with no major reroutes; stipulations and controls present in the current grant would be applied to any renewal of the grant; and JPO's oversight authority would remain unchanged.

In general, the impacting factors associated with the proposed action discussed in Section 4.2.2 will also exist during a grant renewal for a period of less than 30 years. Most of the impacting factors identified in Section 4.2 associated with the proposed action (a 30-year grant renewal) would be either continuous (e.g., an existing workpad's influence on surface water flow patterns) or cyclical (e.g., wastes resulting from corrosion control digs or routine maintenance actions) and can be expected to exhibit those same characteristics with respect to the less-than-30-year renewal alternative each time they occur within that shorter time frame. During a less-than-30-year renewal period, impacting factors associated with the existence of TAPS facilities would be continuous and would be the same as those discussed in Section 4.2.1. Likewise, those cyclical events that constitute routine TAPS operations would also result in the same impacts as those identified in Section 4.2.2. Importantly, impacts from some cyclical routine operations do have a temporal component to them that extends the impacts over long periods of time. For example, the dispersion and deposition of compounds emitted to the atmosphere from pump station and Valdez Marine Terminal equipment are subject to numerous meteorological and terrain influences. While most have relatively short residence times in the atmosphere (on the order of days for most fossil fuel combustion products), some may remain airborne for long periods of time, well after the source that produced them has ceased to operate. For example, carbon dioxide can be expected to have a residence time of as long as 15 years.

While most impacting factors associated with the routine operations of the pipeline, pump stations, and the Valdez Marine Terminal would be expected to be the same over a less-than-30-year period as they are projected to be for the proposed 30-year period of operation, some cyclical events with exceptionally long periodicity might not occur during the less-than-30-year renewal, and, thus, their impacts would not occur. For example, on the basis of current TAPS operating history, pipeline reroutes and main-line valve replacements are less likely to be required over a renewal period substantially shorter than 30 years.

4.2.4 Impacting Factors Associated with Planned Activities under the No-Action Alternative

Section 2.4 broadly outlines the parameters of the no-action alternative. No specific approved plans or designs for termination activities currently exist. Such plans and designs would have to be developed before specific actions could be taken. Any decision on how termination would occur would be subject to further NEPA analysis of the available options. In addition, descriptions of the actions that constitute termination of pipeline operations and restoration are provided in Section 2.4. The following assumptions and conclusions were established to provide a reference point for the identification and analysis of impacts associated with the no-action alternative.

- APSC has the same obligations and liabilities with respect to environmental protection and waste management during termination as it has had during construction and operation of the TAPS (see Federal Grant Stipulation 2.2).
- Federal and state regulations applicable to specific termination activities as well as the provisions of all operating permits will be enforced.
- The issuance of all necessary new or modified federal and state permits will be facilitated; however, performance standards and prescriptive requirements will not be relaxed.

Termination of TAPS Operation

"Termination" is not explicitly defined in the Federal Grant. Here the term is used to define all activities occurring after cessation of crude oil transmission. It is anticipated that termination activities will involve a two-year period of planning and environmental review followed by implementation occurring over a four-year period. However, remediation of environmental damage resulting from accidental releases of crude oil, refined petroleum product, or hazardous materials that occurred during TAPS operations or during termination may extend for a longer period of time.

- APSC continues to have liability and responsibility to respond to all accidental releases of crude oil, refined product, or hazardous materials occurring as a result of termination activities or discovered during termination and to undertake remediation of impacted environmental media to the satisfaction of the appropriate JPO member agencies.

4.2.4.1 Stoppage of Product Flow and System Cleaning

In general, termination activities would start at PS 1 and progress south to allow for transport of cleaning products from one station to the next and finally to the Valdez Marine Terminal. Initially the pipeline would receive batches of oil from North Slope drill rigs, piping carriers, pipelines that deliver oil from the drill rigs to the Central Processing Facility to TAPS PS 1, pump station sumps, tank bottoms, and low-point piping.

Once the last crude oil flow has reached the Valdez Marine Terminal, batches of diesel fuel would be introduced into the pipeline to remove residual crude oil. These batches of diesel fuel would be ultimately received at the Valdez Marine Terminal.[10] Then a mixture of seawater

[10] Kerosene may also be used instead of diesel fuel. In either case, these rinsates will probably be eligible for incorporation into the crude oil product still stored at the Valdez Marine Terminal.

and cleaning solution (e.g., alkaline solutions with chemicals such as trisodium phosphate or nonaqueous surfactant) would be introduced. This mixture would also be received and treated at the Valdez Marine Terminal BWTF before ultimate discharge to Prince William Sound pursuant to NPDES permit requirements. Finally, air compressors would be connected by manifold to the pipe to propel a displacement pig through the pipe to remove the seawater and cleaning solution. This sequence would be repeated at each pump station in succession from north to south (TAPS Owners 2001a).

Under the no-action scenario, aboveground pipe would be removed to 1 ft below grade, and the belowground pipe would be capped. However, it is reasonable to expect that buried segments may nevertheless be excavated in certain locations for system cleaning. Excavations are likely to be necessary to remove the three mainline refrigeration units. Excavation and removal of buried check valves and RGVs can also be anticipated. Removal of buried valves will provide the opportunity for JPO authorities to visually inspect the inside of the pipeline to verify adequate degrees of cleaning. Further, removal of valves provides a convenient point at which temporary manifolds could be installed, through which compressed air can be introduced to displace the final volumes of the pipeline cleaning agent or to propel cleaning pigs. Excavations of buried pipeline in low areas may also be necessary for purposes of visual inspection, complete removal of cleaning agents, or introduction of final cleaning pigs.

The extent to which any such excavations of buried pipeline will be necessary to accomplish satisfactory levels of cleaning, visual inspections, or sealing (capping) of pipeline segments in satisfaction of federal DOT regulations will be determined by JPO authorities overseeing termination activities. Impacts from each such excavation are expected to be similar to those encountered during corrosion digs or valve replacement actions, although the scale of the impacts may be somewhat larger. Impacts include disturbance of land surface of an areal extent of at least 50 by 200 ft per occurrence, impacts to surface waters due to altered drainage patterns, excavation dewatering, and increased potential for siltation. Impacts to air quality and noise would result from the operation of vehicles and excavation equipment. Temporary air compressors that may be installed would also impact air quality and noise. It is anticipated that the original grade of the workpad would be restored after all emptying and cleaning activities are completed at each excavation point. All impacts would be of relatively short duration, lasting perhaps as much as two weeks at each location selected for excavation of the buried pipeline.

Impacts from stoppage of product flow and system cleaning would be similar to those encountered during previous facility rampdown actions at some pump stations and the topping plants. Impacts include the generation of substantial amounts of industrial wastes from the removal of sludge from equipment; removal of tank bottoms, scale, and condensates from storage vessels, dead legs, and transfer piping; removal of cooling fluids from refrigeration systems; and removal of heat transfer fluids and lubricants. Impacts to water resources would result from short-term increases in water demands for equipment cleaning and increased worker populations. Water resources would also be locally impacted from increased amounts of sanitary wastewaters from personnel housing and cafeterias. Wastewaters generated as a result of equipment cleaning are likely to be delivered via the pipeline to the Valdez Marine Terminal for treatment at the BWTF. Air quality and noise impacts would result from increased vehicle traffic. Little to no impacts are anticipated to the terrestrial environment since all activities related to emptying and cleaning TAPS equipment would occur for the most part within structures (i.e., the pump stations or the Valdez Marine Terminal) or on established main-line workpads or existing graveled or paved areas of the pump stations and the Valdez Marine Terminal.

4.2.4.2 Removal of Aboveground Facilities

Dismantling of the aboveground portions of the pipeline, the pump stations, and the Valdez Marine Terminal is assumed to start in 2004 and continue for three years. The final year consists of demobilization (TAPS Owners 2001a). The following TAPS components would be removed: aboveground pipeline segments; remote aboveground valves, power modules, and fencing; aboveground river crossing structures; aboveground pipe passing through workpad and access road culverts and TAPS access road crossings (e.g., converting workpad and access road culverts to low-water crossings and removing workpad bridges);[11] and aboveground pipe adjacent to river training structures. All pump station piping, equipment, buildings, and tanks as well as all mainline refrigeration equipment and buildings would be removed. All aboveground fuel gas piping and mainline refrigeration piping would also be purged, cleaned, and removed. Microwave repeater stations and equipment would be removed. VSMs would be cut off to 1 ft below grade and capped. Heat pipes installed in some of the VSMs would be removed.

At the Valdez Marine Terminal, all aboveground piping, tanks, and concrete containment walls would be removed. All power generation and vapor control facilities, including incinerators, would be removed. The BWTF, including concrete tanks and aboveground structures, would be removed. Finally, all buildings and cable trays would be removed. Berths, berth piping, and mooring dolphins would be removed at the mudline.

The existing pipeline workpad and pump station gravel pads are to be maintained during dismantling operations and left in place at completion. River training structures, except where breached to remove pipe, would be left in place. Workpads adjacent to or in the river crossings and floodplains would be removed, if necessary, to reduce sediment impacts into the river. Therefore, a pad constructed of natural river gravel would not be removed if the adjacent stream had comparable materials, whereas fine-grained material in a pad adjacent to a stream would be removed if erosion of the pad material would lead to significant sediment concerns. In addition, communications sites, the fiber-optic system, Dalton Highway, and the Yukon River Highway Bridge would also remain in place. The fiber-optic cable is not part of the TAPS ROW but has its own ROW. However, it is attached to the pipe in some areas, or to VSMs or other aboveground TAPS structures. It would therefore need to be relocated or supported by other means.

All aboveground facilities would be removed to 1 ft below grade. Belowground facilities may be left in place with the exception of culverts, pipes in road casings, and pipe adjacent to river training structures. Excavation to cap belowground facilities may require dewatering and erosion control devices. Razing of some structures would also involve emptying and removal of foundation refrigeration systems. If suspected contaminated soils are encountered during excavation or removal of aboveground facilities, APSC would undertake remediation in accordance with a remediation plan approved by the appropriate JPO authority. Most of the equipment and supplies to be used in dismantlement must be imported from outside the state because of the small relative size of Alaska's construction industry.

Salvage operations would remove all material for in-state or out-of-state recycling or disposal. All surplus and scrap materials must be removed from Alaska except those buried or otherwise disposed of locally. Pipe and other material from the northern part of the line would be taken to the North Slope to be moved by sea lift for ultimate disposal. Fairbanks is the expected staging area for materials removed from the central portion of the pipeline (north of MP 492), with material transported to Seward or Whittier by truck or train. Valdez is the probable staging area for components removed from the southern portion of the pipeline and the Valdez Marine Terminal. However, as much as 120 acres of additional land may be necessary for other interim staging locations during some portion of the dismantlement period to provide for surge control that may be necessary because of transportation delays. APSC-owned material sites or commercially available land may serve as likely interim material staging areas. Port locations for shipment of scrap materials would be Valdez, Whittier, and Seward (TAPS Owners 2001a). All salvaged materials would have to be moved by truck to the appropriate staging area (Norton 2002b).

The principal impacts from pipeline dismantlement include disturbance of ground

[11] However, culverts under state highways would remain in place and unchanged.

surfaces with subsequent impacts to surface water systems because of altered drainage paths or increased siltation; vegetative clearing on those portions of the ROW that are not wide enough to support the termination activities; consumption of substantial amounts of fuels for vehicles and construction equipment (including vehicles used to haul pipeline components to accumulation points pending final disposition), with subsequent localized air quality and noise impacts; increased amounts of fugitive dust; increased water withdrawals for domestic uses, principally to support substantial increases in workforce personnel; increased water withdrawals for industrial use (cleaning); increased volumes of domestic solid wastes and sanitary wastewaters, with proportional changes to current impacts to surface water, air quality and land from the subsequent management of those solid wastes and wastewaters. Further, new or different impacts can be expected from the solid wastes and wastewaters generated during dismantlement since many of the systems currently in use to manage these wastestreams would no longer be operational (e.g., the turbine exhausts used to evaporate sanitary wastewaters at PS 1, 3, and 4; or the incinerators that burn nonhazardous solid wastes at the pump stations and the Valdez Marine Terminal). Some special industrial wastes will also result from the dismantlement of infrastructure that contains asbestos, mercury, PCBs, or radioactive species; however, quantities of such special wastes will be limited. There may be local impacts to surface water from dewatering of the limited number of excavations that would also be necessary as part of dismantlement of aboveground systems.

Cultural resources may also be impacted by the dismantling of equipment and structures should the TAPS be determined an eligible historic property.

4.2.4.3 Revegetation and Restoration

After removal of aboveground facilities, the cleared land would be contoured and revegetated. Restoration of some areas may also involve importation of fill materials to establish appropriate grades. Revegetation activities must be performed in accordance with requirements of the Federal Grant. In the past, follow-up monitoring was normally conducted for five to seven years following the revegetation activities to ensure erosion control. Short-term, localized impacts may result from increased vehicle and equipment activities and human presence. Impacts include impacts to air quality, noise, increases in fugitive dust, alteration of surface water flow patterns, erosion, and sedimentation, and some minor disturbance of existing vegetation. Off-site impacts may also result if importation of fill materials is required.

Subsidence can be anticipated as a long-term impact in some segments of buried pipeline that are abandoned in place. Subsidence will occur when advanced corrosion causes loss of structural integrity of the 4-ft-diameter pipe to a degree where it can no longer support the weight of the overburden. For example, subsidence along segments of pipeline abandoned below river crossings may dramatically alter surface and subsurface water flows. However, previous experiences with abandoned underground pipe segments (e.g., Atigun Pass) suggest that natural processes (e.g., siltation buildup inside the pipe) will diminish the potential impacts of subsidence events. In addition, segments abandoned in thaw-unstable permafrost (i.e., the previously refrigerated segments) will be subject to frost heaving because they are not anchored and no longer have the weight of the oil to help resist frost movement.

4.2.4.4 Health and Safety Impacts Associated with the No-Action Alternative

Health and safety impacts associated with the stoppage of crude oil flow, emptying, and cleaning of TAPS are essentially equivalent to the impacts associated with routine operations that were discussed in Section 4.2.2.7. Many of the actions to empty and clean equipment that would be performed under this first phase of termination are virtually equivalent to the routine cleaning and maintenance of that equipment that occurred during TAPS operations. However, some additional activities unique to termination can also be anticipated, especially in those instances where the existing system would need to be modified to support a cleaning activity (e.g., the addition of compressors for introducing compressed air for final emptying and cleaning). Further, since cleaning involves the introduction of alternative substances into the TAPS system than those for which it was designed (diesel fuel as an initial rinsing agent, followed by seawater that includes detergent additives), the operational hazards would be somewhat different than those encountered during routine operations. However, the Risk Management Program established within the TAPS Safety Manual (APSC 2001e) would still provide an appropriate venue for identifying and addressing these new risk factors. As with normal operations, TAPS personnel and contractors would be the principal population segment impacted by hazards associated with cleaning and emptying of the TAPS.

The final phases of the no-action alternative, removal of aboveground structures, would present fundamentally different health and safety hazards from those associated with routine TAPS operations but would be very similar to hazards encountered during pipeline rerouting or replacement activities, only at a substantially larger scale. The nature and scale of health and safety impacts for dismantlement would be virtually equivalent with impacts from initial TAPS construction. Principal impacts include those routinely associated with major construction projects: heavy machinery operations, vehicle traffic, overhead lifting, open flame work, handling of fuels and lubricants, trip and fall hazards, electrical hazards (from portable power generation as well as the use of power tools), and high noise environments. As with all outdoor work in Alaska, natural elements as well as wildlife are omnipresent health or safety impacts. Most impacts will primarily affect the construction workforce. However, environmental receptors may also be impacted. In more populated areas, human receptors may also be potentially impacted.

4.2.5 Nonroutine Factors — Spills Hazards under the Proposed Action

Unlike routine pipeline operations where actions are planned and deliberate, spills of crude oil, refined petroleum products, or other environmentally hazardous substances are unplanned events that have both natural (e.g., seismic) and anthropogenic initiators (e.g., equipment failure [including that caused by corrosion] and human error). The spills analysis for this FEIS covers crude and other product spills triggered by events impacting pipeline, Valdez Marine Terminal, Prince William Sound, and North Slope operations. The spills for Prince William Sound and North Slope are covered as cumulative impacts in this FEIS. Spill scenarios to assess impacts during the ROW renewal period of the TAPS and for the no-action alternative were developed for four groups of likelihood of occurrence categories: "anticipated," "likely," "unlikely," and "very unlikely." The spill scenarios developed for this FEIS are discussed and presented in Section 4.4.1. The primary impacting factors on which that analysis is based are discussed below.

In assessing spill impacts for the proposed action alternative, it is assumed that TAPS facilities will operate at three throughput levels, with the minimum 300,000 bbl/d, the maximum 2.1 million bbl/d, and a nominal operating level of 1.1 million bbl/d (see Appendix A). The assessment assumes a 30-year renewal operating period. During this time, major activities will involve the continued pumping of oil from the North Slope to the Valdez Marine Terminal with four to seven operating pump stations, oil production from the North Slope fields, operations of facilities at the Valdez Marine Terminal, and marine transportation through Prince William Sound.

4.2.5.1 Natural Events

Nine natural spill initiators were initially considered in the spills analysis: (1) seismic events, (2) flooding/washout, (3) volcanoes, (4) lightning, (5) wildfires, (6) settlement/subsidence, (7) landslides and avalanches, (8) tornadoes, and (9) tsunamis. Analysis of frequencies of spill events resulting from volcanoes, lightning, wildfires, tornadoes, and tsunamis were deemed not credible and therefore screened from further analysis. Spill events involving earthquakes, washout, settlement, and landslide were determined to be "credible" (with frequency of spill occurrence more likely than one chance in one million, see Appendix A, Section A.15.2) for the pipeline. Except for washout and settlement, these same initiators were determined to be credible spill events for the Valdez Marine Terminal. The spill volumes and frequencies from assessed spill initiating events are discussed in Section 4.4.1. There were no spill scenarios for Prince William Sound and the North Slope involving initiation by a natural event.

The "washout" event is defined as a washing away of earth in areas where the pipeline passes under or near a stream or river. Washout pipeline damage (e.g., small cracks in the pipe associated with dents or deformities) could occur because of its close proximity to a stream or river. Impacts to TAPS structural systems from washout events were considered during the design phase in accordance with Federal Grant Stipulation 3.6.1. Nevertheless, the VSMs on aboveground pipeline segments could potentially be impacted. The stability of VSMs at river crossings could also potentially be impacted by bank erosion, channel migration, or channel scouring that may be a natural follow-on consequence of washout events (see Section 4.2.2.5.3.) Data from 1987 through 1998 show the occurrence of 12 pipeline "washout" spill events in the lower 48 states. (DOT 2001a). The events resulted in medium to small cracks in the impacted pipelines. Although no leaks have resulted from washout in the history of the TAPS, it was assumed that the pipeline could be susceptible to damage if it was located in a floodplain region that is subject to washout.[12] The estimated spill frequency using this approach results in conservative frequency estimates compared with the DOT OPS data. The washout spill hole sizes used in estimating spill volumes are in reasonable agreement with sizes estimated from DOT OPS data for actual washout-initiated spill events that occurred primarily in the contiguous United States.

Review of available data on seismic events revealed that the six largest earthquakes that have occurred in the United States took place in Alaska. Three of the largest Alaska quakes rank in the top 10 of earthquakes occurring worldwide from 1904 through 1992. These three events occurred in 1957, 1964, and 1965. The 1964 earthquake-generated tsunami leveled the town of Valdez with a Moment-magnitude 9.2 M (8.2 to 8.7 on the Richter scale), the second largest seismic event ever recorded (AEIC 2002). Stipulation 3.7 of the Federal Grant requires a consideration of the possible recurrence of such an event in design decision. The TAPS is divided into seismic zones with different seismicity levels; the highest levels are in the Chugach and Alaska mountain ranges and the lowest on the North Slope.

Landslide-initiated events were identified as a credible hazard to the pipeline on the basis of two observations: (1) landslides were experienced in the 1964 earthquake, and (2) landslide-susceptible soils are found along the pipeline. Specifically, colluvial soil of landslide origin was reported by Kreig and Reger (1982). Other colluvial soil and alluvial fan soil can be seen in aerial photographs of the pipeline route (R&M Engineering and Geological Consultants 1974). These are limited to the mountainous regions. Generally, landslides would not be an area of concern for the buried pipeline; however the depth of burial would not be sufficient to place the pipe entirely below the susceptible soil. Further, landslides could result in amounts of soil deposited above a buried segment that could exceed the design specification for overburden weight, thereby leading to crushing deformities in the pipe. In some instances, the pipeline could survive landslide motion. A very site-specific analysis would be required to make this judgment. Anecdotal evidence suggests that, in most instances, pipelines do not survive ground displacement associated with a landslide (Nyman 2001). Therefore, the spills analysis presented in Section 4.4 assumes that a landslide will result in a guillotine break.

Settlement or subsidence has initiated two crude oil spills during TAPS operations, both occurred in 1979, one near Atigun Pass and the other at PS 12. Although crude oil spills occurred only in these two locations, investigation conducted in the late 1970s identified eight additional locations where the pipe showed

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12 The estimated TAPS spill frequency due to washout was estimated using the 95% confidence limit for a binominal distribution with an adjustment factor of 1 or 0 for susceptible and nonsusceptible pipeline regions (Capstone 2001).

signs of buckling curvature. In addition, vertical settlement of a segment of buried pipeline and solifluction (downslope creep) have led to problems of alignment with the adjacent aboveground pipe segment.

4.2.5.2 Human Events

Human spill initiators can be either direct or indirect. Direct human events are either caused by accidents involving transportation vehicles, such as trucks or aircraft, or intentional acts of vandalism or sabotage. Indirect human events are caused by equipment failure or human error.

A total of 12 direct human-initiated spills were assessed in this FEIS, 11 spills resulting from transportation vehicles and 1 spill from a deliberate act of vandalism/sabotage. The transportation events included impact to the pipeline from a truck and an aircraft. For security reasons, detailed scenarios involving deliberate acts of vandalism or sabotage are not specifically identified. Such events, for example, could include the use of an explosive device similar to the 1977 Steele Creek attack to the pipeline, or the random act of pipeline vandalism with a high-powered rifle that occurred near Livengood in the fall of 2001. Analysis of frequencies of spill events resulting from ship or boat impacts along river crossings for the pipeline and at the Valdez Marine Terminal berths indicated that these events were not credible, and they were, therefore, screened from further analysis. However, analysis of frequency data that could involve failure in the loading arms for tankers at Valdez Marine Terminal berths shows this spill scenario would be a credible event. Truck and medium-to-large aircraft crash events were determined to be credible for the pipeline. A medium-to-large aircraft crash into the East Tank Farm was deemed to be the only credible human-initiated event for the Valdez Marine Terminal.

Spill initiators for the pipeline that were determined by frequency analysis to be credible included maintenance-related damage, valve leaks, corrosion, and over-pressurization because of RGV closure. The spill events analyzed in detail for the Valdez Marine Terminal included a tanker vessel crack, fuel line rupture, pipeline failure, and catastrophic ruptures in crude storage and diesel fuel tanks.

All of the spill scenarios assessed under the cumulative impacts for Prince William Sound and the North Slope were the result of indirect human initiators. Five spill events caused by collisions between ships or vessels (tankers) or with other obstacles, drift grounding, vessel structural failure or foundering,[13] power grounding, and fire/explosion occurred at six locations within Prince William Sound. This combination of spill causes and location resulted in 30 of the 34 spill scenarios evaluated for Prince William Sound. The other four were small-to-moderate crude oil and diesel fuel spills occurring during TAPS operations. The North Slope scenarios included six spill events caused by a well blowout, four pipeline ruptures, and a spill occurring at a drilling platform. An additional six small-to-moderate spills involving crude oil, diesel fuel, and saltwater were assessed as anticipated during the TAPS ROW Federal Grant renewal period.

4.2.5.3 Changes to Impacting Factors for Nonroutine Events as a Result of Planned Pump Station Upgrades and Modifications

Section 4.2.2.6.3 provides the details of proposed upgrades to pump stations and modifications to the Valdez Marine Terminal. If pursued, these proposed changes may result in changes to impacting factors for nonroutine events such as spills. Section 4.2.5.1 identifies the natural processes that can serve as initiators of credible spill events. There is no basis for any argument that the proposed upgrades will affect the probability or frequencies of those natural events. However, modifications to the pump stations may result in different consequences for spills caused by natural processes. In general, the simplification of equipment at some pump stations as well as the complete elimination of pump-station–related equipment at other pump stations can be expected to result in potentially less consequence of a spill caused by natural

13 Vessel foundering is defined as the loss of stability because of water ingress.

processes, especially in those instances where the natural event can be seen as affecting the integrity of engineered systems at those pump stations. For example, eliminating the need to store turbine fuel at pump stations that are completely removed (PS 2, 6, 8, and 10) eliminates the possibility of spills of fuel from on-site storage tanks as a result of a natural event such as an earthquake.[14] Further, pump stations that are completely eliminated would be replaced by an RGV. Thus, elimination of a pump station would not result in an increase of the static volume of oil available for release as a result of a main-line break on either side of the former pump station.

Section 4.2.5.2 describes the possible human initiators for credible spill events. In these instances, simplification or elimination of complex mechanical systems and automation of remaining mechanical systems may result in lower probabilities of occurrence for some human initiators such as operator error or equipment failure. Further, by much the same argument as advanced above for natural process-initiated spills, simplified or eliminated mechanical systems can be expected to lower the consequence of any spill initiated by human factors.

4.2.6 Impacting Factors Associated with Nonroutine Events — Spills during the Less-Than-30-Year Renewal Alternative

Impacting factors associated with nonroutine events would be the same whether the renewal period was 30 years or less. However, some factors can be shown to have nonlinear, time-dependent characteristics, depending on the initiators. Section 4.2.5 identifies the natural and human initiators associated with credible spill events. The time dependence of these factors and their effect on frequency and volume of spills along the pipeline, at the Valdez Marine Terminal, at the North Slope, and during tanker transport through Prince William Sound are discussed in Section 4.5.1.2.

4.2.7 Nonroutine Factors Associated with Unplanned Events: Spills during the No-Action Alternative

Under the no-action alternative, prior to dismantlement and removal of the TAPS, the remaining crude oil would be purged from the pipeline. Purging would be implemented using kerosene or diesel fuel as a solvent to clean the pipe.[15] The final purge would be with seawater. The pipeline purge process is estimated to take as long as 90 days. For a relatively short time, termination activities would disrupt the terrestrial environment and result in an increased potential for spills.

4.2.7.1 Natural Events

Purging the remaining crude oil from the pipeline and completing cleaning of the pipeline would take a relatively short time. Comparing the time expected to complete this phase of termination with the frequency of natural occurring events that can act as spill initiators described in Section 4.4, a pipeline or Valdez Marine Terminal spill of crude oil or rinsing agent would have a probability of occurrence of less than one in one million. Such events would be “incredible” and were not considered.

4.2.7.2 Human Events

Human spill initiators can be either direct or indirect. Direct human events are either caused by accidents involving transportation vehicles, such as trucks or aircraft, or intentional acts of vandalism or sabotage. Indirect human events are caused by equipment failure or human error. Indirect human actions have been shown by

[14] Contingency storage of liquid turbine fuel is expected to continue at remaining pump stations.

[15] The presence of detergents may affect the strategy employed to respond to a release of this rinsate. However, the relatively short duration of this activity still argues for a release of rinsates to be a low-probability event.

APSC risk analyses to be the most likely cause of spill events. Spill volumes and frequencies for a total of five diesel oil spill scenarios are described in Section 4.6.1.2 for the no-action alternative.