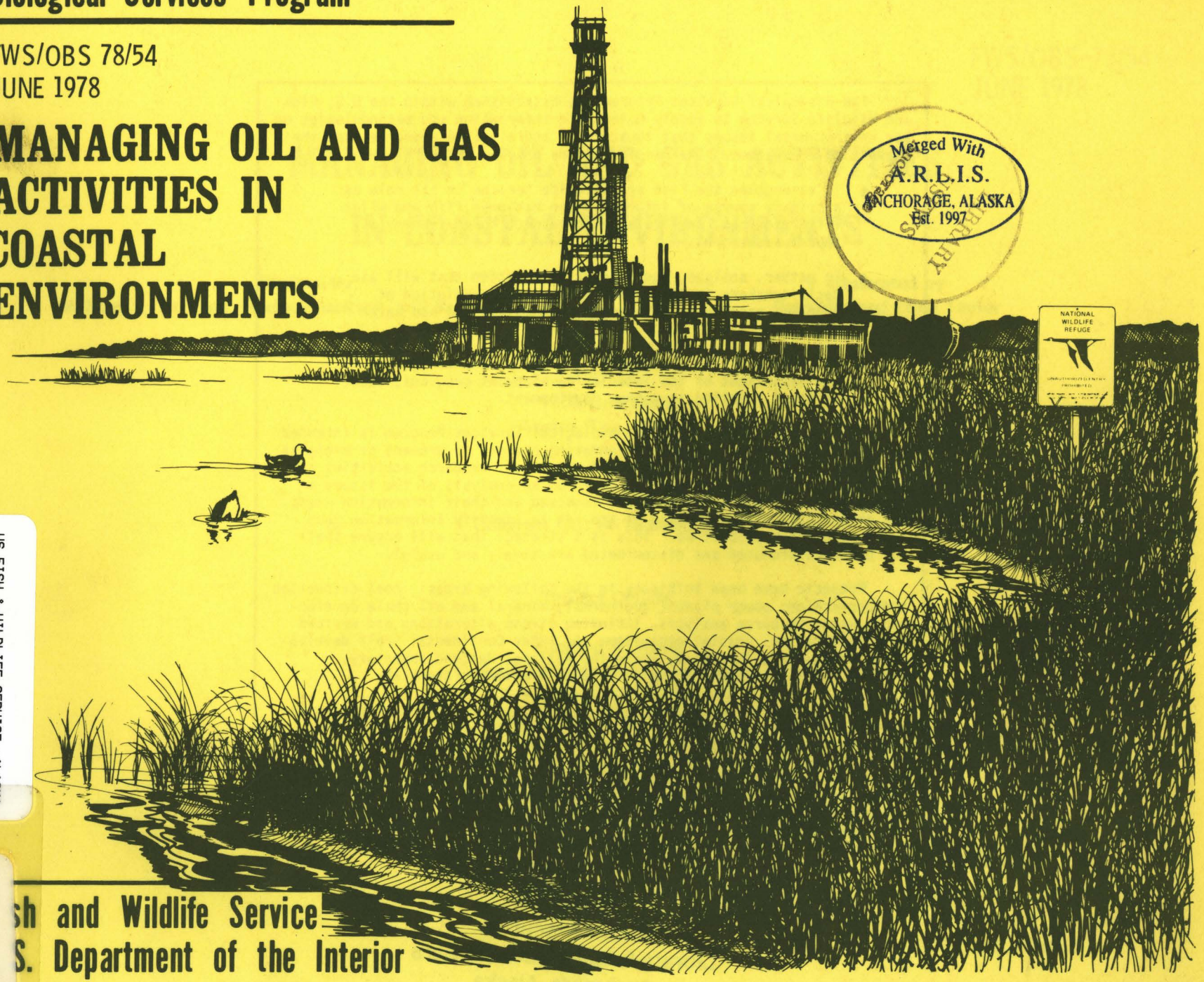
Biological Services Program

FWS/OBS 78/54
JUNE 1978

MANAGING OIL AND GAS ACTIVITIES IN COASTAL ENVIRONMENTS



sh and Wildlife Service
S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staff, who provide a link to problems at the operating level; and staff at certain Fish and Wildlife Service research facilities, who conduct inhouse research studies.

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U.S. Fish and Wildlife Service
U.S. Department of the Interior

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This report should be cited as follows:

Longly, W. L., R. Jackson, and B. Snyder. 1978. Managing Oil and Gas Activities in Coastal Environments. U.S. Fish and Wildlife Service, Biological Services Program. FWS/OBS–78/54. 66 pp.

Preface

This publication was compiled as a summary of a comprehensive technical report, *The Development of Methods and Standards of Operation to Protect Fish and Wildlife Resources and Supporting Habitats of Coastal Wildlife Refuges During Oil and Gas Development.*

It presents general information, based on observation and experience, on the environmental effects of petroleum development activities upon coastal wetlands. It is intended for use by petroleum engineers, land managers, government officials, and others concerned about the preservation of living resources.

The management concepts developed from this study were obtained by analysis of management practices on coastal refuges in Louisiana and Texas. This report is intended to assist coastal land managers in reducing the impacts of oil and gas exploration and production on natural resources. While these management practices were developed for the Gulf Coast Region, they may apply to other coastal areas.

Any suggestions or questions regarding *Managing Oil and Gas Activities in Coastal Environments* should be directed to:

Information Transfer Specialist
National Coastal Ecosystems Team
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NSTL Station, Miss. 39529

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Introduction

To meet increasing national demands for energy, it appears inevitable that petroleum production in the coastal zones of the United States will intensify if resources can be found.

These coastal zones are sensitive environments, serving as habitats for many desirable plants and animals (some of them endangered species). In addition, coastal areas contribute vital organic matter and other substances to the support of life in neighboring lands and waters. These considerations make it necessary to pursue oil and gas development with the least possible disruption of natural land formations, water flows, and indigenous wildlife.

The general comments and suggestions presented in this publication are properly used in conjunction with a thorough understanding of the special conditions prevailing at each development site—information that may be gained from maps, previous studies, and first-hand observations.

Part 1 consists of brief descriptions of several types of coastal ecosystems, grouped into three categories: uplands, seasonally flooded wetlands, and saturated wetlands and open water. Characteristic vegetation (see Appendix for scientific names), animals, water regimes, and management practices are included. The marsh environments described can be arbitrarily classified according to the Wetland Habitat Classification System of the U.S. Fish and Wildlife Service. Salt marsh and brackish marsh are both Estuarine Intertidal Emergent Wetlands; the main differences are in the water regime modifiers. Usually, salt marsh has a water regime of regular or irregular flooding; the brackish marsh water regime is characterized by irregular, intermittent, or seasonal flooding. Fresh marsh corresponds closely to the Palustrine Emergent Wetland type. Delta marsh is difficult to classify, since it is dominated by fresh water with occasional saltwater flooding, resulting from hurricanes or low river flow. The Wetland Habitat Classification System suggests that delta marsh is, in fact, Palustrine Emergent or Palustrine Aquatic Bed Wetland, depending upon water depth. However, because of occasional tidal action, difficulties arise when attempting to distinguish it from some subsystems of the Estuarine System.

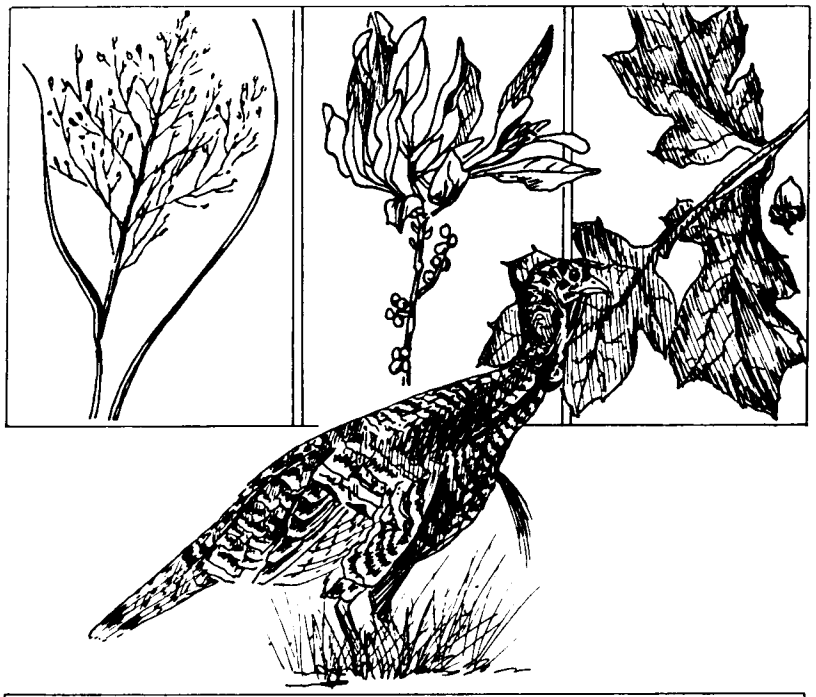
Part 2 deals with the impacts of petroleum development activities, ranging from preexploration surveys through termination of production. Depending upon the category of ecosystem involved, the execution of some of the petroleum development activities varies. In addition to describing the activity and its impacts, this chapter contains comments and suggestions that can help to mitigate the effects of each activity.

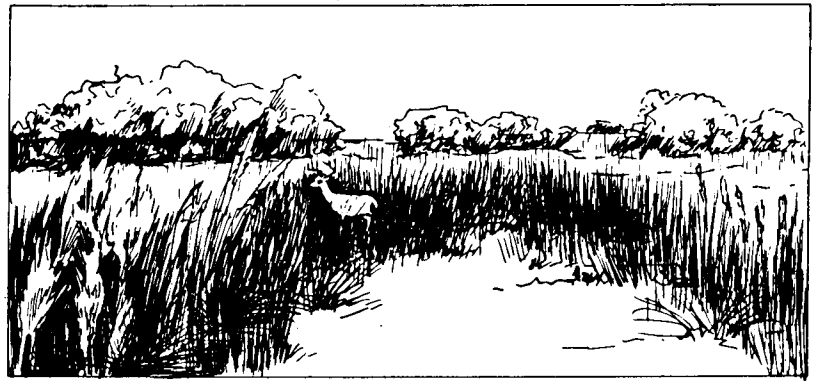
Part 2 relies on graphics to illustrate activities, effects, and mitigative measures. It must be noted that only generalized activities, effects, and comments are depicted here. The user must take full advantage of all information available to him when making decisions on a site-specific basis. Moreover, he must be aware that the most significant impacts of oil and gas development usually occur on a scale that is larger than any one activity or single project.

Information on oil and gas activities and the regulatory processes involved can be obtained from volumes 1 through 5, *Environmental Planning of Offshore Oil and Gas*. 1978. U.S. Fish and Wildlife Service FWS/OBS–77/12-16.

1. ECOSYSTEMS DESCRIPTIONS

UPLANDS





Vegetation. Dominant plant species which are found in upland areas near marshes include grasses, shrubs, and some woody vegetation. Perennials such as bluestem, panic grass, and paspalum are common. Shrubby vegetation frequently includes dwarf live oak, redbay, and wax myrtle. Live oak is characteristic of wooded areas.

Wildlife. Insects, birds, gamebirds, and small rodents abound in coastal grasslands. They are preyed upon by coyotes, hawks, snakes, lizards, and insectivorous songbirds. Shrubby and wooded areas provide food and cover for rabbits, squirrels, rodents, turkeys, quail, songbirds, deer, and feral swine. Predatory animals include foxes, raccons, bobcats, and owls.

Water. Rain, sheetflow, and groundwater are the sources of water to this system. Land slope, evaporation, and soil structure largely determine the availability of moisture to the plants; the plant groups found on water-saturated soils are very different from those found on well-drained soils.

Management Practices. Grazing, cultivation, and fire are the most commonly used techniques for manipulating vegetation. Properly timed fires permit the continued dominance of grassland species over woody species. Overgrazing frequently results in the replacement of grasslands by shrubby areas.

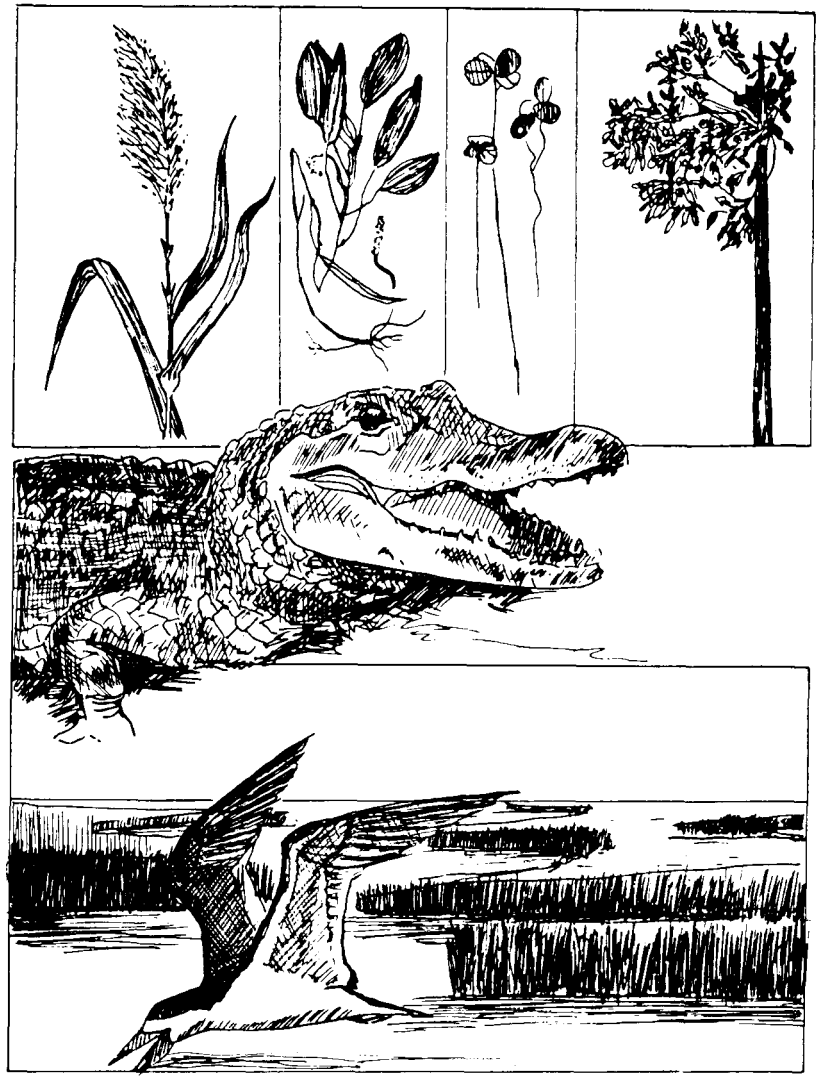
SEASONALLY FLOODED WETLANDS-Delta marsh

Vegetation. Although existing species vary with geographical location, typical vegetation groups are found in predictable zones. Deep water (greater than 2 m) favors floating forms such as duckweeds and submergent forms such as pondweeds. Shallower water (up to 1.5 m) frequently contains tall emergent forms such as bulrush, common reed, and cattail. Other emergents characteristic of shallow water are arrowhead and panic grass.

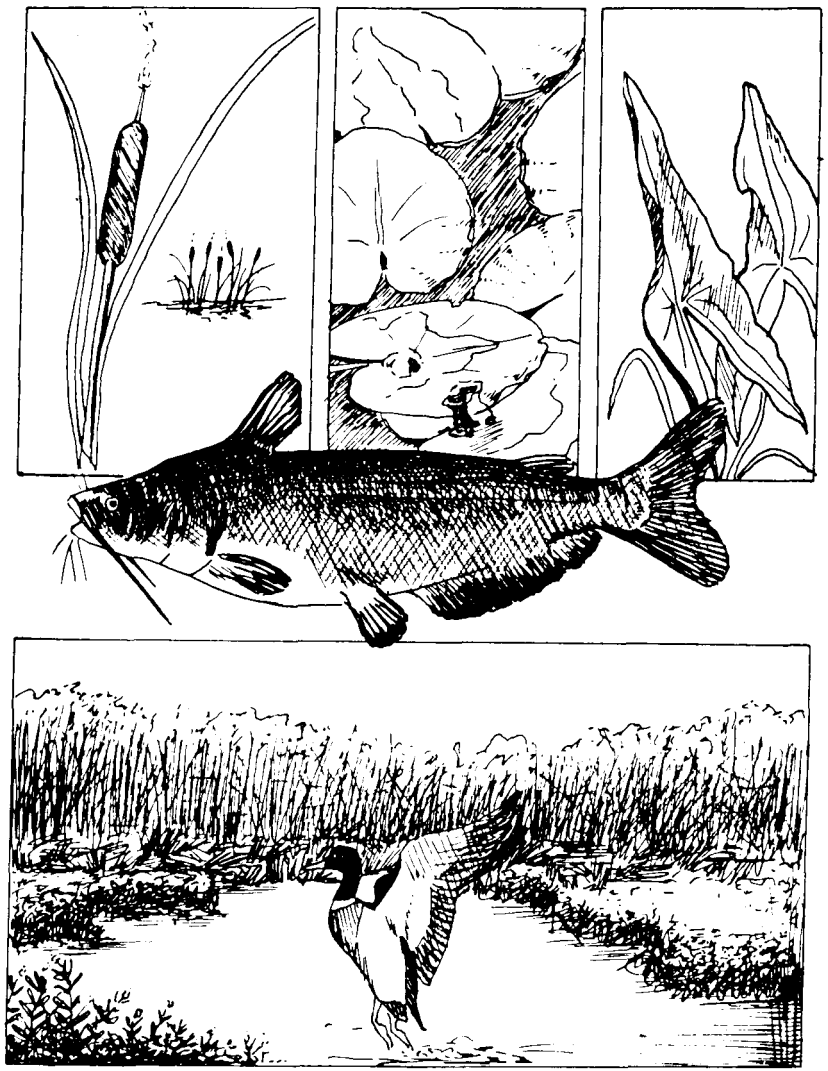
Fish and Wildlife. Crayfish, turtles, catfish, and pinfish are numerous; muskrat and nutria are common furbearers. In warmer regions, alligators find abundant food and shelter in this system. Larger animals, such as raccoon, oppossum, and deer are found on or near natural levees, where drier conditions prevail. Waterfowl and colonial birds rely heavily on the vegetation of this system for food and cover. Egrets, herons, ibises, bitterns, skimmers, gulls, and terns are abundant. During seasonal migrations, ducks and geese feed on the lush vegetation in all the zones of this system.

Water. River discharges supply tremendous volumes of fresh water and sediment to delta marsh systems; maintenance of the system is dependent upon these water flows and accompanying nutrients. Seasonal flooding of natural levees usually occurs in the spring. In areas experiencing rapid subsidence, this overbank flooding deposits sediment which prevents the ponds from becoming too deep to support lush emergent vegetation.

Management Practices. Levee and ditch construction are two common forms of management; both are aimed at controlling water flows. Preclusion of overbank flooding accelerates the loss of land surface (behind the levees) due to subsidence. The leveed river usually deposits its sediment further downstream and thus forms new delta marsh systems where open water earlier existed.



SEASONALLY FLOODED WETLANDS-Fresh marsh



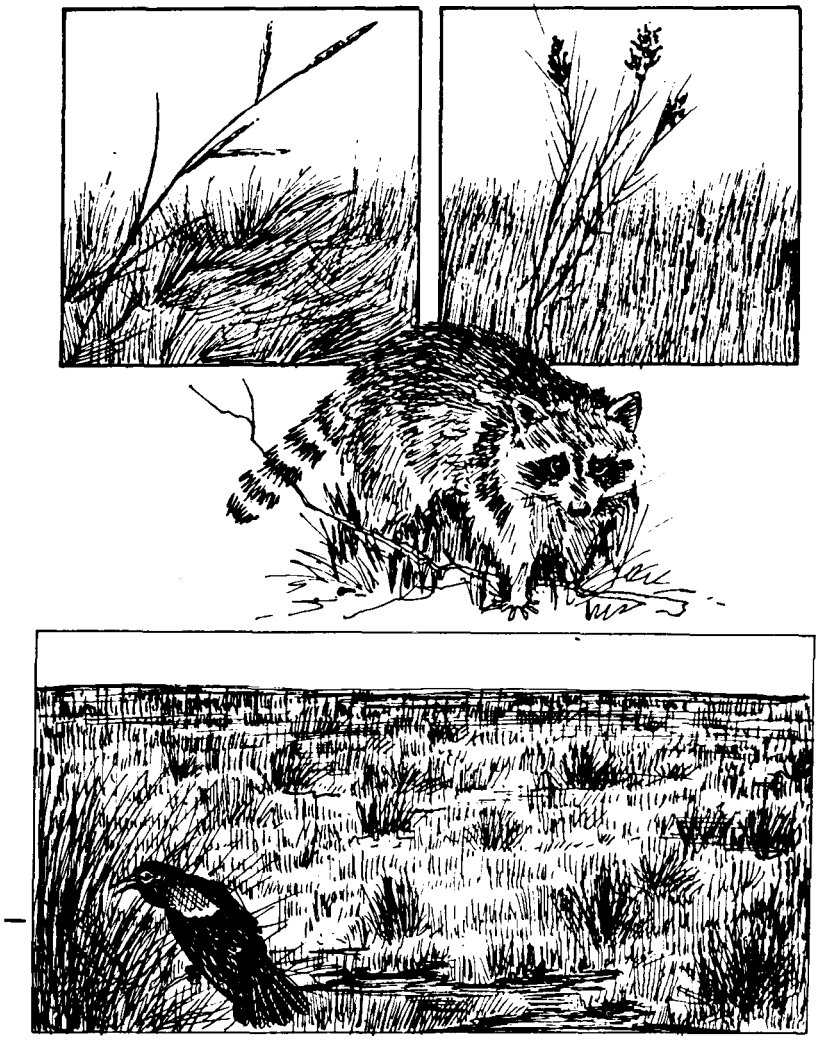
Vegetation. The numerous varieties of plants in fresh marshes, like those of delta marshes, are found in zones which are defined by water depths. Floating plants such as waterlilies and duckweed dominate in waters deeper than 2 m; pondweeds, milfoils and coontails are characteristic submergent plants found in water between 1 and 2 m deep; similar water depths may support tall emergents such as cattails and common reed. Maidencane, arrowhead, and paspalum are common in shallow water and swales.

Fish and Wildlife. Crayfish, turtles, bass, catfish, and sunfish are common. Larger consumers which prey upon these water dwellers include raccoons, oppossums, muskrats, mink, nutria, waterfowl, and alligators (in southern regions). Many species of geese and ducks utilize the dense vegetation during migrations. Other common birds are red-winged blackbirds, sparrows, rails, egrets, and herons.

Water. Fresh marshes are usually completely isolated from salt water influences; upland drainage and rain are the sources of water and nutrients. The depth of continuously standing water determines the forms of plants that predominate; stands of vegetation, in turn, control the abundance of wildlife species.

Management Practices. Impoundments and drawdowns are the most common techniques for regulating conditions in fresh marshes. Through proper timing of water-level regulation, vegetation can be manipulated to favor cattle, waterfowl, fish, or other wildlife. Conditions frequently allow the use of fire and light grazing to favor production of tender grasses and herbs.

SEASONALLY FLOODED WETLANDS-Brackish marsh



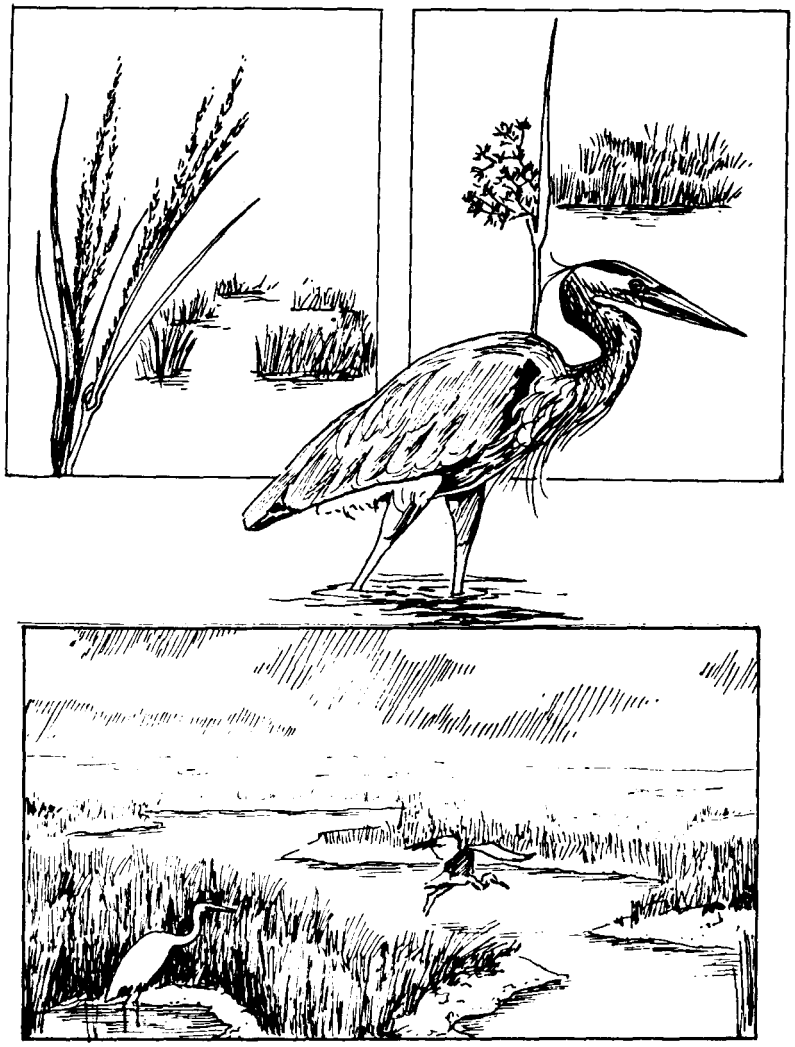
Vegetation. Dominant plant species in brackish marshes include saltmeadow cordgrass and saltgrass. Lower, wetter regions of the marsh contain sedges, rushes, and canes. Elevated areas may harbor growths of shrubs and woody vegetation such as groundsel bush, myrtle, and willow.

Fish and Wildlife. Small fish and turtles inhabit ponds in the brackish marsh, feeding primarily upon plant material and small animals. Consumers include insects, waterfowl, raccoons, oppossums, muskrats, nutria, and alligators (in southern regions). Typical birds are the marsh red-winged blackbirds, bitterns, rails, herons and egrets.

Water. Because the brackish marsh is exposed to salt water on an irregular basis, fresh water is an important regulating factor. Large proportions of fresh water tend to favor broadleafed aquatic and semiaquatic plant species: rushes, sedges, and cattails. More saline conditions favor cordgrasses, saltgrass, glassworts and sea oxeye.

Management Practices. Regulation of water (by impounding or ditching) is the most significant management factor in the brackish marsh. The depth, frequency, duration, and timing of flooding can be used to manipulate the type and density of vegetation. Most ducks and geese prefer the species associated with fresher water conditions. Grazing and fire can be employed to remove the dense "rough" of saltmeadow cordgrass and maintain the tender young vegetation preferred by wildlife.

SATURATED WETLANDS & OPEN WATER-Salt marsh



Vegetation. Salt marshes from the Texas to the New England coasts are dominated by smooth cordgrass. The most common associates, usually found on higher ground, include black rush, saltwort, glasswort, saltgrass, and shoregrass. The cordgrass is characteristically encrusted with algae and diatoms.

Fish and Wildlife. Seasonal cycles in salt marsh animals are common. Salt water and estuarine species migrate into and out of the marsh with the daily tides. Killifish, mullet, spot, croaker, crab, shrimp, and other small fish and crustaceans feed on the abundant dead plant debris and minute living plants. Larger fish include sea trout, flounder, drum, and menhaden. Wading and shore birds (herons, egrets, sandpipers) feed voraciously on these abundant aquatic forms. Furbearers commonly found in salt marshes are the nutria and raccoon.

Water. The daily tide is the prime regulating factor in the salt marsh. Rising tides renew the supply of water, nutrients, and dissolved salts. Falling tides remove these materials, along with dead vegetation. Sediment may be moved in either direction by the forces of moving water.

Management Practices. The vegetation is controlled by the water/soil salinity and the frequency and duration of flooding. Regular daily submergence usually excludes all plants except cordgrass. Weirs, dikes, and ditches are commonly used in management to regulate, divert, or exclude salt water flows.

2. PETROLEUM DEVELOPMENT IMPACTS

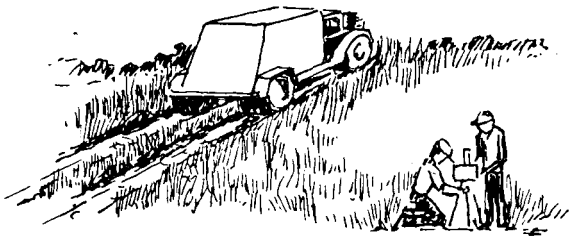
UPLANDS-Preexploration

ACTIVITY

Gravity Measurements. The gravitational pull of subsurface rock formations is measured. This process, utilizing only small, hand-carried equipment, requires less vehicular traffic than other methods of survey, but is less precise than seismic surveys. Many data-collection stations may be occupied during an 8-hour period.

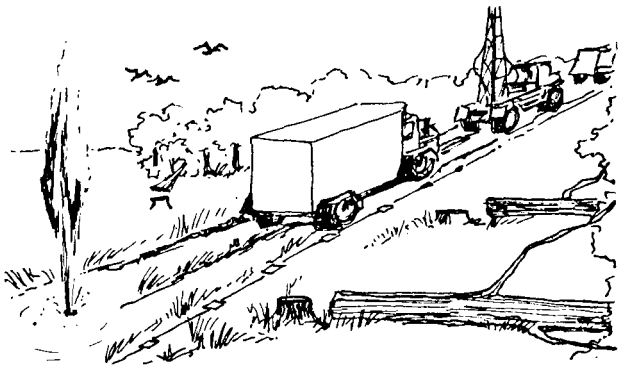
IMPACT

- Crushing of vegetation by vehicle and men.



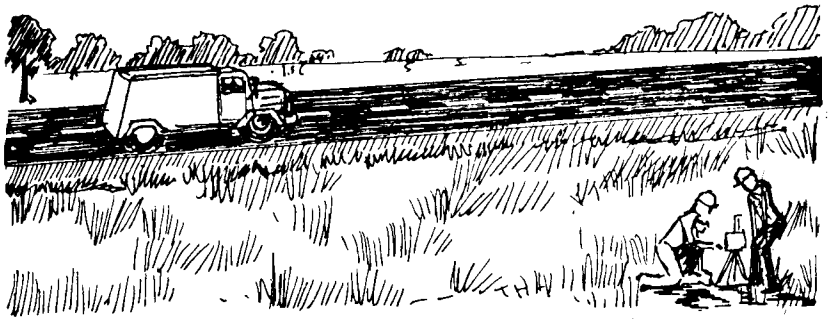
Seismic Measurements. Explosive-charge methods require entry of several trucks into a site. The process usually requires clearing of a survey line, drilling the "shot holes," placing geophones, detonating the explosive, recording the shock waves, and removing equipment. Separate vehicles may be required for drilling, detonation, and recording. The sequence usually progresses 1 to 2 km per day.

- Clearing and crushing of vegetation in shot lanes 3 to 4 m wide and hundreds of meters long; lanes frequently are laid out in a grid pattern.
- Detonation and vehicle movement may disturb wildlife and waterfowl.

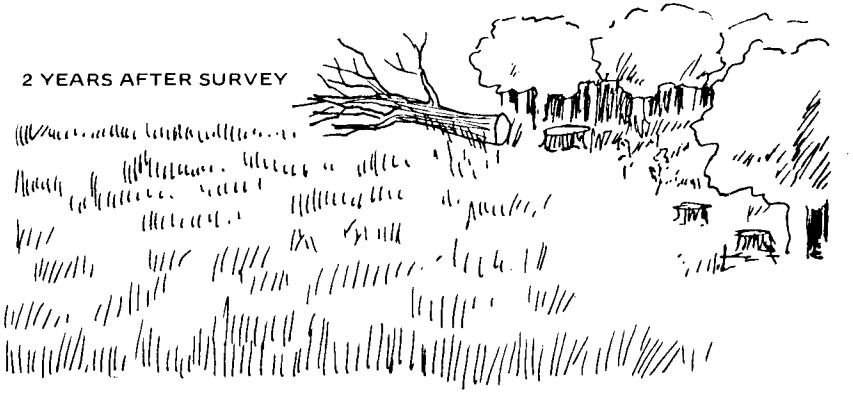


COMMENTS

- This process provides less detailed subsurface information than a seismic survey, but generates small impact.
- Existing roads should be used for vehicle traffic where possible; avoid vehicle movement in low-lying wet areas and waterfowl feeding areas.



- Vegetation reestablishment is slow in shrub and wooded areas.
- Shotholes may present drainage and logistic problems if not adequately filled.
- Vibrators are preferable in wildlife and waterfowl habitat.
- Should be performed during season of minimum waterfowl or wildlife activity.
- Adequate fire-suppression equipment should be on hand.



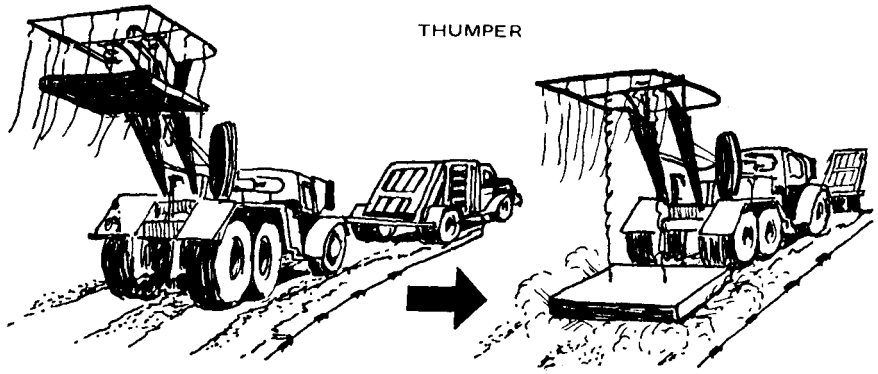
UPLANDS - Preexploration

ACTIVITY

Vibrators. Vibrating equipment ("thumpers" or "shakers") produces seismic waves by mechanical rather than explosive means. A series of vehicles similar to those used in an explosive-charge method is required. The data accumulated are also comparable to those of explosive charge methods.

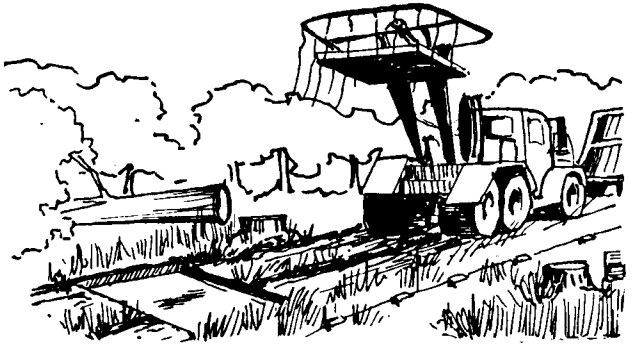
IMPACT

- Clearing and/or crushing of vegetation in a path 3 to 4 m wide and hundreds of meters long.
- Vibration may disturb wildlife and waterfowl, but harassment is less severe than explosive charges.



COMMENTS

- Preferred over explosive charges in areas of wildlife and waterfowl nesting or feeding.
- Should be performed during season of minimum waterfowl or wildlife activity.

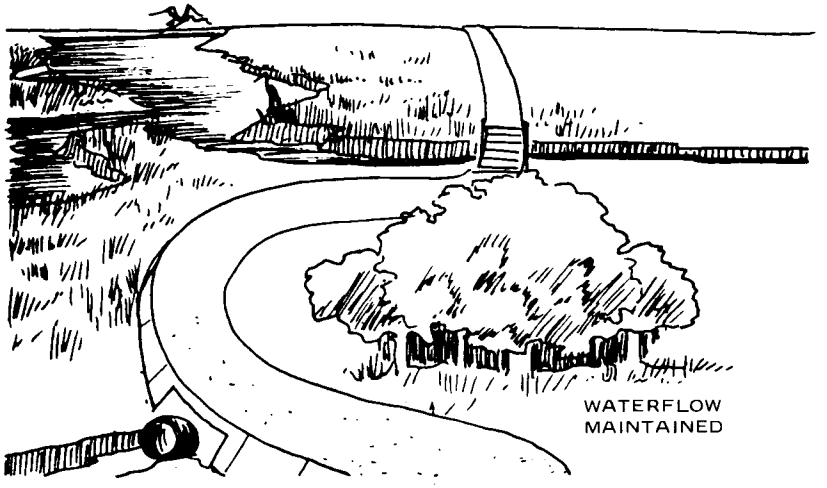


UPLANDS-Site access and preparation

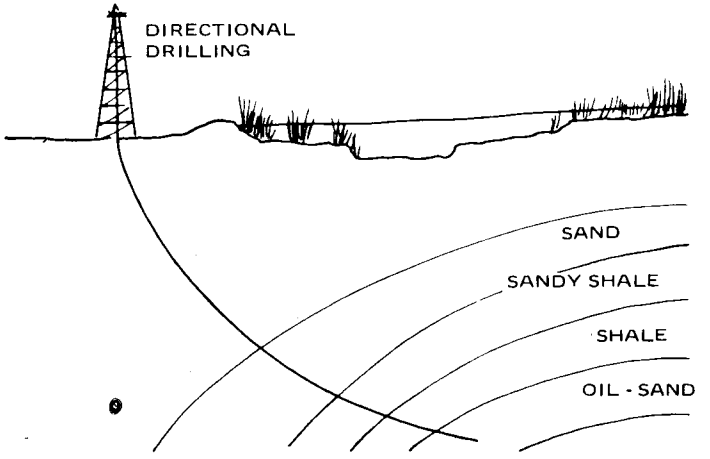
ACTIVITY	IMPACT
Wellsite Access. Standard road construction practices are followed in dry upland areas. Heavy earth-moving equipment is used for clearing rights-of-way and building the access road. Drainage ditches and culverts are commonly employed in wetter areas. Road construction typically proceeds 1 to 2 km per day.	• Removal of vegetation and animals along roadway (6 to 7 m wide). • Compaction of soil and crushing/cutting of vegetation within the right-of-way. • Alteration of surface water drainage. • Displacement of sensitive wildlife species from adjacent areas.
Wellsite Construction. Earth moving machines construct an elevated "pad," which is then surfaced with shell or crushed rock. Bulldozers construct earthen dikes to form a series of pits to hold drilling fluid ingredients, the circulating drilling fluid ("mud"), and products of drilling. Drainage ditches may be necessary. Construction typically requires 5 to 10 days.	• Removal of vegetation and animals in a 0.5 to 1.25 ha area. • Compaction of soil in the entire easement. • Possible alteration of surface water drainage. • Introduction of shell or surfacing material. • Displacement of sensitive wildlife species from adjacent areas.

COMMENTS

- Align roads to avoid critical wildlife areas and sensitive vegetation; develop mitigation measures where possible.
- Install adequate culverts, bridges, and bulkheading to maintain waterflows and prevent erosion.
- Minimize area affected by keeping all materials, vehicles, and activities within the right-of-way.
- Incorporate present and future land uses in the design and alignment.



- Locate wellsite so as to avoid critical wildlife areas and sensitive vegetation; consider directional drilling and mitigation measures.
- Avoid blocking surface drainage and employ adequate erosion control measures.
- Minimize area affected by restricting all equipment and activities within easement; design alignment of pits and storage areas to use space efficiently.



UPLANDS-Drilling

ACTIVITY

Drilling. A backhoe may be used to bury water supply lines and other necessary utility lines parallel to access roads. A period of 4 to 7 days is typical for each type of utility installation. Large amounts of very heavy equipment and materials are moved to the wellsite and stored in predetermined areas. Large, noisy diesel power plants are often required. Operations usually proceed for 1 to 3 months, 24 hours per day, accompanied by heavy service-vehicle traffic. Drilling mud and drilling by-products ("cuttings") are stored onsite during drilling. Mud is often moved and used at other wells after drilling is completed. Cuttings may be buried if pits are pushed down; they may be removed if contaminated with toxic materials or oil. When drilling is completed, the well is tested, treated, and prepared for production: the casing is set and wellhead equipment ("Christmas tree") is installed.

IMPACT

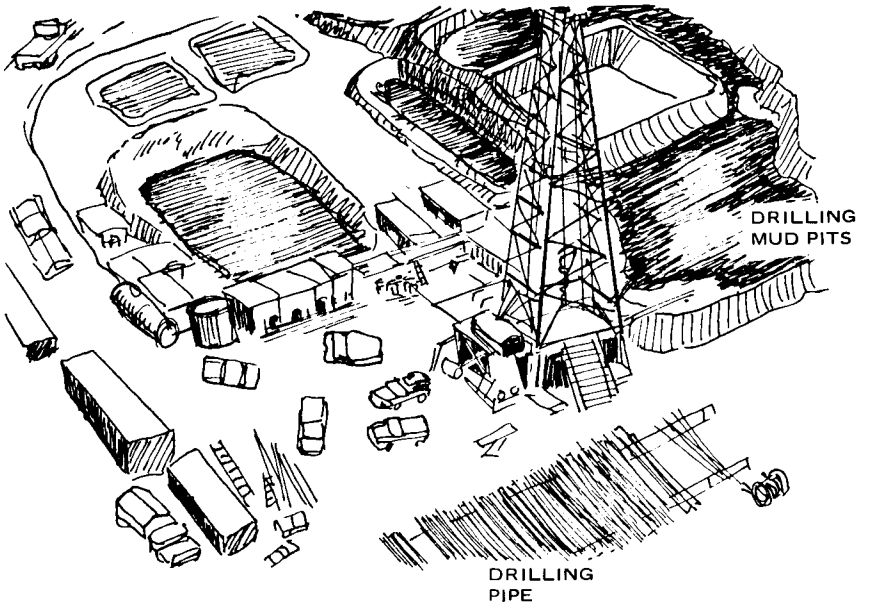
- Potential release of toxic and/or noxious substances into the environment:
  - From accidents or leaks.
  - From rain or washing of equipment on the rotating drilling table.
- Displacement of sensitive wildlife due to constant high level of noise and activity.
- Potential formation of impervious layers (hardened pools of drilling mud).

COMMENTS

- Store supplies, drilling mud, cuttings, and wastes in impervious containers or lined pits; dispose of all harmful wastes offsite.

- Minimize release of pollutants to the environment. Skim oil from wash water and sump water; replace worn, faulty, or leaking equipment.

- Should be performed during season of minimum waterfowl and wildlife activity.



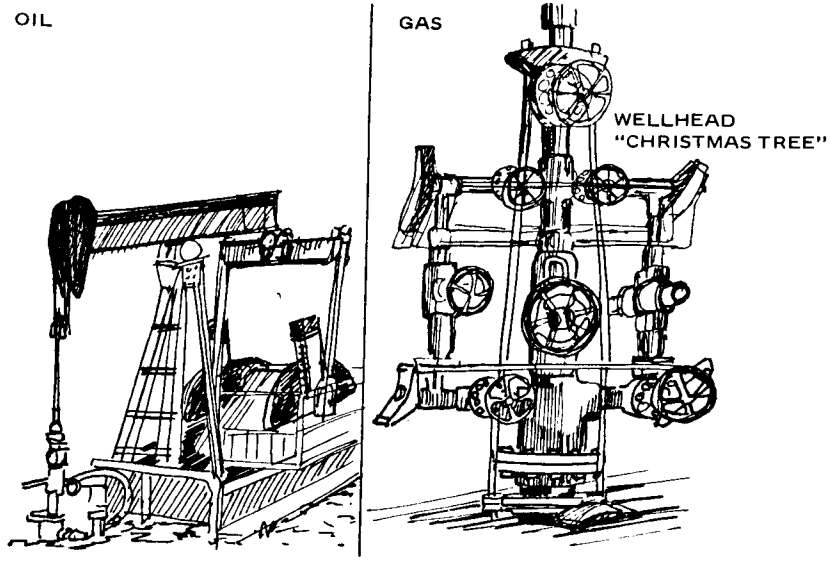
UPLANDS–Production

ACTIVITY

Conversion of Well to Production. Equipment is frequently needed at or near the wellhead to pump fluids in or out of the well, control the flow of products, or treat the petroleum before it is pumped to centralized storage tanks; common items are pumps, regulators, separators, heater-treaters, filters, and brine disposal pits. Prefabricated production equipment is trucked in and securely fastened to previously installed concrete slabs. Retaining walls (earthen or concrete) are constructed around the equipment. Mud pits may be filled and contours restored, thus reducing the total area disrupted. The entire conversion usually takes 10 to 14 days. The frequency of checking may average once per day. Occasional activities will include maintenance of grounds and treatment, logging, and workover of the well.

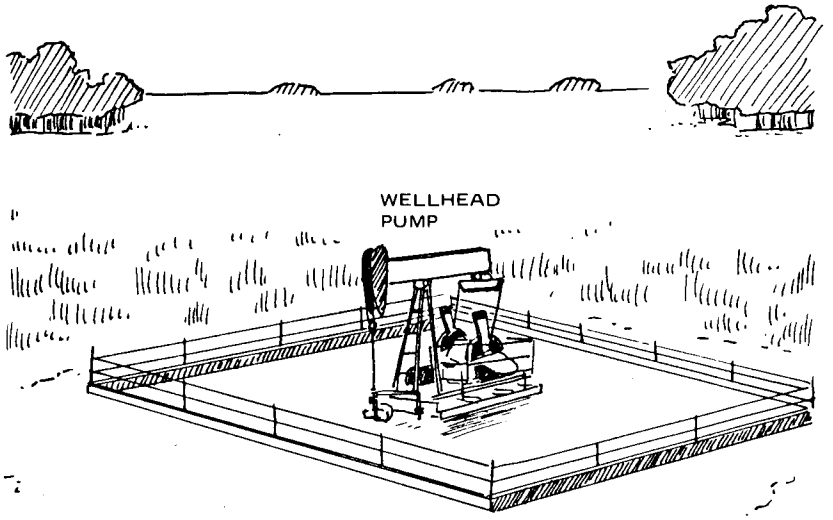
IMPACT

- Possible additional removal of vegetation and animals in a maximum area of (approximately) 0.4 ha.
- Compaction of soil by moving equipment.
- Possible alteration of surface water drainages.
- Continued constant activity (at a lower intensity than during drilling); displacement of sensitive wildlife species may occur during occasional maintenance and workover activities.



COMMENTS

- Conversion generally reduces total area disrupted, especially if contours and soil structure are restored.
- Area around pad starts to revegetate within 2 years—sooner if seeded.
- Retaining wall around wellsite production equipment will reduce likelihood of pollution (these facilities should be located in less desirable or previously disturbed areas).
- Areas may need to be fenced if there is grazing in the area.



UPLANDS-Production

ACTIVITY

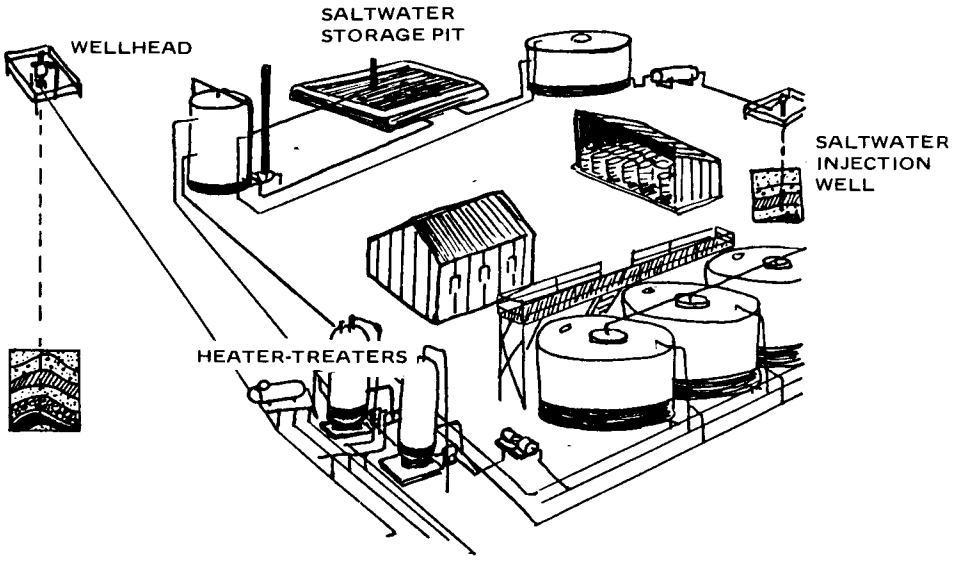
Placement of Centralized Production Facilities. Extensive centralized production facilities are used to collect, store, and further treat the petroleum products from individual wells. Equipment may include monitoring devices, skimmers, separators, heater-treaters, stock tanks, chemical tanks, compressors, filters, pumps, and saltwater storage tanks; components are connected by buried or exposed pipelines. Placement may require 20 to 60 days. Retaining walls are also built around the entire centralized facility, and the area inside is surfaced and/or mowed. Checking and monitoring must be done daily; maintenance activities are frequent. Additional roadways may be necessary for access to some facilities.

IMPACT

- Possible additional removal of vegetation and animals in areas ranging from 1 to 4 ha.
- Compaction of soil by moving equipment.
- Possible alteration of surface water drainages.
- Displacement of sensitive wildlife species during periodic monitoring and maintenance activities.

COMMENTS

- These facilities should be located in less (ecologically) desirable or previously disturbed areas when possible.
- Avoid blocking surface drainage and employ adequate erosion-control measures.
- Space should be used efficiently to minimize disturbed area; dangerous equipment should be fenced in.
- Petroleum wastes (scrapings of paraffin and tar) should be properly stored and discarded.
- Care should be taken to prevent discharge of saltwater brine onto unaltered areas.



UPLANDS–Pipeline installation

ACTIVITY

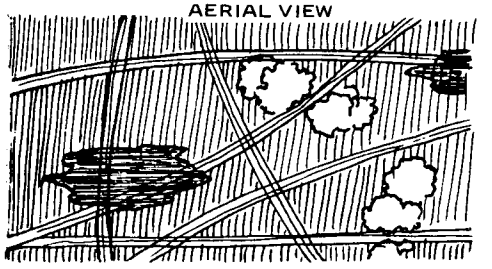
Pipeline Installation. Small lines (brine disposal, flowlines from wellhead to storage tanks) and large transportation lines are usually buried. Installations of small lines (less than 10-cm diameter) require plows, trenches, or backhoes, traversing 1 to 2 km per day. Large-scale pipeline construction involves several distinct sequential activities. The equipment necessary to complete the operation (called a "spread") may move 0.25 to 3.0 km per day along the right-of-way. The right-of-way is cleared and graded; a ditcher digs the trench; the pipe sections are welded and inspected; a single machine cleans, coats, and wraps the pipe; the pipeline is placed and backfilled; and the earth is tamped, leveled, and restored. Boring tunnels and bending pipe are means of crossing such obstacles as roads, highways, railroads, and permanent obstructions. All rights-of-way are maintained periodically.

Intermediate pump stations are constructed along the pipeline every 65 to 80 km. They include compressors, pumps, and equipment for cleaning pipelines. Permanent roads are necessary for access to these pump stations. Each station may require 30 to 60 days for completion.

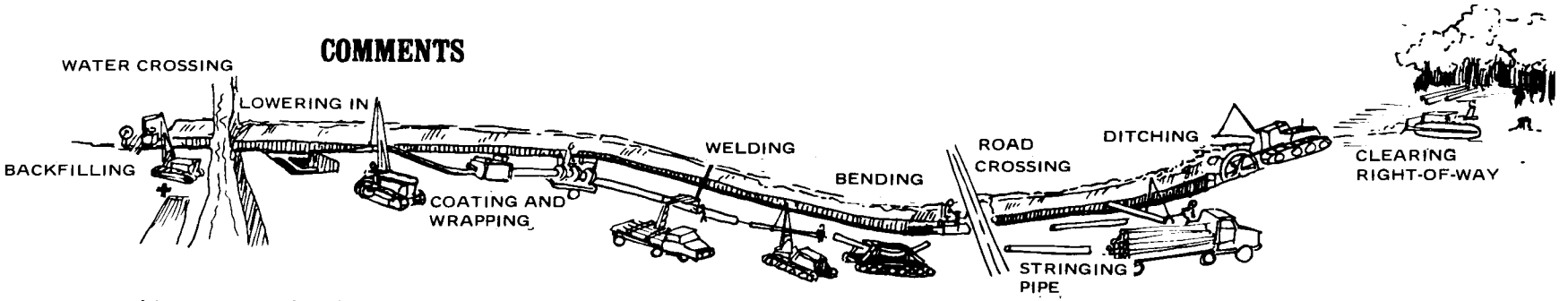
IMPACT

- Similar to road construction requiring heavy earthmoving equipment; altered areas along rights-of-way range from 0.1 to 3.0 ha per km.
- Establishment of subclimax plant communities due to right-of-way maintenance.
- Some wildlife species may reenter and utilize the right-of-way after installation is completed.
- Areas altered by auxiliary facilities (pump stations, cleaning stations, etc.) range from 20 to 4,000 m^2; most stations are at the small end of this range.

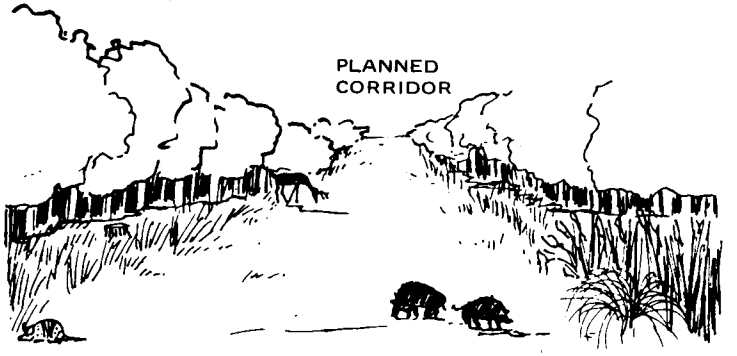
UNPLANNED INSTALLATION
AERIAL VIEW



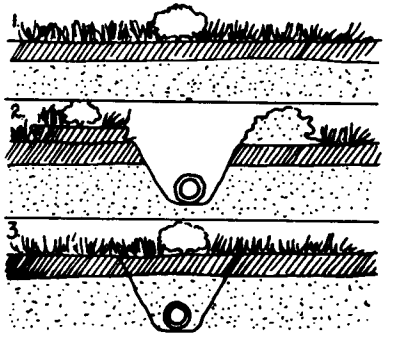
COMMENTS



- Avoid permanently blocking surface drainages during installation.
- Locate pipelines in ecologically less desirable areas; attempt to confine cumulative installations to a "pipeline corridor."
- Restrict all equipment and activities to the right-of-way easement.
- Rapid and comprehensive site restoration minimizes erosion and accelerates use by wildlife; vegetative cover can be manipulated to favor preferred species; only approved herbicides should be used for vegetation control; it is preferable to mow or bushhog right-of-way instead of using herbicides.
- "Double-ditching" technique should be used wherever practicable. This promotes more rapid restoration of vegetation.
- Following installation, right-of-way should be restricted to the width of the pipeline.



DOUBLE DITCHING



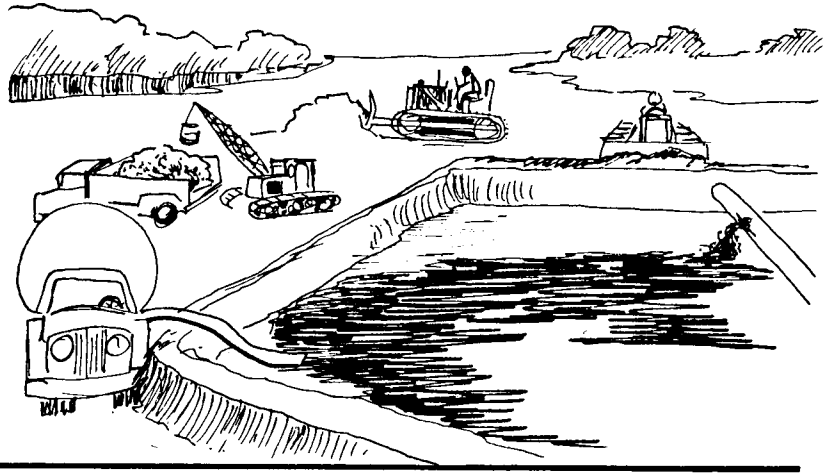
UPLANDS-Spills and cleanup

ACTIVITY

Spills and Cleanup. In some installations, pressure detectors activate automatic valves to control equipment failures; more often, malfunctions are controlled manually. Most operators have emergency plans that conform to State and Federal regulations. The first step—containment of petroleum—may require the bulldozing of levees. Vacuum trucks can remove oil if a deep layer has formed. Various absorbents may be employed; residual oil is usually burned. Petroleum-soaked soils can be excavated and replaced with clean soils.

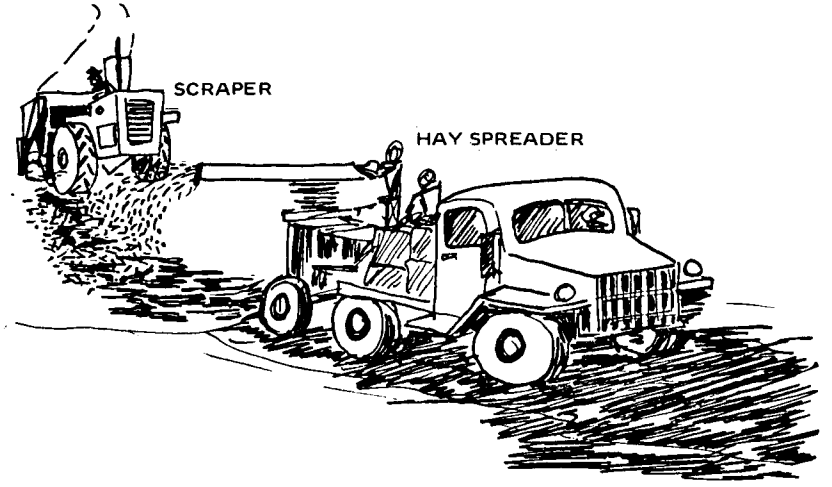
IMPACT

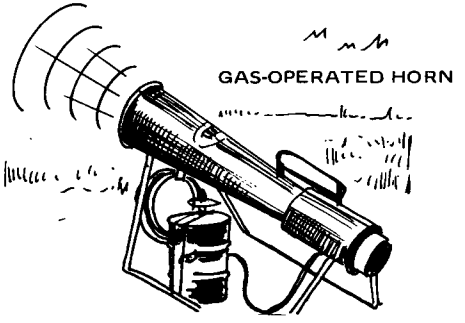
- Plants and animals may be coated by petroleum; oil coating or cleanup operations may kill them.
- Soil and vegetation may become compacted from movement of heavy equipment.
- Soil may be contaminated with hydrocarbons and require excavation before plants will grow.
- Residual toxicants may migrate to adjacent regions; nutrients and soil characteristics will be altered.
- Sensitive wildlife and waterfowl are frequently displaced until the area is restored (1 to 20 years, depending on type of vegetation).



COMMENTS

- Knowledge and implementation of an efficient contingency plan by all involved parties is a must.
- Low-impact techniques should be used; avoid use of dispersants, emulsifiers, and other chemical agents.
- Dispersal techniques may be necessary to discourage use of the area by wildlife and waterfowl (gas-operated horns, etc.).
- Adequate site restoration will accelerate the return of wildlife and waterfowl to the area.





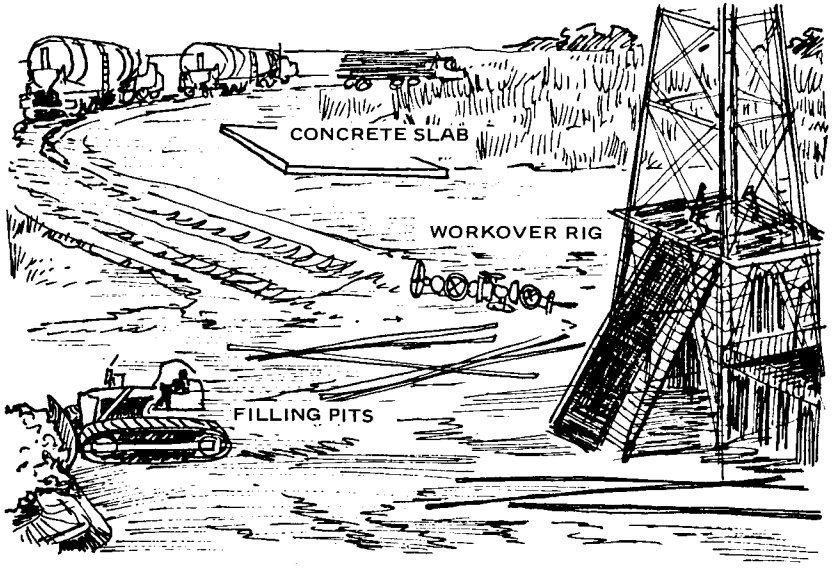
UPLANDS–Termination

ACTIVITY

Well Shutdown. Termination of production involves removal of tubing and downhole equipment by a small rig. The hole is filled with drilling mud and capped with cement; the casing is cut below ground and the area is filled and tamped. All usable wellhead and auxiliary production equipment is removed; small buried lines and concrete foundations are usually left in place. The lining of brine collection pits or burning pits is removed and the pits are filled; roads usually remain. Operations may require 7 to 14 days.

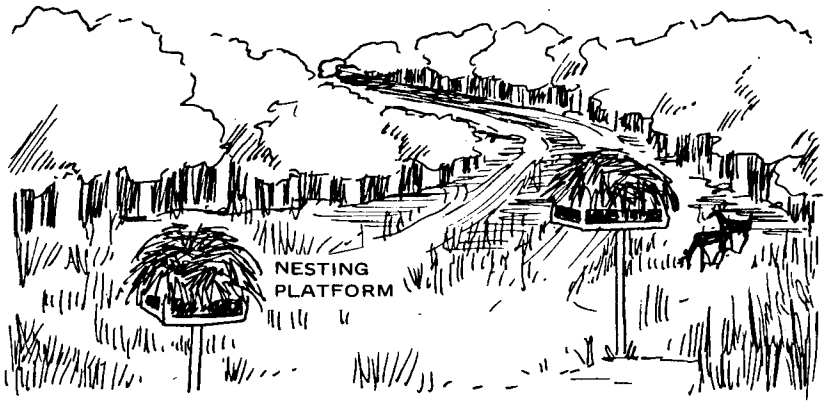
IMPACT

- Soil nutrients and structure may be lost or gained, depending on equipment movement and restoration techniques.
- Petroleum-related pollutants will decrease.
- Vegetation will grow, leading to increased utilization of the area by wildlife and waterfowl.



COMMENTS

- Burial of drilling mud and other wastes must be carefully monitored.
- Restoration of land contours, waterflows, and soil characteristics will speed recovery of area; discing, dressing, and fertilization will accelerate early stages of succession.
- Construction of nesting and/or denning structures may be helpful in encouraging wildlife to return.
- Removal of concrete or other impervious surfaces is beneficial.



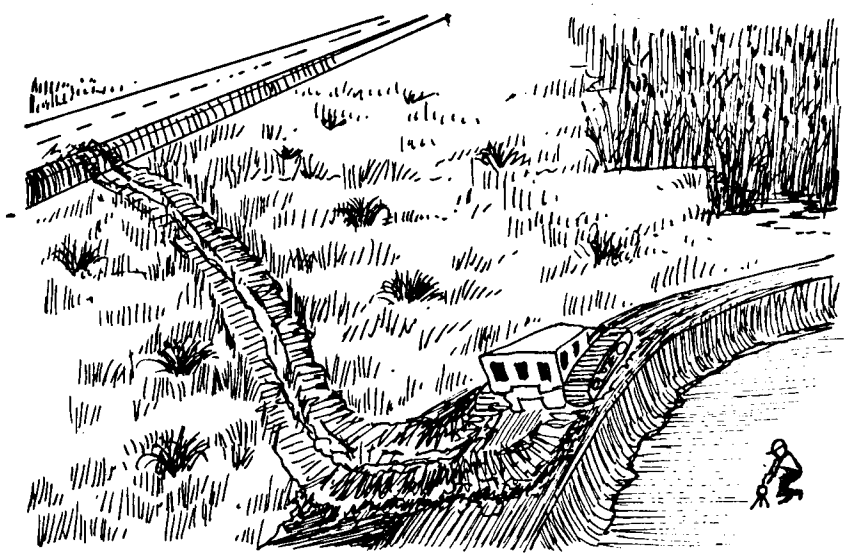
SEASONALLY FLOODED WETLANDS–Preexploration

ACTIVITY

Gravity Measurements. The gravitational pull of subsurface rock formations is measured. This process, utilizing only small, hand-carried equipment, requires less vehicular traffic than other methods of survey but is less precise than seismic surveys. Many data-collection stations may be occupied during an 8-hour period.

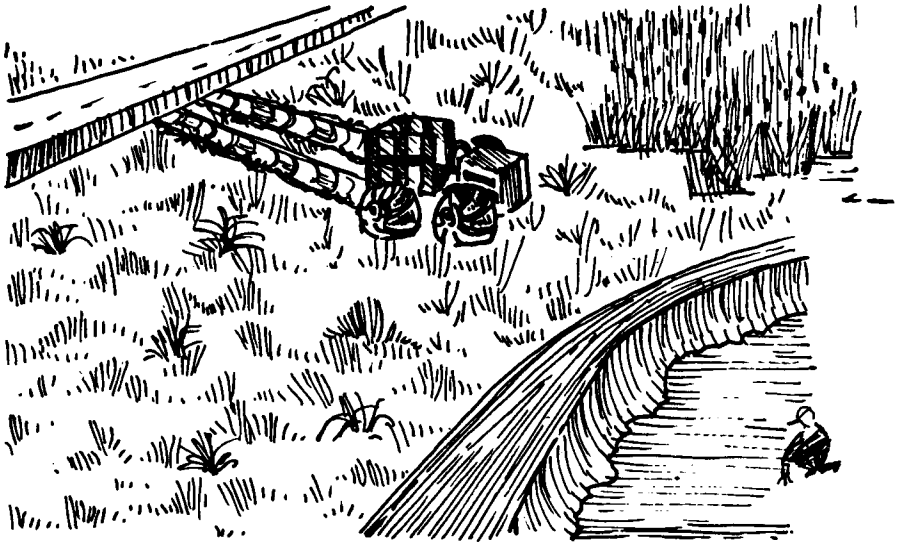
IMPACT

- Crushing of vegetation by vehicles and men.
- Possible formation of ruts by vehicles; could remain for years and affect runoff and/or flooding.



COMMENTS

- Travel by foot or helicopter to minimize physical damage.
- Use of existing roads where possible is preferable; avoid vehicle movement in sensitive pristine areas and waterfowl feeding areas.
- Large balloon-tired vehicles are less destructive than tracked vehicles.



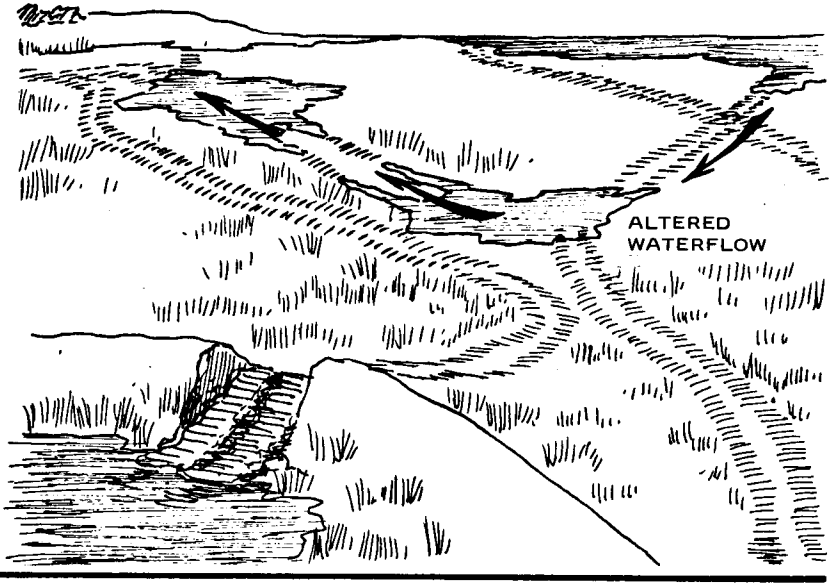
SEASONALLY FLOODED WETLANDS- Preexploration

ACTIVITY

Seismic Measurements. Explosive-charge methods involve the entry of several vehicles into a site. The process usually requires clearing of a survey line, drilling the "shot holes," placing geophones, detonating the explosive, recording the shock waves, and removing equipment. Separate vehicles may be required for drilling, detonation, and recording. The sequence usually progresses 1 to 2 km per day.

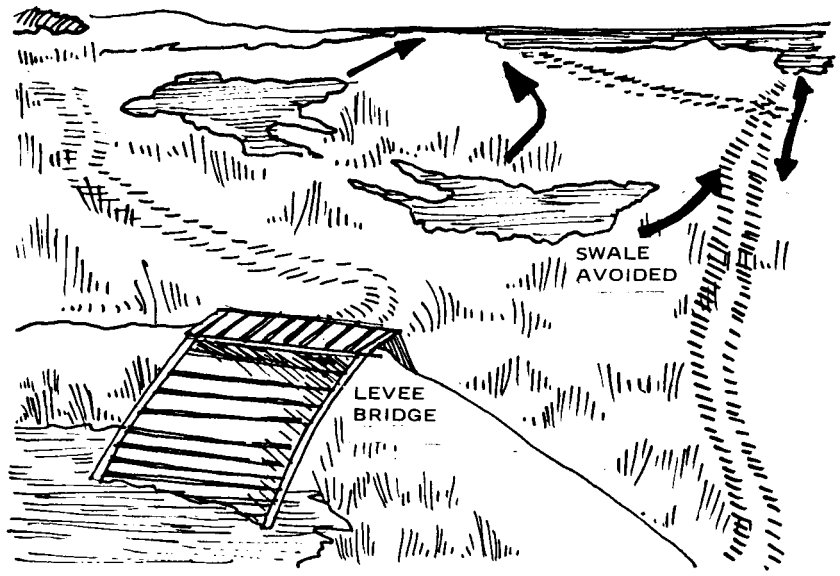
IMPACT

- Crushing or clearing of vegetation in shot lanes 3 to 4 m wide and hundreds of meters long; lanes frequently are laid out in a grid pattern.
- Detonation and vehicle movement may disturb wildlife and waterfowl.
- Vehicle movement creates a long continuous pathway for water movement; may alter runoff and/or flooding regimes for years.
- Levees may be damaged.
- Danger of fire from explosive material.



COMMENTS

- Use existing roadways whenever possible; minimize total number of trips; travel over naturally high areas rather than depressions; prohibit marsh vehicles from crossing unprotected functional levees.
- Number of vehicle trips over same trail should be regulated depending on conditions; in particularly soft areas, retracing of trails should be avoided.
- Balloon-tired vehicles are preferable to tracked vehicles.
- Conducting surveys in dry seasons will help avoid problems; also, scheduling helps to avoid wildlife and waterfowl concentrations.
- Alignments for seismic lanes should avoid small water bodies, nesting and feeding areas for wildlife and waterfowl.
- Changing the waterflow regimes (by elevation alterations of 5 cm) causes major changes in plant species composition.
- Shot holes may present logistic and drainage problems if not adequately filled.



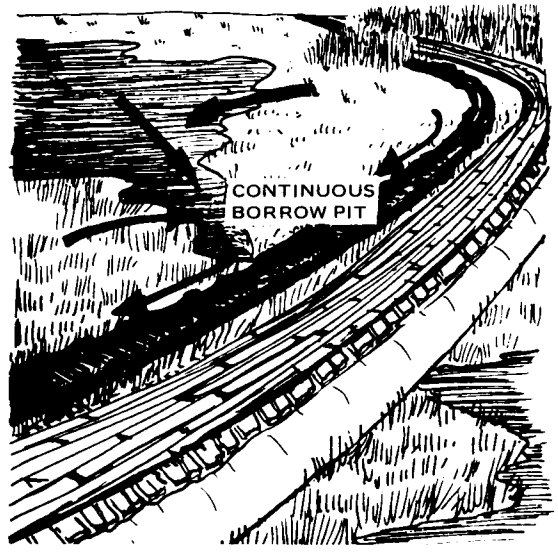
SEASONALLY FLOODED WETLANDS-Site accesss

ACTIVITY

Wellsite Access. In wetland areas, roads are frequently built atop levees aligned as the shortest distance between two points; these require a minimum top width of 6 to 7.5 m and should have 2:1 or 3:1 side slopes. Borrow pits, the typical source of fill, are approximately 10 m wide and 1 to 3 m deep, depending on the amount of earth needed. Following compaction and shaping, the top is surfaced with shell or crushed rock, layers of wooden planks, or both. Culverts and bridges are sometimes employed to maintain drainage. Construction proceeds from 0.1 to 0.5 km per day. Problems occur (due to soft areas in the levee) when heavy equipment is transported for wellsite construction, drilling, and well shutdown. Repair activities during these periods are nearly continuous.

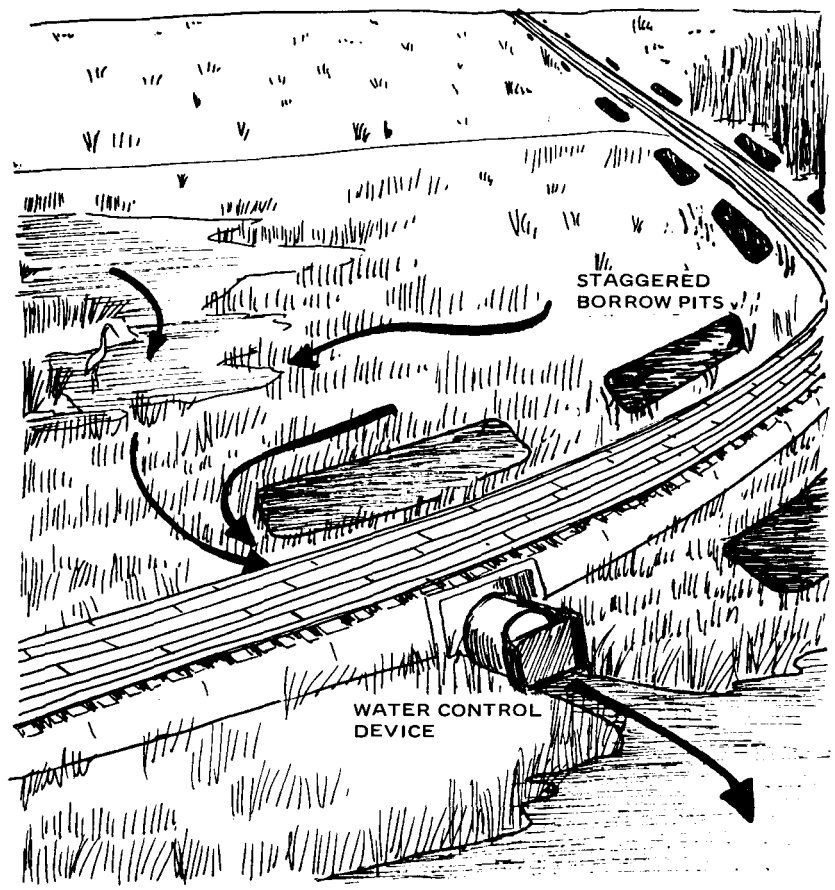
IMPACT

- Marsh-buggy movement on marsh surface creates long, continuous depressions (pathways) that alter waterflows.
- Vegetation and animals are removed from borrow bits and along roadway.
- Continuous borrow pits alter waterflows; runoff or flooding may increase or decrease.
- Turbidity and dissolved nutrients increase due to construction and erosion.
- Levees (particularly if they are aligned perpendicular to waterflows) will block waterflows, thus affecting a large area.



COMMENTS

- Because of alterations of waterflow patterns, this activity is frequently the cause of greatest impacts to wetland systems.
- Directional drilling should be considered when planning alignments.
- Minimize disruption of water regimes and disturbance of wildlife and waterfowl by judicious alignment of roads; align roads parallel rather than perpendicular to surface waterflow.
- Stagger borrow pits to prevent formation of long continuous ditches along roadways; care must be taken to keep staggered pits from joining.
- Avoid crossing drainages where possible; adequate culverts, bridges, and bulkheading can maintain waterflows and prevent erosion.
- Place cloth mats on levees to help prevent erosion and aid revegetation.
- Use innovative engineering and/or alignments to improve conditions for some land uses; build the roadway along higher parts of the marsh surface.
- Confine vehicles to right-of-way at all times; prohibit marsh vehicles from crossing unprotected functional levees.



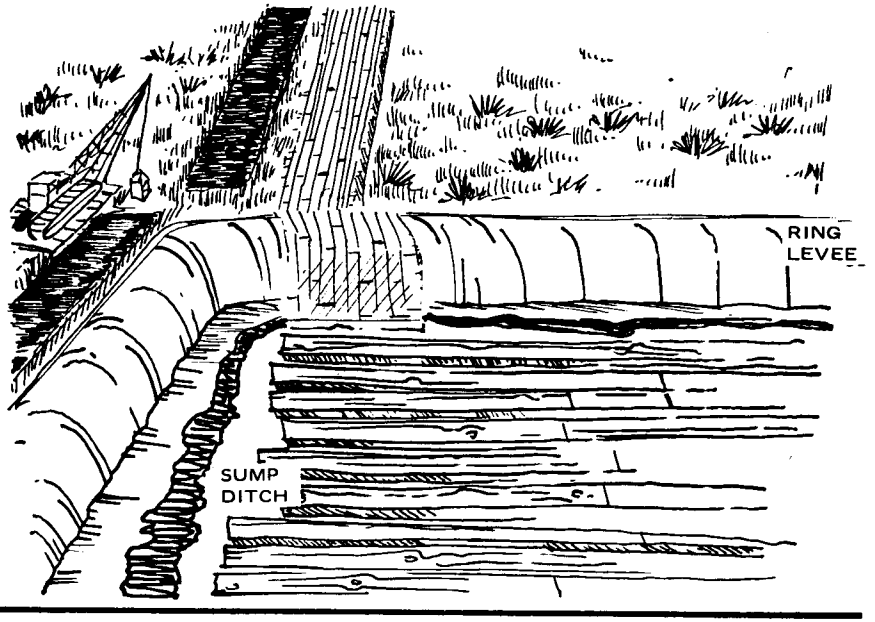
SEASONALLY FLOODED WETLANDS-Site preparation

ACTIVITY

Wellsite Construction. A dragline constructs a levee (with material from borrow pits) completely around the wellsite. A series of reserve pits may also be built and may be lined with impervious material; alternately, steel tanks are placed within the diked area. Several layers of planks are generally placed directly on the marsh surface, and a sump ditch is dug immediately inside the dike surrounding the wellsite. Construction typically requires 10 to 14 days.

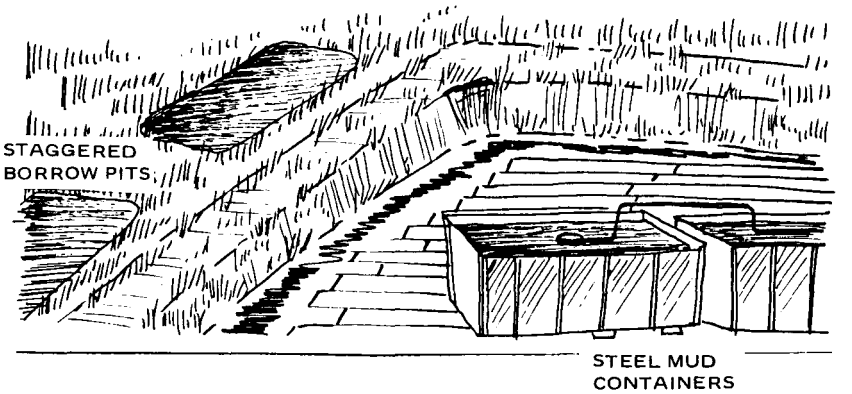
IMPACT

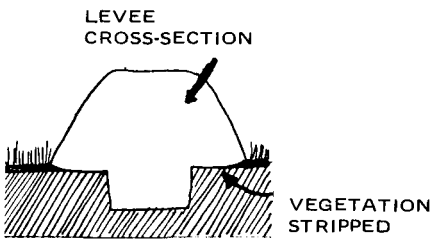
- Vegetation and animals are removed from an area of 0.5 to 1.5 ha.
- Auxiliary vehicle movement may create ruts that alter water movements.
- Borrow pits and ring levees alter local water movements.
- Turbidity and dissolved nutrients increase due to construction and erosion.



COMMENTS

- Directional drilling eliminates the need for additional wellsites nearby.
- Total disturbed area can be minimized by regulating spoil deposition and borrow pit orientation and limiting dimensions of wellsite and construction activities.
- Use of prefabricated containers eliminates excavation of mud pits and minimizes size of wellsites.
- Stripping surface vegetation prior to construction of ring levee helps prevent seepage at base of levee (inset).
- Excavating surface vegetation separately for replanting on fresh spoil helps prevent erosion.
- Potential release of toxic or noxious substances into environment.
- Displacement of sensitive wildlife due to constant noise and activity.
- Total area disturbed may approach 1.5 ha.





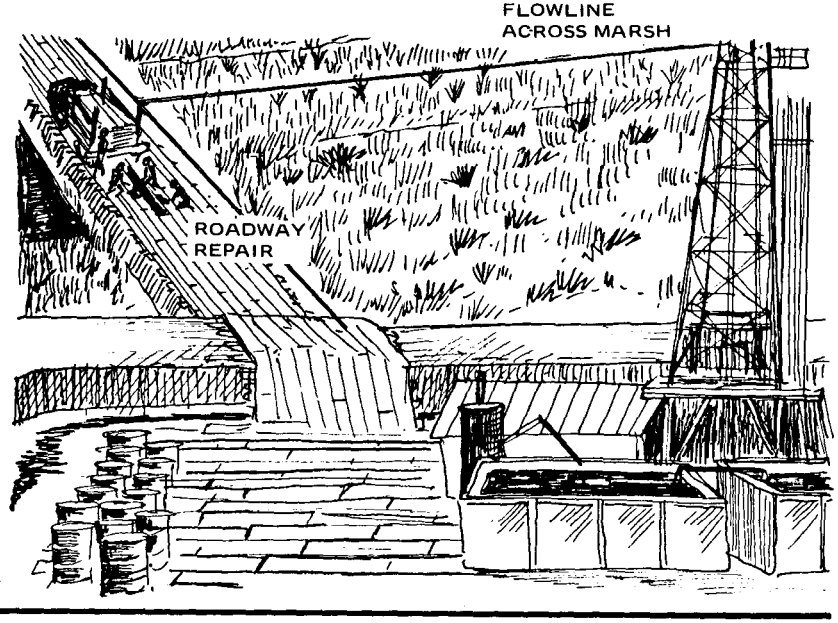
SEASONALLY FLOODED WETLANDS-Drilling

ACTIVITY

Drilling. In wetland areas, small pipelines and utility lines are placed on or along the edge of leveed access roads. Occasionally, marsh buggies are necessary to lay lines across the marsh surface. A period of 4 to 7 days is typical for each type of utility installation. Large amounts of very heavy equipment and materials are moved to the wellsite and stored in preselected areas. Large, noisy diesel powerplants are often required. Operations usually proceed for 1 to 3 months, 24 hours per day, accompanied by heavy service-vehicular traffic. Drilling mud and drilling by-products ("cuttings") are stored onsite during drilling. Mud and other waste materials must be trucked offsite when drilling is completed. The sump collects spills, washdown water (from cleaning equipment at the wellhead), rain water, and seepage. It is vacuumed clean before being pumped into the marsh. When drilling is completed, the well is tested, treated, and prepared for production: the casing is set and wellhead equipment ("Christmas tree") is installed.

IMPACT

- Potential release of toxic or noxious substances into environment.
- Displacement of sensitive wildlife due to constant noise and activity.
- Total area disturbed may approach 1.5 ha.

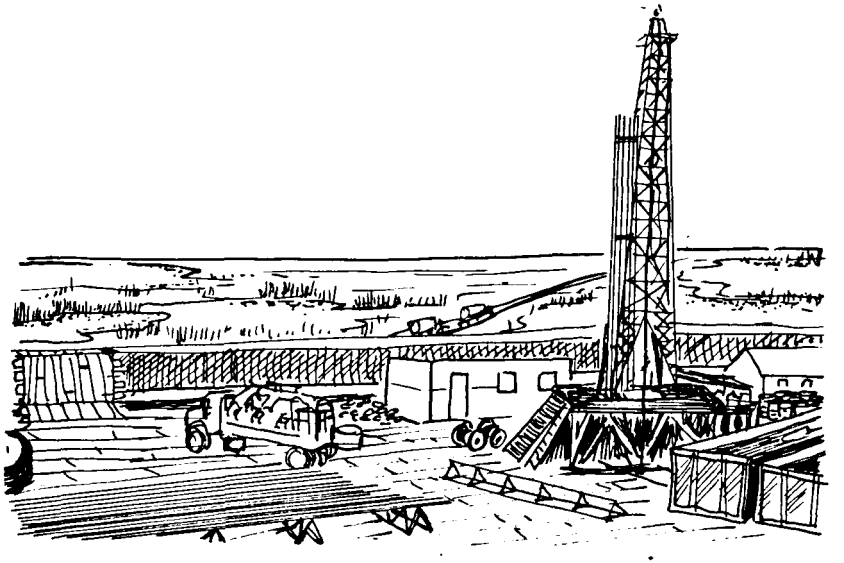


COMMENTS

- Supplies, drilling muds, cuttings, and wastes should be stored in impervious containers or lined pits; all harmful wastes should be disposed of offsite.

- Release of pollutants to the environment should be minimized; skim oil from wash water and sump water; replace worn, faulty, or leaking equipment.

- Activities should be scheduled to avoid seasonal wildlife and waterfowl concentrations.



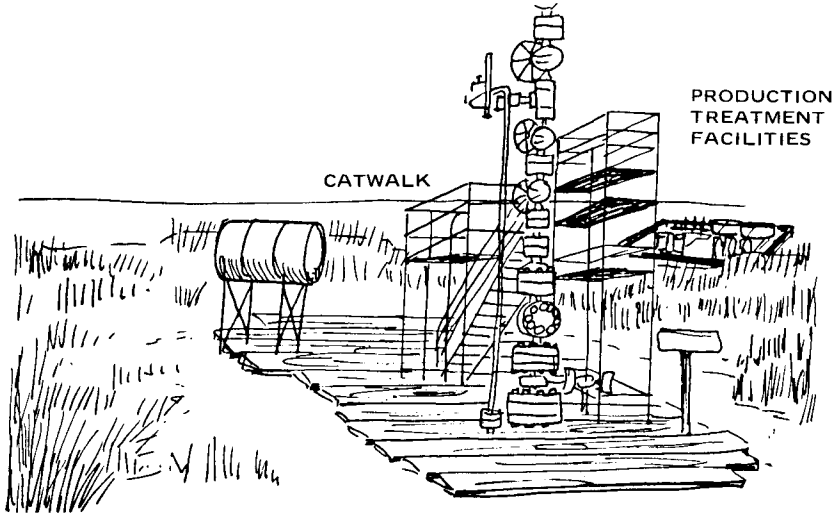
SEASONALLY FLOODED WETLANDS-Production

ACTIVITY

Conversion of Well to Production. Equipment is frequently needed at or near the wellhead to pump fluids in or out of the well, control the flow of products, or treat the petroleum before it is pumped to centralized storage tanks; common items are pumps, regulators, separators, heater-treaters, and filters. Prefabricated production equipment is trucked in and installed on elevated pads surfaced with shell or crushed rock; flowlines are installed. Continuous retaining levees will surround the entire area. Except for those areas housing producing equipment, reusable planking is removed. The entire conversion may take 10 to 14 days. The frequency of checking may average once per day. Occasional activities will include maintenance of grounds and treatment, logging, and workover of the well.

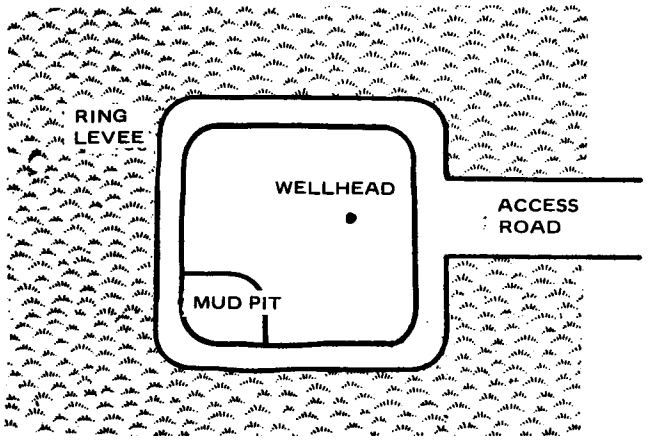
IMPACT

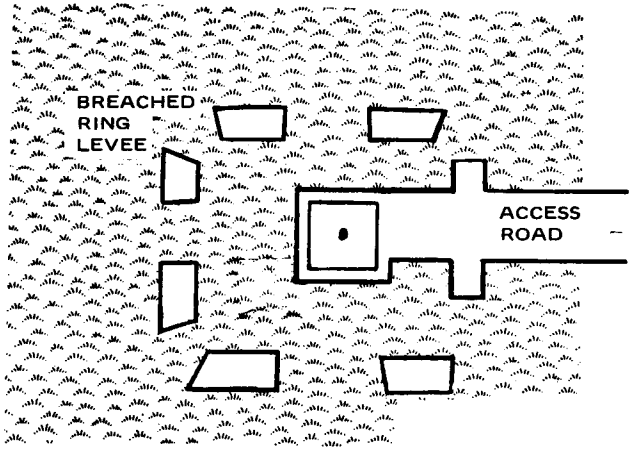
- Levees usually remain to alter waterflows.
- Residual oil and other wastes frequently remain and contaminate marsh.
- Continued constant activity (at a lower intensity than during drilling); displacement of sensitive wildlife species may occur during occasional maintenance and workover activities.



COMMENTS

- Breaching or removing the ring levee system is desirable; the levee should be reduced in size where possible.
- The access road should be made permanent and adequately maintained.
- Revegetation and erosion-control techniques may be very beneficial; especially in maintaining a functional ring levee.





SEASONALLY FLOODED WETLANDS-Production

ACTIVITY

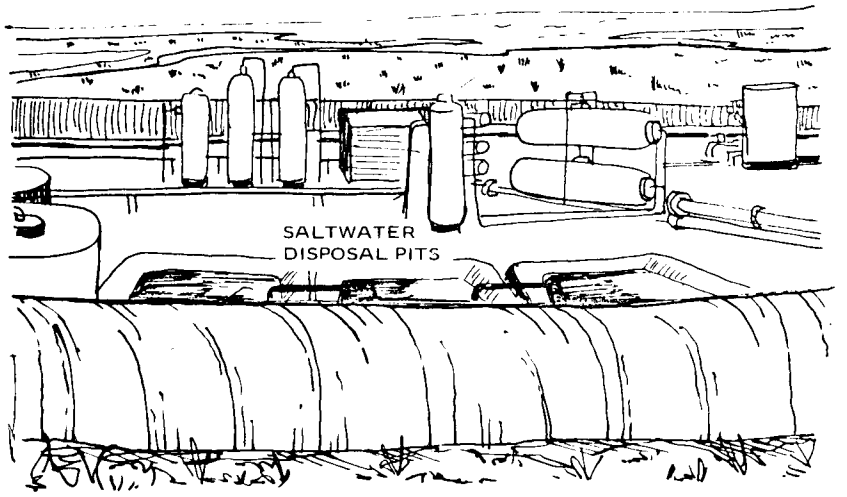
Placement of Centralized Production Facilities. Extensive centralized production facilities are used to collect, store, and further treat the petroleum products from individual wells. Equipment is usually located in upland areas, but may also be placed on large, surfaced pads, surrounded by retaining levees. Facilities may include monitoring devices, skimmers, separators, heater-treaters, stock tanks, chemical tanks, compressors, filters, pumps, and salt water storage tanks; components are connected by buried or exposed pipelines. Placement may require 20 to 60 days. Salt water may be stored in pits and periodically removed by truck; alternately, the brine may be injected into a well or piped into nearby salt water bodies. Checking and monitoring are daily activities; maintenance activities are frequent.

IMPACT

- Possible additional removal of vegetation and animals in areas ranging from 1 to 4 ha.
- All impacts are very similar to roadway and wellsite construction; alignments and areas occupied determine severity of effects.
- Waterflows are usually altered in some way.
- Displacement of sensitive wildlife species during periodic monitoring and maintenance activity.
- Controlled minor spills occur within the facility area.

COMMENTS

- Preferred placement of production facilities is on upland locations.
- Surface or buried lines should follow road alignments in preference to burying them across a marsh.
- Saltwater holding pits should be adequately maintained; disposal of thoroughly cleaned brine into water courses may be acceptable in some salt marshes or delta marshes.
- Sites and installation techniques should be selected to minimize disruption of waterflows, for example, by building on high marsh elevations and avoiding drainages.
- Revegetation and other control measures will minimize turbidity and erosion problems.



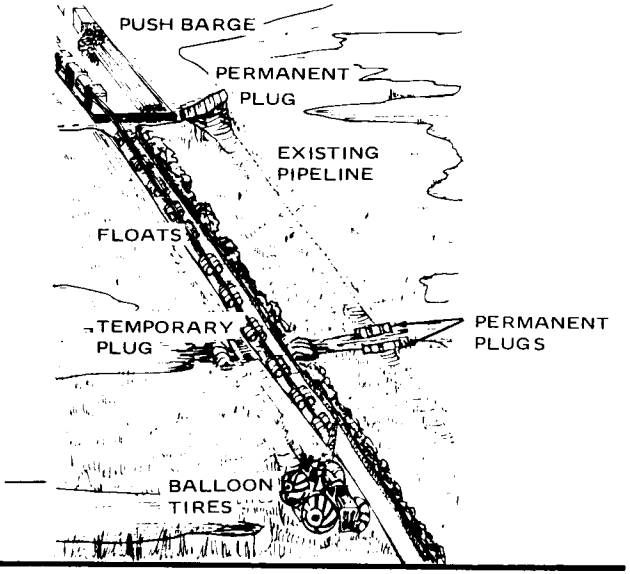
SEASONALLY FLOODED WETLANDS–Pipeline installation

ACTIVITY

Pipeline Installation. All small lines (brine disposal, flowlines, etc.) are placed directly on the marsh surface or along leveed roads. In-Installation progresses 1 to 2 km per day. Large pipelines are frequently installed by the "push method." A dragline, mounted on tracks or a marsh buggy, digs a straight, narrow ditch (2.6 to 3.1 m wide) and forms a spoil levee alongside. The pushing is done from a pipe-laying barge located in a previously dredged slip at the head of the push canal. All pipe-stringing work is done on the barge and is similar to that for upland locations. As each section is completed, floats are attached and it is pushed into the canal; a marsh buggy or vessel guides the head end of the pipe string. Installation typically progresses 0.25 to 1.5 km per day. When the pipe string is completed, floats are removed, the pipe is sunk, and another marsh vehicle completes the backfilling. Where backfilling is not employed, permanent plugs or weirs are often placed at intersections with other watercourses.

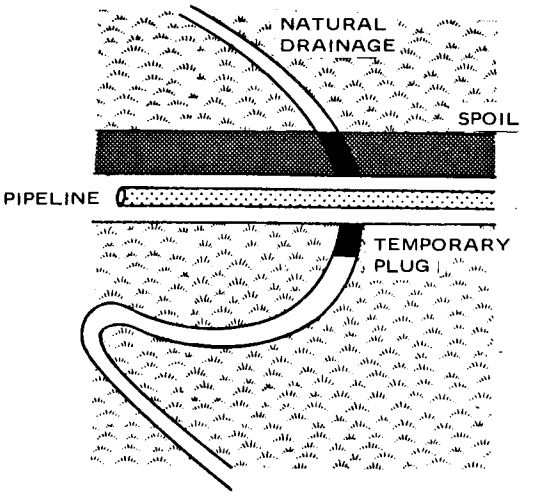
IMPACT

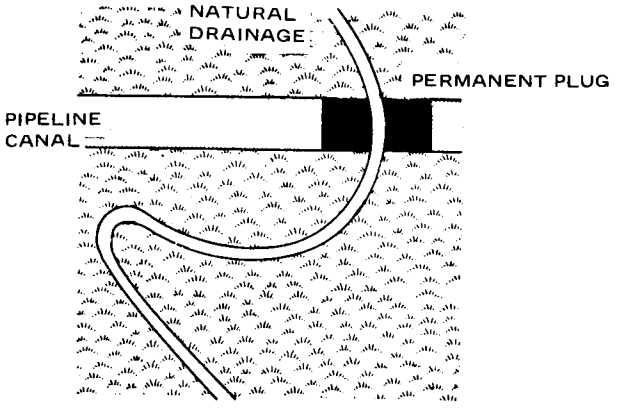
- Clearing and crushing of vegetation by vehicles and work crews over the construction right-of-way, an area much wider than the pipeline itself.
- Formation of vehicle ruts and depressions on marsh surface may allow saltwater intrusion or more rapid drainage.
- Vegetation and animals are removed during excavation of barge access route, barge slip, and push ditch; total altered area is typically 1 ha per km.
- Push ditch and spoil block normal waterflows; may allow flooding by water having different characteristics.



COMMENTS

- The danger that very small changes in land elevations will mix two or more water types should always be seriously considered.
- Flowlines should be adequately supported when crossing water bodies; burial should begin well behind canal or waterway edge.
- Containment of large pipelines in a "pipeline corridor" will minimize total area disturbed over a long period; light-impact excavation equipment should be used.
- Push method disturbs much less area than flotation method.
- Double ditching (topsoil and vegetation removed first, replaced last) helps promote revegetation (page 23).
- Ditch should be backfilled as soon as possible; shrinkage of spoil (due to drying) will always occur to some extent; result is a shallow depression, at best.
- Plugs should be placed at intersections with waterways; also, they should be placed every 400 to 500 m across long, straight waterways to prevent longitudinal water movement.
- Plugs and riprap should be designed and maintained to withstand all abuses for the duration of the pipeline; the width of plugs may range from 2 to 30 m, depending on soil composition and land uses. Plugs may need surface and/or longitudinal reinforcement to withstand damage due to animal movement (cows, alligators, etc.).





SEASONALLY FLOODED WETLANDS - Spills and cleanup

ACTIVITY

Spills and Cleanup. Containment of petroleum may require floating oil booms, surface dams, or piston film herders (chemicals that prevent the spread of surface films). Specialized equipment is frequently used to skim the petroleum from the surface. Hay or other absorbents can be spread, picked up, and burned. Petroleum-soaked vegetation is frequently cut and burned. In navigable waters the U.S. Coast Guard and the State, as well as the company responsible for the spill, are involved. Thus there may be several agencies involved in the cleanup. Cleanup activities must conform to State and Federal regulations.

IMPACT

- Terrestrial and aquatic plants and animals may be coated by petroleum; oil coating or cleanup operations may kill them.
- Contamination of soils will occur at the site.
- Clearing/crushing of vegetation in adjacent areas by work crews and vehicles.
- Formation of vehicle ruts on marsh surface; alteration of water flows.
- Residual toxicants migrate to adjacent regions by water; nutrient and soil characteristics will be altered.

COMMENTS

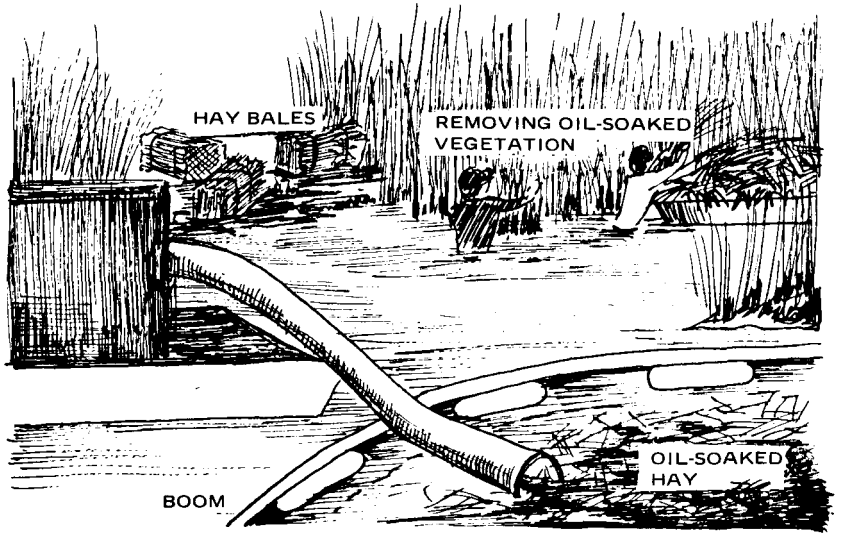
- Knowledge and implementation of an efficient contingency plan is a must; primary action should attempt to contain materials and prevent their entrance into open waterways.

- Low-impact vehicles (skiffs, boats, airboats) and techniques should be utilized; alteration of land surfaces is more persistent (perhaps irreversible), and may be more detrimental than the effects of the spill.

- Avoid the use of dispersants, emulsifiers, and other chemical agents which have not been thoroughly tested and approved.

- Hazing techniques may be necessary to discourage use of the area by wildlife and waterfowl (page 25).

- Artificial restoration may be difficult or impossible in some marsh types; efforts may be limited to seeding and planting, or postponed until dry conditions prevail.



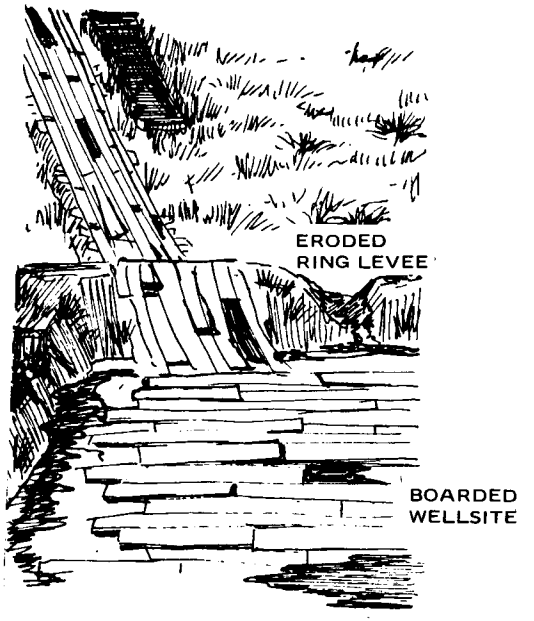
SEASONALLY FLOODED WETLANDS-Termination

ACTIVITY

Well Shutdown. Termination of production involves removal of tubing and downhole equipment by a small rig. The hole is filled with drilling mud and capped with cement; the casing is cut below ground and the area is filled and tamped. Usable wellhead and auxiliary production equipment is removed. Because supply lines and flowlines are usually placed on the surface alongside a leveed road, reusable sections are disconnected and removed. Boarded well pads, leveed roads, and retaining dikes usually remain in place; planks are removed if they can be used elsewhere. Operations may require 7 to 14 days.

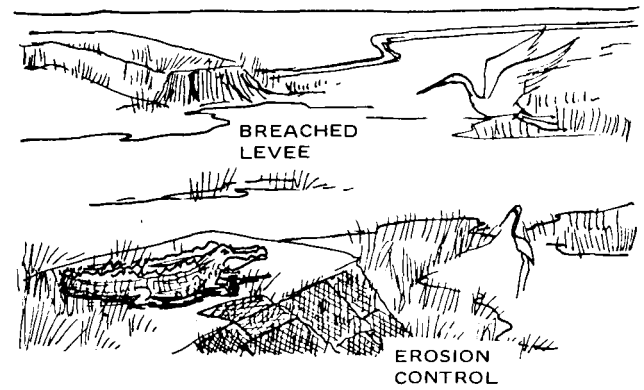
IMPACT

- Elevations of adjacent areas may remain modified and turbidity may remain at high levels, depending upon equipment movement and restoration techniques.
- Petroleum-related pollutants may continue to be released.
- Vegetation and wildlife and waterfowl usage will remain less than in unaltered areas.



COMMENTS

- Area should be evaluated for use as an enhancement to waterfowl and wildlife habitat, with minor modifications; such as conversion to impoundment or stock pond, retention of scattered high areas for loafing and sunning, etc.
- Construction of nesting and denning sites and grit pits will facilitate reestablishment of wildlife.
- To restore water flows it may be preferable to totally backfill borrow areas.
- Burial or removal of drilling mud and other spilled wastes must be carefully monitored.
- Removal of all impervious surfaces is desirable.
- Revegetation of exposed soil will speed restoration and reduce erosion.
- Turbidity-control techniques should be employed wherever practicable.



SATURATED WETLANDS & OPEN WATER-Preexploration

ACTIVITY

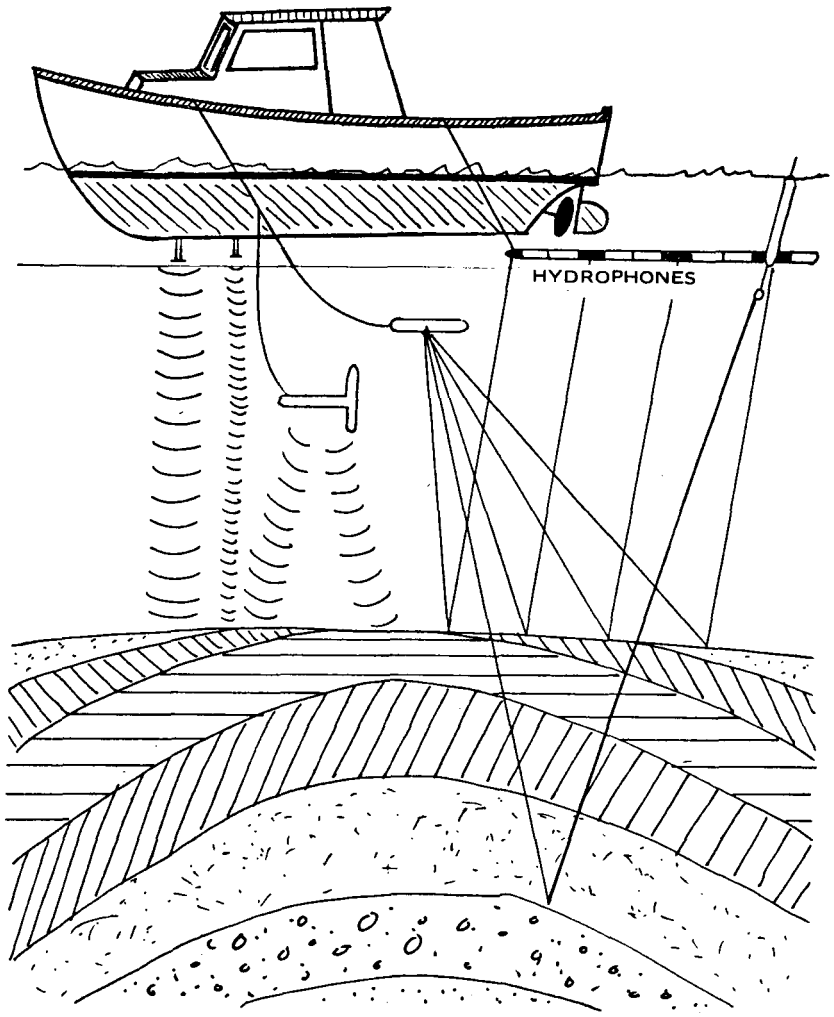
Seismic Surveys. In open water areas a "sparker"—a device that produces shock waves with compressed air—is towed behind a vessel. Recording equipment is located on the same vessel. Transmitters may be placed on shore for use in precise triangulation. In saturated wetlands, seismic methods similar to those employed in seasonally flooded wetlands are used; the same types of impacts result.

IMPACT

- Small-scale crushing of vegetation during boat entry, docking, setting up transmission station.
- Small loss of habitat if dock facilities are constructed.
- Possible formation of ruts if marsh buggies used (less damaging if area is nearly always submerged).

COMMENTS

- Access by vessel is much less damaging than access by marsh buggy.
- Creates less disturbance of waterflows than preexploration surveys on seasonally flooded marshes.
- Gravity surveys in coastal wetlands have been infrequent since mid-1950's.



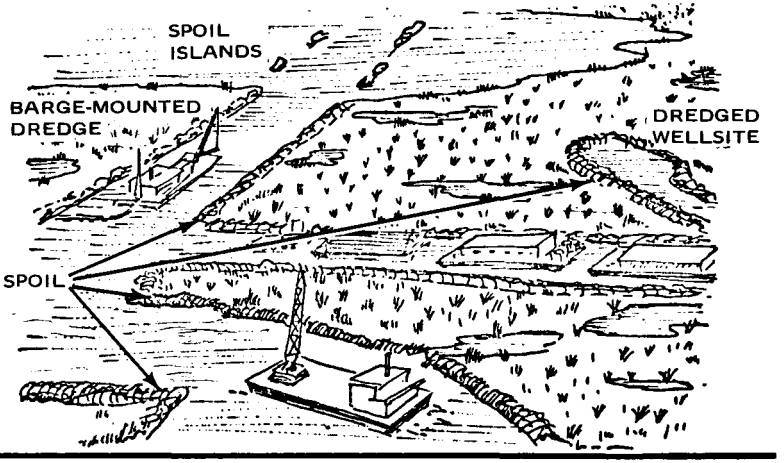
SATURATED WETLANDS & OPEN WATER-Site access and preparation

ACTIVITY

Wellsite Access and Construction. In regions where marsh soils will not support heavy equipment, bucket dredges or hydraulic dredges dig canal routes and build wellsites. If access is from open water toward a marsh, a hydraulic dredge excavates a channel. Spoil is usually submerged on both sides of the channel, but long slurry pipes may be used to transport the spoil far from the excavation site. In the marsh proper, dredged spoil material is typically deposited on one or both sides of the canal. Excavation proceeds at 40 to 300 m per day. The wellsite (typical dimensions are 47 by 133 m) is usually completely surrounded with spoil. No reserve pits are necessary; barges and steel tanks are used to contain the materials. Tugs, supply boats, and other small vessels are necessary auxiliary equipment.

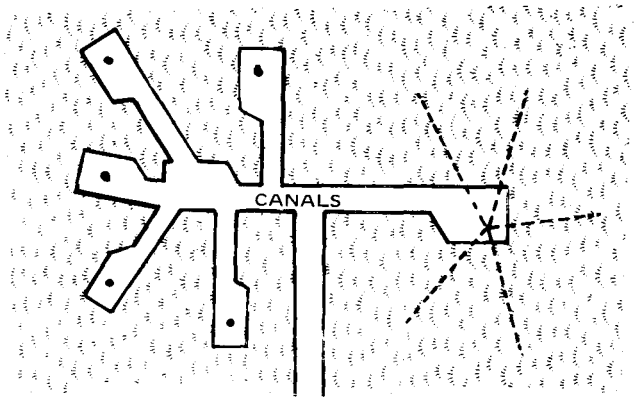
IMPACT

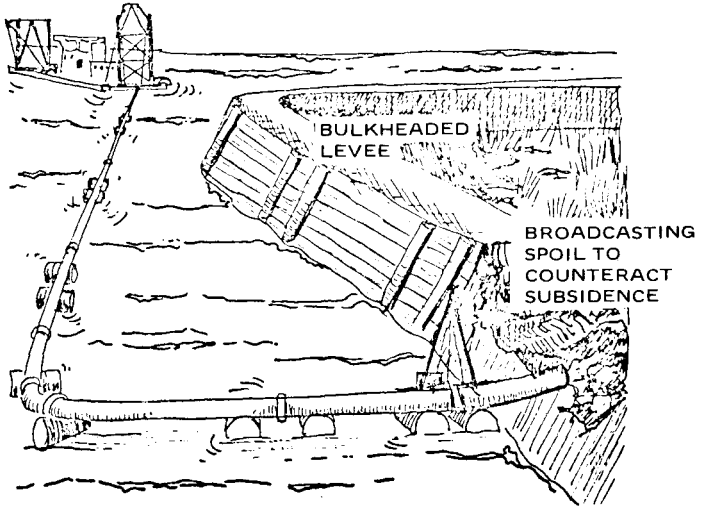
- Loss of vegetation and animals along canal route (20 and 25 m wide) due to excavation; spoil may cover an area up to 5 times the width of the canal; may alter up to 10 ha per km.
- Further loss of aquatic organisms, due to turbidity, sedimentation, and oxygen depletion from high levels of organic matter and limited circulation.
- Blockage of natural water flows by spoil and canal proper; establishment of new pathways (3 m deep) for water flow (possibly in and out of canal, diversion of currents, etc.).
- Creation of new habitat for aquatic species; in relatively fresh marshes, a less desirable waterfowl habitat results.
- Increased drainage of marsh; lower the water table of marsh; more frequent flooding by salt water.



COMMENTS

- Consider directional drilling for every proposed wellsite.
- Orientation of canal may greatly affect its impact; design channels so as to prevent water stagnation—where possible, make them short and straight; they should avoid natural creeks and swales in the marsh proper.
- Spoil-disposal sites and techniques should be carefully considered—retaining structures, turbidity control, broadcast versus distinct mounds and levees, etc.
- Where crossings of other watercourses are necessary, adequate plugs and bulkheading must be installed; plug widths may vary from 2 to 30 m, depending on soil composition and land uses; original plug height should take into account subsidence and shrinkage; spoil plugs may need to be heavily reinforced to withstand biological activity (cows, alligators) and poor-quality construction materials.
- Dimensions for adequate berms, the distance between canal edges and bases of spoil, may range from 5 to 15 m, depending on reinforcement structures, channel size, boat traffic, etc.
- Marsh surface traffic should be minimized and speed limits kept low to minimize erosion.





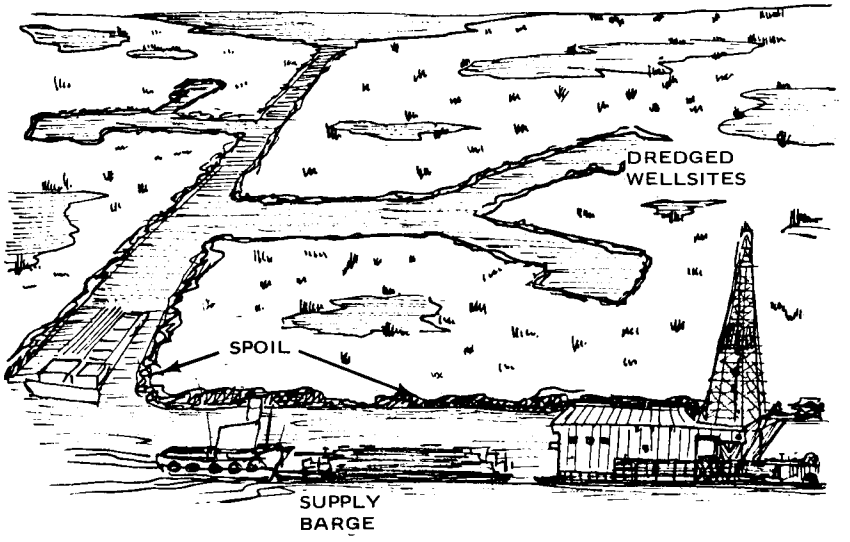
SATURATED WETLANDS & OPEN WATER - Drilling

ACTIVITY

Drilling. Supply lines and utility lines are placed along the edge of canals or buried. All equipment, supplies, and men are moved by barge or supply boats and housed on barges. Items include metal drilling-fluid containers, overland vehicles, and quarters for workmen. Helicopters or floatplanes may be used. The drilling rig, power plant, rotary table, crew facilities, and auxiliary equipment are all located on a single submersible barge. It is aligned over the wellhead, flooded so it settles to the bottom, and secured by driving spuds into the mud. A variety of vessels comprises the constant traffic to the wellsite 24 hours per day. The drilling schedule and well completion activities last 1 to 3 months. Drill cuttings and other wastes must be cleaned and oil-free if they are dumped in adjacent waters.

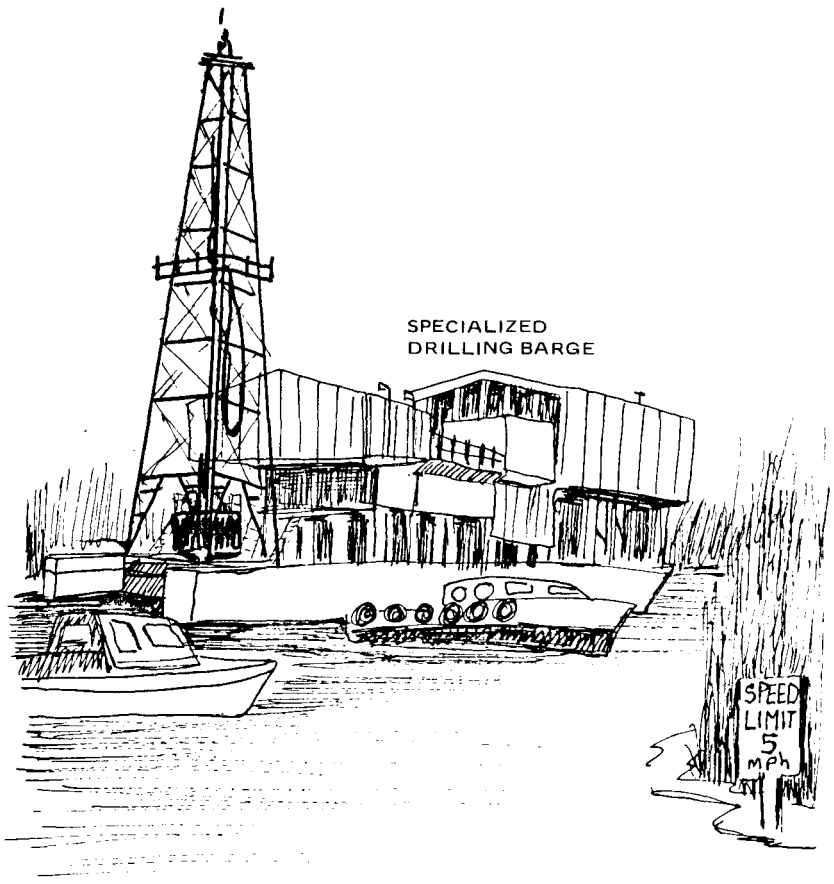
IMPACT

- High turbidity in access canals and wellsite area because of stirring of bottom and erosion of sides (boat traffic).
- Potential release of toxic or noxious substances into environment.
- Displacement of sensitive wildlife due to constant noise and activity.
- Erosion of wetlands from increased boat traffic.



COMMENTS

- If activity, supplies, and equipment are confined to barges, impacts are less severe than on land; care must be taken to avoid slipshod techniques and practices that result in materials entering the water.
- Booms may be strategically placed to control flotsam.
- Total volume and speed of boat traffic affects the turbidity load and wetland erosion.
- Proper scheduling can avoid seasons of wildlife and waterfowl concentrations.
- All drill cuttings and other wastes discarded in the area must be cleaned and pollution-free.



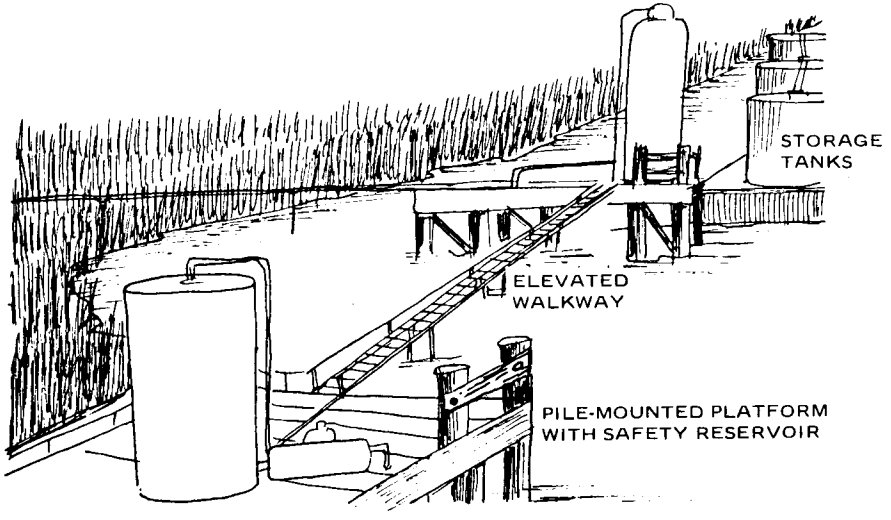
SATURATED WETLANDS & OPEN WATER - Production

ACTIVITY

Conversion of Well to Production. The types of production equipment are similar to those used for upland areas: pumps, regulators, separators, heater-treaters, and filters. This equipment is typically mounted on pile-foundation platforms located near the well-head; the latter is protected by pilings also. The total area occupied is usually less than 0.4 ha. Pipelines are installed to connect each piece of equipment. These activities may require 14 to 21 days. Maintenance dredging at 6-month to 5-year intervals is usually necessary for the life of the well (up to 50 years).

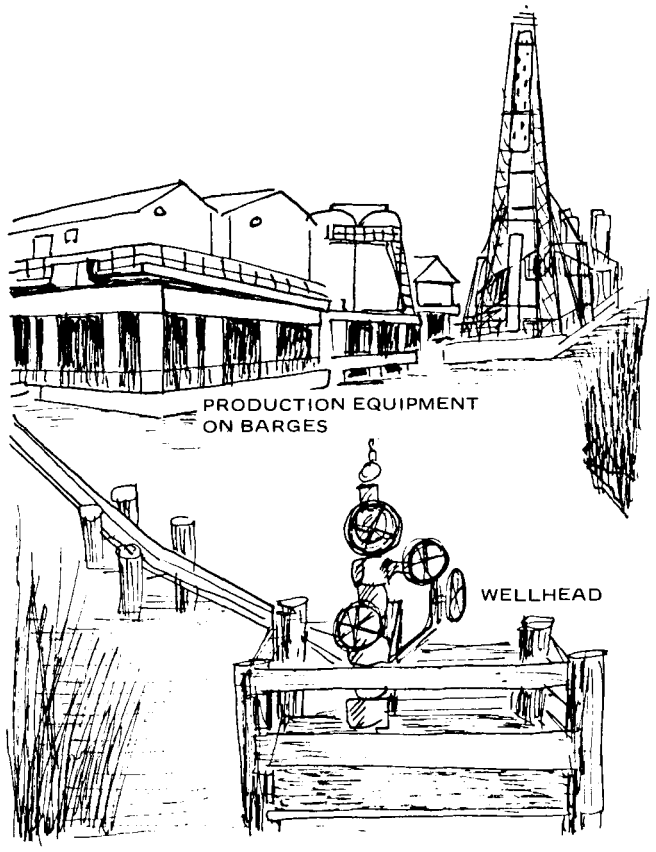
IMPACT

- Turbidity increases due to installation of pilings, frequent boat traffic, and maintenance dredging.
- Bottom-dwelling and some swimming animals displaced or killed—reestablishment after construction is typical.
- Loss of plants and animals if construction occurs on adjacent wetlands.
- Possible release of toxic or noxious substances during construction and operation.
- Flowlines frequently lose support as a result of erosion of canal banks.



COMMENTS

- Placement of equipment (and access to equipment) on pilings is preferable to using solid fill.
- Structures must be designed and installed to withstand all adverse conditions (hurricanes, high water, corrosion, boring organisms, etc.) that will be experienced for many years; equipment must be frequently serviced and/or replaced.
- Use of good techniques and practices during construction will minimize release of harmful materials into water; booms may be employed for containment of flotsam or spills.
- Disposal of salt brine and other wastes must be carefully planned and monitored; waste water production generally increases through lifetime of well.
- Specialized equipment (false bottoms and reservoirs to handle small spills or overspills) may prevent water pollution.
- Vessel speeds should be controlled to reduce erosion.



SATURATED WETLANDS & OPEN WATER - Production

ACTIVITY

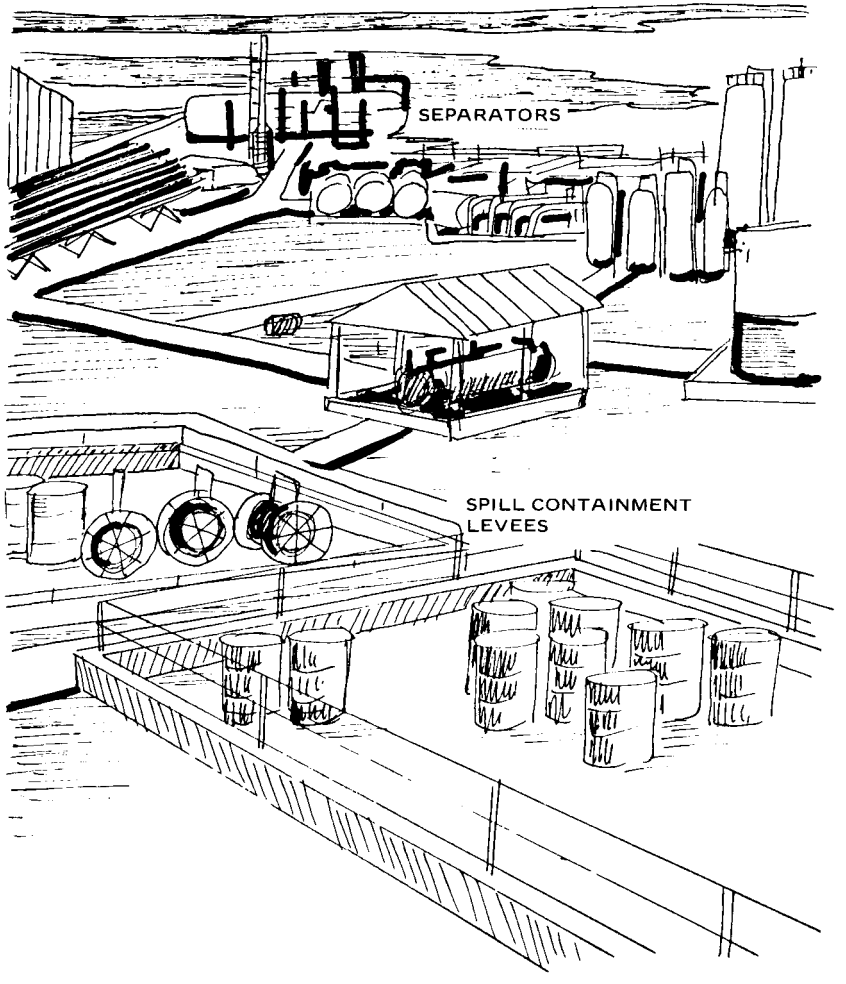
Placement of Centralized Production Facilities. Extensive centralized production facilities are used to collect, store, and further treat the petroleum products from individual wells. Equipment is usually placed on natural levees, pile-foundation platforms, large barges, or a combination of the three. Slips may be dug to accommodate and moor barges. Facilities may include monitoring devices, skimmers, separators, heater-treaters, stock tanks, chemical tanks, compressors, filters, pumps, and saltwater holding tanks; components are connected by buried or exposed pipelines. Placement may require 20 to 60 days. Brine frequently is treated, cleaned to remove oil, and discarded into nearby moving waters. Alternatively, it may be pumped into wells or to upland areas for treatment and disposal. Checking and monitoring activities occur daily; maintenance activities are frequent.

IMPACT

- Possible additional removal of vegetation and animals in areas ranging from 1 to 4 ha; benthic organisms typically become reestablished after construction.
- Turbidity increases due to installation of pilings, dredging of slips, and frequent boat traffic.
- Possible release of toxic or noxious substances during construction and operation.
- Waterflows are usually altered in some fashion; alignments and areas occupied determine severity of effects.
- Displacement of sensitive wildlife species during construction, monitoring, and maintenance activities.
- Controlled minor spills occur within the facility area.

COMMENTS

- Judicious placement of facilities can minimize loss of habitat and alterations of waterflows.
- Structures must be designed and installed to withstand all adverse conditions (hurricanes, high water, corrosion, boring organisms, etc.) that will be experienced for many years; equipment must be frequently serviced and/or replaced.
- Use of good techniques and practices during construction will minimize release of harmful materials into water; booms may be employed for containment of flotsam and spills.
- Disposal of salt brine and other wastes must be carefully planned and monitored; waste water production generally increases through lifetime of well.
- Specialized equipment (false bottoms and reservoirs to handle small spills or overflows) may prevent water pollution.
- Vessel speeds should be controlled to reduce erosion.



SATURATED WETLANDS & OPEN WATER - Pipeline installation

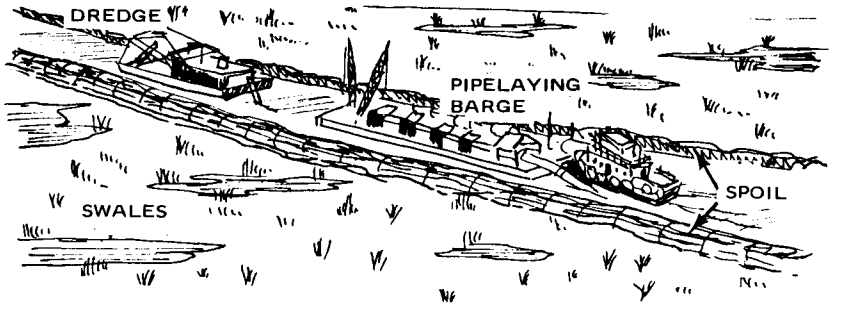
ACTIVITY

Pipeline Installation. All lines are elevated above water level or are buried. Large-scale pipeline construction requires a pipelaying barge that employs the "flotation" technique. Dredges excavate a flotation canal 15 to 20 m wide, which can accomodate the barge and its support vessels. A deeper, narrower ditch is dredged at the bottom of the wide canal, for the pipeline itself. Spoil is placed alongside the canal or pumped away from the site. All pipe-stringing work is done on the barge. As each section is joined, the barge moves ahead and the pipeline sinks directly into place. An alternative method is "jetting in." The pipe string is laid on the bottom of the canal, and a jet barge follows the submerged pipe, pumping high-velocity water around and under the pipe. This forms a trench into which the pipe settles; suspended sediment falls to the bottom and covers the pipe. In deeper water, a narrow ditch is dug or the pipe is directly buried by jetting. Placement by this means can proceed at a rate of 0.25 to 1.5 km per day. An alternative to the flotation method is the "push method" (page 42).

Plugs are necesary where the pipeline intersects existing watercourses and/or where saltwater intrusion may occur.

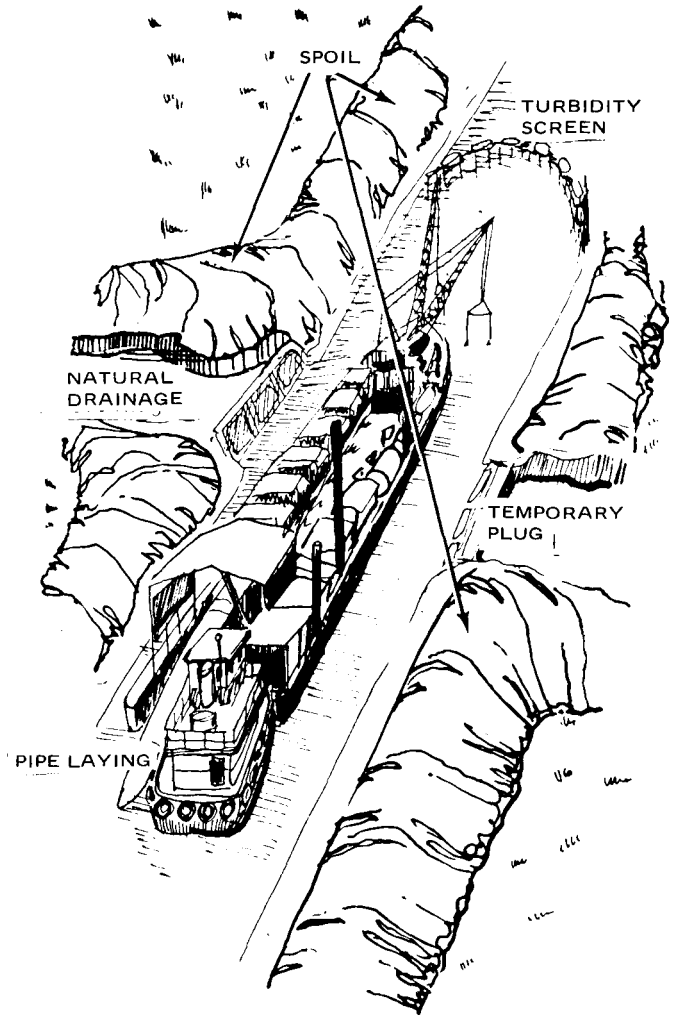
IMPACT

- Loss of vegetation and animals along the canal route due to excavation; spoil may cover an area up to 5 times the width of the canal.
- Further loss of aquatic organisms, due to turbidity, sedimentation, and oxygen depletion from high levels of organic matter and limited circulation.
- Blockage of natural waterflows by spoil and canal proper; gaps in spoil levees reduce alteration of natural drainages.
- Increased drainage of marsh; lower the water table of marsh; more frequent flooding by salt water.
- Creation of new habitat for aquatic species; in relatively fresh marshes, a less desirable waterfowl habitat results.



COMMENTS

- Confinement of pipelines to a corridor will minimize total area disturbed over long period of years.
- Push method is preferred whenever possible.
- Spoil disposal sites and techniques should be carefully considered: retaining structures, turbidity control, broadcast versus distinct mounds and levees, etc.
- Adequate plugs and riprap will decrease the mixing of intercepted water bodies (and will prevent unauthorized boat traffic); plugs may range from 2 to 30 m in thickness.
- Revegetation and other conservation techniques will decrease erosion problems.
- "Jetting in" results in less subaerial spoil.
- Marsh surface traffic should be minimized.



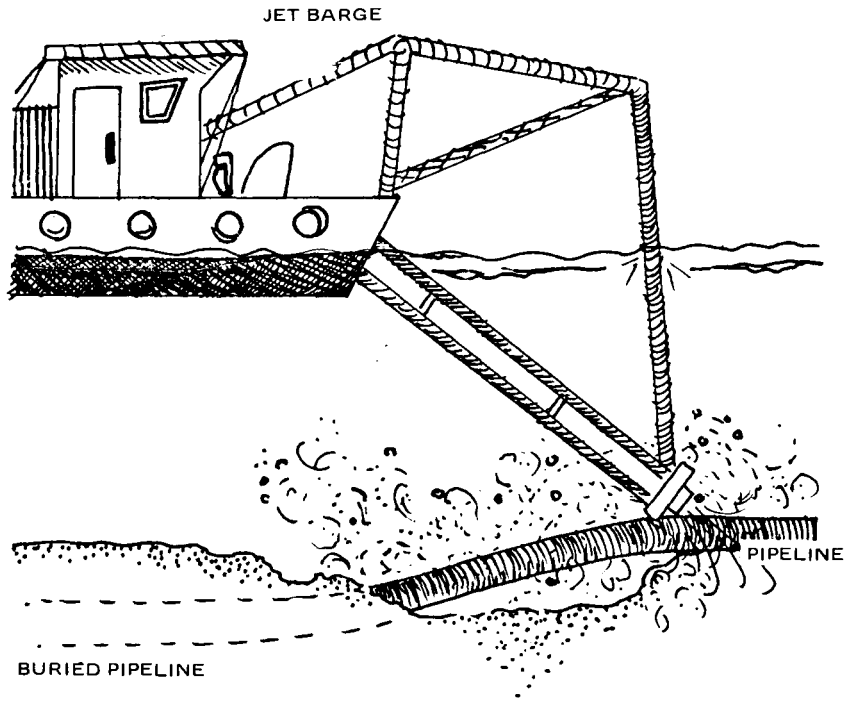
SATURATED WETLANDS & OPEN WATER - Pipeline installation

ACTIVITY

Crossing Rivers, Streams, and Other Obstructions. Pipeline may be bent upwards, emerge from the ground near the stream bank, and cross above the water level. Rivers with heavy traffic and other obstacles may be crossed by means of a suspension bridge high above ground and water level. If the pipeline is to be buried across nonnavigable streams, a partial diversion dam may be built so pipeline laying can proceed behind it; the dam is extended at the front of the pathway and removed at the rear. When pipelines are to be buried across navigable rivers, a trench is excavated by dragline or dredge. Usually, a pipe string long enough to cross the river is assembled and guided into position on floats. The floats are removed, the pipe sinks into position; and coarse filler, gravel, and rocks are used as backfill. A variation of this procedure is to use the jetting-in technique.

IMPACT

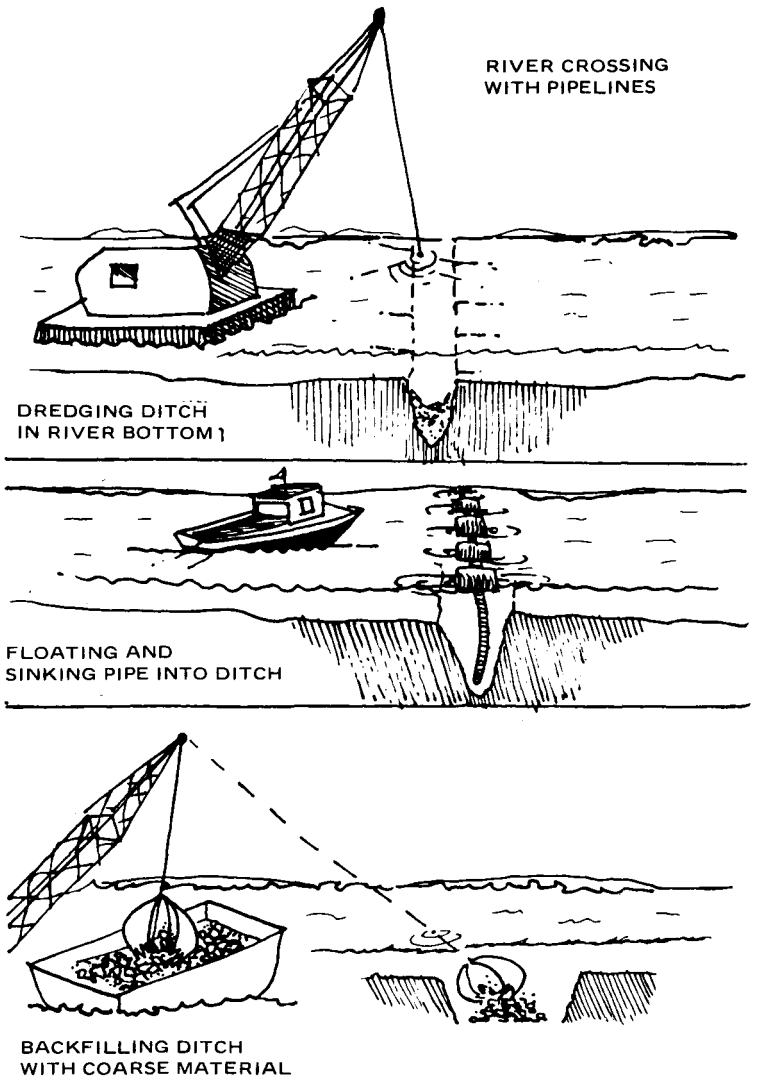
- Impacts are the same as pipeline installation in the appropriate systems—uplands, seasonally flooded wetlands, or saturated wetlands and open water.



COMMENTS

- Relevant comments and safeguards are found throughout other parts of this publication, particularly those sections dealing with dredging and spoil disposal.

- Spanning of waterways nearly always involves temporary alterations of waterflows, the source of the most significant impacts.



SATURATED WETLANDS & OPEN WATER–Spills and cleanup

ACTIVITY

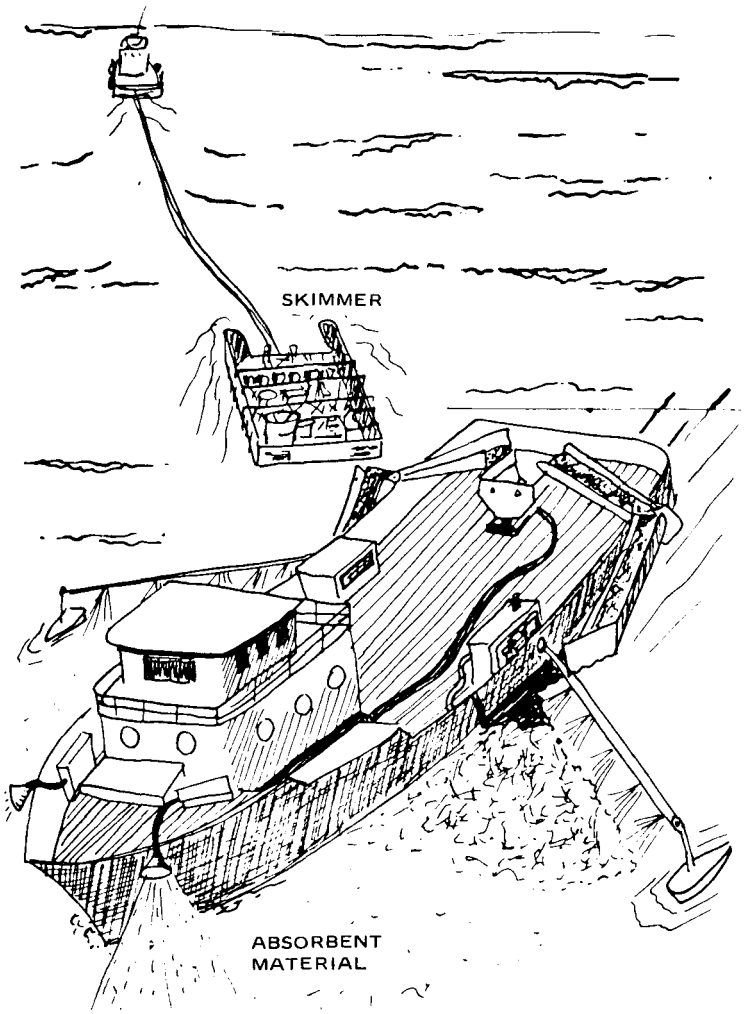
Spills and Cleanup. Containment of petroleum may require floating oil booms, surface dams, or piston film herders (chemicals that prevent the spread of surface films). Specialized equipment is frequently used to skim the petroleum from the surface. Hay or other absorbents can be spread, picked up, and burned. Petroleum-soaked vegetation is frequently cut and burned. In navigable waters the U.S. Coast Guard and the State, as well as the company responsible for the spill, are involved. Thus there may be several agencies involved in the cleanup. Cleanup activities must conform to State and Federal regulations.

IMPACT

- Wildlife, waterfowl, and additional aquatic organisms may be coated by petroleum; oil coating or cleanup operations may kill them.
- Loss of vegetation, due to spill or to surface travel with marsh buggies.
- Residual toxicants transported to adjacent systems, into water column, and into bottom sediment; nutrients and soil characteristics may be altered.

COMMENTS

- Knowledge and implementation of an efficient contingency plan is a must; primary actions should be to confine materials to smallest possible area; oil may spread quickly once it is on open water environments.
- Use of high-impact vehicles on marsh surfaces should be avoided.
- All dispersants, emulsifiers, and other chemical agents should be approved before use.
- Hazing techniques may be necessary to discourage use of the area by wildlife and waterfowl.
- Vacuum trucks and other terrestrial equipment can be barged in for cleanup.
- Restocking of organisms (oysters) may accelerate reestablishment.



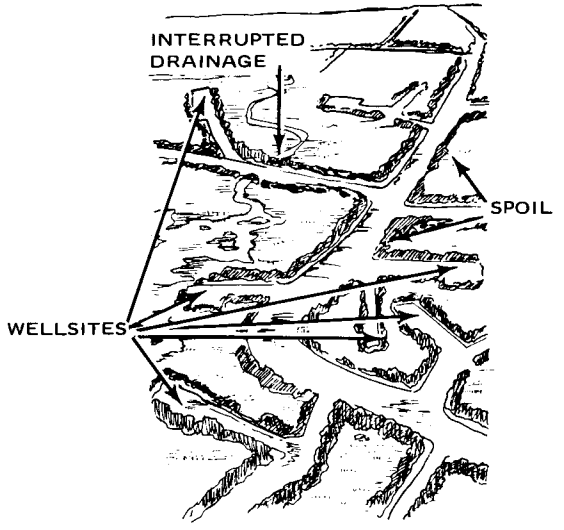
SATURATED WETLANDS & OPEN WATER – Termination

ACTIVITY

Well Shutdown. Dredging may be necessary to allow access for the small floating rig that pulls tubing and equipment from the well bore. The hole is filled with drilling mud capped with cement, and the casing is cut well below the water-sediment interface. Usable wellhead and auxiliary equipment is removed; platforms and pilings are disassembled so that no obstructions remain in the waterway. Operations may require 7 to 14 days. In a few rare instances, the wellsite or canal mouth may be plugged.

IMPACT

- Turbidity increases temporarily due to dredging and removing pilings and structures; use turbidity-control techniques whenever practicable.
- Petroleum and other wastes may accidentally spill during disassembly; some cleaned materials may intentionally be dumped in waterway.
- Petroleum-related pollutants will decrease over a long time period.
- Watefowl usage, vegetation and wildlife will increase.
- Wetland habitat will be lost unless restored.



COMMENTS

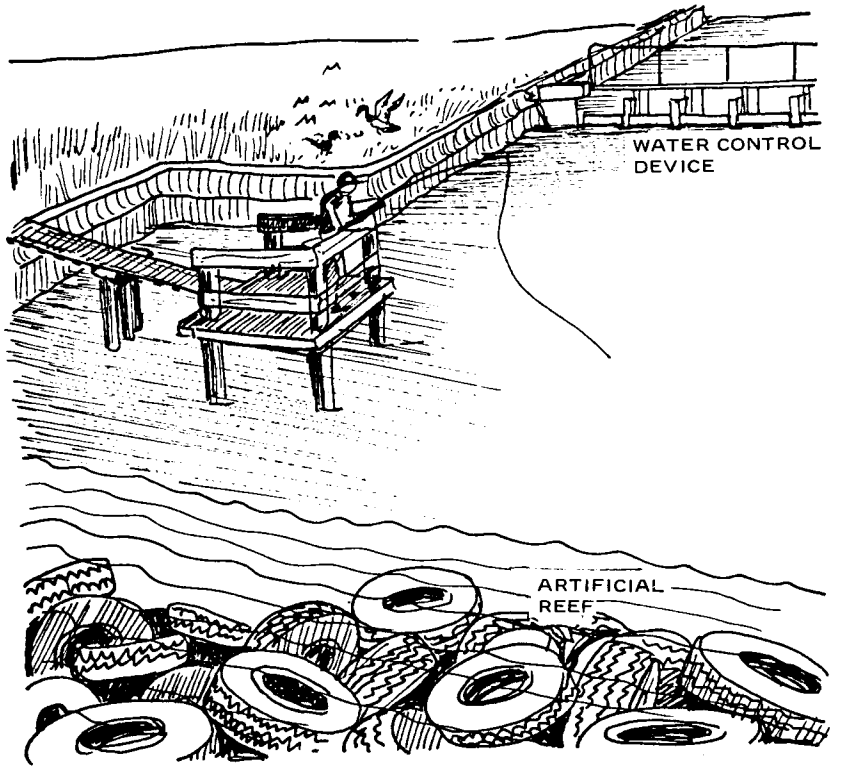
- Area should be evaluated for use as an enhancement to waterfowl and wildlife habitats, with minor modifications (construction of denning and breeding sites or partial breaching of spoil levees), or conversion to aquaculture operations.

- Habitat-improvement structures will facilitate reestablishment of fish or wildlife: grit pits, loafing islands, brush piles, artificial reefs, nesting and denning sites.

- Breached spoil levees (to restore water flows) may be preferable to complete backfilling.

- Riprap and/or revegetation will enhance effectiveness of plugs and decrease erosion of newly exposed spoil.

- Refilling and restoration of wetland will best return natural productivity.



APPENDIX

Common and Scientific Names of Vegetation

Common Name	Scientific Name
Arrowhead	*Sagittaria* spp.
Black rush	*Juncus Roemerianus*
Bluestem	*Andropogon* spp.
Bulrush	*Scirpus* spp.
Cattail	*Typha* spp.
Coontail	*Ceratophyllum* spp.
Cordgrass, saltmeadow	*Spartina patens*
Cordgrass, smooth	*S. alterniflora*
Duckweed	*Lemna* spp.
Glasswort	*Salicornia* spp.
Grass, panic	*Panicum* spp.
Groundsel bush	*Baccharis* spp.
Maidencane	*Panicum hemitomon*
Milfoil	*Myriophyllum* spp.
Oak, dwarf live	*Quercus* spp.
Oak, live	*Q. virginiana*
Paspalum	*Paspalum* spp.
Pondweed	*Potamogeton* spp.
Red bay	*Persea* spp.
Reed, common	*Phragmites communis*
Saltgrass	*Distichlis spicata*
Saltwort	*Batis maritima*
Sea oxeye	*Borrichia* spp.
Shoregrass	*Monathochloe littoralis*
Waterlily	*Nymphaea* spp.
Wax myrtle	*Myrica* spp.
Willow	*Salix* spp.