RPWG
JJ

Alaska Plant Materials Center

Annual Report 1989

Alaska Department of Natural Resources - Division of Agriculture

STEVE COWPER, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES

P.O. BOX 949
PALMER, ALASKA 99645-0949
PHONE: (907) 745-7200

DIVISION OF AGRICULTURE

FROM THE DIRECTOR

January 17, 1990

The Plant Materials Center (PMC) continues to struggle with a maintenance budget but still accomplishes its objectives and goals. Recently, the PMC has received authority to use program receipts and grant money. This new source of revenue was granted by the Alaska Legislature in 1989 and has enabled the PMC to use self-generated funds to fill gaps left by reductions in general fund allocations.

While these external monies have helped, the true force behind the successful operation of the PMC is the continued dedication and perseverance of the PMC staff. Their tireless efforts are unparalleled in state government.

The PMC has exceeded the goals established in the 1988 annual report, and we expect 1990 to bring further advances in public contact and interagency, national and international cooperation.

Last year, two PMC staff members were invited and travelled at their own expense to the Soviet Far East. These contacts led to discussions regarding the mutual exchange of plant material and information in the fields of agriculture and natural resource management.

The PMC also led the state in contacts with the Yukon Territory regarding agricultural development and land reclamation.

These international efforts give all the more credence to the Plant Introduction Station at the PMC, which will be operational by 1991. The division will attempt to secure funding to operate the station as soon as possible.

The Plant Materials Center will continue to be a shining star in the Division of Agriculture, provided acceptable funding levels are maintained.

The PMC staff prepared this annual report to inform you of its programs and contributions to the public in 1989 and also shares findings with farmers, horticulture and private industry in Alaska and other northern regions.

As Director of the Division of Agriculture, I take great pride in the PMC staff and what they have accomplished.

Frank Mielke

Frank Mielke, Director
Division of Agriculture

Alaska Plant Materials Center

1989 Annual Report

prepared by:

Stoney J. Wright
Manager, Plant Materials Center

Nancy J. Moore
Agronomist

Catherine I. Wright
Agronomist

William L. Campbell
Agronomist

Donald R. Ross
Agronomist

Dawnelle Sheaver
Secretary

January, 1990

Table of Contents

Table of Contents

List of Figures

List of Tables

List of Appendices

Introduction

The Alaska Plant Materials Center (PMC) is a section of the Division of Agriculture within the Department of Natural Resources. The Plant Materials Center's work furthers applied plant research for northern latitudes through two major programs: Revegetation and Seed Production, and Vegetable and Landscape Crop Improvement. Each of these programs will be addressed in this report.

Funding for the Plant Materials Center comes from the state's general fund. Additionally, the center brings in small amounts of revenue through cooperative projects with other agencies and the private sector and through the sale of plant materials.

History

Early attempts to establish a federal Plant Materials Center in Alaska were unsuccessful because the U. S. Department of Agriculture believed that the centers at Pullman, Washington and Corvallis, Oregon could serve the needs of Alaska.

The Alaska Legislature was not discouraged, and, at the urging of the University of Alaska, conservation groups and farmers, prepared legislation that would establish the Alaska Plant Materials Center.

In 1972, Governor Bill Egan signed into law a bill creating the Alaska Plant Materials Center. This legislation directed the Plant Materials Center to fulfill several traditional agricultural responsibilities and to develop plant varieties and techniques for revegetation and erosion control and provide technical reclamation assistance to industry.

Soon after the Plant Materials Center bill was enacted, 285 acres near Palmer were selected for the center's site. An additional 120 acres were acquired through a land exchange with the Matanuska-Susitna Borough in 1982. This gave the PMC a total of 405 acres to accomplish its mandated duties which now included revegetation work, horticultural development, foundation seed production and disease-free potato seed stock production.

Within a dozen years after its founding, the program grew to include horticultural development and disease-free potato seed production projects. In 1987, the PMC's programs were consolidated into the two programs it carries out today: the North Latitude Revegetation and Seed Production Project and the North Latitude Vegetable and Landscape Crop Improvement Project.

North Latitude Revegetation & Seed Production Project

The Revegetation and Seed Production Project's products and methods are used to encourage a healthy seed industry and develop new plant materials and methods for land reclamation and erosion control. These two functions are complementary.

Revegetation & Reclamation Efforts

The construction of the Trans Alaska Pipeline in the 70s triggered the current reclamation research activity in Alaska, however, since the pipeline, ideas associated with revegetation have changed. Continued oil development, renewed interest in surface and placer mining, as well as new federal, state and local regulations have caused applied research activities to address "reclamation" as defined by regulations, which in some cases has precluded the use of "traditional" plant material and planting technology.

The Alaska Plant Materials Center continues to lead Alaska in reclamation and erosion control. The use of dormant seedings to extend planting seasons, cost-effective and successful methods in willow planting, and wetland and coastal restoration are priorities for the Plant Materials Center.

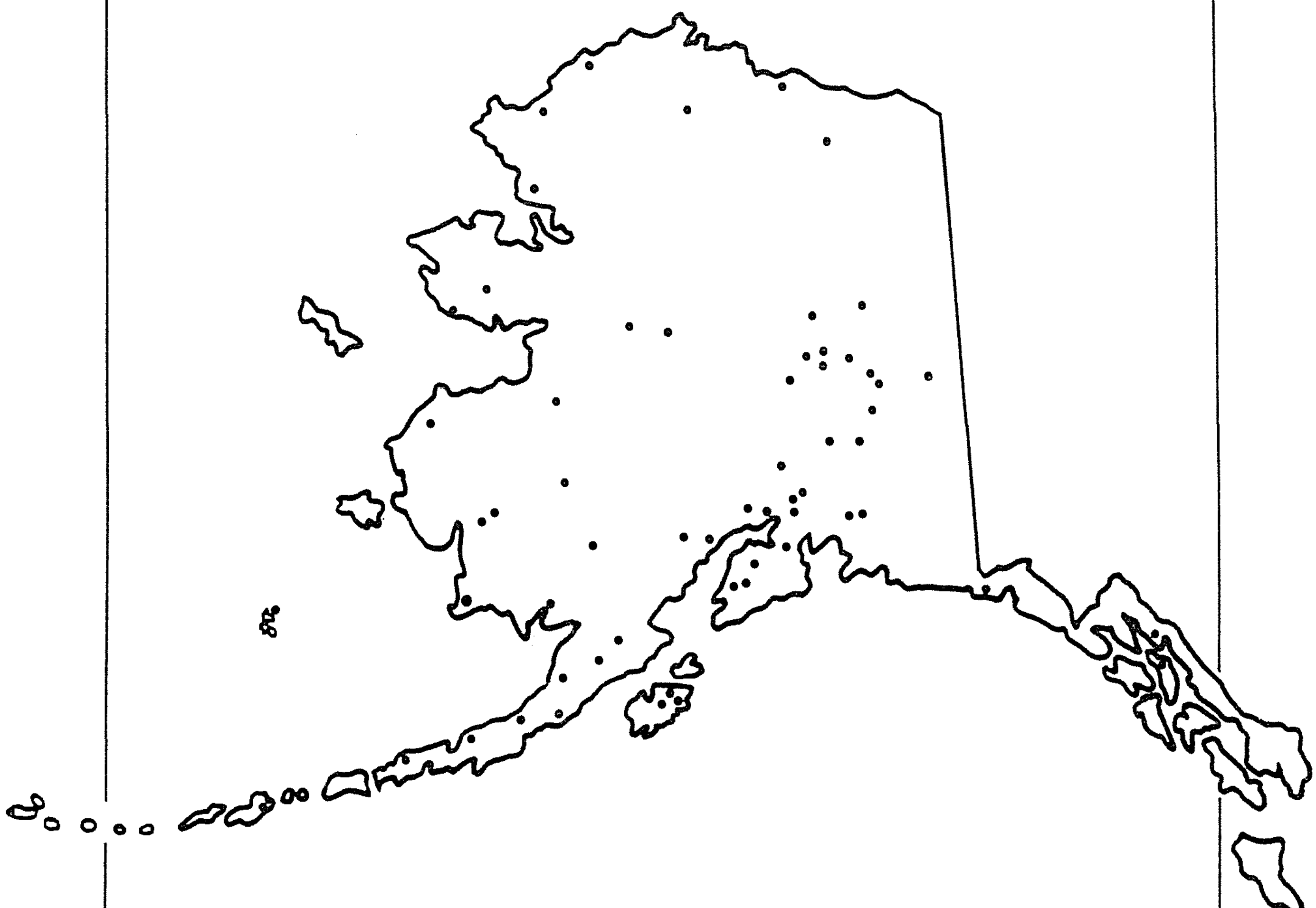
The project follows seven basic steps to establish a resource of conservation plants for use in land reclamation, wildlife habitat improvement and erosion control. They are: 1) Define and anticipate conservation problems and establish priorities; 2) research and assemble candidate plant materials; 3) conduct initial evaluations; 4) establish small scale seed or vegetative increases; 5) advanced and final testing and field evaluation plantings; 6) establish large scale seed or vegetative increases; and, 7) release of a variety or cultivar.

To date, this program has gathered 162 plot years of information collected from sites around the state (Figure 1), developed 7 new cultivars for revegetation and reclamation and assisted scores of agencies and private companies in reclamation, erosion control and revegetation. Figure 2 represents a typical plot layout used in off-site evaluations.

This report outlines some of the present revegetation and reclamation research being conducted by the PMC and summarizes current activities at sites around the state. Additional information can be found in the individual reports that are listed elsewhere in this report. Copies of the reports are available from the Alaska Plant Materials Center.

Figure 1

Map of Alaska Plant Materials Center Plot Locations



Alaska Plant Materials Center Advanced Evaluation
and Demonstration Plot Network Representing
184 Plot Years as of 1989

Figure 2 - Typical Plot Layout

Nugget Kentucky Bluegrass	Merion Kentucky Bluegrass
Park Kentucky Bluegrass	Banff Kentucky Bluegrass
Sydsport Kentucky Bluegrass	Fylking Kentucky Bluegrass
Poa Ampla	Troy Kentucky Bluegrass
Sherman Big Bluegrass	Canbar Canby Bluegrass
Tundra Bluegrass	Reubans Canada Bluegrass
Poa Glauca T08867	Poa Alpina
Agropyron Subsecundum 371698	Sodar Streambank Wheatgrass
Nordan Crested Wheatgrass	Agropyron Subsecundum
Fairway Crested Wheatgrass	Agropyron Violaceum
Summit Crested Wheatgrass	Agropyron Boreal
Critana Thickspike Wheatgrass	Agropyron Yukonese
Fults Alkaligrass	Vantage Reed Canarygrass
Climax Timothy	Engmo Timothy
Elymus Arenarius	Elymus Sibiricus 34560
Elymus Sibiricus 1966	Elymus Sibiricus 2144
Norcoast Bering Hairgrass	Tufted Hairgrass
Sourdough Bluejoint	Calamagrostis Canadensis
Meadow Foxtail	Alopecurus Geniculatus
Garrison Creeping Foxtail	Arctared Red Fescue
Boreal Red Fescue	Festuca Scabrella
Beckmannia	Pennlawn Red Fescue
Durar Hard Fescue	Highlight Red Fescue
Covar Sheep Fescue	Manchar Smooth Brome
Alyeska	Carlton Smooth Brome
Tilesy Sage	Polar Brome

Adak Naval Air Station Erosion Control & Reclamation Project

As a result of the successful Shemya Air Force Base Beach Wildrye project, the U. S. Navy asked the PMC to assist in developing a Natural Resource Management Plan for Adak Naval Air Station.

The Navy project involved all aspects of sand erosion control, lawn establishment, mine restoration and base landscaping.

As a result, several plots were established to evaluate species for the following purposes:

1. Beach stabilization using transplanted Beach Wildrye sprigs and the enhancement of natural stands of Beach Wildrye through the use of fertilizer.
2. Landfill, quarry and World War II structure site restoration and land rehabilitation using seeded species.
3. Landscaping for beautification and morale purposes using hardy species.
4. Additional plots were established to test new plant material being developed by the PMC. These plots include native trees, shrubs, forbs and grass. The plots are located on a variety of sites on the base.

This project started in May 1988 and will continue through 1990. The Navy will reimburse the PMC $ 27,100.00 by 1990 for personal services, transportation and supplies.

The first years's work was successful, and the Navy expanded the PMC's role in 1989. In 1989, selected sites within the housing areas were seeded to control sand erosion and enhance the appearance of the base. Also in September, 1989, additional PMC services were requested in the area of horticultural landscaping. These 1989 efforts were successful and have led to possible expanded roles for the PMC on Adak through 1992.

A complete report will be prepared in October, 1990 covering the initial program at Adak NAS.

Red Dog Mine Revegetation & Demonstration Plots

This project grew out of a mutual need for information. The PMC required revegetation data from northwestern Alaska, and Cominco needed information on species that would perform well in future mine revegetation programs. In 1987, Cominco agreed to provide the PMC with a site to establish evaluation and demonstration plots.

In order to provide the best information for both the PMC and Cominco, three plot sites, representing different conditions were selected. A site was selected near the Port Site. This site was a sandy-gravel beach area common to the region. The second site was at the original camp site fuel bladder containment area. The third plot was similar to the camp area, but provided a site to compare spring and fall seedings.

This combination of plots is intended to supply data for revegetation species selection and time of seeding. The Port Site plot was planted on July 6, 1987. This site will provide information regarding revegetation in the coastal portion of the mine project.

A dormant plot was seeded at the Camp Area on September 8, 1987. Because of space limitations, the plot dimensions were slightly reduced and 12 accessions were dropped from the plot. The accessions that were eliminated are species that have failed elsewhere in Alaska. Their elimination from the plantings should not compromise the value of the information obtained from these plots. The third plot, planted on June 15, 1988, was placed on gravely soil similar to the surface that will exist when construction is complete.

The evaluation process for these plots will be continued for a period of four growing seasons after planting.

A major demonstration planting was established on June 14, 1988. This plot, an abandoned disposal site north of the Port Site, was recontoured and seeded entirely with native species. It will also be evaluated for four growing seasons. The completion of the evaluation program is scheduled for September, 1990, at which time a final comprehensive report will be prepared for Cominco.

In 1989, the PMC assisted Cominco in a project intended to revegetate all the major stream crossings on the Access Corridor. Initial results of this project, which used a seed mix composed entirely of native species, is promising.

Steese - White Mountan Mining District

In June, 1988, the Plant Materials Center (PMC) in cooperation with the Bureau of Land Management (BLM) Steese-White Mountain Mining District, established revegetation test plots on recontoured mining tailings. Each plot consisted of 50 smaller plots containing 49 grasses and one forb.

The BLM selected three sites in the district that had been recontoured and should not be disturbed for several years. A total of four evaluation plots were planted; two replicates of the plots were planted at the Birch Creek site, Mile 98 of the Steese Highway. This site is visible and readily accessible from the highway and hopefully will serve to inform others of the possibilities for revegetation. Other plots were planted at Nome Creek and Hope Creek, both of which were several miles off the Steese Highway. Staff from the Fairbanks BLM office volunteered their time to help layout, seed and fertilize the plots.

All of the plots looked relatively good after the first winter and second growing season except for the Birch Creek #1 plot. This plot was planted on a bench approximately four feet above the mean water level in a small side channel of Birch Creek. During high water, the creek changed its course and the side channel became the main channel. As a result, 75 percent of the plot was lost due to erosion.

The performance of the accessions varied between varieties and sites. However, the following accessions performed the best: 'Nugget' Kentucky Bluegrass, Big Bluegrass 387931, two native wheatgrasses, Agropyron boreal and A. yukonese, 'Nortran' Tufted Hairgrass and 'Arctared' and 'Boreal' Red Fescue. The plots will be evaluated on an annual basis through 1991 at which time a final report will be prepared describing the performance of the plots and making recommendations for revegetation of mine tailings for the area.

A cooperative agreement was signed with BLM for additional mine site revegetation work for the 1989 season. BLM staff selected mine tailings left from the 1930s in the Maze area along Nome Creek for the test site. Three treatments were tested and each treatment was replicated three times. Ten different revegetation species were planted in adjacent plots for one treatment. Another treatment consisted of seeding a site with a mix of the ten species. All sites were fertilized and the final treatment consisted of an application of fertilizer only.

Plant establishment varied considerably and was very localized. The seeded species appeared to grow best at sites that contained some fines, in depressions where a more favorable moisture regime would exist, and also at those sites where the native vegetation had already become established. Performance of the seeded species cannot be effectively evaluated until the plantings have gone through at least one winter and preferably two to three growing seasons.

The native vegetation responded favorably to the fertilizer. Plants receiving fertilizer were greener than those plants growing nearby that did not receive fertilizer. Seed production may have been increased in some of the forbs and some of the willows showed a current annual growth of 20-24 inches compared to 2-4 inches for the previous year.

Although these sites need to be evaluated for a couple of years before any conclusions can be drawn, the plants do appear to benefit from fertilizer by increased growth and also possibly by increased seed production. The best treatment for these sites may be to periodically apply fertilizer to enhance native plant cover.

Nome Mine Site Revegetation Plots

In 1989, the Soil Conservation Service (SCS) requested the PMC's assistance to establish evaluation plots at various mine sites in the Nome area. On June 21 and 22, 1989, three diverse sites were planted with 44-47 varieties that have been planted in other evaluation plots around the state. The sites varied in moisture regimes as well as substrate characteristics. One site contained a highly organic substrate, while the other two sites contained a more mineral substrate. All sites contained adequate fine material for plant establshment.

The plots were evaluated on September 14, 1989. All plots had become well established. The plot containing high organic content supported a 65 percent moss and vascular plant cover in addition to the seeded grass species.

These plots will continue to be monitored for three more growing seasons. After the final evaluation, a final report will be prepared.

Fairbanks Division Of Mining Demonstration Plantings

The Plant Materials Center and the Fairbanks Office of the Division of Mining (DOM) established demonstration revegetation plantings on recontoured mining tailings in the Fairbanks area. Division of Mining selected two sites each with four to five acres that would be left undisturbed for several years for the demonstration plantings.

The A. J. Taylor mine site was naturally divided into two segments by a creek. Most of the site was scarified and then each segment was divided into three plots. Each plot received one of the following treatments: seed and fertilizer, fertilizer only, or no treatment at all. The unscarified area was divided into two plots, one of which was fertilized; the other was untreated.

At the end of the growing season, the scarified plots that received seed and fertilizer exhibited the highest plant cover. The existing vegetation in the unscarified plot which received fertilizer showed a pronounced increase in growth compared to the vegetation in the unfertilized plot.

The second site provided several diverse areas for the revegetation demonstration. The remnants of the settling pond contained a broad area of moisture-saturated mineral soil which was seeded with Egan Sloughgrass. Floods that occurred in midsummer before the grass became well established, eliminated any trace of the planting.

Another area planted was composed primarily of overburden. The area was divided into six plots, two were unscarified, one of which was fertilized, the other was left untreated. The remaining four plots were scarified, one was seeded with no fertilizer, one was seeded with fertilizer, another was not seeded but fertilized and the fourth plot was a control.

Additional isolated areas that consisted primarily of mine tailings were seeded and fertilized.

The seed mix that was used for all of the plantings consisted of Arctared Red Fescue, Gruening Alpine Bluegrass, Norcoast Bering Hairgrass, Alyeska Polargrass, Sourdough Bluejoint and Caiggluk Tilesy Sage. The plots were fertilized with 20-20-10 fertilizer which was applied at a rate of 450 pounds to the acre.

Both native vegetation and the seeded grasses benefited from the fertilizer. The plots that exhibited the highest plant cover were those that had been seeded and fertilized.

The plantings at these two sites demonstrate that a wide variety of substrates can support seeded grasses. As these sites are observed over the next few years, hopefully people will recognize that placer mine revegetation is possible with minimal effort.

Interior Alaska Evaluation & Demonstration Planting

Over the years, a variety of efforts have been made to establish an Interior Plant Materials Center (PMC). In lieu of developing an Interior PMC, the PMC, in cooperation with the Fairbanks Soil and Water Conservation District, decided to establish an evaluation and demonstration plot in the Eielson Agricultural Development. A farmer has provided up to five acres of newly cleared and prepared land for a variety of plots which will evaluate revegetation plant materials, grains and horticultural plants.

In 1989, three revegetation evaluation plots and one demonstration plot were planted. The site was in excellent condition. By fall, the plantings had grown very well. The only areas that showed poor vigor were the edges of the plots where the fertilizer was probably applied at a lower rate.

Evidently, the soils in the Eielson Agricultural Project are nutrient poor and crops are heavily dependent on fertilizer. Since our plots are fertilized at the time they are planted and then left without any further fertilizer applications, it will be very interesting to watch how these plots perform over the next few years. No trends in performance can be reported for the first year's growth. Evaluations will need to be conducted over the next several years before any recommendations can be made.

Branching Out Into Southeast Alaska

After trying for many years to establish evaluation plots in Southeast, the North Latitude Revegetation and Seed Production Project finally was able to develop a cooperative agreement with two mining companies in the Juneau area. Green's Creek Mine on Admiralty Island, and Echo Bay Mining Company in Juneau agreed to pay travel and per diem for PMC staff to come to their sites and establish spring and fall evaluation plots. The PMC provided seed and labor.

Green's Creek Mine

Because Green's Creek Mine is within the boundaries of Admiralty National Monument, the U. S. Forest Service limited the species that could be planted to those that were known to occur on the island. As a result, the plots contained only 15 accessions compared to 48 to 50 accessions that are normally planted. Two spring plantings were established at one site. In the fall, two more plantings were established at two different elevations. All plantings were fertilized with 20-20-10 fertilizer at a rate of 450 pounds per acre.

The spring plantings were evaluated at the same time that the fall plantings were planted. One of the spring plots had been disturbed during the summer and some of the plantings were completely destroyed. Data collected from the undisturbed plot indicated that the best performing accessions after one growing season were 'Boreal' and 'Pennlawn' Red Fescue. Evaluations will need to continue over the next three years before any recommendations can be made based on these plantings. A complete report will be prepared at the end of the evaluation period.

Echo Bay Mines

During the summer of 1989, a total of three plots, each containing 40 to 46 taxa, were established at Echo Bay Mine sites. Two spring plots and one fall plot were planted. One of the spring plots was planted at a sandy location near the office building. The other spring plot and the fall plot were planted near the mine portal in the Sheep Creek Valley. The Sheep Creek site was more gravelly than the office site.

Numerous accessions performed very well at both sites. It will be necessary to continue evaluating the plots to determine the best accessions for these sites.

Valdez Oil Spill Grant

On April 20, 1989, the PMC was notified that Governor Cowper accepted its proposal to assess oil spill damage to Beach Wildrye communities in Prince William Sound. The proposed study would have identified damage communities, rated damage and potential natural recovery, and if necessary, developed reclamation plans to restore these impacted communities.

Unfortunately, money was not released by the responsible state agency in a timely manner and the study was not attempted. Other unwarranted policies developed by the lead state agency, along with a significant reduction in the available funds, made the study unattractive to the PMC.

Perhaps in 1990 the study can proceed in a timely and acceptable manner.

Upper Susitna Demonstration & Evaluation Plots

The Plant Materials Center (PMC) and the Upper Susitna Soil and Water Conservation District established demonstration and evaluation plots near Trapper Creek in June, 1987. The former hay field was plowed and cultivated by the landowner and the plots were seeded and fertilized by staff from the PMC and the Palmer Soil Conservation Service.

The evaluation plots, consisting of 50 grasses and 1 forb planted in 4 x 10 foot areas, were replicated three times; a fourth plot contained rod rows, 20 feet long, of the same collection of plants as the broadcast plots. The demonstration plot consisted of 18 plant varieties recommended for the area by The Revegetative Guide for Alaska. These plantings were made in 20 x 60 foot plots; each 20 foot section received different fertilizer applications.

The plants germinated and became well established, but in many cases the plants were obscured by timothy and hemp nettle. In the spring of 1988, the plots were sprayed with 2,4,D, which was relatively ineffective in killing the broadleaf weeds. In July, the PMC decided to spray the entire plot with a broad spectrum herbicide and replant in June, 1989.

Prior to planting in June, 1989, the site was sprayed again with a broad spectrum herbicide and allowed to stand for one week before planting. The site was disked and large clumps of vegetation were removed by hand from each of the plots before planting. We were concerned that if the herbicide had not effectively killed the weeds, we would lose our plantings again.

Staff from the Palmer Soil Conservation Service and the PMC reseeded the site. Three evaluation plots and one demonstration plot were planted. The rod row plot (1987) was eliminated. The plots were evaluated in September. Although one plot was quite weedy, the plots overall were much cleaner than the 1987 planting. Evaluations were made and will continue over the next three years. Another broadleaf herbicide treatment may be necessary to sufficiently control weeds over the evaluation period.

Our test sites are not irrigated and the lack of precipitation prevented germination from occurring in any of the plots for at least one month after planting. Even so, most of the accessions performed quite well during the first growing season. We will be able to make seeding recommendations based on the results from these plots in a couple of years.

Kuparuk Arctic Pendant Grass Study

In 1985, the Plant Materials Center and ARCO Alaska, Inc., established a cooperative agreement to evaluate revegetation techniques with an emergent grass species, *Arctophila fulva*. During the past four field seasons, two PMC staff have spent two to three weeks each season in the Kuparuk Field wetlands, transplanting Arctophila and evaluating the success of the plantings. Various planting locations and planting techniques have been tested and have met with a wide range of success.

During 1987 and 1988, general laborers conducted the plantings while being supervised by PMC staff. An ARCO contractor supplied laborers the first year, and the PMC supplied four laborers from their staff during 1988. This phase of the study evaluated the ability of general laborers to harvest and transplant Arctophila. The primary focus of the investigation has centered on the issue that if Arctophila can be transplanted successfully, then is it economically feasible, and/or what is the cost of transplanting Arctophila with an unskilled labor force?

No new plantings were conducted during the 1989 season. However, data was collected on the survival of the various plantings conducted over the years. Analysis of the data should begin to answer some of the questions, and will be presented in a final report that will be completed in early 1990.

Kenai Wetland Restoration Plots

In April, 1989, the PMC was contacted by an engineering company and requested to restore an area of illegal fill on a wetland. The PMC responded with a plan acceptable to both the Corps of Engineers and the Alaska Department of Fish and Game.

The plan utilized a seed mix containing native species adapted for wet sites. The mix relied heavily on 'Egan' American Sloughgrass, a cultivar released by the PMC. Initial results appear promising. Unfortunately, during the scheduled evaluation in September, 1989, the Kenai River was running high and was covering the plots. The flooding prevented the plots from being evaluated satisfactorily.

An effort will be made to evaluate the site in 1990 and again in 1991.

Fort Richardson Off-Road Vehicle Trail Restoration Project

This project, initiated in June 1988, was requested and funded by the U. S. Army at Fort Richardson and the Corps of Engineers Cold Regions Research Laboratory at Hanover, New Hampshire. Its basic purpose is to demonstrate alpine restoration of the trail system damaged by unauthorized civilian off-road vehicles (ORV), and to develop techniques for large-scale alpine revegetation.

The results of this study will be useful as Southcentral Alaska expands its winter recreation areas.

This project will provide results on alpine streambank revegetation, alpine wetland revegetation and revegetation of extremely dry, gravely, alpine sites. Off-road vehicle use continued during the first year of this project and damaged a portion of the plot area, however, the study has not been severely impacted at this time.

Although an occasional ORV passes through the sites, very little additional damage has occurred to the plots. Evaluations occurred in September, 1989 and some trends in performance of the grasses appear to be emerging. 'Norcoast' Bering Hairgrass and 'Arctared' Red Fescue have been the most consistent and best performing varieties at all of the sites. 'Gruening' Alpine Bluegrass has also performed reasonably well, but it has received lower ratings because the grass blade tips have been chlorotic. Results from the evaluation plot, which was planted with 50 different varieties, suggest that there is another species, 'Nortran' Tufted Hairgrass, that should be included in future trials.

The plots will continue to be evaluated for two more growing seasons, and at that time a final report will be prepared.

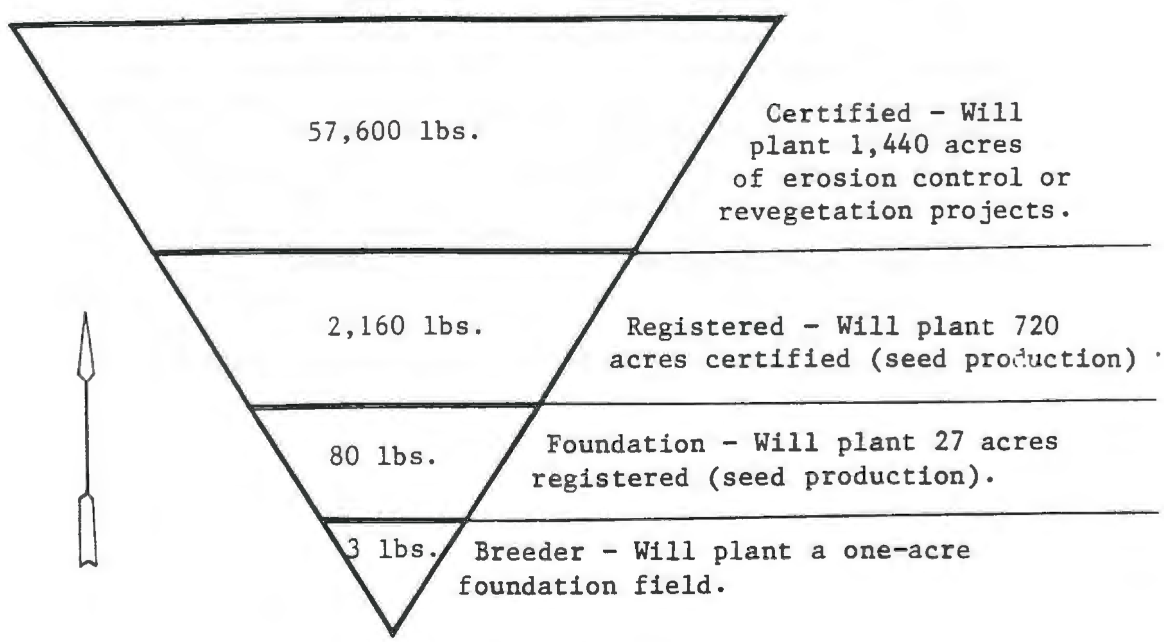
Foundation Seed Program

This section of the North Latitude Revegetation and Seed Production Project increases and preserves cereal grain and grass varieties developed especially for the growing conditions prevalent in Alaska and other northern latitude countries.

Small amounts of "breeder" seed are obtained from the University of Alaska, Agricultural and Forestry Experiment Station, PMC breeder plots, or other northern latitude sources. This seed is planted, grown, and processed at the PMC according to standards and procedures that ensure genetic purity, absence of noxious weed seeds, and freedom from injurious plant diseases.

The progeny of breeder seed, designated "foundation" seed, is made available to the industry through the state's seed certifying organization, the Alaska Seed Growers, Inc., in conjunction with the state Division of Agriculture. This process ensures that farmers growing "registered" (progeny of foundation) and "certified" (progeny of registered) classes of seed meet all requirements of genetic purity and cleanliness, and are in compliance with state seed regulations and the Federal Seed Act.

Figure 3 - Seed Increase Pyramid



This illustrates the increase of three pounds of breeder seed to a commercially useable quantity. Clean seed yield is based on 80 lbs./acre. The planting rate is based on 3 lbs./acre for seed production and 40 lbs./acre for reclamation purposes.

Table 1 - Revegetation and Turf Varieties in Production in 1989

Variety	Class	Acres
'Nugget' Kentucky Bluegrass	Foundation	5.0
'Arctared' Fescue	Foundation	5.0
'Norcoast' Bering Hairgrass	Foundation	3.0
'Polar' Brome	Foundation	2.9
'Tundra' Glaucous Bluegrass	Foundation	0.1
'Kenai' Polargrass	Foundation	2.0
'Sourdough' Bluejoint	Foundation	1.4
'Gruening' Alpine Bluegrass	Foundation	1.0
'Egan' American Sloughgrass	Foundation	1.0
'Nortran' Tufted Hairgrass	Foundation	1.0
'Alyeska' Polargrass	Foundation	1.0
'Egan' American Sloughgrass	Breeder	1.0
'Gruening' Alpine Bluegrass	Breeder	1.0
'Service' Big Bluegrass	Breeder	1.0
'Caiggluk' Tilesy Sage	Breeder	1.0

Table 2 - Cereal grain seed & oil seed varieties in storage at the Plant Materials Center, December, 1989

Barley		Wheat		Oats		Rye		Rapeseed		Buckwheat	
Variety	Tons	Variety	Tons	Variety	Tons	Variety	Tons	Variety	Tons	Variety	Tons
Lidal	15.0	Chena	9.2	Toral	6.3	Bebral	0.9	Candle	3.0	Oly	0.1
Otal	8.4	Ingal	4.7	Ceal	2.1						
Thual	5.4	Vigal	1.9	Nip	2.3						
Weal	5.2	Nogal	1.4	Golden Rain	0.1						
Datal	4.3	1397	0.5	Freedom	.05						
Finnaska	1.0	66116243344	0.3	**Total**	10.9						
Pokko	0.6	Norstar	0.07								
Arra	0.4	Gasser	0.04								
Eero	0.3	Froid	0.03								
Edda	0.05	Roughrider	0.03								
Paavo	0.03	**Total**	18.3								
Tibet Hulless	0.03										
Galt	0.01										
Otra	trace										
Steptoe	trace										
Total	40.7										

Table 3 - Grass Varieties in Storage at the Plant Materials Center December, 1989

Variety	Pounds
'Engmo' Timothy	1,836
'Arctared' Fescue	1,118
'Nugget' Kentucky Bluegrass	475
'Polar' Brome	528
'Norcoast' Bering Hairgrass	260
'Alyeska' Polargrass	422
'Egan' American Sloughgrass	175
'Gruening' Alpine Bluegrass	346
'Sourdough' Bluejoint	63
'Nortran' Tufted Hairgrass	100
'Tundra' Glaucous Bluegrass	36
'Kenai' Polargrass	87
'Service' Big Bluegrass	183
Total	5,689

Table 4 - Cereal Grains Sales & Receipts, 1987 - 1989

Type	1989	1988	1987
Barley	2,100 lbs	3,750 lbs	12,750 lbs
	$ 653.24	$1,074.09	$2,478.28
Oats	1,600 lbs	1,200 lbs	7,978 lbs
	$ 486.15	$ 355.40	$2,097.37
Wheat	275 lbs	300 lbs	150 lbs
	$ 75.16	$ 70.82	$ 24.13
Rye	134 lbs	-0-	320 lbs
	$ 30.72	-0-	$ 51.15
Rapeseed	180 lbs	-0-	119 lbs
	-0-	-0-	-0-
Buckwheat	300 lbs	-0-	-0-
	$ 57.00	-0-	-0-
Total	4,589 lbs	5,250 lbs	21,317 lbs
	$1,302.27	$1,500.31	$4,650.93

Table 5 - Grass Seed Sales & Receipts, 1987 - 1989

Variety		1989	1988	1987
'Nugget' Kentucky Bluegrass		505 lbs	550 lbs	855 lbs
		$4,543.70	$4,547.60	$6,840.00
'Arctared' Red Fescue		60 lbs	100 lbs	200 lbs
		$ 205.60	$ 936.00	$2,000.00
'Sourdough' Bluejoint		30 lbs	6 lbs	-0-
		$ 810.70	$ 209.94	$ -0-
'Engmo' Timothy		25 lbs	50 lbs	50 lbs
		$ 75.50	$ 151.00	$ 225.00
'Alyeska' Polargrass		-0-	-0-	95 lbs
		-0-	-0-	$1,000.00
'Gruening' Alpine Bluegrass		30 lbs	10 lbs	Not Available
		$ 400.50	$ 130.20	
'Egan' American Sloughgrass		21 lbs	2 lbs	10 lbs
		$ 181.20	$ 17.58	$ 80.00
'Norcoast' Bering Hairgrass		20 lbs	-0-	-0-
		$ 221.80	-0-	-0-
'Nortran' Tufted Hairgrass		133 lbs	-0-	-0-
		$2,169.23	-0-	-0-
'Polar' Brome		160 lbs	-0-	-0-
		$ 466.40	-0-	-0-
Total		984 lbs	718 lbs	1,210 lbs
		$ 9,074.63	$5,992.32	$10,145.00

Three new grass fields were established during the 1989 growing season; Foundation-class 'Gruening' alpine bluegrass, and new breeder blocks of 'Egan' American sloughrass and Beach Wildrye. Except for 'Tundra' glaucous bluegrass, yields were good on fields two or more years old. Over 28 acres were devoted to grass seed production at the PMC for 1989, the highest acreage in the PMC's history.

Cereal grains increased for 1989 included 'Thual' hulless barley and 'Freedom' hulless oats. Foundation seed stocks of most other grain varieties has remained high.

Spring and early summer weather was generally favorable for crop growth. Irrigation was necessary for newly sown fields due to dry, sunny days. The early maturing grasses were harvested under favorable conditions; however, after August 18, nearly constant cloudy, moist weather caused deterioration in grain quality, with the growth of late tillers, and with the appearance of ergot in the barley and rust in the grasses. A short break in the wet weather allowed the barley to be harvested on September 19, and although the moisture content was high, the crop was dried with little damage. Results from pre-clean testing indicate an 81% germination rate.

Flooding from the Matanuska River became a growing problem in 1989. Fields two and five were unuseable and portions of fields three and six were saturated so that they would not support farm machinery. This seasonal flooding began in the summer of 1986, and has repeated each year, eliminating approximately 100 acres from agricultural production.

Foundation seed sales for 1989 were mixed. Cereal grain sales totaled 4,589 pounds; down slightly from 5,250 pounds in 1988. Grass seed sales for 1989 totaled 984 pounds; up from 718 pounds in 1988. Receipts for all 1989 seed sales totaled $10,376.90; up from $7,492.63 in 1988.

North Latitude Vegetable & Landscape Crop Improvement Project

The North Latitude Vegetable and Landscape Crop Improvement Project is comprised of two programs. They are the Horticulture Development Program and the Potato Disease Control Program. The combination was made in an effort to streamline PMC operations. For clarity, the activities of each project are reported separately in this report.

Horticulture Development Project

This project is responsible for trials of vegetable, small fruit, and ornamental plants. Both introduced and native plants are evaluated in the trials. Cultural and production techniques may also be evaluated. The project co-sponsored the Alaska Greenhouse and Nursery Conference and Polar Grower Trade Show with the University of Alaska Cooperative Extension Service and Alaska Horticultural Association.

Strawberry Plant Production Trial

In 1988, the PMC and University of Alaska Fairbanks began a joint study on the potential of strawberry plant production in Alaska. Six California strawberry varieties were grown in this study. The effects of Alaska's cool temperatures in August and September, and the long summer photoperiod were evaluated.

Mother plants were heeled in peat moss and greened up in a lathhouse before being transplanted to the field. The mother plants were transplanted on 1 and 2 June, and were irrigated with a sprinkler system, cultivated and disbudded as required.

Daughter plants were harvested on 15 September and 27 September. Three of the varieties were expected to produce fifteen daughter plants per mother plant. At the PMC, these varieties produced an average of 4.4 plants/mother plant. The other three varieties were expected to produce ten daughter plants per mother plant; at the PMC they produced an average of 4.02 plants/mother plant. The 1988 Annual Report indicated that the study would continue in 1989, but since the production of daughter plants was lower than expected, the project was terminated.

Blueberry Applied Agricultural Research Account (AARA)Grant Study

Several growers have requested information on techniques to improve the fruit production of native stands of blueberries. In 1988, the project received an AARA Grant to investigate cultural techniques to increase the fruit production in wild stands of blueberries. Three trials, each consisting of four 10-meter by 10-meter plots were established. One trial is located in the Bartlett Hills Agricultural Project and two are located on a farm in the Montana Creek area.

All of the plots, plus a 1-meter band around the perimeter of each plot, were cleared of trees and other shrubs. One plot of each trial was used as a control and received no additional treatment. The other three plots received a combination of different fertilizer and pruning treatments. Ten grams of elemental nitrogen, phosphorus and potassium per meter square were applied to the fertilized plots. A weed whip modified with a triangular sawblade was used to prune the plots. Data was collected on cover, density and current annual growth.

In 1989, no additional fertilizer was applied and no additional pruning occurred to control the regrowth of competing vegetation in the plots. Observations made in 1989, indicated that the fertilized, pruned plots set less fruit than any of the unpruned plots. In 1989, the fertilized, pruned plots set more flower buds than any of the unpruned plots. The first reliable harvest to determine the effects of the pruning and fertilization treatments will be the 1990 harvest.

Due to circumstances beyond our control, 1989 yield data was collected for only one of the plots. Yield data will be collected on all plots for at least the 1990 and 1991 seasons.

The results of the study will help to determine the length of time these treatments have an effect on stands of native Alaska blueberries. Interim reports will be available in 1990 and 1991. The final report will be prepared upon completion of the study.

Small Fruit Applied Agricultural Research Account (AARA) Grant Study

The Small Fruit AARA grant is a cooperative project with the University of Alaska Fairbanks Agriculture and Forestry Experiment Station. This study's goal is to systematically evaluate small fruit varieties in 13 locations in the railbelt area. Fruit types planted in the trials in 1988 include four varieties of amelanchier or serviceberry, four black currant varieties, two red currant varieties, six raspberry varieties and three half-high blueberry varieties. In 1989, seven raspberry varieties and two amelanchier varieties were planted in the plots. One raspberry variety, 'Heritage', did not perform well in 1988 and was replanted in 1989, with replacement plants from the supplier.

Information to be collected in this study includes winter hardiness rating, date of bud break, bloom dates and harvest dates and yields. A summary report of winter hardiness, 1989 fruit production and harvest dates is being compiled. The plants in this study will be observed for five years. A final report will be prepared upon completion of the study.

Vegetable Variety Trials

The 1989 vegetable variety trials were a cooperative effort between the Plant Materials Center, University of Alaska Fairbanks Cooperative Extension Service, and Agriculture and Forestry Experiment Station. Vegetable crops and varieties for commercial production were emphasized in the trials. All trials were grown at the Matanuska Farm in Palmer. Varieties of broccoli, cabbage, carrots, lettuce and potatoes were planted in the trials.

The Plant Materials Center was responsible for the storage cabbage and the fresh market cabbage trials. Transpalnts for both cabbage trials were grown by Paul Giauque, Gold Nugget Farm, Palmer, Alaska. Ten storage cabbage varieties were seeded on 17 April 1989, and hand-transplanted to the field on 12 May 1989. Three of the varieties produced marketable-size heads which were harvested between 22 September and 6 October 1989. Twelve fresh market cabbage varieties were seeded on 24 April and hand transplanted on 18 and 19 May 1989 to the field. Eleven of these varieties produced marketable-size heads that were harvested between 17 July and 6 October 1989.

The complete report of the cooperative trials is available in Vegetable Variety Trials, Matanuska Valley, Alaska 1989, published by the University of Alaska Fairbanks Agriculture and Forestry Experiment Station.

Off-site Plant Trials

The PMC has established plant trials throughout Alaska. Trials are located in Fairbanks, Delta, Kenai, Kodiak, Trapper Creek and in the Manillaq area. Cooperators assisting with the trials include the Cooperative Extension Service, individual cooperators, local governments and native corporations. Ornamental trees and shrubs and small fruits have been planted at these sites.

In 1989, two new sites were established. One is located in Nenana and the other in Unalaska. The Unalaska site could not have been established without the assistance of Markair, which shipped the plants for no charge to Unalaska. The trial is a cooperative effort with the Unalaska Pride organization. The Nenana trial is a cooperative effort with the Cooperative Extension Service and individual cooperators.

The Kodiak site was reestablished at the Kodiak fairgrounds. Ornamental trees and shrubs and small fruits were also planted at these sites. Evaluation lists of the plants on each site are being prepared.

Alaska Greenhouse & Nursery Conference

The 8th Annual Alaska Greenhouse and Nursery Conference was held February 23 and 24, 1989 in Fairbanks at the Westmark Hotel. The Polar Grower Trade Show, held in conjunction with the conference, had thirteen commercial exhibits and three non-profit exhibits. The commercial exhibitors came from Alaska, California, Illinois, Minnesota, Montana and Canada. One hundred fifty people attended the conference.

The conference was sponsored by the Alaska Plant Materials Center (PMC), the University of Alaska Cooperative Extension Service and the Alaska Horticultural Association (AHA). Guest speakers at the conference included Tom Haught, a Technical Sales Representative for Ethyl Corporation, Orange, California; and Erric Ross, a Technical Representative for W. R. Grace, Portland, Oregon. Mr. Haught discussed "Plastic Culture in Horticulture" and Mr. Ross's presentation was on "Diagnosing Ornamental Plant Problems".

Alaska speakers were also featured at the conference. University of Alaska Fairbanks staff made presentations on the "Effects of Mulches on Ornamentals in Fairbanks" by Dr. Pat Holloway, Assistant Professor of Horticulture; "How Light and Temperature Affect Plant Growth and Development" by Dr. Meriam Karlsson, Assistant Professor of Horticulture; "The Marketing of Products" by Dr. Laura M. Milner, Assistant Professor of Marketing; and "The Role of Palmer AFES Laboratory in Soil Testing and Plant Tissue Analysis" by Dr. Rudy Candler, Laboratory Supervisor. Mr. Ken Childress, Senior Sales Engineer with Transalaska Data Systems spoke on "Bar Coding Horticultural Products"; Molly McCafferty, City Gardener, City of Ketchikan, discussed "Ketchikan's Beautification Program"; and Susan Miller, supervisor of the Anchorage Beautification Program, presented "Flower Bed Design with Annuals". Many other speakers from Alaska made informative presentations.

Plant Sales & Distribution

In order to develop commercial horticulture production, several types of plants have been sold by the PMC to commercial growers since 1979. Plant materials for both horticultural and revegetation uses are sold. These plants have been promoted for use in Alaska by the University of Alaska Agriculture and Forestry Experiment Station and the PMC. Growers purchasing plants must use them as stock plants or for food production. As growers propagate these plant materials, the demand on the PMC to supply them has decreased.

The 1989 plant sales were:

'Holland Long Bunch' Currant	75	1-0 plants
'Swedish Black' Currant	75	1-0 plants
'Friedrichsenii' Potentilla	30	rooted cuttings plants
'Pioneer' Strawberry	50	plants
'Sitka' Strawberry	50	plants
'Skwenta' Strawberry	100	plants
'Talkeetna' Strawberry	100	plants
'Long' Barclay Willow	120	cuttings
'Oliver' Barrenground Willow	100	cuttings
'Rhode' Feltleaf Willow	120	cuttings
'Roland' Pacific Willow	100	cuttings
'Wilson' Bebb Willow	100	cuttings
Feltleaf Willow	1,300	cuttings (special project)

Potato Disease Control Program

Potatoes have been grown and sold in Alaska since prior to the establishment of the Matanuska Colony. Alaska grown potatoes have had an average annual value exceeding $ 2,000,000 through the last decade. Alaska's production of quality potatoes has kept over $ 20,000,000 from being exported during the last ten years.

Commercial potato production is highly capital intensive. High yields of good quality potatoes are required to assure a fair return on investment. Many production problems that would limit yield, such as untimely frost or rain, are beyond grower control. A successful grower manages the production factors which are under his control. Planting high quality seed can make the difference between a good harvest and a poor one.

Diseases are capable of causing severe losses. Many of the diseases affecting the potato are carried in or on the potatoes themselves. The use of seed in which diseases are absent or at low levels, has been proven to greatly reduce the risk of losses caused by disease. Inspections for disease incidence are the function of the certification program.

Seed quality is based primarily on the amount and types of diseases present. Seed-borne diseases were significantly reducing the Alaskan growers' yields during the late 1970s. Good seed of the varieties of potatoes grown in Alaska were not available locally. Importing seed from outside the state carries with it the potential to introduce pests and diseases not now known to occur in Alaska. The Potato Disease Control Project was initiated to help overcome these problems. The project assists the industry by producing seed potatoes free from diseases and monitoring the health of the seed and commercial fields. The maintenance of a prosperous potato industry is accomplished by providing quality seed, monitoring disease incidence and education.

Disease-Tested Seed Potato Production

In 1989, the project produced 9,000 disease-tested plants of 36 varieties. Six varieties accounted for 60% of this total. The varieties most in demand were Shepody, Bake-King, Iditared, Superior, Alaska 114 and Green Mountain.

Approximately 1,000 plants were made available to ten growers for production of Generation 1 (G1) seed. The remaining plants were grown in greenhouses at the Plant Materials Center (PMC), and produced 1,200 pounds of G1 seed to meet the orders placed in 1988.

Disease-tested seed amounting to 3,000 pounds of nine russet-skinned varieties were field grown to provide seed for trials to be conducted by the Cooperative Extension Service in 1990.

The potato project performed over 8,000 tests to ascertain the health of the materials produced. Each tuber or mother plant was tested for Bacterial Ring Rot, six potato viruses (X, S, Y, A, M, LR) and Potato Spindle Tuber Viroid prior to propagation. Tests for virus infection were also conducted at harvest.

TUBER INTRODUCTION

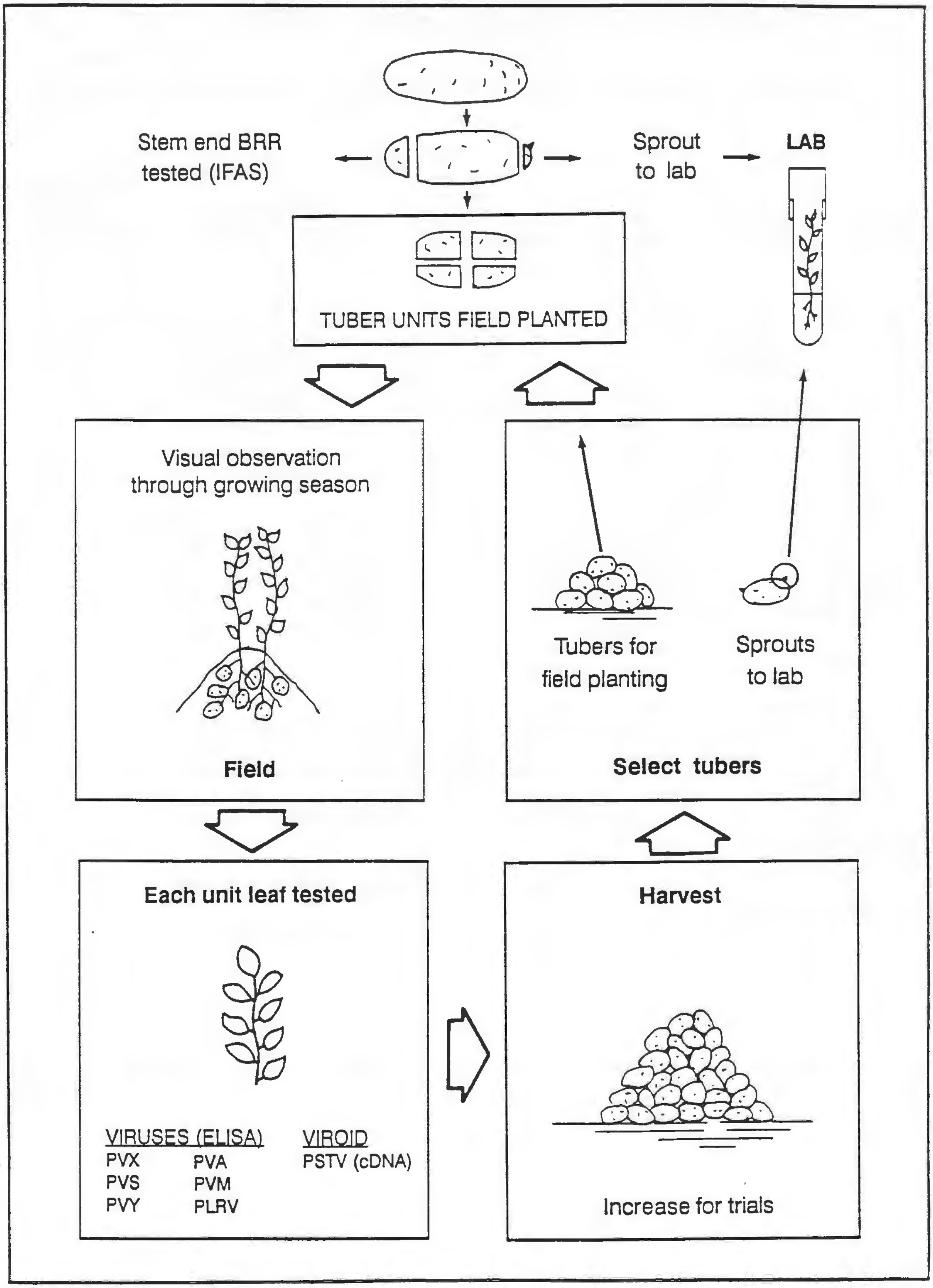


Figure 4

Alaska Seed Potato Production & Disease Testing

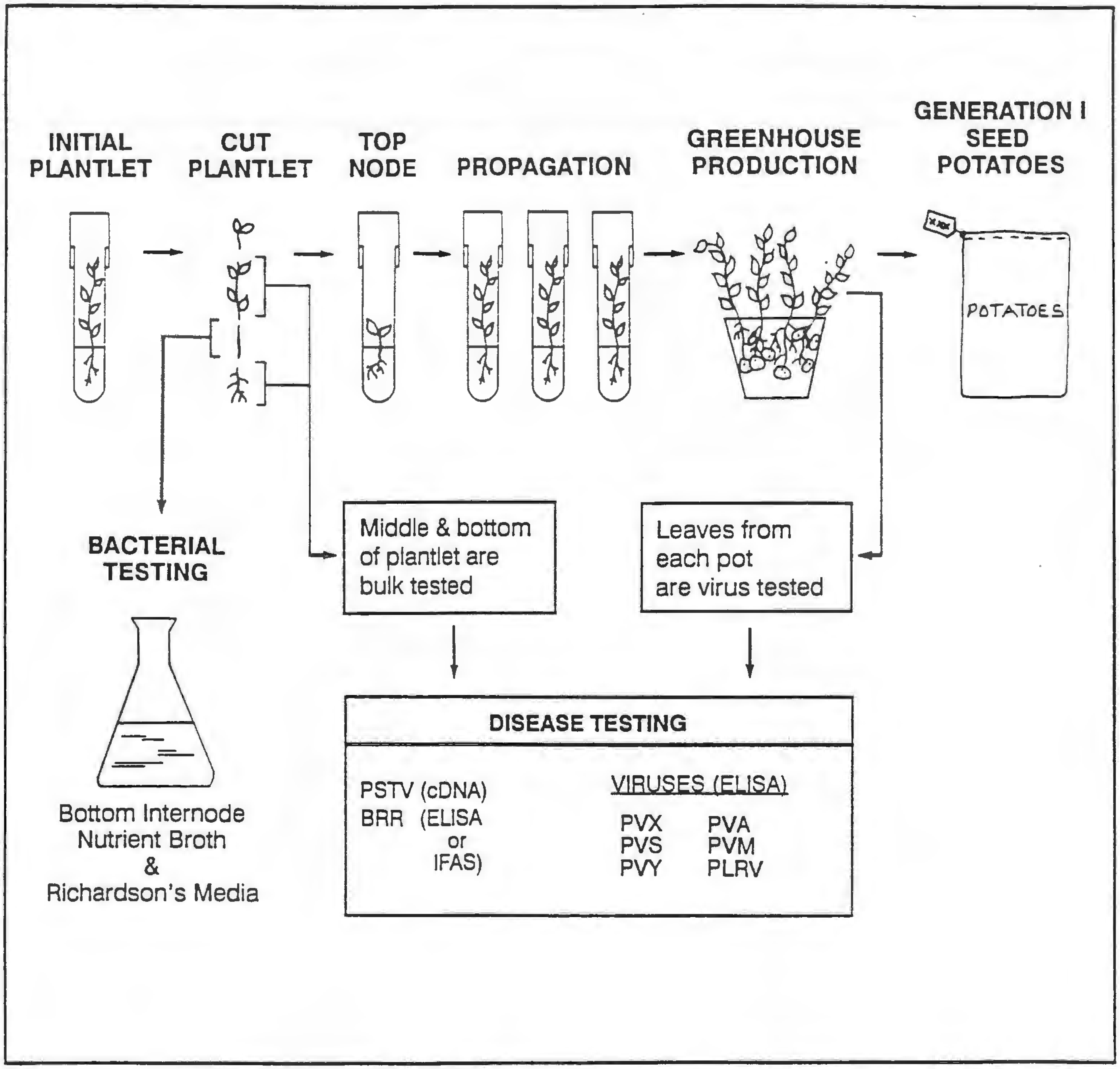


Figure 5

Seed Potato Certification

Potato seed certification programs are important to the health of the potato industry. Disease-free seed can quickly become infected with disease when exposed to pathogens. Growers manage their seed production to limit possible exposure to diseases, but reinfection from soil or other sources can occur. Certification is designed to identify and remove from use as seed those seed lots which have become diseased, or otherwise are of reduced value for use as seed. This is accomplished by inspection for diseases in potato fields.

Diseased plants typically appear different from healthy plants, however the symptoms of some diseases can be masked or obscured by growing conditions such as physiological maturity, fertility levels, and cool temperature. The particular variety's resistance to a disease also plays a part in symptom expression.

The term "latent" is used to describe the situation where a disease is present, but symptoms are not expressed. The idea that a disease can be present and go undetected is cause for concern. The use of laboratory tests for the detection of Potato Virus X, which can be latent, has been shown to be an effective procedure for indicating the relative infection level of the disease. Laboratory procedures which would allow the detection of latent Bacterial Ring Rot are being developed but are not commonly being used.

Alaska's Certified Seed Program is administered by the Alaska Seed Growers, Inc. The inspections are conducted by the Potato Disease Control Project. Inspections were performed during the 1989 growing season on 119 lots planted to 48 acres. There were 27 varieties grown as certified seed. Certified seed potatoes were grown in the Matanuska Valley, Tanana Valley, Fairbanks and Bartlett Hills area near Talkeetna. Each lot was inspected according to certification standards for disease and varietal purity.

Educational Program

Dr. Ed Jones, retired Potato Certification Specialist from Cornell University, was brought to Alaska in mid-August to instruct growers and inspectors on the finer points of finding Bacterial Ring Rot (BRR) symptoms in potato fields. The Division of Agriculture, in cooperation with the Alaska Seed Growers, Inc., provided travel funds for his visit. Dr. Jones and his wife Barbara, who is a potato specialist in her own right, inspected all seed fields as well as some of the table stock production fields. No BRR was found in any seed. Observation of an innoculated plot on a table stock farm indicated that the disease was more difficult to find in the variety Green Mountain than in the variety Bake-King. Symptom expression was not as readily observed.

Dr. Jones also presented information to growers on the Seed Production Program at Cornell's Uihlein Farm which is located in upstate New York, at a meeting held in Palmer.

Matanuska Valley Demonstration Plot

A demonstration planting of 48 varieties was planted at Nugen's Ranch on May 19, 1989. This planting was made to allow growers the opportunity to observe the growth characteristics and tubers of the varieties on a side by side basis. The plot was comprised of 16 russet, 13 red, and 19 white/buff skinnned cultivars. Local growers were invited to observe the planting prior to harvest on September 26. Tuber defects and disease were noted. Total yield was recorded. Time from planting to harvest was 126 days.

Skin set, shape and yield appeared acceptable for seven of the russeted varieties; Alaska Russet, Allagash, Belrus, Hilite, Lemhi, AF465-2 and Norgold "M". The red-skinned varieties were all relatively equal in regard to feathering. Red Pontiac and Sangre were a bit tougher. Redsen had the brightest color and uniformly smaller size. The white/buff were a mix of early and processing varieties. Sable, Jemseg, Conestoga, Avon and Cherokee were uniform in size. Carlton had excessive hollow heart. Monona produced only small tubers. Mirton Pearl yielded well but had deep eyes and poor shape.

Copper River Native Association Trials

Seed of 12 varieties was planted at the Copper River Native Association plots in Copper Center. Observations of quality and total production were recorded by the Copper River Agriculture Specialist. The varieties Green Mountain, Yukon Gold, Kennebec, and Chieftain produced the largest total yields. Approximately 40 people in the Copper Center area benefited from this program.

Alaska State Fairground Educational Plot

A small plot was established at the fairground near Palmer for educational use during the annual State Fair. The common Alaska cultivars, as well as some novelty potatoes, were planted in twenty-foot long rows. Hills were dug and displayed at the end of the rows during the fair.

Cooperative National Plant Pest Survey

The Potato Disease Control Project joined the National Plant Pest Survey Program in 1984. The project assists the survey program by reporting the incidence of potato diseases found during inspections. The program is designed to promote disease surveys and improve methods used in the detection of important plant pests. The inspection data is entered into a computer system and is accessible by program participants. The information will facilitate research, extension and regulatory agencies in making decisions concerning plant pests.

Appendix A

Current & Historical Budget Information

Calendar Year 1989 Authorizations, Expenditures & Program Receipts

Authorizations

Authorization FY 89 PMC Total	$ 556,100.00
North Latitude Revegetation & Seed Production Project	
Project Total	314,200.00
Personal Services	251,100.00
Travel	4,100.00
Contractual	48,400.00
Supplies	10,600.00
Equipment	-0-
North Latitude Vegetable & Landscape Crop Improvement Project	
Project Total	241,900.00
Personal Services	214,700.00
Travel	4,400.00
Contractual	19,600.00
Supplies	3,200.00
Equipment	-0-
Special Appropriations FY 89	
PMC Flood Control Project	50,000.00
Authorization FY 90 PMC Total	$ 566,600.00
North Latitude Revegetation & Seed Production Project	
Project Total	320,800.00
Personal Services	260,400.00
Travel	2,600.00
Contractual	47,200.00
Supplies	10,600.00
Equipment	-0-
North Latitude Vegetable & Landscape Crop Improvement Project	
Project Total	245,800.00
Personal Services	219,600.00
Travel	3,900.00
Contractual	19,100.00
Supplies	3,200.00
Equipment	-0-

General PMC Operating Budgets for the Past Ten Fiscal Years

	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90
Authorization	343,000	361,900	743,100	725,900	912,300	863,400	888,500	733,700	596,700	556,100	566,600
Personnel	13	13	21	21	25	19	21	17	16	16	16
Full Time	7	7	10	10	12	10	10	9	7	7	7
Part Time	6	6	11	11	13	9	9	8	9	9	9

When comparing personnel figures listed for FY 89 and FY 90 to those in FY 80, bear in mind that the Potato Disease Control Project and the Horticultural Development Project were added in FY 85 and FY 82 respectively. Total FY 80 allotted man hours equalled 112 man month. FY 89 and FY 90 man months only totalled 121 as many of the seasonal positions are two to three month assignments.

1989 Calendar Year Monthly Expenditures to the Nearest Dollar

	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
PMC Totals	35,174	41,265	47,328	50,799	24,799	58,755	30,145	70,370	55,444	49,949	39,363	36,506
Personal Services	31,421	34,188	36,423	39,291	18,043	51,133	29,388	59,472	50,572	38,201	34,581	32,080
Travel	-0-	-0-	453	431	274	-0-	720	911	1,155	1,956	627	338
Contractual	3,040	4,806	8,011	7,878	5,566	5,237	37	6,826	2,834	4,834	3,153	4,024
Supplies	712	2,271	2,441	3,199	916	2,385	-0-	3,161	883	4,944	1,002	64
North Latitude Revegetation and Seed Production Project												
Totals	15,939	24,075	24,538	19,203	5,183	27,561	14,971	39,256	27,786	27,530	22m390	20,750
Personal Services	13,650	22,063	17,335	13,222	928	24,034	14,934	33,259	25,170	21,024	18,930	18,751
Travel	-0-	-0-	-0-	329	274	-0-	-0-	-0-	381	860	627	125
Contractual	1,809	1,681	5,223	4,236	3,238	2,050	37	3,135	1,987	3,139	2,166	1,810
Supplies	480	331	1,980	1,416	743	1,477	-0-	2,862	248	2,507	667	64
North Latitude Vegetable and Landscape Crop Improvement Project												
Totals	19,235	17,190	22,790	31,596	19,616	31,194	15,174	31,114	27,658	22,419	16,973	15,756
Personal Services	17,771	12,125	19,088	26,069	17,115	27,099	14,454	26,213	25,402	17,177	15,651	13,329
Travel	-0-	-0-	453	102	-0-	-0-	720	911	774	1,096	-0-	213
Contractual	1,232	3,125	2,788	3,642	2,328	3,187	-0-	3,691	847	1,709	987	2,214
Supplies	232	1,940	461	1,783	173	908	-0-	299	635	2,437	335	-0-

Program Receipts

Receipts Calendar Year 89	
Technical Assistance	
U. S. Navy	10,637.00
Greens Creek Mine	357.00
Echo Bay Mine	821.00
Wishbone Hill	1,570.00
National Park Service	8,901.00
Bureau of Land Mngmt.	2,047.00
Sales	
Grass, Grain, Potato Seed	7,074.00
Total Receipts	31,407.00

Appendix B

New & Pending Crop Releases

New Crop Cultivars Developed by the Alaska Plant Materials Center

'Long' Barclay Willow - This attractive, fast-growing native willow was released for commercial production in 1985. This cultivar will be used for reclamation, landscaping and shelter belts.

'Roland' Pacific Willow - 'Roland' was released in 1985 and is probably the most attractive willow selected by the PMC to date. This cultivar will be used for landscaping, stream protection and revegetation throughout most of Alaska.

'Wilson' Bebb Willow - This willow has a dense growth form and has many potential uses for screening, windbreaks and living fences. Because of the the species' wide range of adaptability, it is also expected to be utilized for reclamation activities. 'Wilson' is a 1985 release.

'Oliver' Barren Ground Willow - 'Oliver' was released for commercial production in 1985. This cultivar's interesting growth form will lend itself well for incorporation into hedges. Additional uses range from reclamation to windbreaks.

'Rhode' Feltleaf Willow - 'Rhode' was also released for commercial production in 1985. This species occurs throughout Alaska and is listed as a preferred wildlife species. This cultivar will find uses in habitat restoration, reclamation, streambank protection and shelter belts.

'Egan' American Sloughgrass - 'Egan' was released for commercial seed production in 1986. This cultivar has performed well at most test sites. Its expected uses are wetland restoration and waterfowl habitat enhancement.

'Gruening' Alpine Bluegrass - This selection of Alpine Bluegrass was released for production in 1987. A native species, Alpine Bluegrass has shown extreme hardiness throughout Alaska and it is well adapted to harsh sites such as mine spoil.

'Caiggluk' Tilesy Sage - 'Caiggluk' Tilesy Sage is a native collection of Sagebrush. It was placed in commercial production in 1989. The expected uses range from mine reclamation to restoration of sites contaminated with toxic metals. The cultivar will allow for more species diverse seed mixes. This is the first native broadleaf species brought into commercial production in Alaska.

'Service' Big Bluegrass - This accession of big bluegrass was derived from a collection made in the Yukon Territories. During the PMC evaluation process, the collection out-performed 'Sherman' Big Bluegrass (the only known cultivar of Big Bluegrass) in all categories. 'Service' is expected to find use in dry land revegetation projects in Alaska south of the Yukon River.

Pending Releases

Beach Wildrye - The Plant Materials Center is presently in the final evaluation stages on two collections of Beach wildrye. Both may be released for commercial production. The first is a collection from Norway that has exhibited hardiness throughout most southwestern and southcentral coastal Alaska. This collection is capable of producing viable seed in commercial quantities. The second collection of Beach wildrye originated on Kodiak Island and does not produce seed, a trait common to native stands of the species. Commercial production of this collection would be limited to vegetative production.

Release is expected for either or both in 1990 or 1991.

Violet Wheatgrass - This native accession has undergone evaluation by the PMC since 1979. It has exhibited superior hardiness throughout Alaska, especially on dry, gravelly sites.

Appendix C

List of Publications & Presentations

Publications

Campbell, W. L. 1987. Potatoes Alaska! Spudman. January and February 1987. 4 pp.

Campbell, W. L. 1988. Potato Disease Control Technical Report 1984 - 1988. State of Alaska, Division of Agriculture, Plant Materials Center. 14 pp.

Moore, N. J. 1986. Recommendations for Reclamation Species and Techniques. Alaska Miner. April, 1986. 2 pp.

Moore, N. J. 1986. Evaluation of Conservation Species at Fort Richardson, 1983-1986. State of Alaska, Division of Agriculture, Plant Materials Center. 11 pp.

Moore, N. J., P. Brna, W. Evans, and S. J. Wright. 1986. Field Guide for Streambank Revegetation. State of Alaska, Division of Agriculture, Plant Materials Center. 15 pp.

Moore, N. J. 1986. Final Report for the Bank Revegetation Program, Bethel Small Boat Harbor. State of Alaska, Division of Agriculture, Plant Materials Center. 23 pp.

Moore, N. J. 1986. Final Report for Evaluation of Conservation Species at Fort Richardson, 1983 - 1986. State of Alaska, Division of Agriculture, Plant Materials Center. 11 pp.

Moore, N. J. and P. J. Brna. 1987. Streambank Revegetation With Woody Plants. Alaska Fish and Game. 19:2. 4pp.

Moore, N. J. 1987. Plant Profile 'Roland' Salix lasiandra. The Public Garden. The American Association of Botanical Gardens and Arboreta, Inc. January, 1987. 1 p.

Moore, N. J. et. al. 1989. Directory of Alaska Native Plant Sources. Municipality of Anchorage Coastal Management Program, and Alaska Department of Natural Resources, Division of Agriculture, Plant Materials Center. 23 pp.

Moore, N. J. and S. Wright. (in press) Studies on the Techniques for Revegetation with Arctophila Fulva (for years 1986, 1987 and 1988). State of Alaska, Division of Agriculture, Plant Materials Center. 53 pp, 30 pp and 16 pp.

Ross, D. R. 1987. Controlled Release Fertilizer Trials on Four Containerized Woody Plants. State of Alaska, Division of Agriculture, Plant Materials Center. 9 pp.

Ross, D. R. and E. J. Heyward. 1989. Foundation Seed Production Technical Report. State of Alaska, Division of Agriculture, Plant Materials Center. 24 pp.

Wright, C. I. and K. Eberhardt. 1982. Survey of Greenhouse and Nursery Production in Alaska, 1982. State of Alaska, Division of Agriculture, Plant Materials Center. 12 pp.

Wright, C. I., J. Bunker and K. Eberhardt. 1983. Strawberry Plant Market Survey and Production Feasibility Study. State of Alaska, Division of Agriculture, Plant Materials Center. 53 pp.

Wright, C. I. 1986. Summary of Vegetable Variety Trials. State of Alaska, Division of Agriculture, Plant Materials Center. 14 pp.

Wright, C. I. 1987. Pruning Principles for Nursery Stock. State of Alaska, Division of Agriculture, Plant Materials Center. 5 pp.

Wright, C. I. 1988. Freidrichsenii-Old Alaskan Stand-by That's Got It All Together. The Anchorage Times. Gardening Supplement. May 14, 1988.

Wright, C. I. 1988. Rhubarb. The Anchorage Times. Gardening Supplement. May 14, 1988.

Wright, C. I. 1988. A Better Mouse Trap? Alaska NAFEX Newsletter. December, 1988. Vol. 3. No. 10.

Wright, C. I. 1989. Summary of Vegetable Variety Observations 1987. State of Alaska, Division of Agriculture, Plant Materials Center. 5 pp.

Wright, C. I. 1989. Rhubarb Variety Trials. State of Alaska, Division of Agriculture, Plant Materials Center. 1 pp.

Wright, C. I. 1989. Summary of Vegetable Variety Observations, Palmer, Alaska, 1988. State of Alaska, Division of Agriculture, Plant Materials Center. 10 pp.

Wright, S. J. 1985. Willow Varieties for Alaska. State of Alaska, Division of Agriculture, Plant Materials Center and USDA Soil Conservation Service. 7 pp.

Wright, S. J. 1986. Release Notice 'Egan' American Sloughgrass. State of Alaska, Division of Agriculture, Plant Materials Center. 2 pp.

Wright, S. J. 1986. Release Notice 'Gruening' Alpine Bluegrass. State of Alaska, Division of Agriculture, Plant Materials Center. 2 pp.

Wright, S. J. and N. J. Moore. 1986. 1986 Progress Report for the Conservation Plant Project. State of Alaska, Division of Agriculture, Plant Materials Center. 87 pp.

Wright, S. J. 1986. Initial Data and Observations Obtained From the 2C Access Spur and Mine Site D Herbaceous Evaluation Plots Located in the Kuparuk Unit. State of Alaska, Division of Agriculture, Plant Materials Center. 10 pp.

Wright, S. J. 1986. Beach Wildrye (Elymus arenarius) Sprigging on Shemya Air Force Base, Lateral Clear Zone - A Qualitative Study in Response to Questions Arising From Contract DACA 85-86-C-0042. State of Alaska, Division of Agriculture, Plant Materials Center. 37 pp.

Wright, S. J. 1987. Final Report on Demonstration and Advanced Conservation Plantings at Kalsin Bay, Kodiak, Alaska 1982-1986. State of Alaska, Division of Agriculture, Plant Materials Center. 16 pp.

Wright, S. J. 1987. Final Report on Evaluation of Advanced Herbaceous Conservation Species at Usibelli Coal Mine, Healy, Alaska 1983 - 1986. State of Alaska, Division of Agriculture, Plant Materials Center. 11 pp.

Wright, S. J. 1987. Final Report of Initial and Advanced Conservation Plantings at Ruby, Alaska 1984 - 1986. State of Alaska, Division of Agriculture, Plant Materials Center. 16 pp.

Wright, S. J. 1987. Evaluation of Conservation Species at Premier Coal Mine Near Palmer, Alaska 1983 - 1986. State of Alaska, Division of Agriculture, Plant Materials Center. 14 pp.

Wright, S. J. 1987. Final Report on Evaluations of Advanced Herbaceous Conservation Species at Diamond Alaska Test Pits Near Tyonek, Alaska 1983 - 1987. State of Alaska, Division of Agriculture, Plant Materials Center. 13 pp.

Wright, S. J. 1987. Reclamation In Alaska. 1987 Annual Meeting of the Alaska Miners Association Technology Short Course. State of Alaska, Division of Agriculture, Plant Materials Center. 13 pp.

Wright, S. J., L. H. Fanter, and J. M. Ikeda. 1987. Sand Stabilization Within the Lateral Clear Zone at Shemya Air Force Base, Alaska Using Beach Wildrye, Elymus arenarius. State of Alaska, Division of Agriculture, Plant Materials Center and U. S. Army Corps of Engineers, Alaska District. 16 pp.

Wright, S. J. 1988. Final Report of Advanced Conservation Grasses at Terror Lake Hydro Electric Project, Kodiak, Alaska. State of Alaska, Division of Agriculture, Plant Materials Center. 13 pp.

Wright, S. J. 1988. Final Report on Evaluation of Conservation Species at Valdez Creek Mine Near the Susitna River off the Denali Highway 1985 - 1987. State of Alaska, Division of Agriculture, Plant Materials Center. 12 pp.

Wright, S. J. 1988. Initial Demonstration and Advanced Conservation Plantings at the City of Kenai Evaluation Plot 1984 - 1987. State of Alaska, Division of Agriculture, Plant Materials Center. 12 pp.

Wright, S. J. 1988. Initial Demonstration and Advanced Conservation Plantings at Mile Post 1408 Near Delta, Alaska 1983 - 1987. State of Alaska, Division of Agriculture, Plant Materials Center. 15 pp.

Wright, S. J. 1988. Advances in Plant Material and Revegetation Technology in Alaska. Proceedings of the High Altitude Revegetation Conference. Colorado State University. Fort Collins, Colorado. 38 pp.

Wright, S. J. 1988. Advances in Revegetation Technology Following the Completion of TAPS. Renergy - Alaska Oil and Industry. Vol. 7. No. 6. June, 1988.

Wright, S. J. 1989. Final Report of Data and Observations Obtained From the 2C Access Spur and Mine Site D Herbaceous Evaluation Plots Located in the Kuparuk Unit. State of Alaska, Division of Agriculture, Plant Materials Center. 13 pp.

Wright, S. J. 1989. 1988 Interim Report of Initial Data and Observations Obtained From the Red Dog Mine Evaluation and Demonstration Plots. State of Alaska, Division of Agriculture, Plant Materials Center. 16 pp.

Wright, S. J. 1989. Final Report of Data and Observations Obtained From the Chena Flood Control Project Evaluation Plots Located Near North Pole, Alaska. State of Alaska, Division of Agriculture, Plant Materials Center. 14 pp.

Wright, S. J. 1989. Final Report of Data Obtained From the Fairbanks Evaluation and Demonstration Plots. State of Alaska, Division of Agriculture, Plant Materials Center. 12 pp.

Wright, S. J. 1989. Advances in Plant Materials Technology and Revegetation Technology in Alaska. Reclamation, a Global Perspective. American Society for Surface Mining and Reclamation. Calgary, Alberta Canada. 10 pp.

Wright, S. J. 1989. Release Notice - 'Caiggluk' Tilesy Sage. State of Alaska, Division of Agriculture, Plant Materials Center. 2 pp.

Wright, S. J. 1989. Release Notice - 'Service' Big Bluegrass. State of Alaska, Division of Alaska, Plant Materials Center. 2 pp.

Presentations During 1989

Campbell, W. Seed Certification/Sources 11th Annual Potato Growers Conference, Matanuska Susitna Community College, Palmer, Alaska. March 8, 1989.

Moore, N. J. Revegetation Plant Materials: Techniques for Handling, Processing and Planting Seed and Revegetative Material. Course lecture for ALRF 393 Ecology of Disturbed Lands, 1989.

Wright, C. I. Cabbage and Broccoli Variety Trials in Palmer. 1989 Vegetable Growers Conference, Palmer, Alaska. March 9, 1989.

Wright, C. I. Small Fruit and Ornamentals for the Talkeetna Area. Cooperative Extension Service Talkeetna Winter Workshops. Susitna Valley High School. March 29, 1989.

Wright, C. I. Horticulture and Agriculture in Alaska. Problems of Horticulture in the U. S. S. R. North-East Conference. Institute of Biological Problems of the North, Magadan, U.S.S.R. November 28-31, 1989.

Wright, C. I. Lawn Establishment and Maintenance in Alaska. Problems of Horticulture in the U. S. S. R. North-East Conference. Institute of Biological Problems of the North, Magadan, U.S.S.R. November 28-31, 1989.

Wright, C. I. Ornamental Plants for Alaska. Problems of Horticulture in the U. S. S. R. North-East Conference. Institute of Biological Problems of the North, Magadan, U.S.S.R. November 28-30, 1989.

Wright, C. I. Pruning Practices. University of Alaska Anchorage. Grounds Crew Lecture. Anchorage, Alaska. December 19, 1989.

Wright, S. J. Developing Reclamation Plans. U. S. Bureau of Mines/University of Alaska Anchorage. Anchorage, Alaska. March 14, 1989.

Wright, S. J. Certified Seed Production in Alaska. Yukon Livestock and Agriculture Association. Whitehorse, Yukon. March 18, 1988.

Wright, S. J. Mine Reclamation and Revegetation. Alaska Miners Association. Fairbanks, Alaska. March 30, 1989.

Wright, S. J. Commercial Use of Native Plant Material. University of Alaska Cooperative Extension Service. Talkeetna, Alaska. April 12, 1989.

Wright, S. J. Mine Revegetation Using Native Species. Bureau of Land Management. Fairbanks, Alaska. April 27, 1989.

Presentations During 1989

Wright, S. J. Revegetation in the Arctic. U. S. Army Corps of Engineers. Anchorage, Alaska. May 19, 1989.

Wright, S. J. Sand Control on Adak Naval Air Station. American Society of Agronomy, Annual Meeting. Las Vegas, Nevada. October 17, 1989.

Wright, S. J. The Plant Materials Center - Who We Are and What We Do. University of Alaska Agricultural and Forestry Experiment Station. Palmer, Alaska. December 6, 1989.

Tours - Field Days

Moore, N. J. and C. I. Wright. Interpretive Walk for 4th Grade Class. Anchorage School District. Johnson Creek Trail.

Moore, N. J., C. I. Wright, W. L. Campbell, D. R. Ross. PMC Programs: Presentations and Tour for 6th Grade Participants of Outdoor School.

Campbell, W. L., N. J. Moore, D. R. Ross, D. Sheaver, K. Vanzant, C. I. Wright, S. J. Wright. Annual PMC Open House. August 12, 1989.

Plant Materials Center Staff, Division of Agriculture, T. Pyrah. Picnic and Tour of PMC Operations for A. Nesterenko, Deputy Director, Institute for Arable Lands. A. Yuzhakov, Head of Agrochemistry Laboratory, and I. Sharkov, Head of Plant Nutrition Cycle Laboratory. July 31, 1989.

Plant Materials Center Staff. Tour of Plant Materials Center. Murray, D. F., Curator, U. of A. Fairbanks Herbarium, and Argus, G., Taxonomist, Museum of Natural Sciences, A. Galanin, Taxonomist, Main Botanical Garden, A. C. Skvortsov, Moscow, I. M. Krasnoborov, Vice Director of Central Siberian Botanical Garden, Novosibirsk, I. C. Koropachinsky, Director, Central Siberian Botanical Garden, Novosibirsk. August, 9, 1989.

Appendix D

Acknowledgements

Acknowledgements

This annual report is composed of activities undertaken by the Plant Materials Center. Private industry, individuals and government agencies often assisted in these activities. The implementation of these activities would have been impossible without the cooperation and contribution of many individuals.

There are many people other than the industry and government agencies mentioned in the text, who the authors wish to thank for their assistance. They include:

AARA Small Fruit Cooperators
Alaska Horticultural Association (GHC Sponsor)
Birch Creek Ranch
Ed Bostrom
Bruce Campbell
Fairbanks Soil and Water Conservation District
Gold Nugget Farm
Don Kratzer
Mark Air
Hunter Michaelbrink
Andy Muscovich
Nugen's Ranch
Pyrah's Pioneer Peak Farm
Salcha-Big Delta Soil and Water Conservation District
Spring Valley Farm
Unalaska Pride/Marty Norton
Upper Susitna Soil and Water Conservation District
Wasilla Soil and Water Conservation District
Bob Watkins Family

We also wish to thank industry sponsors and government cooperators.

We apologize to any of you who may not have been included here, but we are not any the less thankful for your assistance.

Restoring the

Environment

After the

Exxon Valdez

Oil Spill

Spring 1990

The *Exxon Valdez* oil spill has received an enormous amount of attention since that fateful Good Friday, March 24, 1989. Most of the attention has concerned the fate and clean-up of the oil and its impacts on wildlife, the environment, and the people who live, work, and play in Prince William Sound and the western Gulf of Alaska. The stories about clean-up and damages are important and still unfolding, but there is a new subject that deserves attention—RESTORATION.

How can we work together to restore natural resources affected by the oil spill? The State of Alaska and the United States Government are cooperating to identify different needs, alternatives, and priorities for environmental restoration, and we need your help. The purpose of this brochure is to describe the restoration planning process and how you can participate.

How You Can Help

RPWG
LL

Oil Spill Damages

In the weeks and months after the spilling of 11 million gallons of crude oil at Bligh Reef, the oil left Prince William Sound and traveled south and west, far down the Alaska Peninsula. More than 1,000 miles of shoreline were oiled, and the oil spread over at least 3,000 square miles of ocean.

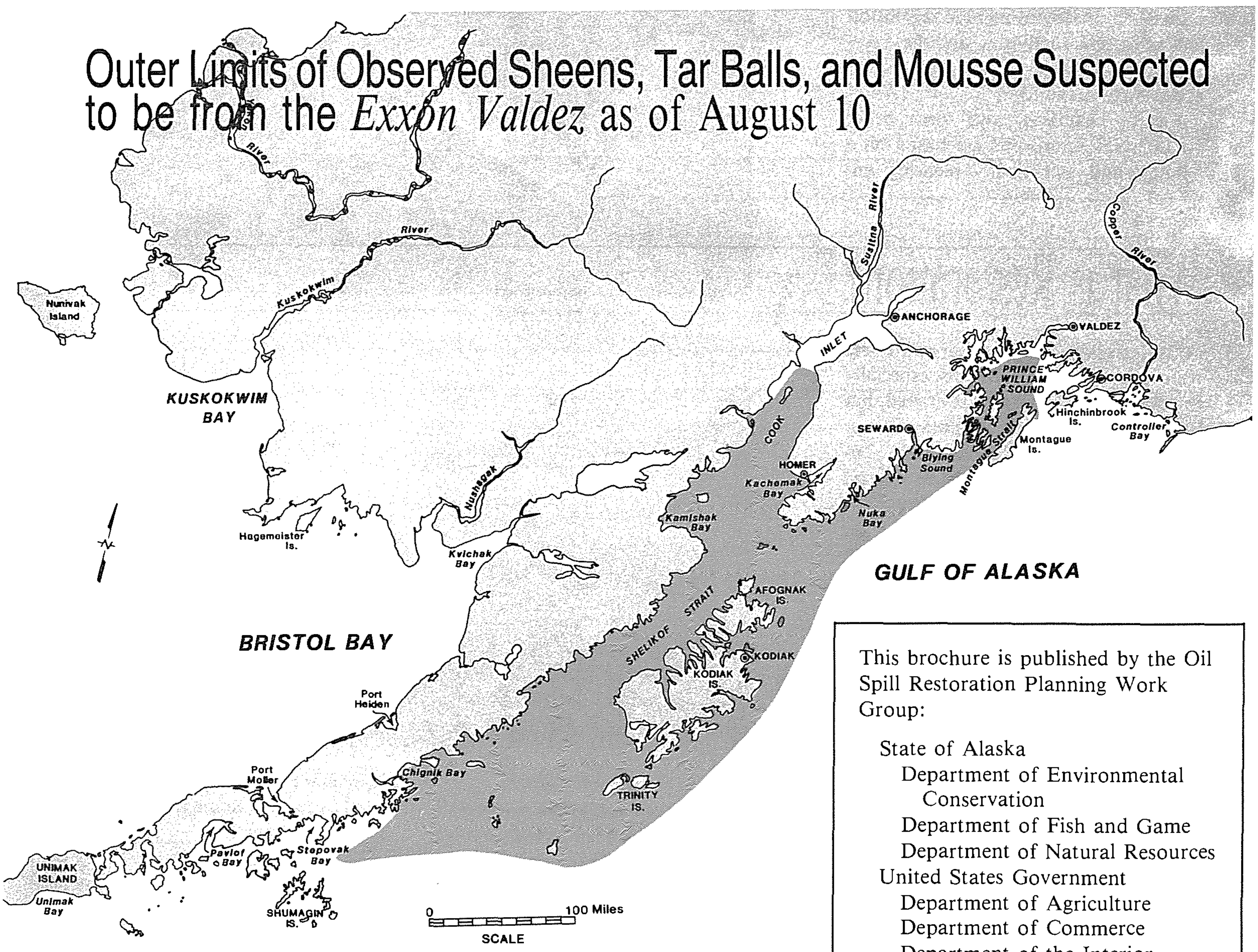
The oil left a disaster in its wake. Carcasses of about 36,000 birds were found; many more birds are thought to have died. At least 1,000 sea otters were killed. Injury to coastal and marine habitats, fish and shellfish, birds, and mammals and loss of other natural resources are still being documented and quantified through scientific studies as part of a formal Natural Resources Damage Assessment.

Commercial herring and salmon fisheries were closed in major areas, disrupting the lives and livelihoods of thousands of Alaskans. Beach set-net fishing sites were made unusable by oil. Native Alaskans who depend on subsistence resources, such as salmon and clams, were afraid to eat what they caught and gathered.

The wilderness experience—so valued by recreational users, visitors, and armchair travelers around the world—has been deeply altered. Tour- and charter-boat operators have seen their businesses sharply decline. Cultural heritage information has been damaged or lost, both through direct oiling and disturbance. Communities and villages in Prince William Sound, the Kenai Peninsula, and on Kodiak Island experienced high levels of stress. Uncertainty about the future remains at high levels.

All of these are real impacts on the environment and people during the first year following the spill. But the effects of the spill are not over—and may not be over for a long time—as people living in the affected communities know all to well.

Outer Limits of Observed Sheens, Tar Balls, and Mousse Suspected to be from the *Exxon Valdez* as of August 10



This brochure is published by the Oil Spill Restoration Planning Work Group:

- State of Alaska
  - Department of Environmental Conservation
  - Department of Fish and Game
  - Department of Natural Resources
- United States Government
  - Department of Agriculture
  - Department of Commerce
  - Department of the Interior
  - Environmental Protection Agency

Printed on Recycled Paper

The Law and Restoration

Federal and State laws have established a framework for assessing damages to natural resources and submitting financial claims to potentially responsible parties. It is expected—and it is our goal—that there will be a significant sum of money available for restoration of the environment. Funds recovered under Federal law, must be spent to restore, replace, or acquire the equivalent of injured natural resources.

Natural resources include land and water vegetation, fish, wildlife and other biota. Such cultural resources as historical and archaeological sites also may be considered for purposes of the restoration program. Human uses of the natural environment include recreation and subsistence activities, and these services too are appropriate subjects for restoration activities.

Fishing, tourism, and some other commercial enterprises are based on a healthy and esthetically pleasing environment. Restoring the natural resources on which businesses depend is appropriate for the restoration program. However, direct damages to commercial businesses, such as losses of income, are not appropriately compensated under the environmental restoration program.

The Natural Resources Damage Assessment, including planning for the restoration of the areas affected by the oil spill, is being coordinated by the natural-resource Trustees, which at this time consist of the Secretaries of the Federal departments of Agriculture, Commerce, and Interior and the Commissioner of the Alaska Department of Fish and Game. Although the process is still taking shape, it is our goal that decisions to allocate funds for specific restoration projects will be made jointly by Federal and State officials, with guidance from the public.

What is Restoration?

Experience with environmental restoration following oil spills, especially in northern environments, is limited, but a broad array of activities may be appropriate to help correct the environmental damage caused by the oil spill. The following descriptions of the terms "restore, replace, or acquire the equivalent resources" illustrate some possibilities.

"Restoration" includes direct attempts to return an injured resource to its pre-oil spill condition or function. An example would be to rehabilitate an oiled marsh ecosystem by supplementing natural plant and animal populations after removal of the oil. Restoration in this sense is a direct, on-site activity.

"Replacement" includes substitution of a new resource for an injured resource. An example is to use hatchery/aquaculture techniques to establish an entirely new fishery stock in place of one that has been severely damaged. Replacement may or may not be limited to the specific site or area where damage occurred.

"Acquisition of equivalent resources" means to purchase or otherwise protect resources that are similar or related to the injured resources in terms of ecological value, functions, or uses. An example is to purchase or protect undamaged wildlife habitats as alternatives to direct restoration of injured habitats. Equivalent resources need not be confined to specific damaged sites or to the direct spill area.

As you can see, there are many different possibilities to environmental restoration. The Restoration Planning Process will help identify those alternatives that are scientifically and economically feasible.

What is the Restoration Planning Process?

Representatives of Federal and State agencies are participating in a Restoration Planning Work Group for the purpose of identifying restoration alternatives and making recommendations to the Trustees and the public. This process will involve consultations with the public and the scientific community.

Public participation in this process began with a public Restoration Symposium on March 26 and 27 in Anchorage. A series of public Scoping Meetings has been scheduled for some of the communities directly affected by the oil spill. Several progress reports will be published to update the public on the results of the restoration planning and to invite additional comments.

The Restoration Planning Work Group wants to consider a wide range of restoration alternatives. To that end, the work group is committed to active public participation throughout the process. The public will be given the opportunity for formal review and comment on any final recommendations about restoration alternatives.

How Can You Participate?

You are invited to share your ideas and comments with the Restoration Planning Work Group. Please use the space below to present your comments and ideas or send additional comments by letter. We appreciate and value your assistance.

You may mail your response to: Oil Spill Restroation Planning Office, 437 "E" Street, Suite 301, Anchorage, AK 99501, (907) 271-2461.

What natural resources need the most attention? Do you have suggestions for restoration, replacement, or acquisition projects?

May we contact you for additional information? Yes ______ No ______

Name ______

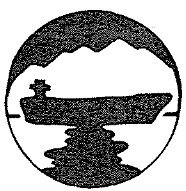
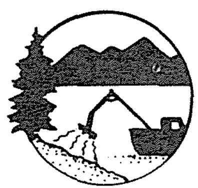
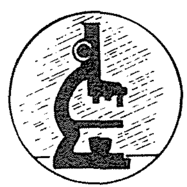
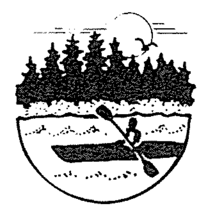
Organization (if any) ______

Mailing Address ______

City ______ State ______ Zip ______

Alaska Department of Fish and Game
Oil Spill Impact Assessment & Restoration
333 Raspberry Road
Anchorage, Alaska 99518-1599

Restoring the Environment After the *Exxon Valdez* Oil Spill

Brian For your info

RPWG
JJ

ART17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 383: POLREP236 EXXON VALDEZ
ENTERED 01/17/90 9:22 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.

BT
UNCLAS //N16465//
SUBJ: POLREP 236 MAJOR CRUDE OIL SPILL, T/V EXXON VALDEZ,
PRINCE WILLIAM SOUND, AK, MP89002004. FPN 33-179007
1. SITUATION: DATA PROVIDED IS THRU 15JAN UNLESS OTHERWISE NOTED.

A. PRINCE WILLIAM SOUND AREA: THERE HAS BEEN 1 FLIGHT FOR THIS PERIOD AND 10 VESSEL OPERATIONS.

B. WESTERN ALASKA AREA: THERE HAVE BEEN 2 FLIGHTS FOR THIS PERIOD AND NO VESSEL OPERATIONS.

C. WX 15JAN90:

1. PRINCE WILLIAM SOUND: WINDS SW AT 50 KTS, AIR TEMP 28, SEAS 14 FT, VIS 1 MILE.

2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS SW AT 45 KTS, AIR TEMP 44, SEAS 21 FT, VIS 15 MILES.

2. ACTION:

A. PRINCE WILLIAM SOUND AREA: M/V ADELE CANDIES CONDUCTED THE FOLLOWING SCAT A AND B SHORELINE ASSESSMENTS: (KN-24) KNIGHT ISL AND NOTED NO OIL ON THE UPPER TIDAL ZONE OR IN THE SUBSURFACE; (CH-10) CHENEGA ISL AND NOTED A LIGHT IMPACT ON THE UPPER AND INTERMEDIATE TIDAL ZONES WITH A 1/2 IN TO 1 IN PENETRATION OF THE SUBSURFACE; (SM-6) SMITH ISL AND NOTED ONLY A LIGHT IMPACT IN THE UPPER TIDAL ZONE WITH NO IMPACT IN THE INTERMEDIATE OR LOWER TIDAL ZONES. THIS SEGMENT IS REMARKABLY CLEAN CONSIDERING INITIAL IMPACT. M/V DON BOLLINGER P/U DEBRIS ALONG (EL-55), (EL-58) AND ALONG THE EAST SIDE OF ELEANOR ISL. THE VESSEL ALSO FOUND/RETRIEVED A DEAD SEA OTTER ON (EL-11) ELEANOR ISL. THE OTTER HAD BEEN DEAD FOR 2 TO 3 DAYS AND WAS HEAVILY OILED. THERE WAS ONLY A LIGHT SHEENING NOTED OFF (EL-11). OVERFLIGHT INDICATED RAINBOW SHEENS IN THE FOLLOWING LOCATIONS: SEGMENT (LS-46) LITTLE SMITH ISL (20 FT X 200 FT), (SM-6) SMITH ISL (100 FT X 20 FT), (EL-107) ELEANOR ISL (40 FT X 150 FT) AND (EL-105) ELEANOR ISL (10 FT X 100 FT).

B. WESTERN ALASKA AREA: ONE SCAT B FLIGHT OF (RE-16) DRIFTWOOD COVE AND (BM-6) TAROKA ARM NOTED NO VISIBLE SHEEN. A SHORELINE ASSESSMENT SURVEY FLIGHT OF (KB-3) KITOI BAY, KODIAK ISL NOTED ONE MOUSSE PATTIE (6 IN X 3 IN X 1 CM) WITH NO OTHER SIGNS OF OILING. THE USCGC MUSTANG IS SUPPORTING THE WIMP PROGRAM IN SEWARD. WIMP PROGRAM LIABILITY ISSUE RESOLVED WITH STATE AGENCIES. ONLY AGENCY REFUSING TO SIGN EXXON LIABILITY WAIVER RELEASE REMAINS THE NATIONAL PARK SERVICE.

3. FUTURE PLANS AND RECOMMENDATIONS: RADM CIANCAGLINI ARRIVED FOSC ON 16JAN90 FOR MEETINGS AND BRIEFINGS. WILL ATTEND EXXON STRATEGY MEETING WITH CAPTAIN ZAWADZKI IN SAN FRANCISCO 19JAN90 AND RETURN TO FOSC 23JAN90.

4. CASE STATUS: PENDING.

BT
#5141
NNNN

ART17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 339: POLREP 237 EXXON VALDEZ

ENTERED 01/19/90 8:55 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.
-
BT
UNCLAS //N16465//
SUBJ: POLREP 237 MAJOR CRUDE OIL SPILL, T/V EXXON VALDEZ,
PRINCE WILLIAM SOUND, AK, MP89002004, FPN 33-179007
1. SITUATION: DATA PROVIDED IS THRU 17JAN UNLESS OTHERWISE
NOTED.
A. PRINCE WILLIAM SOUND AREA: THERE HAVE BEEN 3 FLIGHTS FOR
THIS PERIOD AND 6 VESSEL OPERATIONS.
B. WESTERN ALASKA AREA: THERE HAVE BEEN NO FLIGHTS FOR THIS
PERIOD AND 2 VESSEL OPERATIONS.
C. WX 17JAN90:
1. PRINCE WILLIAM SOUND: WINDS E AT 45 KTS, AIR TEMP 31,
SEAS 8 FT, VIS 1 MILE.
2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS SE AT 35 KTS,
AIR TEMP 38, SEAS 16 FT, VIS 3 MILES.
2. ACTION:
A. PRINCE WILLIAM SOUND AREA: M/V DON BOLLINGER P/U DEBRIS
ALONG EAST SIDE OF ELEANOR ISLAND AND ON SQUIRE ISLAND. M/V
ADELE CANDIES CONDUCTED SHORELINE ASSESSMENT SURVEYS OF (KN-15)
KNIGHT ISLAND AND (EL-56 AND EL-58) ELEANOR ISLAND AND NOTED
THE FOLLOWING: (KN-15) INDICATED A LIGHT SUBSURFACE OILING TO
A 3 INCH DEPTH IN THE INTERMEDIATE TIDAL ZONE AND A LIGHT
OILING TO A 6 INCH DEPTH IN THE LOWER TIDAL ZONE - THIS IS A
LOW ENERGY SEGMENT; (EL-56) INDICATED LIGHT OILING WITH MODERATE
STAINING OF LARGE BOULDERS IN THE UPPER AND INTERMEDIATE TIDAL
ZONES WITH A SUBSURFACE OIL DEPTH OF 30 CM IN BOTH ZONES, (EL-58)
INDICATED LIGHT OILING WITH SOME STAINING OF LARGE BOULDERS IN
THE IN THE UPPER AND INTERMEDIATE TIDAL ZONES WITH A SUBSURFACE
OIL DEPTH OF 35 CM TO 45 CM DEPTH IN BOTH ZONES. (EL-56 AND
EL-58) RANGE FROM LOW TO HIGH ENERGY SHORELINES DEPENDENT ON THE
WIND. THE M/V BEULAH CANDIES NOTED A SMALL SHEEN (30 FT X 5 IN)
VICINITY OF WEST MOUTH OF MUMMY BAY, KNIGHT ISLAND.
B. WESTERN ALASKA AREA: THE USCGC MUSTANG IS SUPPORTING THE
WIMP PROGRAM IN SEWARD THRU 19JAN90.
3. FUTURE PLANS AND RECOMMENDATIONS:
A. RADM CIANCAGLINI TO ATTEND EXXON VALDEZ STRATEGY MEETING
WITH CAPTAIN ZAWADZKI IN SAN FRANCISCO 19JAN90 AND RETURN TO
FOSC 23JAN90.
B. EXXON REQUESTED FOSC OPS ATTEND PLANNING MEETING TO DISCUSS
SUMMER OPERATIONAL NEEDS/REQUIREMENTS WITH THEM AND ADEC ON 20JAN90.
4. CASE STATUS: PENDING.
BT
NNNN

RRT17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 340: OSC PRINCE WILLIAM SOUND EXXON VALDEZ EV
ENTERED 01/24/90 9:10 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.
-
1. SITUATION: DATA PROVIDED IS THRU 22JAN UNLESS OTHERWISE
NOTED.
A. PRINCE WILLIAM SOUND AREA: THERE HAVE BEEN 2 FLIGHTS FOR
THIS PERIOD AND 13 VESSEL OPERATIONS.
B. WESTERN ALASKA AREA: THERE HAVE BEEN 6 FLIGHTS FOR THIS
PERIOD AND ONE VESSEL OPERATION.
C. WX 22JAN90:

C. WX 22JAN90:

1. PRINCE WILLIAM SOUND: WINDS W AT 15 KTS, AIR TEMP 31, SEAS 3 FT, VIS 5 MILE.

2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS W AT 15 KTS, AIR TEMP 29, SEAS 7 FT, VIS 15 MILES.

2. ACTION:

A. PRINCE WILLIAM SOUND AREA: M/V ADELE CANDIES CONDUCTED A SHORELINE ASSESSMENT SURVEY OF (IN-29) INGOT ISLAND AND NOTED ONLY A LIGHT STAINING OF SURFACE MATERIAL IN THE UPPER TIDAL ZONE, A VERY LIGHT STAINING IN THE INTERMEDIATE ZONE WITH SUBSURFACE OILING TO 2 INCHES AND NO OILING IN THE LOWER ZONE. THIS IS A HIGH ENERGY BEACH. THE M/V DON BOLLINGER CONDUCTED A SHORELINE ASSESSMENT SURVEY (SAS) OF (LA-16 THRU 20) LATOUCHE ISLAND AND NOTED A MODERATE TO HEAVY COVERING OF MOUSSE PATCHES WITH 80-90 PERCENT OILING IN THE UPPER TIDAL ZONE, 60-70 PERCENT OILING IN THE INTERMEDIATE ZONE AND A 40-50 PERCENT IN THE LOWER ZONE. THERE WAS NO SUBSURFACE OILING INDICATED IN THIS HIGH ENERGY BEACH. THE M/V BEULAH CANDIES AND M/V DON BOLLINGER IN BOOM DEPLOYMENT EXERCISE WITH CHENEGA VILLAGE ON EVANS ISLAND. AIR OPS WERE ALL OVERFLIGHTS WITH NO OIL SIGHTINGS NOTED.

B. WESTERN ALASKA AREA: THE USCGC MUSTANG SUPPORTED THE WIMP PROGRAM IN SEWARD THRU 19JAN90, AND A SUMMARY OF THAT ACTIVITY WILL BE ON THE NEXT POLREP. A SAS OF (US-10) USHAGAT ISLAND INDICATED THAT MOST OF THE OIL AND OILY DEBRIS IN THIS VERY HIGH ENERGY BEACH HAS BEEN PUSHED UP THE BASE OF THE CLIFF. A SAS OF (PP-1) PETROF POINT INDICATED A HEAVY OILING OF THE UPPER TIDAL ZONE WITH SUBSURFACE OILING (NO DEPTH INDICATED), THE INTERMEDIATE ZONE INDICATED A VERY LIGHT OILING WITH SCATTERED MOUSSE PATTIES AND THE LOWER TIDAL ZONE INDICATED NO OILING. THIS IS A HIGH ENERGY BEACH. A SAS OF (RB-4) ROCKY BAY INDICATED NO OILING IN THE AREA. THIS IS A HIGH ENERGY BEACH WHICH WHEN LAST VISITED, DECEMBER 1989, SHOWED THICK PATCHES OF MOUSSE AND OILY DEBRIS IN SCURVY CREEK.

3. FUTURE PLANS AND RECOMMENDATIONS:

A. CONSOLIDATED OPS MEETING SCHEDULED FOR 24JAN90 WITH EXXON, ADEC AND CG IN ANCHORAGE.

B. CAPT ZAWADZKI WILL ATTEND OPS METTING WITH NOAA, ADEC, EPA AND EXXON REPS IN LOS ANGELES ON 01 TO 02FEB90.

4. CASE STATUS: PENDING.

RRT17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 341: OSC PWS EXXON VALDEZ POLREP 239
ENTERED 01/26/90 10:58 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.
-

1. SITUATION: DATA PROVIDED IS THRU 24JAN UNLESS OTHERWISE NOTED.

A. PRINCE WILLIAM SOUND AREA: THERE HAVE BEEN 3 FLIGHTS FOR THIS PERIOD AND 1 VESSEL OPERATION.

B. WESTERN ALASKA AREA: THERE HAVE BEEN 4 FLIGHTS FOR THIS PERIOD AND 0 VESSEL OPERATIONS.

C. WX 24JAN90:

1. PRINCE WILLIAM SOUND: WINDS NE AT 35 KTS, AIR TEMP 20, SEAS 3 FT, VIS 5 MILE.

2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS NW AT 15 KTS, AIR TEMP 25, SEAS 4 FT, VIS 15 MILES.

2. ACTION:

A. PRINCE WILLIAM SOUND AREA: M/V ADELE CANDIES CONDUCTED SHORELINE ASSESSMENT SURVEYS, (SAS), OF (KN-4), (KN-5), (KN-14), (KN-134), (KN-135), (KN-203) AND (KN-206). ALL OF THESE SEGMENTS

REPRESENT LOW ENERGY BEACH ENVIRONMENTS ON KNIGHT ISLAND. OIL IMPACT IN THESE AREAS VARIED FROM VERY LIGHT TO MODERATE.
TWO ADEC FLIGHTS CONDUCTED SAS'S OF SEGMENTS (MA-6) MAIN ISL, (EB-8) ESHAMY BAY, AND (EV-56) EVANS ISL. VERY LIGHT TO NO OIL IMPACT WAS OBSERVED ON THESE LOW ENERGY BEACHES. BOTH FLIGHTS ALSO OBSERVED SHEENS OVER THE WATERS OF PRINCE WILLIAM SOUND.
CG H-3 OVERFLIGHT WITH NBC NEWS CREW ABOARD OVERFLEW SEAL ISLAND AND PWS WITH NO OIL SIGHTINGS NOTED.

B. WESTERN ALASKA AREA: USCGC MUSTANG, IN SUPPORT OF WINTER INTERAGENCY MONITORING PROGRAM OPERATIONS, CONDUCTED SAS'S OF SEGMENTS (BM-5) TAROKA ARM, (PY-8) MORNING COVE AND (YG-2) YALIK GLACIER BEACH THRU 19JAN90. THE HIGH ENERGY BEACHES VISITED CONTINUE TO SHOW IMPROVEMENT. THE LOW ENERGY BEACH SURVEYED SHOWED NO SIGNIFICANT IMPROVEMENT. OVERFLIGHT TO KITOI HATCHERY AREA SIGHTED NO OIL. SAS'S WERE CONDUCTED ON SEGMENTS (K9-08) CAPE DOUGLAS, (K9-19) HALLO BAY, (K10-7) PUALE BAY AND (K11-10) WIDE BAY. THESE SURVEYS INDICATED VERY LIGHT TO LIGHT OIL IMPACT ON THESE SHORELINES. TWO OTHER FLIGHTS CONDUCTED SAS'S ON SEGMENTS (WA-1) WEST AMATULI, (NK-1) NUKA BAY AND (GP-1002) GORE POINT, AND NOTED IMPACT WHICH VARIED FROM VERY LIGHT TO MODERATE.

3. FUTURE PLANS AND RECOMMENDATIONS:

A. CAPT ZAWADZKI WILL ATTEND OPS METTING WITH NOAA, ADEC, EPA AND EXXON REPS IN LOS ANGELES ON 01 TO 02FEB90.

B. THE USCGC MUSTANG IS TENTATIVELY SCHEDULED TO SUPPORT THE WINTER INTERAGENCY MONITORING PROGRAM AGAIN IN FEBRUARY DUE TO IT'S OVERWHELMING SUCCESS THIS MONTH.

C. THE AGREEMENT TO SET ASIDE SPECIFIED OILED BEACHES FOR SCIENTIFIC STUDY HAS BEEN EXECUTED.

D. A COMPREHENSIVE SCAT OF LOW ENERGY, MODERATE TO HEAVILY OILED BEACHES IN PWS AND GOA IS SCHEDULED FOR 28JAN TO 05FEB90. SCAT TEAM WILL BE MADE UP COAST GUARD, ADEC AND EXXON PERSONNEL.

4. CASE STATUS: PENDING

RRT17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 342: OSC PWS EXXON VALDEZ POLREP 240
ENTERED 01/31/90 9:10 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.
-

1. SITUATION: DATA PROVIDED IS THRU 29JAN UNLESS OTHERWISE NOTED.

A. PRINCE WILLIAM SOUND AREA: THERE HAVE BEEN 6 FLIGHTS FOR THIS PERIOD AND 5 VESSEL OPERATIONS.

B. WESTERN ALASKA AREA: THERE HAVE BEEN 6 FLIGHTS FOR THIS PERIOD AND 1 VESSEL OPERATION.

C. WX 29JAN90:

1. PRINCE WILLIAM SOUND: WINDS NW AT 30 KTS, AIR TEMP 05, SEAS 6 FT, VIS 5 MILE.

2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS NW AT 25 KTS, AIR TEMP 25, SEAS 12 FT, VIS 15 MILES.

2. ACTION:

A. PRINCE WILLIAM SOUND AREA: M/V ADELE CANDIES CONDUCTED SHORELINE ASSESSMENT SURVEYS (SAS) OF (KN-115, 117 THRU 119, 400, AND 702) KNIGHT ISLAND AND (EL-52) ELEANOR ISLAND. ALL SEGMENTS WERE LOW ENERGY SHORELINE ENVIRONMENTS AND IMPACTS VARIED FROM VERY LIGHT TO MODERATE AND MOST INDICATING NONE TO LIGHT SUBSURFACE OILING. OVERFLIGHTS OF PWS NOTED ONLY LIGHT RAINBOW SHEENS OR NO OIL SIGHTINGS. SAS SCAT FLIGHTS TO (GR-4, 8, 101 AND 302) GREEN ISLAND, ALL ARE LOW ENERGY SHORELINE ENVIRONMENTS

AND 302) GREEN ISLAND, ALL ARE LOW ENERGY SHORELINE ENVIRONMENTS

EXCEPT (GR-101), AND ALL EXCEPT (GR-101) INDICATED NO OILING TO LIGHT OILING AND ONLY LIGHT SUBSURFACE OILING. (GR-101), A HIGH ENERGY SHORELINE ENVIRONMENT, INDICATED LIGHT OILING WITH SUBSURFACE OILING FROM 2 TO 8 INCHES.

B. WESTERN ALASKA AREA: M/V ENSCO ATLAS CONDUCTED A SAS OF (WB-3) WINDY BAY, A LOW ENERGY SHORELINE ENVIRONMENT, WHICH INDICATED A VERY LIGHT TO LIGHT OILING AND NO SUBSURFACE OILING NOTED. A SAS FLIGHT TO (EI-1) ELIZABETH ISLAND AND (CI-1) CHUGACH ISLAND, BOTH HIGH ENERGY SHORELINE ENVIRONMENTS, INDICATED A RANGE FROM NO OILING TO LIGHT OILING. A SAS FLIGHT TO (K1-11) PEREVALINE ISLAND, A HIGH ENERGY SHORELINE ENVIRONMENT, INDICATED NO OILING IN ANY ZONE OR IN THE SUBSURFACE. A SAS FLIGHT TO (K3-2) IZHUT BAY, A LOW ENERGY SHORELINE ENVIRONMENT, INDICATED ONLY LIGHT OILING WITHIN THE TIDAL ZONES AND THE SUBSURFACE. A SCAT FLIGHT TO (K2-4) FOUL BAY AND (K2-10) MALINA BAY, BOTH HIGH ENERGY SHORELINE ENVIRONMENTS, INDICATED NO OILING WITHIN THE TIDAL ZONES OR SUBSURFACE.

3. FUTURE PLANS AND RECOMMENDATIONS:

A. CAPT ZAWADZKI WILL ATTEND OPS PLANNING MEETING WITH NOAA, ADEC, EPA AND EXXON REPS IN LOS ANGELES ON 01 TO 02FEB90.

B. THE USCGC MUSTANG IS TENTATIVELY SCHEDULED TO SUPPORT THE WINTER INTERAGENCY MONITORING PROGRAM AGAIN IN FEBRUARY.

C. A COMPREHENSIVE SCAT OF LOW ENERGY, MODERATELY TO HEAVILY OILED SHORELINE IN PWS AND GOA COMMENCED 28JAN AND WILL RUN THRU 05FEB90. TEAMS ARE MADE UP OF CG, ADEC AND EXXON PERSONNEL.

D. AVSUPFAC CORDOVA HELO PULLED TO KODIAK FOR SAR RESPONSE DUE TO LACK OF AVAILABLE PLATFORMS AT KODIAK. CGAS KODIAK WORKING TO IDENTIFY A REPLACEMENT PLATFORM.

RRT17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 343: OSC PWS POLREP 241, EXXON VALDEZ
ENTERED 02/02/90 9:01 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.
-
BT
UNCLAS //N16465//
SUBJ: POLREP 241 MAJOR CRUDE OIL SPILL, T/V EXXON VALDEZ, PRINCE WILLIAM SOUND, AK, MP89002004, FPN 33-179007

1. SITUATION: DATA PROVIDED IS THRU 31JAN UNLESS OTHERWISE NOTED.

A. PRINCE WILLIAM SOUND AREA: THERE HAVE BEEN 4 FLIGHTS FOR THIS PERIOD AND 2 VESSEL OPERATIONS.

B. WESTERN ALASKA AREA: THERE HAVE BEEN NO FLIGHTS FOR THIS PERIOD AND 2 VESSEL OPERATIONS.

C. WX 31JAN90:

1. PRINCE WILLIAM SOUND: WINDS SE AT 35 KTS, AIR TEMP 10, SEAS 12 FT, VIS 5 MILE.

2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS SE AT 35 KTS, AIR TEMP 25, SEAS 18 FT, VIS 2 MILES.

2. ACTION:

A. PRINCE WILLIAM SOUND AREA: M/V ADELE CANDIES CONDUCTED SHORELINE ASSESSMENT SURVEYS (SAS) OF (EL-10A, B AND C, 11, 12, 13A AND B, 15) ELEANOR ISL AND (IN-22A, B, C AND D) INGOT ISL (EL-10A), A LOW ENERGY SHORELINE, INDICATED LIGHT TO MODERATE OILING IN ALL 3 ZONES, WITH SUBSURFACE OILING TO 3 INCHES; (EL-10B), A HIGH ENERGY SHORELINE, INDICATED NO OILING IN ANY ZONE OR SUBSURFACE; (EL-10C) A LOW ENRGY SHORELINE, INDICATED LIGHT OILING IN THE UPPER TIDAL ZONE WITH NO OILING IN THE OTHER

ZONES OR SUBSURFACE; (EL-11 AND 12), BOTH LOW ENERGY SHORELINES, INDICATED VERY LIGHT TO LIGHT OILING IN ALL 3 ZONES WITH SUBSURFACE OILING FROM 1-6 INCHES IN THE INTERMEDIATE ZONES ONLY; (EL-13A), A LOW ENERGY SHORELINE, INDICATED VERY LIGHT TO LIGHT OILING IN ALL 3 ZONES WITH NO SUBSURFACE OILING INDICATED; (EL-13B), A LOW ENERGY SHORELINE, INDICATED LIGHT TO HEAVY OILING, WITH SUBSURFACE OILING TO 3 INCHES, IN ALL 3 ZONES; (EL-15), A LOW ENERGY SHORELINE, INDICATED A LIGHT TO MODERATE OILING IN THE UPPER TIDAL ZONE AND A LIGHT OILING IN THE INTERMEDIATE AND LOWER ZONES WITH NO SUBSURFACE OILING INDICATED IN ANY ZONE; (IN-22A), A HIGH ENERGY SHORELINE, INDICATED VERY LIGHT OILING IN ALL 3 ZONES AND SUBSURFACE OILING TO 12 INCHES IN THE UPPER TWO TIDAL ZONES; (IN-22B, C AND D), LOW ENERGY SHORELINES, INDICATED VERY LIGHT TO MODERATE OILING IN ALL THREE ZONES WITH SUBSURFACE OILING TO 5 INCHES. THERE WERE SCAT FLIGHTS TO (EV-12, 17, AND 18) EVANS ISL, (GR-5 AND 14) GREEN ISL, (LG-50) LITTLE GREEN ISL AND (ER-07, 11 AND 23) ERLINGTON ISL. (EV-12, 17 AND 18), HIGH ENERGY SHORELINES, INDICATED LIGHT TO HEAVY OILING IN THE UPPER AND INTERMEDIATE TIDAL ZONES WITH SUBSURFACE OILING FROM 1-12 INCHES AND NOTHING INDICATED FOR THE LOWER ZONES; (EV-21 AND 25), LOW ENERGY SHORELINES, INDICATED MODERATE TO HEAVY OILING WITH ASPHALT AND TAR PATTIES AND SUBSURFACE OILING TO 4 INCHES IN THE UPPER AND INTERMEDIATE ZONES AND LIGHT OILING IN THE LOWER TIDAL ZONE; (GR-5 AND 14), BOTH LOW ENERGY SHORELINES, INDICATED VERY LIGHT OILING, WITH SUBSURFACE OILING TO 2 INCHES, IN THE UPPER ZONE OF (GR-5) AND NO OTHER OILING NOTED; (LG-50), A LOW TO HIGH ENERGY SHORELINE AND SEAL HAUL OUT AREA, INDICATED NO OILING IN ANY ZONE OR SUBSURFACE; (ER-07, 11 AND 23), LOW ENERGY SHORELINES, INDICATED LIGHT TO MODERATE OILING IN ALL 3 ZONES AND NO SUBSURFACE OILING IN (ER-07); (ER-11) INDICATED MODERATE OILING AND SUBSURFACE OILING FROM 2-5 INCHES IN ALL 3 ZONES, (ER-23) INDICATED VERY LIGHT OILING IN THE UPPER TIDAL ZONE ONLY.

B. WESTERN ALASKA AREA: M/V ENSCO ATLAS CONDUCTED TWO DAYS OF SHORELINE ASSESSMENT SURVEYS WITH REPORTS TO FOLLOW WHEN VSL COMMS PERMIT.

3. FUTURE PLANS AND RECOMMENDATIONS:

A. CAPT ZAWADZKI ATTENDING OPS PLANNING MEETING WITH NOAA, ADEC, EPA AND EXXON REPS IN LOS ANGELES ON 01 TO 02FEB90.

B. THE USCGC MUSTANG IS TENTATIVELY SCHEDULED TO SUPPORT THE WINTER INTERAGENCY MONITORING PROGRAM AGAIN IN FEBRUARY.

C. A COMPREHENSIVE SCAT OF LOW ENERGY, MODERATELY TO HEAVILY OILED SHORELINE IN PWS AND GOA COMMENCED 28JAN AND WILL RUN THRU 05FEB90. TEAMS ARE MADE UP OF CG, ADEC AND EXXON PERSONNEL.

D. AVSUPFAC CORDOVA HELO IS AN H-65 FROM SITKA UNTIL 17FEB90 DUE TO SHORTAGE OF H-3 AIRCRAFT.

4. CASE STATUS: PENDING.

BT

NN

DRAFT

NOAA Recommendation for 1990 Cleanup of the EXXON VALDEZ Oil Spill

Developing a strategy for continued cleanup of the Alaskan coast from the EXXON VALDEZ oil spill will be a complex process involving consideration of a variety of often conflicting objectives. In all major oil spills the question "How clean is clean?" has proven difficult to answer; seldom can a simplistic endpoint be specified that will meet all resource management objectives. Despite the apparent desirability of intervening mechanically or chemically to rid the environment of all traces of oil pollution, the actions required to reach the literal definition of "clean" often in themselves are capable of inflicting more injury to the environment than most in society would find acceptable.

In this paper we will discuss the role of natural forces in the cleanup of the EXXON VALDEZ oil spill, define the key issues that bear on the appropriateness of human intervention in the cleanup process, and lay out procedures to allow us to resolve remaining questions on the strategy for cleanup in 1990.

The Role of Natural Cleanup Processes

Past oil spills provide a good indication of the role of natural processes in the removal of oil from the environment. Regardless of further human intervention in the EXXON VALDEZ spill, most of the surface oil (< 10 cm deep) remaining on *high-energy* segments of the Alaskan coast will be removed within the next year or two, based on observations of the AMOCO CADIZ spill in Brittany and the NESTUCCA spill along the Washington and British Columbia coasts. However, without further cleanup activity, oil could remain in *sheltered, low-energy* areas for a period of twenty years or longer, as evidenced by the METULA spill in Tierra Del Fuego and the ARROW spill in Chedabucto Bay, Nova Scotia. While a wide range of shoreline types in Alaska fall between these two extremes (Table 1), the majority of the shoreline affected by the EXXON VALDEZ spill can be classified as moderate- to high-energy, indicating relatively short persistence of surface oil on the average.

Table 1. Approximate Distribution of Wave Exposure in Oil Impact Areas

	Low Energy	Moderate Energy	High Energy
Prince William Sound	34%	40%	26%
Gulf of Alaska	12%	27%	61%

Analysis of past spills also indicates that oil buried deeply in subsurface sediments, even in high-energy areas, will prove much less amenable to natural removal processes. Nonetheless, even in the absence of further cleanup, some progress in the removal of subsurface oil should be evident from year to year as major storms contribute to sediment reworking along the coast.

Consistent with this historical perspective, field studies in Alaska this fall indicate that natural cleansing of the shoreline is proceeding at a significant rate in most moderate- to high-energy areas, especially those facing in a northeasterly to southeasterly direction (the prevailing storm direction). However, after three months of fall storms, significant contamination remains in most sheltered areas. It is important to note that the depth of original oil penetration in the more sheltered locations tends to be considerably less than that along high-energy sections of the coast.

Chemical analysis of surface samples this fall indicates significant removal of the oil's most toxic components, primarily as a result of the action of oil-degrading microorganisms and photo-oxidation. Subsurface oil, both physically and biologically isolated from natural removal processes, shows much less degradation.

Oil Contamination Expected to Remain by Spring 1990

In summary, the following levels of oil contamination are expected by spring 1990:

- *Moderate- to High-energy* areas of the Alaska coast should be relatively free of surface oil (< 10 cm depth) with the exception of residual staining and thin patches of viscous oil in wave shadows. There will be isolated cases of subsurface oil deposits where well-sorted (high porosity) sediments resulted in oil penetration below the depth that reworking will occur this fall and winter. In these instances, oil may be encountered below 15 cm and range in depth to 60 cm.

- *Low energy* areas will show little change in oil coverage and distribution from the last surveys conducted in September, 1989. Some reduction may occur in surface oiling, however subsurface oil deposits, while generally shallow (<10 cm), will not reflect significant improvement. Only very isolated patches of deep oil deposits occur in the more sheltered areas, due to the hard-packed nature of the substrate.

Cleanup Objectives and Limitations

It is clear from the above discussion that most cleanup attention should be directed to sheltered areas of the Alaska coast. However, past experience dictates caution when approaching cleanup in sheltered areas — it is in these areas the ecosystem is most fragile and vulnerable to long-term damage from overly aggressive action. Thus the strategy for cleanup should clearly be one of enhancing natural processes where opportunities exist that pose no undue risk to the environment or its use.

In evaluating cleanup options, the benefit to be derived from each action should be weighed carefully against the ecological or aesthetic implications of leaving the oil to be dealt with by natural processes. Further cleanup should thus be guided by the following general principles:

- Within the framework of the "zero tolerance" policy, a major objective should be the preservation of as much of the 1990 commercial and subsistence fishing season as is possible. Removal of oily debris will clearly contribute to this objective, however considerable care should be taken to avoid any unnecessary disturbance to subsurface sediments that would contribute to the release of sheens from shoreline areas.

- No greater human stresses should be placed on the area than are necessary to achieve the desired level of cleanup. All cleanup efforts should be scaled to a minimum consistent with the problem being addressed.

- Nothing should be done that would risk further disturbance of archaeological deposits.

- The chronic health hazard associated with oil leaching into important subsistence shellfishing areas should be eliminated. While this problem appears to be limited to Windy Bay, the magnitude and extent of the problem should be further investigated.

- An extremely conservative approach should be taken in the use of solvents, beach cleaners or other chemical agents. Chemicals should not be used that involve significant toxicity or would be likely to aggravate recovery of oil released from the shoreline.

- Sheltered areas supporting major populations of birds and marine mammals should be sufficiently cleaned to prevent the transfer of oil to fur or feathers, if means can be found that are consistent with the limitations cited above.

- The aesthetic character of recreational sites fouled by oil contamination should, to the extent feasible, be restored to pre-spill conditions.

Proposed Cleanup Program for 1990

Based on the considerations outlined above, the following cleanup actions are recommended for 1990:

- If current questions regarding the effectiveness of nutrient augmentation can be resolved, bioremediation technology should be used to improve surface conditions at recreational sites and in sheltered areas supporting major bird and marine mammal populations. Limitations on the application of nutrients should be established by resource and land management agencies. Use of this technology should be suspended when the addition of nutrients fails to significantly increase degradation over that which occurs naturally.

- To prevent further contamination of the water surface during the fishing season, cleanup debris and unattached oily vegetation remaining at or above the high tide line should be collected and removed as early in the year as possible. Small work parties and hand tools should be utilized. Oiled logs should only be removed if necessary to improve the aesthetic appearance of significant public use areas.

- To eliminate the chronic health threat due to contamination of shellfish at Windy Bay, subsurface oil deposits in this area should be removed. Sediments should either be cleaned on-site or replaced with clean material. Monitoring of hydrocarbon levels in shellfish tissue should be continued in all areas that historically provide a significant quantity of shellfish for Native subsistence. If other areas are identified by the Oil Spill Health Task Force that pose health risks, similar treatment should be undertaken.

- Surface tar mats remaining in areas of high recreational or biological value should be removed or broken up. Small work parties and hand tools should be utilized. Periodic monitoring should be undertaken to identify additional accumulations that may become exposed after major storms.

- Following the close of the 1990 fishing season, sheltered areas of the coast containing high concentrations of oil should be mechanically tilled to improve the exposure of subsurface oil to winter storms and microbial degradation. This action should be taken with due consideration for the preservation of archaeological sites.

Proposed process to clarify and resolve remaining issues

Following Regional Response Team approval or modification of the general strategy for continued shoreline cleanup outlined in this document, NOAA should continue to work with resource and land management agencies (including private landowners) to identify the nature, location, and timing of sensitive resource issues that will constrain response activities. Special use areas (e.g., subsistence shellfisheries, recreational areas, set net sites, etc.) not thoroughly specified during the 1989 planning process should be identified. The result of these planning steps should be a complete statement of the objectives and limitations of each cleanup method to be applied in 1990 (elaborating as necessary on the material included in Attachment A), including overall restrictions on the size of the labor force and extent of supporting aircraft and vessel traffic.

In late March, the shoreline should be resurveyed to determine the full extent of surface and subsurface oil contamination, including oily vegetation and cleanup debris, and to complete work on the identification of archaeological sites. This survey should be jointly conducted by Federal and State agencies together with Exxon. Based on this survey, and the previous planning material, a cleanup plan for the entire affected area should be prepared by the Coast Guard and submitted to the Regional Response Team for review and comment. Following action by the RRT, the Coast Guard should prepare the necessary work orders to implement the PLAN.

Attachment A
Further Definition of Proposed Cleanup Methods

Bioremediation

Recommendation:
If current questions regarding the effectiveness of nutrient augmentation can be resolved, bioremediation technology should be used to improve surface conditions at recreational sites and in sheltered areas supporting major bird and marine mammal populations. Limitations on the application of nutrients should be established by resource and land management agencies. Use of this technology should be suspended when the addition of nutrients fails to significantly increase degradation over that which occurs naturally.

Three methods of nutrient augmentation are recommended:

1) Water-soluble - This method consists of applying nutrients dissolved in sea water by means of sprinklers, trickle irrigation, and spray hoses. For subsurface application, oxygen may be added if necessary. Application concentrations and frequencies will be determined to minimize ammonia levels in adjacent nearshore waters.

2) Oleophilic - Inipol is likely to be the only oleophilic fertilizer to have been sufficiently well tested to be acceptable for use in 1990. Because of the its ability to cling to oil-coated substrate, Inipol will be best applied on rocky shores (which were not treated with the substance in 1989).

3) Granule - The method consists of broadcasting a solid-form blend of slow-release fertilizer. It may be used alone or in conjunction with the two other nutrient formulations discussed above.

Limitations:
- Ammonia levels must not exceed that which would cause sublethal impact to salmon fry during outmigration
- No application within 50 m of anadromous fish streams

- No application adjacent to herring spawning areas for the period one week before and after spawning periods
- No application in tidal pools or other sensitive intertidal habitats
- No granule application adjacent to bird nesting colonies
- No application in areas likely to have wooden artifacts
- No application to haulout areas during marine mammal pupping season

Termination:

Use of this technology should be suspended when the addition of nutrients fails to increase degradation over that which occurs naturally. Establishing the point of termination will require monitoring of control and treated plots representative of a variety of shoreline type/degree of oiling combinations. A definitive measure of degradation rate will need to be specified by EPA. Comparisons will have to be made throughout the summer to determine the need for multiple applications, particularly for the water-soluble fertilizer which may need to be frequently re-applied.

Tilling of Shoreline Sediments

Recommendation:
Following the close of the 1990 fishing season, sheltered areas of the coast containing high concentrations of oil should be mechanically tilled to improve the exposure of subsurface oil to winter storms and microbial degradation. This action should be taken with due consideration for the preservation of archaeological sites.

Tilling can be combined with nutrient addition to speed microbial degradation. Mechanical mixing of the sediments will increase physical and chemical weathering as the oil is brought to the surface, and it will prevent the formation of tar mats. This procedure may include some degree of relocation of sediment to the surf zone in the fall to enhance physical removal of oil by waves during transport of sediments up the beach face.

Limitations:

- Should only be used in sheltered areas containing heavy subsurface oiling
- Should be limited to shoreline areas with relatively small sediment size
- Activity should not occur until fall, after the close of the fishing season
- No sediment disturbance should occur within 50 m of anadromous streams, unless specifically approved by ADF&G
- No tilling is to be conducted near archaeological sites

Termination:
This technique will be applied only once within the limitations specified above.

Removal of Oily Vegetation and Cleanup Debris

Recommendation:
To prevent further contamination of the water surface during the fishing season, cleanup debris and unattached oily vegetation remaining at or above the high tide line should be collected and removed as early in the year as possible. Small work parties and hand tools should be utilized. Oiled logs should only be removed if necessary to improve the aesthetic appearance of significant public use areas.

Limitations:

- Removal should be limited to surface accumulations
- No live vegetation should be removed
- Debris removal should occur no more than twice during the spring and summer season
- No removal activities are to be conducted within 100 m of active bird nesting sites
- No removal activities at marine mammal haulouts during pupping season
- Activity must be closely monitored by archaeologists

Termination:
Debris removal should continue until significant accumulations of material with more than 10% oil coverage has been removed (with the exception of oiled logs as indicated above).

Removal of Tar Mats

Recommendation:
Surface tar mats remaining in areas of high recreational or biological value should be removed or broken up. Small work parties and hand tools should be utilized. Periodic monitoring should be undertaken to identify additional accumulations that may become exposed after major storms.

Complete removal of tar mats is appropriate for all areas except relatively inaccessible, high energy shorelines.

Limitations:

- No activity is to be conducted within 100 m of active bird nesting sites
- No activity at marine mammal haulouts during pupping season
- Activity must be closely monitored by archaeologists
- Removal should be limited to surface accumulations

Termination:

Removal activities should continue until all tar mats 6 inches or greater in size have been broken up and/or removed.

Removal of Oil Deposits Near Subsistence Shellfish Areas

Recommendation:

To eliminate the chronic health threat due to contamination of shellfish at Windy Bay, subsurface oil deposits in this area should be removed. Sediments should either be cleaned on-site or replaced with clean material. Monitoring of hydrocarbon levels in shellfish tissue should be continued in all areas that historically provide a significant quantity of shellfish for Native subsistence. If other areas are identified by the Oil Spill Health Task Force that pose health risks, similar treatment should be undertaken.

Limitations:

- Should be used only at areas identified by the Oil Spill Health Task Force
- No sediment removal should be undertaken within 50 m of an anadromous stream unless approved by ADF&G
- Sediment excavation must be closely monitored by archaeologists

Termination:

All contaminated sediments are to be removed, using the bucket sheen test on samples collected from the bottom of the excavation trench to determine the depth of excavation. Samples for sheen test should be collected every five meters of shoreline length or width, or 25 square meter area. Only completely clean sediments are to be replaced into the excavation area. Monitoring of hydrocarbon levels in shellfish tissue should be continued until reductions to levels safe for human consumption are observed.

January 1990 ARRT Meeting Anchorage Alaska

Tuesday,Jan 30th

10:30-10:45	Opening remarks and welcome (Co Chairs EPA/USCG)
10:45-11:30	NRT/RRT Co Chairs Dec89 Meeting Debrief (EPA/USCG)
11:30-12:00	ARRT FY 90 Workplan Review & approval (EPA/DOI/USCG)
12:00-1:15	Lunch
1:15-2:00	Working Group Reports Dispersants (EPA/ADEC) Wildlife Protection (DOI) Preparedness (EPA/FEMA/ADES/ADEC)
2:00-2:30	Unfinished Business (review of prior commitments EPA)
2:30-2:45	Break
2:45-3:15	Contingency Planning, National Report to the President (USCG)
3:15-3:30	Outer Continental Shelf Activities (DOI-MMS)
3:30-4:00	Pipeline Monitoring Office/TAPS Contingency Planning (DOI-BLM)
4:00	Adjourn

January 1990 ARRT Meeting Anchorage Alaska

Wedensday, Jan 31st

8:30-9:30	OSC Reports USCG MSO's EPA AOO ADEC
9:30-10:30	Exxon Valdez 1990 Cleanup Plans (USCG-RRT Member Agencies)
10:30-10:45	Break
10:45-11:15	Prince William Sound Restoration Overview of Planning (EPA)
11:15-11:30	NOAA Technology Conference
11:30-11:45	ADEC Testing Protocols
11:45-12:00	New Business
12:00	Adjourn

RRT17 INCIDENT 34 : T/V EXXON VALDEZ, MAJOR OIL SPILL
REPORT 336: OSC PWS EXXON VALDEZ POLREP 239
ENTERED 01/26/90 10:58 BY CGD17
THE FOLLOWING INFORMATION IS BASED ON THE MOST CURRENT DATA PROVIDED TO NOAA.
-
1. SITUATION: DATA PROVIDED IS THRU 24JAN UNLESS OTHERWISE NOTED.

A. PRINCE WILLIAM SOUND AREA: THERE HAVE BEEN 3 FLIGHTS FOR THIS PERIOD AND 1 VESSEL OPERATION.

B. WESTERN ALASKA AREA: THERE HAVE BEEN 4 FLIGHTS FOR THIS PERIOD AND 0 VESSEL OPERATIONS.

C. WX 24JAN90:

1. PRINCE WILLIAM SOUND: WINDS NE AT 35 KTS, AIR TEMP 20, SEAS 3 FT, VIS 5 MILE.

2. KODIAK ISLAND WATERS/BARREN ISLANDS: WINDS NW AT 15 KTS, AIR TEMP 25, SEAS 4 FT, VIS 15 MILES.

2. ACTION:

A. PRINCE WILLIAM SOUND AREA: M/V ADELE CANDIES CONDUCTED SHORELINE ASSESSMENT SURVEYS, (SAS), OF (KN-4), (KN-5), (KN-14), (KN-134), (KN-135), (KN-203) AND (KN-206). ALL OF THESE SEGMENTS REPRESENT LOW ENERGY BEACH ENVIRONMENTS ON KNIGHT ISLAND. OIL IMPACT IN THESE AREAS VARIED FROM VERY LIGHT TO MODERATE.
TWO ADEC FLIGHTS CONDUCTED SAS'S OF SEGMENTS (MA-6) MAIN ISL, (EB-8) ESHAMY BAY, AND (EV-56) EVANS ISL. VERY LIGHT TO NO OIL IMPACT WAS OBSERVED ON THESE LOW ENERGY BEACHES. BOTH FLIGHTS ALSO OBSERVED SHEENS OVER THE WATERS OF PRINCE WILLIAM SOUND.
CG H-3 OVERFLIGHT WITH NBC NEWS CREW ABOARD OVERFLEW SEAL ISLAND AND PWS WITH NO OIL SIGHTINGS NOTED.

B. WESTERN ALASKA AREA: USCGC MUSTANG, IN SUPPORT OF WINTER INTERAGENCY MONITORING PROGRAM OPERATIONS, CONDUCTED SAS'S OF SEGMENTS (BM-5) TAROKA ARM, (PY-8) MORNING COVE AND (YG-2) YALIK GLACIER BEACH THRU 19JAN90. THE HIGH ENERGY BEACHES VISITED CONTINUE TO SHOW IMPROVEMENT. THE LOW ENERGY BEACH SURVEYED SHOWED NO SIGNIFICANT IMPROVEMENT. OVERFLIGHT TO KITOI HATCHERY AREA SIGHTED NO OIL. SAS'S WERE CONDUCTED ON SEGMENTS (K9-08) CAPE DOUGLAS, (K9-19) HALLO BAY, (K10-7) PUALE BAY AND (K11-10) WIDE BAY. THESE SURVEYS INDICATED VERY LIGHT TO LIGHT OIL IMPACT ON THESE SHORELINES. TWO OTHER FLIGHTS CONDUCTED SAS'S ON SEGMENTS (WA-1) WEST AMATULI, (NK-1) NUKA BAY AND (GP-1002) GORE POINT, AND NOTED IMPACT WHICH VARIED FROM VERY LIGHT TO MODERATE.

3. FUTURE PLANS AND RECOMMENDATIONS:

A. CAPT ZAWADZKI WILL ATTEND OPS METTING WITH NOAA, ADEC, EPA AND EXXON REPS IN LOS ANGELES ON 01 TO 02FEB90.

B. THE USCGC MUSTANG IS TENTATIVELY SCHEDULED TO SUPPORT THE WINTER INTERAGENCY MONITORING PROGRAM AGAIN IN FEBRUARY DUE TO IT'S OVERWHELMING SUCCESS THIS MONTH.

C. THE AGREEMENT TO SET ASIDE SPECIFIED OILED BEACHES FOR SCIENTIFIC STUDY HAS BEEN EXECUTED.

D. A COMPREHENSIVE SCAT OF LOW ENERGY, MODERATE TO HEAVILY OILED BEACHES IN PWS AND GOA IS SCHEDULED FOR 28JAN TO 05FEB90. SCAT TEAM WILL BE MADE UP COAST GUARD, ADEC AND EXXON PERSONNEL.

4. C

U.S. Fish and Wildlife Service
Beached Bird and Sea Otter Retrieval
PROTOCOL
Spring\Summer 1990

REVISED APRIL 3, 1990

The following revised protocol for retrieving birds and sea otters is designed to provide guidance to all personnel (federal, state, borough and private) who will be in the T\V *Exxon Valdez* oil spill zone during the spring and summer of 1990.

CARCASS RETRIEVAL-BIRDS

1) Dried or scavenged, non-oiled bird carcasses should be left on the beach to become part of the natural food chain. All other bird carcasses should be retrieved, especially fresh non-oiled and oiled carcasses. If in doubt, pick it up.

2) Fill out a separate U.S. Fish and Wildlife Service Beached Bird\Sea Otter Retrieval form (retrieval form) for each bird carcass, even if a dried or scavenged, non-oiled carcass is left on the beach. If more retrieval forms are needed, please make copies of the attached form or obtain copies from the contacts listed below. If retrieval forms are not available, please provide, on sturdy paper, the following information: date, location of bird, name of observer, degree of bird oiling, degree of beach oiling, and condition of bird.

3) To avoid double-counting the dried or scavenged, non-oiled bird carcasses left on the beach, toss the carcasses far above high tide line. Complete a separate retrieval form for each of these bird carcasses. If a retrieval form is not completed to account for the bird carcass, leave the carcass where found so others may count it.

4) **If a bird carcass is retrieved**, bag it individually (double bag). Complete a retrieval form and place the form in a ziplock bag for protection. Put the ziplock-protected retrieval form in the bag with the bird carcass. Return the bagged bird carcass to the nearest contact site listed at the bottom of each form and at the end of this protocol. Keep carcass cool, not frozen.

5) **Even if a bird carcass is NOT retrieved**, please complete a retrieval form. Return the completed retrieval form to the nearest contact site listed at the bottom of each form and at the end of this protocol. Alternately, return the completed retrieval form to the U.S. Fish and Wildlife Service, Attn. Tina Odenbaugh, 1011 E. Tudor Road, Anchorage, Alaska 99503.

CARCASS RETRIEVAL-SEA OTTERS

1) All sea otter carcasses should be retrieved. EXCEPTION: All sea otters found on Green Island, Little Green Island, or Channel Island before May 15, 1990 are to remain on the beach to avoid interference with an on-going U.S. Fish and Wildlife Service research project. After May 15, retrieve all sea otter carcasses.

2) Complete a separate U.S. Fish and Wildlife Service Beached Bird\Sea Otter Retrieval form (retrieval form) for each sea otter carcass, even if the carcass is left on the beach. If more retrieval forms are needed, please make copies of the attached form or obtain copies from the contacts listed below. If retrieval forms are not available, please provide, on sturdy paper, the following information: date, location of sea otter, name of observer, degree of sea otter oiling, degree of beach oiling, and condition of sea otter.

3) **If a sea otter carcass is retrieved,** please bag individually (double bag). Complete a retrieval form and place the form in a ziplock bag for protection. Put the ziplock-protected form in the bag with the carcass. Return the bagged sea otter carcass to the nearest contact site listed on the bottom of each retrieval form and at the end of this protocol. Keep cool, not frozen.

4) **Even if a sea otter carcass is NOT retrieved**, please complete a retrieval form. Return the completed retrieval form to the nearest contact site listed on the bottom of each form and at the end of this protocal. Alternately, return the completed retrieval form to the U.S. Fish and Wildlife Service, Attn. Tina Odenbaugh, 1011 E. Tudor Road, Anchorage, Alaska 99503.

LIVE SICK OR INJURED BIRDS

1) **Do not chase, pick-up, or handle sick or injured birds.** Complete a separate U.S. Fish and Wildlife Beached Bird\Sea Otter Retrieval form (attached) for each sick or injured bird observed. If more retrieval forms are needed, please make copies of the attached form or obtain copies from the contacts listed below. If retrieval forms are not available, please provide, on sturdy paper, the following information: date, location of bird, name of observer, degree of bird oiling, degree of beach oiling, and condition of bird.

2) Call the nearest U.S. Fish and Wildlife Service contact for further instructions. Contacts are listed on the bottom of each retrieval form and at the end of this protocol.

NOTE: DO NOT HANDLE, CHASE, OR FEED CHICKS. Chicks may be found in or near the nest while the parents are elsewhere foraging for food; This is normal behavior. Handling, chasing, or feeding chicks could lead to injury or death, or abandonment by the parents. If the health of the chick is in question, call the nearest U.S. Fish and Wildlife Service contact for further instructions.

LIVE SICK OR INJURED SEA OTTERS

1) **Do not chase, pick-up, or handle sick or injured sea otters.**
Complete a separate U.S. Fish and Wildlife Service Beached Bird\Sea Otter Retrieval form (retrieval form) for each sick or injured sea otter observed. If more retrieval forms are needed, please make copies of the attached form or obtain copies from the contacts listed below. If no retrieval forms are available, please provide, on sturdy paper, the following information: date, location of sea otter, name of observer, degree of sea otter oiling, degree of beach oiling, and condition of sea otter.

2) Call the nearest U.S. Fish and Wildlife Service contact for further instructions. Contacts are listed on the bottom of each retrieval form and at the end of this protocol.

NOTE: DO NOT HANDLE, CHASE, OR FEED SEA OTTER PUPS. Pups may be found beached or floating while the parents are elsewhere foraging for food. This is normal behavior. Handling, chasing, or feeding these lone pups can lead to injury or death, or abandonment by the parents. If the health of the pup is in question, call the nearest U.S. Fish and Wildlife Service contact for further instructions.

U.S. FISH AND WILDLIFE SERVICE CONTACTS

Anchorage:	Tina Odenbaugh, U.S. Fish and Wildlife Service (Mon-Fri 8-5 pm) 786-3479
Homer:	Alaska Maritime National Wildlife Refuge Staff (Mon-Fri 7-5 pm) 235-6546
Kodiak:	Kodiak National Wildlife Refuge Staff (Mon-Fri 8-4:30 pm) 487-2600
Seward:	National Park Service Staff (Mon-Fri 8-5 pm until Memorial Day, then 8-7 pm daily) 224-3175
Valdez:	Barbara Ward, Alaska Department of Environmental Conservation (Mon-Fri 9-11:30 & 1:30-4 pm) 835-5260
Cordova:	Prince William Sound Science Center (Mon-Fri 9-12 & 1-5 pm) 424-5800
King Salmon:	Becharof National Wildlife Refuge Staff (Mon-Fri 8-4:30 pm) 246-3339
Whittier:	Whittier Police Department (Mon-Fri 8-5 pm) 472-2340

ANSWER MACHINE (24-HR WEEKENDS AND 5pm-7am WEEKDAYS) 786-3479

U.S. FISH AND WILDLIFE SERVICE
BEACHED BIRD/SEA OTTER RETRIEVAL
T/V *EXXON VALDEZ* SPILL ZONE
SPRING AND SUMMER 1990

REVISED APRIL 3, 1990

COMPLETE ONE FORM PER ANIMAL EVEN IF ANIMAL IS NOT RETRIEVED. PUT COMPLETED FORM IN ZIPLOCK BAG FOR PROTECTION. *IMPORTANT*: PLACE ZIPLOCK-PROTECTED FORM IN THE BAG WITH THE CARCASS--ONE CARCASS PER BAG, DOUBLE BAG. RETURN BAGGED CARCASS WITH ENCLOSED FORM TO CONTACTS LISTED BELOW. IF CARCASS IS NOT RETRIEVED, OR IF SICK OR INJURED ANIMAL IS OBSERVED, COMPLETE FORM AND GIVE FORM TO NEAREST CONTACT PERSON OR SEND FORM TO *USFWS-ATTN. T. ODENBAUGH, 1011 E. TUDOR RD. ANCHORAGE, AK 99503.*

NAME AND ORGANIZATION OF OBSERVER:______________________________

____

DATE:________________

DEC BEACH SEGMENT NUMBER:____________________________________
OR
SPECIFIC LOCATION NAME: (ie, beach, bay, island, lat\long)

____

SEA OTTER, BIRD: (circle one) BIRD SPECIES, IF KNOWN________________

TAG #, IF OBSERVED ON ANIMAL:____________________________________

OILED: NONE, LIGHT, MODERATE, HEAVY, UNKNOWN (circle one)

CONDITION OF ANIMAL: ALIVE, FRESH DEAD, DECOMPOSING, OLD\DRIED, SCAVENGED, UNKNOWN (circle one or more)

DATE AND TIME OF DEATH, IF OBSERVED: ____________________________

ANIMAL RETRIEVED: YES, NO (circle one)

OIL ON BEACH: NONE, LIGHT, MODERATE, HEAVY, UNKNOWN (circle one)

NOTES: (Please add any information you feel is important)

____

____

____

DRIED OR SCAVENGED NON-OILED BIRD CARCASSES SHOULD BE LEFT ON THE BEACH TO BECOME PART OF THE FOOD CHAIN. FRESH NON-OILED AND ALL OILED BIRD CARCASSES SHOULD BE RETRIEVED. ALL SEA OTTER CARCASSES SHOULD BE RETRIEVED.

CONTACTS

ANCHORAGE: TINA ODENBAUGH 786-3479
HOMER: REFUGE STAFF 235-6546
KING SALMON: REFUGE STAFF 246-3339
SEWARD: NATL. PARK SERVICE 224-3175
VALDEZ: BARBARA WARD 835-5260
KODIAK: REFUGE STAFF 487-2600
CORDOVA: PWS SC. CTR 424-5800
WHITTIER: POLICE DEPT. 472-2340

ANSWER MACHINE (24-HR WEEKENDS AND 5pm-7am WEEKDAYS) 786-3479

ADDITIONAL FORMS ARE AVAILABLE THROUGH YOUR AREA CONTACT PERSON

U.S. FISH AND WILDLIFE SERVICE
BEACHED BIRD/SEA OTTER RETRIEVAL
T/V *EXXON VALDEZ* SPILL ZONE
SPRING AND SUMMER 1990

REVISED APRIL 3, 1990

COMPLETE ONE FORM PER ANIMAL EVEN IF ANIMAL IS NOT RETRIEVED. PUT COMPLETED FORM IN ZIPLOCK BAG FOR PROTECTION. *IMPORTANT*: PLACE ZIPLOCK-PROTECTED FORM IN THE BAG WITH THE CARCASS--ONE CARCASS PER BAG, DOUBLE BAG. RETURN BAGGED CARCASS WITH ENCLOSED FORM TO CONTACTS LISTED BELOW. IF CARCASS IS NOT RETRIEVED, OR IF SICK OR INJURED ANIMAL IS OBSERVED, COMPLETE FORM AND GIVE FORM TO NEAREST CONTACT PERSON OR SEND FORM TO *USFWS-ATTN. T. ODENBAUGH, 1011 E. TUDOR RD. ANCHORAGE, AK 99503.*

NAME AND ORGANIZATION OF OBSERVER:______________________________

____

DATE:______________

DEC BEACH SEGMENT NUMBER:______________________________
OR
SPECIFIC LOCATION NAME: (ie, beach, bay, island, lat\long)

____

SEA OTTER, BIRD: (circle one) BIRD SPECIES, IF KNOWN______________

TAG #, IF OBSERVED ON ANIMAL:______________________________

OILED: NONE, LIGHT, MODERATE, HEAVY, UNKNOWN (circle one)

CONDITION OF ANIMAL: ALIVE, FRESH DEAD, DECOMPOSING, OLD\DRIED, SCAVENGED, UNKNOWN (circle one or more)

DATE AND TIME OF DEATH, IF OBSERVED: ______________________

ANIMAL RETRIEVED: YES, NO (circle one)

OIL ON BEACH: NONE, LIGHT, MODERATE, HEAVY, UNKNOWN (circle one)

NOTES: (Please add any information you feel is important)

____
____
____

DRIED OR SCAVENGED NON-OILED BIRD CARCASSES SHOULD BE LEFT ON THE BEACH TO BECOME PART OF THE FOOD CHAIN. FRESH NON-OILED AND ALL OILED BIRD CARCASSES SHOULD BE RETRIEVED. ALL SEA OTTER CARCASSES SHOULD BE RETRIEVED.

CONTACTS

ANCHORAGE: TINA ODENBAUGH 786-3479
HOMER: REFUGE STAFF 235-6546
KING SALMON: REFUGE STAFF 246-3339
SEWARD: NATL. PARK SERVICE 224-3175
VALDEZ: BARBARA WARD 835-5260
KODIAK: REFUGE STAFF 487-2600
CORDOVA: PWS SC. CTR 424-5800
WHITTIER: POLICE DEPT. 472-2340

ANSWER MACHINE (24-HR WEEKENDS AND 5pm-7am WEEKDAYS) 786-3479

ADDITIONAL FORMS ARE AVAILABLE THROUGH YOUR AREA CONTACT PERSON

Laux
Bstan
RECEIVED

FEB 12 1990

EPA-AOO-ANCHORAGE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB - 6 1990

OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Status of Alaska Shorelines and Clean-up Plans for 1990

FROM: John H. Skinner, Acting John H. Skinner
Deputy Assistant Administrator for Research and Development

THROUGH: Erich Bretthauer, Acting
Assistant Administrator for Research and Development

TO: William Reilly
Administrator

On February 1 and 2, 1990, I attended a planning meeting with Exxon, Alaska Department of Environmental Conservation (ADEC), U.S. Coast Guard (USCG), and the National Ocean and Atmospheric Agency (NOAA) to review the current status of oil contamination on Alaska's shorelines and begin to plan clean-up for this year. My conclusion is that clean-up in Alaska in 1990 will be very different from in 1989. The oil conditions have changed dramatically and very different technologies will be used. The remainder of this memo explains further.

Status of Oiled Shorelines

ADEC just released the results of the shoreline survey conducted from August 24 to November 20, 1989. This survey was conducted by walking the shorelines where possible and by low flying helicopters and boats in areas inaccessible by foot. A total of 886 shoreline segments were surveyed covering all areas where oiling was previously detected. It is important to note that the survey was conducted before the onset of the severe winter weather and storms.

The results are shown on the next table:

Alaska Shoreline Oil Contamination
(November 1989)

	Sheltered Shoreline Heavy or moderate oil	Exposed Shoreline Heavy or moderate oil	Total Heavy or moderate oil
Prince William Sound	21 miles	66 miles	87 miles
Seward area	2.6	1.0	3.6
Homer area	6.3	6.2	12.5
Kodiac area	2.2	12.0	14.2
Total	32.1 miles	85.2 miles	117.3 miles

There are 32 miles of moderate to heavy oiled sheltered shoreline (bays, coves, protected areas). These should show the longest persistence of spilled oil. In addition, there are 85 miles of moderate to heavy oiled shoreline in areas relatively exposed to storms, winds and high energy waves.

Another critical factor is the penetration of oil into the shoreline substrate. The survey team dug pits on each shoreline segment to determine penetration. It is not possible to estimate the <u>miles</u> of shoreline with deep oil penetration. Instead the <u>number</u> of shoreline segments in which the maximum penetration was greater than 15 cm (6 inches) is shown below:

Oil Penetration
(Number of Shoreline Segments with
Oil Deeper than 15 cm.)

	Number	Mean Penetration Depth
Prince William Sound	164	32 cm.
Seward area	14	45 cm.
Homer area	25	42 cm.
Kodiac area	21	32 cm.
Total	224	

Of the 886 shoreline segments surveyed 224 had oil penetrated greater than 15 cm. Oil that has penetrated deeply will tend to persist longer. A Spring Shoreline Assessment jointly conducted by Exxon and State and Federal agencies is planned to be completed by mid-April 1990.

Clean-Up Options for 1990

NOAA as technical advisor to the USCG has circulated a set of recommendations for the 1990 clean-up of the Exxon-Valdez oil spill. These recommendations were very similar to those presented by Exxon representatives at the February 1-2, 1990 meeting. The recommendations are based on several premises:

1. Most of the oil in the high-energy segments of the Alaskan coast will be removed by natural activities within the next year or two.

2. Oil in the sheltered, low-energy areas could remain much longer (e.g. 20 years) in the absence of further clean-up.

3. Oil buried deeply in subsurface sediments, even in high-energy areas, will prove less amenable to natural removal processes.

There seems to be a growing consensus that continued natural cleansing and uninterrupted biological activity are the preferred clean-up options for the majority of impacted shorelines. In addition, the NOAA plan stresses that no greater human stresses should be placed on the area than are necessary to achieve the desired level of clean-up. The general conclusions from the meeting were as follows:

1. Non-intrusive, low impact techniques including manual pick-up, snare booms, tarmat break-up and removal and bioremediation are the preferred methods.

2. High impact techniques such as washing/flushing, chemical beach cleaners and excavation may be considered in a site specific basis but will probably have very limited application.

The NOAA paper states:

1. If current questions regarding the effectiveness of nutrient addition can be resolved, bioremediation should be considered a primary option for the removal or reduction of shoreline oil contamination.

2. An extremely conservative approach should be taken in the use of solvents, beach cleaners or other chemical agents. (Note that these cleaners require a washing/flushing and skimming operation following application.)

In summary, it is quite possible that bioremediation will be widely used in Alaska this year. I do not believe that we will see a large scale, 10,000 person beach washing operation such as occurred in 1989.

The USCG requested that EPA resolve the current questions concerning bioremediation as soon as possible and that we issue a statement of the EPA position on bioremediation by early March 1990. I agreed that we would do this.

cc: LaJuana Wilcher
Hank Habicht
Gordan Binder
Dan Esty
Tudor Davies
Al Ewing

2. An extremely conservative approach should be taken in the use of solvents, beach cleaners or other chemical agents. (Note that these cleaners require a washing/flushing and skimming operation following application.)

In summary, it is quite possible that bioremediation will be widely used in Alaska this year. I do not believe that we will see a large scale, 10,000 person beach washing operation such as occurred in 1989.

The USCG requested that EPA resolve the current questions concerning bioremediation as soon as possible and that we issue a statement of the EPA position on bioremediation by early March 1990. I agreed that we would do this.

cc: LaJuana Wilcher
Hank Habicht
Gordan Binder
Dan Esty
Tudor Davies
Al Ewing

5/2/90 ops mtg
Doug Manning, USCG
0845 in
- DOI / PAM mtg re segments TAG vs lnd mgr
- permits for radio Repeaters for DEC
- continuing lnd mgr ID - complex
- F+WS - @ Exxon's Req F+WS emp.
to station in sound to ID sensitive
wildlife areas
- Pye is lnd mgr / workplan prob.
~~to 7 segments~~
- preference to Federal agencies
in use of BIOR (used in past)
DNR vs USF+WS / NPS
— no to Inipol ∴ assumed custom blend OK
- USCG base judgement on intertidal mgr
*dual apply in intertidal zone; to disc. conflicting ...
(DNR) exceptions to natives possibly
- Admiral to review all previously
signed off segments / subs. of great concern
— implied joint ownership
esp Chugach w/ cultural resource
& USFS
+ resp. for mgt of those lands

5/2/90 ops mtg
- Monitoring problems w/observer on vessels - min 2 monitors
NOAA + Exxon (w) minimum
worst case 3 land mgrs
USCG Want trust & confidence
Survey later in season
flights 2-3 x's/wk to take mgrs out. for spot checks
- someone suggested to use these for monitor swapping
sugg - land mgrs get together to make agreement for one monitor.
- Why not vessel for mgrs only - why a prob this yr
- 1 fed, 1 state, 1 land mgr
- 311K funds may not be availible for other feds to make own accomidations
- NPS permits state that brg LM moni is to be on scene + Congressional mandate expressed for auth. over FOSC
[illegible]

5/2/90 ops mtg
- intent is there to comply w/permit ops should not stop if weather precludes placement of LM on ops vessel
- problem w/ agreement w/ processes & then they are not adhered
USFS to - makes everything difficult
- USFS chief (in house trip) to come to Anch & to stop @ maybe Grn Is. & fly over PWS
- Minerals mgt service → PWS (~27 ppl)
- Exxon permits USFS
- DNR permit for test for exp. tech "outside of spill" another ap for land use - they will say no field testing @ Knight island
- Rock washing to become an Issue - Aprehensions in Nat forest. - real concerns Re testing & cult. res.
- will probably go thru same dec. process

5/2/90

- Rockwasher -
  - benificial analysis - Jackie (NOAA) Rochell & ADEC & Exxon
  - development process - complex
    lg barges to store tanks, gener. wastes, etc.
    Asked Exxon to take over project & USCG engineers
    July is probable testing date
    will make viability dec. there
- benefit analysis & desires } to make dec.
- USCG Corps has to get involved [dredge & fill permit]
- USFS - benefit of oil recovered questioned
  - moving lg amount of gravel/rock - change in attitude (?) vs. miner
  - will beach be destroyed?
    - they think beach will not be recontoured - will storms fix?

(ADEC ... B. Roto ...)

5/2/90

- EPA permits for H_2O discharg if nec. - ~~exp~~ no to Alyeska if emulsifiers/detergents to be used

USCG "Cape Douglas looks good"

- Problem in Kodiak w/ getting in priority segments for survey & does not feel that (MAJOR #) "their being reasonable 57 to v498 now. (and are now planning phase III & IV for Kodiak)

- no phase III or IV in Kenai

- STOP AK DOL is not being allowed on USCG vessels for safety insp. (prob w/OSHA vs DOL)

DOL stated outright "Political Reason

USCG SAT Assmt for Applegate Is

NOAA - impressed w/ effort to Subsist fisheries

- 1-2 mo turnaround for Sub. Fish data - maybe more

- Rockwashing - benefit analy-

5/2/90

NOAA Gen. Analy. - final report by mid June (not nec. written)

Jon Knost NOAA admin to PWS Wed. weath. permitting

- halibut clean for opening now -

ask concerns #1 ~~fa~~ fish

#2 Sub

#3 recreational

EPA - working w DEC + Exxon for comprehensive mont. program.

- NAT. ENV. TECH. ASSMT. CORP. for more RD testing + RRT approval

ORD in town in FBX @ Req of ADEC [redacted] to disc w/ panel of sci @ FBX Prof. whoever looks @ data

~~EAP~~ indep. rev. panel @ req ADEC

press afls for Dec. on BIOR

Based upon their Rev ADEC's given cond. approval

working w/ Ex + ADEC to put together Mont plan by end of wk

copies here

file - cleanup

JJ

NEWS RELEASE

STATE OF ALASKA

OFFICE OF THE GOVERNOR
P.O. BOX A
JUNEAU, ALASKA 99811

STEVE COWPER,
GOVERNOR

FOR INFORMATION CONTACT:

DAVID RAMSEUR
PRESS SECRETARY

TERENCE O'MALLEY
DEPUTY PRESS SECRETARY

(907) 465-3500

FOR IMMEDIATE RELEASE
Nov. 26, 1990
No. 90-151

COWPER RELEASES 1991 OIL SPILL CLEAN UP PLAN

JUNEAU--Gov. Steve Cowper said today that more than half of the sites in Prince William Sound and the Kenai Peninsula damaged by the Exxon Valdez oil spill have been cleaned to the state's satisfaction, and a 1991 cleanup plan prepared by state officials will help bring the operation to a close next summer.

The state's plan, released today, is designed to give all parties involved a clear understanding of what the state will require to complete the job. It will be followed up by site-specific workplans developed after the spring shoreline assessment, due to begin in May 1991.

"It's gratifying to finally have an end point in sight," Cowper said. "It's critical that Alaskans be the ones to determine that end point. Alaskans have lived with the spill and its effects on their resources, and their voices must be heard and heeded."

The document makes clear the state's intention to make independent judgments and, if necessary, require state-directed cleanup beyond what the Coast Guard orders. State and federal law give Alaska the ability to enact stricter standards for completion than those employed by the federal government.

"We're not looking for disagreement," Cowper said. "We are merely making it clear that states sometimes have different priorities, and that we're ready and willing to step up and make sure those priorities are met."

-MORE

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 18
To GARY H	From Colleen
Co.	Co.
Dept.	Phone # 563-1126

The plan also includes a summary of conditions at 757 shoreline segments in the Sound and the upper Gulf of Alaska, based on survey data collected from 1989 through the local response effort in October of this year. Of those segments, the state has determined that 404 need no further treatment. While Cowper said some oil remains at many of those sites, crews have done all that is technically and environmentally possible there.

"We have to be honest with ourselves," said Cowper, "The state, the Coast Guard and Exxon have made substantial progress throughout the spill area. Many areas are free of oil. However, there are limits to what we can and should do. In this last season it's important for us to focus our efforts, do the best we can at the remaining sites, and move on."

The 1991 plan is designed as a set of instructions, including state policies, that will guide the development of an actual field operations plan for next spring and summer. The state uses a similar approach, on a smaller scale, in directing other spills. Cowper took the unusual step of putting the plan out to public review because of the size and scope of the Exxon Valdez spill.

Other highlights of the plan include:

- A procedure for setting priorities for cleanup, according to state resource uses;
- A list of approved cleanup techniques and guidelines for use;
- Standards addressing the question, "How clean is clean?";
- Tasks to be delegated to Local Response Groups.

Copies of the plan are being mailed this week to interested parties such as local government, fishing organizations, tourism and recreation groups, private landowners, and subsistence users. Other copies are available from the Department of Environmental Conservation.

For more information, contact L.J. Evans, ADEC Public Information Officer, State on-Scene Coordinator's Office at 563-1126.

State of Alaska
Department of Environmental Conservation

Exxon Valdez Oil Spill Response

1991 State Response Plan: Policies, Requirements, Guidelines

November 26, 1990

Steve Cowper, Governor

Dennis Kelso, Commissioner

Table of Contents

1.0 INTENT OF PLAN

The response to the T/V Exxon Valdez oil spill of March 24, 1989, will enter its third field season on or about May 1, 1991. The response activities under state and federal direction have resulted in substantial progress in improving the condition of the shorelines. Continued response, under a carefully designed plan of action, will be necessary in certain areas.

This plan provides the spiller with a clear understanding of the State of Alaska's policies, requirements, and guidelines for the 1991 response season. It explains how the State of Alaska will implement existing oil spill statutes and regulations, given the specific conditions of the T/V Exxon Valdez oil spill.

The spiller will use this document to produce a 1991 workplan that should complete cleanup to the satisfaction of the State of Alaska.

The wreck of the Exxon Valdez was the largest tanker spill in North American history, resulting in at least 1,285 miles of shoreline oiled to some degree. The state considers it neither technically possible nor environmentally practical to remove all remaining contamination. This document explains the state's clear priorities for work, reasonable expectations for results, and methods to achieve those results.

1.1 REQUIREMENT FOR PLAN

Under state regulations, the party responsible for an oil or hazardous substance spill must submit a cleanup workplan for approval by the State On-Scene Coordinator.

Oiling of various kinds continues to concern the State of Alaska for a variety of ecological, environmental, and other land and resource management reasons. Further, the areas requiring cleanup are likely to be more localized than in the 1989 or 1990 seasons. This allows agencies to tailor work plans to highly specific areas and conditions.

The state intends to integrate the state and federal workplans to the maximum extent possible, consistent with state law. Any work under state direction is a supplement to federal response.

1.2 SCOPE OF WORK

This document sets out the authorities and responsibilities of the state government with respect to oil spill cleanup, and how they will be applied to the 1991 T/V Exxon Valdez response.

These parameters include:

* Sources of legal authority for spill response;
* Definitions of key terms;
* Matters of state policy;
* The process for establishing state priorities;
* General operational guidelines for cleanup techniques affecting state lands, waters, and other natural resources;
* General conditions under which the state will determine adequacy or limits of cleanup;
* Other instructions necessary for development of a workplan for 1991 field operations.

1.3 PUBLIC REVIEW

The response to the T/V Exxon Valdez oil spill raises critical issues regarding publicly owned natural resources. Meaningful public participation in decisions about those resources is essential.

***1.3.1** Written comments* — Interested parties should send written comments to the following address no later than the close of business January 31, 1991:

State On-Scene Coordinator
Exxon Valdez Oil Spill Response
1991 Workplan
ADEC
4241 B Street, Suite 304
Anchorage, Alaska 99503

***1.3.2** Public meetings* — State officials will conduct public workshops during the month of February in the communities closest to the Exxon Valdez oil spill, and in Juneau, Anchorage, and Fairbanks.

1.4 WORKPLAN DEVELOPMENT

The state will work with the Coast Guard and Exxon to produce an integrated 1991 field operations plan based on these instructions, on federal requirements, and on the results of spring field surveys.

1.5 STATE-FED COOPERATION

The state continues to support the efforts of the U.S. Coast Guard. The state will continue to cooperate fully in helping the Coast Guard fulfill its duties and responsibilities under the federal Clean Water Act and the National Contingency Plan.

Supplemental activities under state direction are not meant to imply disagreement with, or disapproval of, federal activities.

2.0 Response Structure

The state and federal governments direct the spiller to undertake necessary and appropriate tasks designed to eliminate the pollution caused by the T/V Exxon Valdez oil spill.

Exxon accepted responsibility for the oil spill after the grounding, and has worked directly with the governments or hired contractors to do the work.

2.1 FEDERAL RESPONSE

National pollution control statutes lay the foundation for oil spill response under federal law, including the minimum requirements for actual cleanup. The U.S Coast Guard is charged with enforcing those requirements under the direction of the Federal On-Scene Coordinator.

2.2 STATE RESPONSE

The State of Alaska holds a concurrent authority regarding pollution control and oil spill response under provisions of the federal Clean Water Act, other federal pollution control statutes, and Title 46 of the Alaska Statutes (Appendix A).

Federal requirements are a base, not an upper limit. Congress preserved this structure in the Oil Pollution Act of 1990, recognizing the need for states to tailor pollution regulations to local needs and desires.

The state retains the option to require Exxon to do more work at a given site, or throughout the spill area. It is likely that the SOSC and FOSC will concur on a number of decisions regarding completeness of cleanup. Where they do not concur, the SOSC will work directly with Exxon under state authority.

2.3 FEDERAL TECHNICAL ADVISORY GROUP (TAG)

The federal government has convened the TAG to assist the FOSC in making technical decisions regarding cleanup. The TAG's recommendations to the FOSC are designed to meet the federal government's minimum requirements for cleanup. They do not bind the state to the decisions, policies, or recommendations of the FOSC or any federal agency.

2.3.1 *State participation* — The state will continue to offer advice, expertise, and recommendations to the TAG and the FOSC. The state's participation in TAG does not necessarily imply concurrence with federal decisions or policies.

2.3.2 *Concurrent activites under state direction* — If the state sets stricter requirements or requires additional work, the state will work directly with Exxon to insure full compliance with state pollution statutes, regulations, and policies.

The advisory group to the SOSC may include representatives of the principal state resource agencies, scientific advisors as necessary, local landowners, governments, or other community representatives designated by the mayor or chief officer of the applicable local governments.

3.0

STATUTES AND POLICIES

The state's response to the Exxon Valdez oil spill is conducted primarily through the three resources agencies: ADEC, the Department of Natural Resources, and the Department of Fish and Game.

3.1 ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Under Title 46 of the Alaska Statutes, ADEC is the lead agency for oil and hazardous substance spill response. The department has broad responsibilities to "abate and prevent" pollution that may affect everything from the public health to the economy. State regulations require the SOSC to continue cleanup of a contaminated or polluted site until he or she determines that:

a) available technology has reached its practical limit;

b) extracting the pollution will cause greater harm than leaving the pollution in place.

In the case of the Exxon Valdez response, the SOSC will implement the requirements in the context of the responsibilities and resource values of all state agencies, particularly the Department of Natural Resources and the Department of Fish and Game. Depending on the situation, the SOSC may place more or less weight on a given resource value when making decisions about a specific site or oiling condition.

3.2 ALASKA DEPARTMENT OF NATURAL RESOURCES

Under Title 38 of the Alaska Statutes, ADNR must provide for the maximum use of state resources consistent with the public interest, including use by future generations. The Division of Land and Water Management (DLWM) oversees and encourages a wide variety of activities on state lands, including, but not limited to, uses defined by economic, social, cultural, and aesthetic values. State lands continue to be affected by pollution from the T/V Exxon Valdez.

In addition, Title 41 requires the Division of Parks and Outdoor Recreation (DOPOR) to develop and maintain a system of parks, recreation facilities, and other opportunities with state lands and resources. In the spill area, there are 12 marine parks in Prince William Sound, the Kachemak Bay Wilderness State Park, and Shuyak Island State Park in the Kodiak archipelago.

Further, the Office of History and Archeology within DOPOR is responsible for the protection of historic, prehistoric, and archeological resources of the state. The spill area contains many important archeological and culturally significant sites.

The Exxon Valdez oil spill continues to affect state lands and waters managed by ADNR. The law requires the resources to be cleaned and restored to a condition that allows for the continued and future use and enjoyment by the public.

3.3. ALASKA DEPARTMENT OF FISH AND GAME

Under Title 16 of the Alaska Statutes, ADF&G is required to "manage, protect, maintain, improve and extend the fish, game and aquatic resources of the state."

The department must ensure that fish and wildlife populations, habitats, and harvests are given adequate consideration during response and cleanup planning. Specific permitting authorities for cleanup activities apply to anadromous fish streams and legislatively designated special areas (critical habitats, refuges, and game sanctuaries).

The department has a special concern regarding the potential effects of hydrocarbon exposure on fish that inhabit nearshore and intertidal environments. Salmon and herring, in particular, are commercially valuable species whose habitats are threatened by residual oil.

3.4 DEFINITIONS

Following are the definitions of some of the key terms for the purpose of this document:

3.4.1 *Pollution or contamination* — Oil, in any form (mousse, asphalt, tarballs, fouled debris, oiled sediments, etc.) spilled from the T/V Exxon Valdez on and after March 24, 1989.

3.4.2 *Harm* — The presence of pollution or contamination.

3.4.3 *Environment* — Any natural resource owned or managed by the State of Alaska, and spatial area containing such a resource, and, by extension, any activity depending on proper management of the resources.

3.4.4 *Technology* — Techniques or products that have been approved for use during the Exxon Valdez response. The state is basing its plans on those techniques that have already been employed and refined over the course of the spill thus far.

3.5 STATE POLICY: CONTAMINATION AND REMOVAL

The pollution spilled from the T/V Exxon Valdez must be removed from state waters and lands, consistent with the conditions established in Alaska law and regulation. The state requires removal of the most oil over the shortest period of time practical, in the judgment of the SOSC. The state will base its decisions on a target completion date of September 15, 1991.

It is state policy that a one-year commitment to finish shoreline treatment using an active program far outweighs a passive, multiyear approach that may extend far into the future. The oil on the shorelines and under the surface is not naturally occurring, and its continued presence degrades the natural resources and their values.

Under the regulatory conditions explained in this section, the state requires the following:

3.5.1 *Surface oiling* — Oiling must be reduced to light cover and stain. Pooled oil, mousse, oiled debris, asphalt patches, tarmats, and tarballs must be removed during the 1991 field season.

3.5.2 Subsurface oiling — Where subsurface oil can, in the SOSC's determination, be reasonably exposed by manual effort or light mechanical equipment, oil-contaminated sediments, mousse, oiled debris, asphalt patches, tarmats and tarballs must be removed during the 1991 field season.

3.5.3 Priority exceptions — Certain state resource priority areas (e.g., state parks, certain fish or wildlife habitat) may require cleanup beyond conditions described elsewhere in this section.

3.5.4 *Unrecovered oil* — Under the criteria set in Alaska law and the administrative code, the spiller remains liable for damages caused by pollution that is not recoverable.

4.0

RESOURCE AND OILING CATEGORIES

The state has established categories for shoreline segments, according to resource or land type, the nature of land or resource use, and remaining oiling. These categories will target spring assessment efforts, guide development of the actual workplan, and establish a framework for determining proper levels of manpower and materiel for the 1991 field season.

These classifications are for 1991 Exxon Valdez oil spill field response only. They reflect priorities established within the context of specific oiling conditions, the state of the weathered oil, the size of the affected area, status or sensitivity of a given population or species, and the special logistical considerations for the area.

They do not necessarily reflect the relative value of the resources in their unoiled state.

4.1 CATEGORY A

4.1.1 *Severely oiled sites* — Generally, these are the remaining "problem" sites that are heavily oiled at the surface, continue to bleed into the water, or contain large amounts of subsurface oil over a large area. These include "special work sites" described in section 5.7.

4.1.2 *Anadromous fish streams and herring spawning areas* — These areas support fish that have high economic, recreational and social values for users. Fish are known to be particularly vulnerable to injury from oil contamination, especially during their early life stages. In addition, these species have a high fidelity to specific and limited habitat areas. The loss or other damage to year classes of herring and salmon could have long-term effects on population recovery.

4.1.3 *State parks* — These areas were selected for legislative protections because of high recreational, cultural, aesthetic, and wildlife values. Alaska's state park system, including the Kachemak Bay Wilderness State Park, the marine parks of Prince William Sound, and Shuyak Island, are unique in the United States.

4.1.4 *Other special legislative designations* — These include critical habitat areas, refuges, game sanctuaries, and other special management areas created by the Alaska State Legislature.

4.2 CATEGORY B

4.2.1 *Subsistence* — Areas in which the presence of oil has a direct effect on the ability of local residents to gather food, hunt or fish for subsistence purposes.

4.2.2 *Shore fishery or leased economic sites* — Areas in which the presence of oil has a direct and demonstrated effect on the ability of a lease holder to work.

4.2.3 *Hatchery zones* — This includes not only the hatchery itself, but also rearing and release areas, migratory paths of juveniles and adults, and oiled areas that, left untreated in 1991, could threaten defined hatchery zones.

4.2.4 *Commercial fisheries* — Areas that, left without treatment in 1991, could affect 1991 harvests or markets.

4.2.5 *Pinniped haulouts and rookeries* — Areas used by seals and sea lions for functions such as pupping, molting, and resting.

4.2.6 *Recreation areas* — Either commercial or private use areas with a relatively high level of traffic, including sport fishing areas.

4.2.7 *Commercial tourism* — Either areas with high scenic values or areas actually used for commercial camping, fishing, guiding, etc.

4.2.8 *Mariculture sites* — Areas designated by ADNR as having high potential for commercial shellfish site leases.

4.3 CATEGORY C

All remaining oiled shorelines.

5.0 WORKPLAN

The state will ask the FOSC to include all State of Alaska requirements in a single, integrated workplan. If the FOSC is unable to do so, the state will prepare with the spiller a supplemental plan to meet state requirements. Logistical efforts will be combined wherever possible. The state believes an early and cooperative planning process will produce a well-integrated joint logistics plan that maximizes worker safety and shoreline results.

5.1 SAFETY

Worker safety continues to be the state's first priority when planning, monitoring, or conducting field operations. Exxon and its contractors, the Coast Guard, the State of Alaska and Local Response Groups have established and maintained high safety standards throughout the cleanup.

The workplan must contain a safety program approved by the state Department of Labor.

5.2 STATE PERMITS

The workplan must include all applicable state permits.

5.3 ARCHEOLOGICAL SITES

The workplan must include a program, approved by ADNR, for identification, preservation and protection of significant cultural and archeological sites. To prevent desecration or destruction of sites, access to information about the locations or descriptions of the sites may be restricted at the discretion of the Commissioner of Natural Resources.

5.4 PRIVATE LANDOWNERS

The workplan must contain provisions for consulting private landowners, including Alaska Native regional and village corporations, before operations take place adjacent to private lands.

5.5 COMPLETION LIST

The state has prepared a list of shoreline segments at which no further assessment will be required (Appendix B) for the purposes of the 1991 response. The state requires neither assessment nor work at 404 of 757 segments in Prince William Sound and the Kenai Peninsula. (Note: Kodiak data will be available at a later date. Public review may be extended for the purpose of commenting on Kodiak shoreline data.)

5.6 WILDLIFE CONSIDERATIONS

The workplan will include provisions for minimizing the disruption to fish, wildlife and their habitat. The state will consult appropriate federal agencies to reach agreement on timing windows and guidelines for field operations.

5.7 SPECIAL WORK SITES

The most heavily contaminated sites, or sites with special or unique oiling conditions, will be designated by the SOSC as "special work sites." These sites represent the areas that present the most obvious and imminent threats to public health and resources. They automatically fall into Category A, as defined in section 4.0.

These areas will require special commitments of time and resources, including detailed workplans that include discrete calculations of manpower and equipment. It is the state's intention that these sites be worked continually until finished. Crews and equipment should not be diverted from these sites to other tasks until the SOSC determines that work has reached its practical limit.

The state will work with Exxon and the Coast Guard to establish a realistic and practical strategy for special sites, including well-defined schedules and end points.

This is intended to be a selective designation.

5.8 ORDER OF WORK

Order of work will be determined by the classifications in section 4.0, timing "windows" established for reasonable resource management reasons (seal pupping, salmon spawning, bird nesting, etc.), and relevant weather and safety considerations.

Work at Category A sites must be completed before the relevant timing windows close. The state may require work to begin at Category A sites before the entire sping shoreline assessment is complete.

If Category A sites drop out of the schedule because of wildlife or other constraints, work crews may be deployed at a Category B or C site. When the "window" reopens at the Category A site, crews must be on the shoreline. Crews may be pulled off a lower category site to work a higher category site. Crews may not leave an A site in favor of another site unless it is for wildlife constraints, weather, worker safety, or special cases approved by thre SOSC or his field designee.

The workplan is based on the state requirement that all work be completed at all sites by September 15, 1991.

5.9 WASTE MANAGEMENT

A full waste management program will be part of the workplan. The plan should assume some removal from oil-saturated sediments, as well as oiled debris and trash generated by workers. Waste management should not detract from base cleanup efforts.

6.0

TECHNOLOGY

The state's policy of maximum removal in the shortest practical time will determine choices about techniques, as well as levels of manpower and equipment required to complete the 1991 response. The state intends to work with the Coast Guard and Exxon to make sure plans made this winter accurately reflect the type and scope of work the state and federal government require, either independently or concurrently.

6.1 REMOVAL

Pooled oil, mousse, tarmats, tarballs, asphalt patches, oil-contaminated sediments, and other forms of weathered oil must be removed, or its precense minimized, consistent with state law and regulation. This may be accomplished with any combination of treatments described in this section.

6.2 TRACKED VEHICLES

The SOSC may require the use of tracked vehicles such as small tractors and backhoes, either to remove material or to aid manual pickup.

6.3 MANUAL

This includes physical removal of oiled material with conventional hand tools. This type of work should be limited to small areas of contamination. Large tarmats, asphalt patches, pooled oil, contaminated sediments, etc., should be removed with mechanical equipment wherever possible.

6.4 STORM BERM ALTERATION

Sediments under storm berms may be exposed by mechanical means for the purpose of removing or bioremediating the subsurface oil.

The dumping or spreading of pollution in the intertidal areas to be left for natural degradation is not a generally approved treatment technique, except in cases when oiling is light, and only with the prior approval of the SOSC or his field designee.

6.5 TILLING

Where tilling is used, the equipment must reach to the depth of the oil contained in the shoreline.

6.6 SOLVENTS

Because of logistical and operational considerations, solvents are not anticipated to be approved as a shoreline cleanup technique.

6.7 WASHING

Hot, warm, and cold seawater flooding or flushing will be approved on a site-specific basis. The plan should assume that at least one crew will have the capability to conduct washing operations.

6.8 BIOREMEDIATION

The use of Inipol EAP 22, Customblen or other fertilizers may be approved for a third season of conditional use. The state will release its preliminary finding by February 1, 1991, and will issue a final decision by March 1, 1991, after public review. The state's decision, as before, will come through the Alaska Regional Response Team.

6.8.1 *Type of approval* — If approved, bioremediation may be restricted to specific oiling conditions and types of sites, rather than the "broadcast" approval in 1990. The state is currently continuing research to determine the field efficiency of the technique, particularly on older, more weathered oil. The results of this research may provide the SOSC and the public with the information to determine if removal or natural degradation are preferable to continued fertilizer use on weathered oil types.

6.8.2 *Operational guidelines* — If approved, fertilizers must be applied according to state guidelines, which will be developed over the winter. (The state will wait until February to write guidelines, which may be based on bioremediation research data that will become available in January.)

Based on existing research, bioremediation is a finishing technique and is not appropriate for heavy or moderate oiling conditions, tarmats, asphalt, or other hardened oil. If this winter's research produces no substantially new information about the effectiveness of the technique on Alaska shorelines, bioremediation will be applied only in cases where the contamination level has been reduced to predominantly light, residual oiling.

6.8.3 *Site sampling* — State monitors may sample sites randomly before bioremediation application to ascertain if the "eyeball" judgments in the field are matching the conditions that laboratory tests deem optimal for bioremediation to complete treatment in a year.

6.9 SKIMMING CAPACITY

A skimmer and appropriate support equipment should be available to be deployed at sites where recoverable oil is likely to come off of oiled beaches or worksites.

7.0 SPRING SURVEY

The state will participate in the 1991 spring shoreline survey with Exxon and the Coast Guard. The shoreline segment list in Appendix B and the resource classifications in section 4.0 of this document will form the starting point for the assessment plan.

7.1 SCOPE OF ASSESSMENT

The state will require entire segments to be covered, not just those subdivisions that received treatment. The SOSC or his field designee may waive this requirement on a site-specific basis.

7.2 LOCAL RESPONSE GROUPS

The state Local Response Groups may be included in the assessment. If activated, the LRGs will work under direct supervision of trained state personnel, and according to approved assessment guidelines.

8.0 CONTRACT CLEANUP

If the spiller is unable or unwilling to conduct work to the state's requirements and specifications, ADEC may hire contractors to complete the work under the direction of the SOSC. If this situation occurs, the SOSC will continue to work with the Coast Guard to make sure the state's supplemental operation in no way interferes with federally directed operations.

8.1 SOURCE OF FUNDING

The Oil and Hazardous Substance Release Fund is the source for all response activities.

8.2 REQUEST FOR PROPOSALS

The state assumes Exxon will continue its active and attentive involvement in spill response for 1991.

However, as a contingency, the state is preparing a Request for Proposals for spill response and will release it to prospective bidders if it becomes apparent that state-contracted response will be necessary.

8.3 STATE OVERSIGHT

The successful bidder would work under direct supervision of the SOSC.

8.4 WORKER SAFETY TRAINING

The successful bidder would have a demonstrated ability to conduct remote site operations with the special worker safety requirements in place under the current operations scheme.

8.6 LOCAL HIRE PROVISIONS

Bidders may receive bonus points for a hiring plan that maximized employment of Alaskans, particularly those with training and experience gained in oil spill response work in Prince William Sound and the Gulf of Alaska.

EMERGENCY PHONE NUMBERS

EXXON CALAIS OPERATIONS

FIRE DEPARTMENT	911	
POLICE	911	
AMBULANCE	911	
HOSPITAL	261-3111	PROVIDENCE ER
	264-1222	HUMANA ER
EMERGENCY MEDICAL TRANSPORTATION	266-6582	(BY RADIO, EXXON TRANSPORTATION FOLLOWING)
BUILDING SECURITY	564-3280	DAYS
	564-3200	NIGHTS
EXXON SAFETY	564-3627	DAYS
	244-1178	NIGHTS
	268-8261	PAGER

SAFETY FIRST

OVERVIEW OF BASIC FIRST AID

John Howard, M.D.
Occupational Health Center
University of California
Irvine, California

I. ASSESSMENT

A. General Principles

1. Take charge and instruct someone to obtain medical help and others to assist as directed.

2. Secure the scene. Make the area safe, if necessary.

3. Make a primary survey of the patient for immediately life-threatening conditions:

   a. Respiratory arrest (no breathing), initiate CPR
   b. Circulatory arrest (no heartbeat or pulse), initiate CPR
   c. Severe bleeding (large amounts of visible or hidden blood)

4. Care for life-threatening conditions

5. Use a tourniquet only under extreme conditions as a last resort

6. If several people have been injured decide on priorities in caring for each victim

7. Make a secondary survey of the victim (medical personnel)

8. Keep injured person lying down

9. Loosen all restrictive clothing

10. Cover the victim to keep him/her warm and dry

11. Cover all wounds completely

12. Do not attempt to remove embedded objects

OVERVIEW OF BASIC FIRST AID

John Howard, M.D.
Occupational Health Center
University of California
Irvine, California

I. ASSESSMENT

A. General Principles

1. Take charge and instruct someone to obtain medical help and others to assist as directed.

2. Secure the scene. Make the area safe, if necessary.

3. Make a primary survey of the patient for immediately life-threatening conditions:

   a. Respiratory arrest (no breathing), initiate CPR
   b. Circulatory arrest (no heartbeat or pulse), initiate CPR
   c. Severe bleeding (large amounts of visible or hidden blood)

4. Care for life-threatening conditions

5. Use a tourniquet only under extreme conditions as a last resort

6. If several people have been injured decide on priorities in caring for each victim

7. Make a secondary survey of the victim (medical personnel)

8. Keep injured person lying down

9. Loosen all restrictive clothing

10. Cover the victim to keep him/her warm and dry

11. Cover all wounds completely

12. Do not attempt to remove embedded objects

B. Specific Signs and Symptoms of Chemical Exposure and Heat Stress that Indicate Potential Medical Emergencies

1. Chemical Hazards

a. Irritation of eyes, nose, or throat
b. Sneezing or tearing of eyes
c. Tightness in chest, breathing difficulties or coughing
d. Headache or Light-headedness
e. Nausea or diarrhea
f. Behavioral changes
g. Changes in complexion or skin color
h. Fatigue or weakness
i. Irritability, coordination difficulties or dizziness

2. Heat Exhaustion

a. Clammy skin
b. Confusion
c. Light-headedness, dizziness or fainting
d. Nausea
e. Heat rash
f. Profuse sweating
g. Slurred speech
h. Weak pulse

3. Heat Stoke

a. Confusion
b. Convulsions
c. Hot skin, high temperature (yet person may feel chilled)
d. Incoherent speech
e. Convulsions
f. Staggering gait
g. Sweating stops
h. Unconsciousness

II. CONTROL OF BLEEDING

A. Types of Hemorrhaging or Bleeding

1. Bleeding from an Artery

(a) Spurting Blood
(b) Pulsating Flow
(c) Bright Red Color

2. Bleeding from a Vein

   (a) Steady Flow
   (b) Dark Red Color

3. Bleeding from Capillaries

   (a) Slow, even flow (oozing)

B. Methods of Control

1. Direct pressure with sterile bandage, if available

2. Elevation

3. Pressure points (for arterial bleeding)

3. Tourniquet (last resort)

C. First Aid for Nosebleeds

1. Keep victim quietly seated, leaning forward if possible.
2. Gently pinch the nostrils shut
3. Apply cold compresses to the victim's nose and face

III. SKIN INJURIES

A. Burns

1. Chemical

   a. Remove all clothing containing the chemical agent

   b. Do not use any neutralizing solution, unless recommended by a physician

   c. Irrigate with water for al least 15 minutes, use potable water if possible

   d. Treat for shock, and transport.

2. Thermal (Heat)

   a. Minor -- Use cool, moist applications of gauze or bandage material to minimize blistering, and treat for physical shock if necessary.

   b. Moderate and Severe -- Do not use cold applications on extensive burns; cold could result in chilling. Cover the burn with a clean, dry dressing. Treat for shock and transport.

B. Open Wounds

1. Six Categories of Open Wounds

   a. Abrasions
   b. Amputations
   c. Avulsion
   d. Incisions
   e. Lacerations
   f. Punctures

2. General First Aid for Open Wounds

   a. Carefully cut or tear the clothing so that the injury may be seen

   b. If loose foreign particles are around the wound, wipe them away with clean material. Always wipe away from the wound, not toward it.

   c. Do not attempt to remove an object impaled in the wound. Serious bleeding and other damage may occur if the object is removed. Stabilize the object with a bulky dressing.

   d. Do not touch the wound with your hands, clothing or anything that is not clean.

   e. Keep the victim quiet and lying still (any movement will increase circulation which could start rebleeding)

   f. Reassure the victim to ease emotional reaction.

   g. Dress wound (medical personnel).

IV. BITES FROM BLOOD-FEEDING ARTHROPODS: MOSQUITOES

A. Blood-Feeding Arthropods in General

1. Of all insects, mosquitoes are the foremost disease carriers affecting man.

2. They belong to the order Diptera (two-winged flies), like blackflies, biting midges, deer flies, horse flies, green heads, tsetse flies, stable flies, sand flies and snipe flies.

B. Mosquitoes (Family Culcidae)

1. More people are bitten by mosquitoes than any other blood sucker. On a preference scale from 1 to 10, with 1 being the most attractive, humans rank 8 or 9 as the preferred host of blood-feeding arthropods.
2. Most mosquitoes can be separated into daytime and nighttime biters, but most will bite at twilight.

3. THE BITE -- Blood feeding takes only a few minutes. Mosquito saliva is released into the wound which causes the capillaries to dilate; blood pools, and the mosquito rapidly pumps its stomach full.

4. Only female mosquitoes bite and they feed every 3 to 4 days. Males feed solely on plant juices and nectar.

5. Mosquitoes rely on their sense of smell rather than sight to find a blood meal. They can detect the presence of a large mammal in darkness at a distance of 40 yards. Attractiveness of individual persons to mosquitoes varies. Postulated attractants: carbon dioxide exhaled from the lungs, lactic acid (from exercise) and body heat.

6. Periodic occurrence of dense mosquito populations results from natural and human-induced conditions. Natural population fluctuations are associated with time of year, weather, habitat, predators, disease, and breeding potential. Seasonally, tremendous numbers of mosquitoes are found in tidal marshes, the subarctic north, and flooded lowlands bordering lakes and rivers.

C. Reaction to Mosquito Bites

1. Aside from pain, reactions to bites vary, depending on the number of previous bites and individual sensitivity.

2. Sensitivity may develop on initial exposure, but for most people, symptoms diminish after subsequent encounters. There are people who manifest no skin reactions from mosquito bites--they are said to be desensitized.

D. Disease Potential

1. High -- In tropical and subtropical areas, e.g., malaria, dengue, yellow fever, plague, etc.

2. Moderate -- encephalitis (entire mainland U.S.), Rock Mountain Spotted Fever (South Atlantic, West Coast Central), Lyme Disease (Northeast), etc.

3. Low -- subarctic region

E. Protection

1. Personal Protection

a. Avoidance of infested areas

b. Use of physical barriers

Clothing should prevent all access to the skin.

c. Use of chemical protection

(1) Repellents

(a) Best repellant: N,N-diethyl-meta-toluamide, recently renamed N,N-diethyl-3-methylbenzamide, commonly referred to as deet.

(b) Deet is major active ingredient in 90% of commercial repellant formulations marketed worldwide.

(c) Toxicity of Deet is low, but it can sensitize the skin and cause severe skin reactions

(2) Insecticides

Clothing treated with contact insecticide (insecticide which kills insects which alight upon it, e.g. permethrin).

F. First Aid for Mosquito Bites is as follows:

1. Application of ice or ice water to the bite helps to slow absorption of toxin into the blood stream.

2. Victim should be observed for signs of an allergic reaction. For those that are allergic, maintain an open airway and get the victim to medical help as quickly as possible.

V. MUSCULOSKELETAL INJURIES

A. Four Categories of Injuries

1. Strains

a. Definition -- injury to a muscle or a tendon caused by overexertion.

b. Symptoms

(1) Intense pain
(2) Moderate swelling
(3) Painful and difficult movement
(4) Discoloration (sometimes)

c. First Aid

(1) Place victim in comfortable position
(2) Apply a hot, wet towel
(3) Keep the injured area at rest
(4) Seek Medical Help

2. Sprains

a. Definition -- injury due to stretching or tearing ligaments or other tissues at a particular point.

b. Symptoms

(1) Pain on movement
(2) Swelling
(3) Tenderness
(4) Discoloration

c. First Aid

(1) Elevate injured area
(2) Apply ice
(3) If ankle is injured, untie show, but do not remove it
(3) Obtain Medical Help

3. Fractures

a. Definition -- broken or cracked bone

b. Symptoms

(1) Pain or tenderness in region of fracture
(2) Deformity or irregularity of the affected area
(3) Loss of function of the affected area
(4) Moderate or severe swelling
(5) Discoloration
(6) Victim may have heard the bone "snap"

c. First Aid -- Obtain Medical Help

4. Dislocations

a. Definition -- when one or more of the bones forming a joint slip out of normal position.

b. Symptoms

(1) Rigidity and loss of function
(2) Deformity
(3) Pain
(4) Swelling
(5) Tenderness
(6) Discoloration

c. First Aid -- Obtain Medical Help

VI. HANDLING AND TRANSPORTATION

A. Unless absolutely necessary, never move a victim until fractures have been immobilized.

B. Test a stretch before use, and carefully place an injured person on the stretcher.

C. Carry the victim on a stretcher without any unnecessary rough movements.

ORANGE-SOL, INC.

Post Office Box 306 Chandler, Arizona 85244 (602) 961-0975

MATERIAL SAFETY DATA SHEET Form 29002

DE-SOLV-IT ®
Multi-Purpose Solvent

For Information call: (602) 497-8822
Form is essentially similar to OSHA-174

Date of Preparation
December 1, 1989

SECTION I - IDENTIFICATION

PRODUCT NAME: DE-SOLV-IT®, Multi-Purpose Solvent
CHEMICAL NAME & SYNONYMS: Technical grade mineral oil and orange oil mixture.
CHEMICAL FAMILY: Hydrocarbon
PROPER DOT SHIPPING NAME: The combustible mixture n.o.s. not otherwise specified label is exempt in containers under 110 gallons. Regulation 49 CFR 173.118A.

SECTION II - HAZARDOUS COMPONENTS/IDENTITY INFORMATION

PRODUCT MIXTURE (U.S. PAT 3,933,674; RE #29,649): The product has a flash point of 205° F (C.O.C.). No other hazards as per OSHA 1910:1200. See SECTION VI for test results.
closed cup

WASTE CLASSIFICATION: Product has been evaluated for RCRA characteristics and does not meet criteria of a hazardous waste if discarded in its purchased form.

The product in its purchased form is not regulated under the SARA hazard categories as per the EPA "Hazard Categories" under sections 311 and 312 of the Superfund Amendment and the Reauthorization Act of 1986 (SARA Title III).

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

APPEARANCE: A liquid of orange color - citrus odor
BOILING POINT: (Initial) 367° F; 50%- 416° F; 90%- 461° F.
VAPOR PRESSURE: 0.15 psi @ 20° C 14.7 norm Atmos P
VAPOR DENSITY (AIR=1): 4.5
SOLUBILITY IN WATER: Less than 0.001
SPECIFIC GRAVITY (H_2O=1): 0.801; 6.69 lbs./U.S. Gal.
EVAPORATION RATE (BUTYL ACETATE=1): 0.06
POUR POINT: -60° F (ASTM D-97). There is no true freezing point for this mixture of hydrocarbons.
DIELECTRIC STRENGTH: 50,000 volts.

SECTION IV - FIRE & EXPLOSION HAZARD DATA

FLASH POINT: 205° F C.O.C. Test Method
AUTO IGNITION TEMPERATURE: 675° F
FLAMMABLE LIMITS: Unknown
COMBUSTIBLE LIMITS: 205° F
EXTINGUISHING MEDIA: Water fog, carbon dioxide, dry chem., or foam.
SPECIAL FIREFIGHTING PROCEDURES: Do not use streams of water. This

® trademark of Orange-Sol, Inc.

may cause the scatter of burning liquid and thus spreading a fire.
UNUSUAL FIRE & EXPLOSION HAZARD: May produce dense, black smoke. Stay upwind of a fire.

SECTION V - REACTIVITY DATA

STABILITY: Stable.
INCOMPATIBILITY: Strong oxidizing agents.
HAZARDOUS DECOMPOSITION PRODUCTS: As with any other organic material, combustion will produce carbon dioxide.
MATERIALS TO AVOID: Strong oxidizing agents.
HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VI - HEALTH & TOXICITY DATA

PRIMARY ROUTES OF ENTRY: Oral, inhalation and skin absorption.
CARCINOGEN: NTP: None. IARC: None. OSHA: None.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Dermatitis may be aggravated by overexposure of sensitive individuals.
EMERGENCY & FIRST AID PROCEDURES: In case of swallowing, do not induce vomiting. Harmful or fatal if ingested into the lungs. Call a physican. If contacted externally, flush eyes or skin with water; remove soiled clothing.
TOXICITY TESTS - ALL TEST DATA AVAILABLE UPON REQUEST.
ORAL: LD50 Greater than 17,750 mg/kg (>16 ml/kg)
INHALATION: No toxic manifestations.
DRAIZE EYE IRRITATION: Score 0.00
PRIMARY SKIN IRRITATION: Irritation index 0.2 (low)
MUSCLE TISSUE: No deleterious effects.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING & USE

STEPS TO BE TAKEN IN CASE OF MATERIAL RELEASE OR SPILL: Absorb with dry sand or oil absorbent. Dispose in a waste container.
WASTE DISPOSAL METHOD: Product is biodegradable. Landfill or incineration at any approved facility conforming to local, state and federal regulations.
SPECIAL HANDLING & STORAGE PRECAUTIONS: Keep away from open flame or other ignition sources; otherwise no special requirements beyond adequate general ventilation and good handling practices.

This product, as with all chemicals, should be kept out of reach of children.

SECTION VIII - PERSONAL PROTECTION & CONTROL

SKIN & EYE PROTECTION: No special controls are required beyond good handling practices.

The information contained herein is furnished without warranty of any kind. Users should consider this data only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use and disposal of these materials and the safety and health of employees and customers.

A DIVISION OF EXXON CORPORATION
(PRODUCTION DEPARTMENT)

DATE ISSUED: 05/15/88

MATERIAL SAFETY DATA SHEET

EXXON COMPANY, U.S.A. P. O. BOX 2180 HOUSTON, TEXAS 77252-2180

A. IDENTIFICATION AND EMERGENCY INFORMATION

PRODUCT NAME
Crude Oil

CHEMICAL NAME
Crude Oil

CAS NUMBER Chem. Abst. #
8002-05-9

APPEARANCE AND ODOR
Dark liquid
Strong hydrocarbon solvent odor

EMERGENCY TELEPHONE NUMBER
(713) 656-3424

B. COMPONENTS AND HAZARD INFORMATION

COMPONENTS	CAS NO. OF COMPONENTS	APPROXIMATE CONCENTRATION
Crude Oil - a naturally occurring combination of hydrocarbons with gases, sulfur and nitrogen compounds	8002-05-9	100%

See Section E for health and hazard information

EXPOSURE LIMIT FOR TOTAL PRODUCT
Not established for total product

C. PRIMARY ROUTES OF ENTRY AND EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT
If hot product is splashed into eyes, flush with clear water and contact physician immediately. If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.

SKIN CONTACT
Immediately contact a physician for treatment of thermal burns. In case of skin contact with product under other conditions, wash thoroughly with soap and water. Removal of product from skin may be aided by use of waterless handcleaner.

INHALATION
If overcome by vapor, remove from exposure and call a physician immediately. If breathing is irregular or has stopped, start resuscitation, administer oxygen, if available.

INGESTION
If ingested, DO NOT induce vomiting; call a physician immediately.

D. FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT (MINIMUM)
Less than 16°C (60°F) to greater than 93°C (200°F) PMCC

AUTOIGNITION TEMPERATURE
Not Determined

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - HAZARD IDENTIFICATION

Health	Flammability	Reactivity	BASIS
1	3	0	Not Determined

HANDLING PRECAUTIONS
Keep product away from heat sparks, pilot lights, static electricity, and open flame.

FLAMMABLE OR EXPLOSIVE LIMITS (APPROXIMATE PERCENT BY VOLUME IN AIR)
Estimated Values: Lower Flammable Limit: 0.6% Upper Flammable Limit 15%

HOT CRUDE FLASH WARNING
Studies have shown that relatively low flash point substances, such as low boiling hydrocarbons, may accumulate in the vapor space of crude tanks and bulk transport compartments. Such vapors may exhibit flammability characteristics of a significantly lower flash product than would be indicated by the flash test. As a precaution, keep ignition sources away from vents and openings, including prevention of accumulation of pyrophoric iron sulfide.

AIR Ry

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES
Foam, water spray (fog), dry chemical, carbon dioxide and vaporizing liquid type extinguishing agents may all be suitable for extinguishing fires involving this type of product, depending on size or potential size of fire and circumstances related to the situation. Plan fire protection and response strategy through consultation with local fire protection authorities or appropriate specialists.

The following procedures for this type of product are based on the recommendations in the National Fire Protection Association's "Fire Protection Guide on Hazardous Materials", Eighth Edition (1984):

Use water spray, dry chemical, foam, or carbon dioxide. Water or foam may cause forthing. Use water to keep fire-exposed containers cool. Water spray may be used to flush spills away from exposures. Minimize breathing gases, vapor, fumes or decomposition products. Use supplied-air breathing equipment for enclosed or confined spaces or as otherwise needed.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS
Fumes, smoke, carbon monoxide, aldehydes and other decomposition products, in the case of incomplete combustion.

"EMPTY" CONTAINER WARNING

"Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All other containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. For work on tanks refer to Occupational Safety and Health Administration regulations, ANSI Z49.1, and other governmental and industrial references pertaining to cleaning repairing, welding, or other contemplated operations.

E. HEALTH AND HAZARD INFORMATION

VARIABILITY AMONG INDIVIDUALS

Health studies have shown that many petroleum hydrocarbons pose potential human health risks which may vary from person to person. As a precaution, exposure to liquids, vapors, mists or fumes should be minimized.

EFFECTS OF OVEREXPOSURE (SIGNS AND SYMPTOMS OF EXPOSURE)

High vapor concentrations are irritating to the eyes and the respiratory tract, may cause headaches and dizziness, are anesthetic, may cause unconsciousness, and may have other central nervous system effects including death. **CAUTION:** Product sometimes shipped hot; protect against burns.

Neurological

NATURE OF HAZARD AND TOXICITY INFORMATION

Skin contact with hot product may cause thermal burns. Prolonged or repeated contact with this product at warm or ambient temperatures tends to remove skin oils, possibly leading to irritation and dermatitis.

Eye contact with hot product may cause thermal burns. Contact with this product at warm or ambient temperatures may cause eye irritation but will not damage eye tissue.

This product may contain benzene, CAS #71-43-2, as a natural constituent. Benzene can cause anemia and other blood diseases, including leukemia (cancer of the blood-forming system), after prolonged or repeated exposures at high concentrations (e.g., 50-500 ppm). It has also caused fetal defects in tests on laboratory animals.

OSHA Regulation 29 CFR1910.1028 establishes an action level for benzene of 0.5 ppm as an 8-hour time weighted average, and permissible exposure limits of 1 ppm as an 8-hour time weighted average, and a short-term exposure limit of 5 ppm as averaged over any 15 minute period.

The American Conference of Government Industrial Hygienists (ACGIH) has adopted a threshold limit value for benzene of 10 ppm in air (30 mg/m^3) as a time weighted average for an 8-hour workday with 25 ppm (75 mg/m^3) STEL.

Short term Exp. limit

Crude Oil has been shown to cause skin cancer in animal tests. In such lifetime skin painting tests the substance was applied to the shaved backs of mice at regular intervals without cleanup between applications. In view of these findings, there may be a potential risk of skin cancer in humans from prolonged and repeated skin contact with this product in the absence of good personal hygiene.

Limited studies on oils that are very active carcinogens have shown that washing the the animals' skin with soap and water between applications greatly reduces tumor formation. These studies demonstrate the effectiveness of cleansing the skin after contact.

Potential risks to humans can be minimized by observing good work practices and personal hygiene procedures generally recommended for petroleum products. See Section I for recommended protection and precautions.

PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE

Benzene - Individuals with liver disease may be more susceptible to toxic effects.

Petroleum Solvents/Petroleum Hydrocarbons - Skin contact may aggravate an existing dermatitis.

F. PHYSICAL DATA

THE FOLLOWING DATA ARE APPROXIMATE OR TYPICAL VALUES AND SHOULD NOT BE USED FOR PRECISE DESIGN PURPOSES

BOILING POINT
Gas to 550°C (1000°F +)

SPECIFIC GRAVITY (H_2O = 1)
Greater than or equal to 0.7

MOLECULAR WEIGHT
Not Available

pH
Essentially Neutral

POUR, CONGEALING OR MELTING POINT
Not Available

VISCOSITY
Not Available

VAPOR PRESSURE
Not Available

VAPOR DENSITY (AIR = 1)
Not Available

PERCENT VOLATILE BY VOLUME
Up to 50%

EVAPORATION RATE @ ATM. AND 25°c (77°F) (n-BUTYL ACETATE = 1)
Not Available

SOLUBILITY IN WATER
Negligible

G. REACTIVITY

This product is stable. Hazardous polymerization will not occur. Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite. Hot product in contact with water can cause foaming or sudden evolution of steam which could cause pressure build-up and possibly rupture a tank or vessel.

Hydrogen sulfide from the product can react with the iron in Crude storage tank to form ferrous sulfide which is pyrophoric.

H. ENVIRONMENTAL INFORMATION

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Shut off and eliminate all ignition sources. Keep people away. Recover free liquid. Add sand, earth or other suitable absorbent to spill area. Minimize breathing vapors. Minimize skin contact. Ventilate confined spaces. Hot product may solidify when cooled. Keep product out of sewers and watercourses by diking or impounding. Advise authorities if product has entered or may enter sewers or watercourses.

Assure conformity with applicable governmental regulations. Continue to observe precautions for volatile, flammable vapors from absorbed material.

EPA HAZARD CLASSIFICATION CODE:

ACUTE HAZARD	CHRONIC HAZARD	FIRE HAZARD	PRESSURE HAZARD	REACTIVE HAZARD	NOT APPLICABLE
XXX	XXX	XXX			

I. PROTECTION AND PRECAUTIONS

VENTILATION

Provide ventilation sufficient to prevent exceeding recommended exposure limit or build-up of explosive concentrations of vapor in air. Use explosion-proof equipment

RESPIRATORY PROTECTION

Use supplied-air respiratory protection in confined or enclosed spaces, if needed.

PROTECTIVE GLOVES

Protect against hot liquid. Use chemical-resistant gloves to avoid skin contact.

EYE PROTECTION

Use splash goggles or fact shield when eye contact may occur.

OTHER PROTECTIVE EQUIPMENT
Use chemical-resistant apron or other impervious clothing, if needed, to protect against hot liquid and to avoid skin contact.

'RK PRACTICES / ENGINEERING CONTROLS
Jse explosion-proof equipment. No smoking or open lights.

PERSONAL HYGIENE
Minimize breathing vapor, mist or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing; launder or dry-clean reuse. Remove contaminated shoes and thoroughly clean before reuse; discard if oil-soaked. Cleanse skin thoroughly after contact, before breaks and meals, and at end of work period. Product is readily removed from skin by waterless hand cleaners, followed by washing thoroughly with soap and water.

J. TRANSPORTATION INFORMATION

TRANSPORTATION INCIDENT INFORMATION
For further information relative to spills resulting from transportation incidents, refer to latest Department of Transportation Emergency Response Guidebook for Hazardous Materials Incidents, DOT P 5800.3.

DOT IDENTIFICATION NUMBER
UN 1267

DOT CLASSIFICATION
Not regulated if flash point is ≥200°F
Flammable Liquid (flash point <100°F)
ombustible Liquid (flash point 100 to <200°F)

DOT SHIPPING NAME
Crude Oil Petroleum

The information and recommendations contained herein are, to the best of Exxon's knowledge and belief, accurate and reliable as of the date issued. Exxon does not warrant or guarantee their accuracy or reliability, and Exxon shall not be liable for any loss or damage arising out of use thereof.

The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use.

The Environmental Information included under Section H hereof as well as the National Fire Protection Association (NFPA) ratings have been included by Exxon Company, U.S.A. in order to provide additional health and hazard classification information. The ratings recommended are based upon the criteria supplied by the developers of these rating system, together with Exxon's interpretation of the available data.

FOR ADDITIONAL INFORMATION ON HEALTH EFFECTS CONTACT:

Director of Industrial Hygiene
Exxon Company, U.S.A.
P. O. Box 2180 - Room 3157
.ouston, Texas 77252-2180
(713) 656-2443

... Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

21

IDENTITY (As Used on Label and List)
Custoblen(TM) 28-8-0

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: Sierra Chemical Company	Emergency Telephone Number: (408)263-8083
Address (Number, Street, City, State, and ZIP Code): 1001 Yosemite Drive, Milpitas, CA 95035	Telephone Number for Information: (408)263-8080
	Date Prepared: 7-20-89
	Signature of Preparer (optional): Mark Lawrence

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)

This product is classified as an OXIDIZER for shipping purposes. Each prill is a mixture of: ammonium nitrate (NH_4NO_3); calcium phosphate ($CaPO_4$); and ammonium phosphates ($NH_4H_2PO_4$ and $(NH_4)_2HPO_4$). Each prill has a controlled release coating made from vegetable oil (linseed oil or soybean oil) reacted with cyclic diene.

Section III — Physical/Chemical Characteristics

Boiling Point: Decomposes on heating	Not Known	Specific Gravity (H_2O = 1)	1.2
Vapor Pressure (mm Hg.)	Not Known	Melting Point	Not Known
Vapor Density (AIR = 1)	non-volitale	Evaporation Rate (Butyl Acetate = 1)	non-volitale

Solubility in Water: 80-85%

Appearance and Odor: No odor. Prills are spherical in shape and mixed light and dark tan.

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
Decomposes on heating	Non-flammable	Non-flammable	Non-flammable

Extinguishing Media

Special Fire Fighting Procedures: Flood with water to cool containers.

Unusual Fire and Explosion Hazards: Decomposes on heating to nitrogen oxides.

...peratures above 300 F can cause

	Stable	X	decomposition to nitrogen oxides.

Incompatibility (Materials to Avoid) Reducing agents.

Hazardous Decomposition or Byproducts Nitrogen oxides.

Hazardous Polymerization			
	May Occur		Conditions to Avoid None
	Will Not Occur	X	

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? No Skin? No Ingestion? Yes

Health Hazards (Acute and Chronic) Rat oral LD50 greater than 20gm/kg

Carcinogenicity: NTP? None IARC Monographs? None OSHA Regulated? No

Signs and Symptoms of Exposure Ingestion can lead to gastro-intestinal disturbances.

Medical Conditions Generally Aggravated by Exposure Ingestion could aggravate gastro-intestinal problems.

Emergency and First Aid Procedures Ingestion: delay absorption of nitrates by giving water, milk ~~or activated charcol and then~~ remove by forced vomiting or gastric lavage.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled Sweep up.

Waste Disposal Method Apply to field as fertilizer, or transport to an approved hazardous waste disposal facility.

Precautions to Be Taken in Handling and Storing Protect from heat and moisture.

Other Precautions None

Section VIII — Control Measures

Respiratory Protection (Specify Type) None required

Ventilation			
None required	Local Exhaust	Special	None
	Mechanical (General)	Other	None

Protective Gloves None **Eye Protection** None

Other Protective Clothing or Equipment None

Hygienic Practices Adequate personal hygiene.

* U.S.G.P.O.: [illegible]

EXXON CHEMICAL

MATERIAL SAFETY DATA SHEET

EXXON CHEMICAL AMERICAS • P.O. BOX 3272, HOUSTON, TEXAS 77001
A Division of EXXON CHEMICAL COMPANY, A Division of EXXON CORPORATION

08/01/89

NO. 795800

SECTION 1 PRODUCT IDENTIFICATION & EMERGENCY INFORMATION

PRODUCT NAME
Corexit 9580 7-9580

CHEMICAL NAME
Not applicable: Blend

CHEMICAL FAMILY
Shoreline Cleaner

PRODUCT APPEARANCE/DESCRIPTION
Clear Straw Colored Liquid
Hydrocarbon Odor

EMERGENCY TELEPHONE NUMBERS:	EXXON CHEMICAL AMERICAS	713-870-6000
	CHEMTREC	800-424-9300

SECTION 2 HAZARDOUS INGREDIENT INFORMATION

The composition of this mixture may be proprietary information. In the event of a medical emergency, compositional information will be provided to a physician or nurse. This product is hazardous as defined in 29 CFR1910.1200, based on the following compositional information:

COMPONENT	OSHA HAZARD
Paraffinic Solvent	Combustible Liquid
Paraffinic Solvent, Organic Esters	Eye and Skin Irritant
Paraffinic Solvent	Vapors Irritant to Eyes
	and Respiratory Tract

For additional information see Section 3.

SECTION 3 HEALTH INFORMATION & PROTECTION

NATURE OF HAZARD

EYE CONTACT:
Irritating, but does not injure eye tissue.

SKIN CONTACT:
Low order of toxicity.
Frequent or prolonged contact may irritate and cause dermatitis.

INHALATION:
High vapor concentrations are irritating to the eyes and the respiratory tract, may cause headaches and dizziness, are anesthetic and may have other central nervous system effects.

INGESTION:
Small amounts of the liquid aspirated into the respiratory system during ingestion, or from vomiting, may cause bronchiopneumonia or pulmonary edema.

FIRST AID

EYE CONTACT:
Flush eyes with large amounts of water until irritation subsides. If irritation persists, get medical attention.

SKIN CONTACT:
Flush with large amounts of water; use soap if available.
Remove grossly contaminated clothing, including shoes, and launder before reuse.
If irritation persists, seek medical attention.

INHALATION:
Using proper respiratory protection, immediately remove the affected victim from exposure. Administer artificial respiration if breathing is stopped. Keep at rest. Call for prompt medical attention.

NO O_2

INGESTION:
If swallowed, DO NOT induce vomiting. Keep at rest. Get prompt medical attention.

WORKPLACE EXPOSURE LIMITS

EXXON RECOMMENDS THE FOLLOWING OCCUPATIONAL EXPOSURE LIMITS:
300 ppm total hydrocarbon based on composition.

PRECAUTIONS

PERSONAL PROTECTION
For open systems where contact is likely, wear safety glasses with side shields, long sleeves, and chemical resistant gloves.
Where contact may occur, wear safety glasses with side shields.
Where concentrations in air may exceed the limits given in this Section and engineering, work practice or other means of exposure reduction are not adequate, NIOSH/MSHA approved respirators may be necessary to prevent overexposure by inhalation.

VENTILATION
The use of mechanical dilution ventilation is recommended whenever this product is used in a confined space, is heated above ambient temperatures, or is agitated.

CHRONIC EFFECTS
Laboratory animal studies have shown that prolonged and repeated inhalation exposure to light hydrocarbon vapors in the same naphtha boiling range as this product can produce adverse kidney effects in male rats. However, these effects were not observed in similar studies with female rats and male and female mice and in limited studies with other animal species. Additionally, in a number of human studies, there was no clinical evidence of such effects at normal occupational levels. It is therefore highly unlikely that the kidney effects observed in male rats have significant implications for humans exposed at or below recommended vapor limits in the workplace.

CHRONIC TOXICITY DATA IS AVAILABLE UPON REQUEST

SECTION 4 FIRE & EXPLOSION HAZARD

FLASHPOINT: 174 Deg F. METHOD: Seta CC NOTE: Not available
FLAMMABLE LIMITS: LEL: 0.6 UEL: 7.0 NOTE: Not available
AUTOIGNITION TEMPERATURE: NOTE: Not available

GENERAL HAZARD
Combustible Liquid, can form combustible mixtures at temperatures at or above the flashpoint.
Toxic gases will form upon combustion.
"Empty" containers retain product residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner, or properly disposed of.

FIRE FIGHTING
Use water spray to cool fire exposed surfaces and to protect personnel.
Isolate "fuel" supply from fire.
Use alcohol type foam, dry chemical or water spray to extinguish fire.

Respiratory and eye protection required for fire fighting personnel. Avoid spraying water directly into storage containers due to danger of boilover.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS
Smoke, Fumes, Carbon Monoxide, Carbon Dioxide

SECTION 5 SPILL CONTROL PROCEDURE

LAND SPILL
Eliminate sources of ignition. Prevent additional discharge of material, if possible to do so without hazard. For small spills implement cleanup procedures; for large spills implement cleanup procedures and, if in public area, keep public away and advise authorities. Also, if this product is subject to CERCLA reporting (see Section VII) notify the National Response Center.
Prevent liquid from entering sewers, watercourses, or low areas. Contain spilled liquid with sand or earth. Do not use combustible materials such as sawdust.
Recover by pumping (use an explosion proof or hand pump) or with a suitable absorbent.
Consult an expert on disposal of recovered material and ensure conformity to local disposal regulations.

WATER SPILL
Consult an expert on disposal of recovered material and ensure conformity to local disposal regulations.

SECTION 6 NOTES

other

This product may contain trace amounts of ethylene oxide (CAS No. 75-21-8), a condition which creates the potential for accumulation of ethylene oxide in the head space of shipping and storage containers and in enclosed areas where the product is being handled or used. Ethylene oxide is considered by OSHA, IARC, and NTP as a potential carcinogen for humans. Ethylene oxide may also present reproductive, mutagenic, genotoxic, neurologic and sensitization hazards in humans. If this product is handled with adequate ventilation, the presence of these trace amounts is not expected to result in any short or long term hazards.

SECTION 7 REGULATORY INFORMATION

TSCA:
Components of this product are listed on the TSCA Inventory.

CERCLA:
If this product is accidentally spilled, it is not subject to any special reporting under the requirements of the Comprehensive Response, Compensation, and Liability Act (CERCLA). We recommend you contact local authorities to determine if there may be other local reporting requirements.

SARA TITLE III:
Under the provisions of Title III, Sections 311/312 of the Superfund Amendments and Reauthorization Act, this product is classified into the following hazard categories: Immediate health, Delayed Health, Fire.
This product does not contain Section 313 Reportable Ingredients.

SECTION 8 TYPICAL PHYSICAL & CHEMICAL PROPERTIES

SPECIFIC GRAVITY:
0.81 at 60 Not available
Density: 6.8 lbs/gal at 60

SOLUBILITY IN WATER, WT. % AT °F:
Dispersible

SP. GRAV. OF VAPOR, at 1 atm (Air=1):
5.00 Not available

EVAPORATION RATE, n-Bu Acetate=1:
0.0 Calculated

VAPOR PRESSURE, mmHg at °F:
2 at 100 Calculated

VISCOSITY OF LIQUID, CST AT °F:
3 at 100 Cannon-Fenske
2 at 150 Cannon-Fenske

FREEZING/MELTING POINT, °F:
-65 Pour Point

BOILING POINT, °F:
429 Not available

SECTION 9 REACTIVITY DATA

STABILITY:
Stable

CONDITIONS TO AVOID INSTABILITY:
None

HAZARDOUS POLYMERIZATION:
Will not occur

COND. TO AVOID HAZARDOUS POLYMERIZATION:
Not applicable

MATERIALS AND CONDITIONS TO AVOID INCOMPATIBILITY:
Strong Oxidizing Agents

HAZARDOUS DECOMPOSITION PRODUCTS:
None

SECTION 10 TRANSPORT AND STORAGE

U.S. DOT CLASSIFICATION:
Combustible Liquid

ELECTROSTATIC ACCUMULATION HAZARD:
Unknown, use proper grounding procedure

STORAGE TEMPERATURE, °F:
Ambient

STORAGE/TRANSPORT PRESSURE, mmHg:
Atmospheric

UN NUMBER:
U.S. DOT Identification Number: NA 1993

LOADING/UNLOADING TEMPERATURE, °F:
Ambient

VISC. AT LOADING/UNLOADING TEMP., cST:
Not available

REFERENCE NUMBER:	DATE PREPARED:	SUPERCEDES ISSUE DATE:
HDHA-A-12003	August 1, 1989	July 27, 1989

FOR ADDITIONAL PRODUCT INFORMATION, CONTACT YOUR TECHNICAL SALES REPRESENTATIVE
FOR ADDITIONAL HEALTH/SAFETY INFORMATION, CALL 713-870-6885

EXXON COMPANY, U.S.A.
A DIVISION OF EXXON CORPORATION

DATE ISSUED: 07/28/89
SUPERSEDES DATE: **********

MATERIAL SAFETY DATA SHEET

EXXON COMPANY, U.S.A. P.O. BOX 2180 HOUSTON, TX 77252-2180

A. IDENTIFICATION AND EMERGENCY INFORMATION

PRODUCT NAME
INIPOL EAP 22

PRODUCT CODE
134681 - 84681

CHEMICAL NAME
Biodegradation accelerating agent

CAS NUMBER
Complex Mixture
CAS Number not applicable

PRODUCT APPEARANCE AND ODOR
Clear liquid

MEDICAL EMERGENCY TELEPHONE NUMBER
(713) 656-3424

MANUFACTURED BY CECA COMPANY

B. COMPONENTS AND HAZARD INFORMATION

COMPONENTS	CAS NO. OF COMPONENTS	APPROXIMATE CONCENTRATION
This formulation contains the following hazardous component:		
2-Butoxyethanol (ethylene glycol monobutyl ether)	111-76-2	

See Section E for Health and Hazard Information.

See Section H for additional Environmental Information.

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)

Health	Flammability	Reactivity	BASIS
2	1	0	Recommended by Exxon

EXPOSURE LIMIT FOR TOTAL PRODUCT
25 ppm (120 mg/m3) for 2-Butoxyethanol (skin)

BASIS
Recommended by the American Conference of Governmental Industrial Hygienists (ACGIH)
OSHA Regulation 29 CFR 1910.1000

C. PRIMARY ROUTES OF ENTRY AND EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT
If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.

SKIN
In case of skin contact, remove any contaminated clothing and wash skin thoroughly with soap and water.

INHALATION
If overcome by vapor, remove from exposure and call a physician immediately. If breathing is irregular or has stopped, start resuscitation, administer oxygen, if available.

INGESTION
If ingested, DO NOT induce vomiting; call a physician immediately.

D. FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT (MINIMUM)
Greater than 100°C

AUTOIGNITION TEMPERATURE
Not determined

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - HAZARD IDENTIFICATION

Health	Flammability	Reactivity	BASIS
3	1	0	Recommended by Exxon

HANDLING PRECAUTIONS
Use product with caution around heat, sparks, pilot lights, static electricity, and open flame.

FLAMMABLE OR EXPLOSIVE LIMITS (APPROXIMATE PERCENT BY VOLUME IN AIR)
Estimated values: Lower Flammable Limit 0.9% Upper Flammable Limit 7%

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES
Foam, water spray (fog), dry chemical, carbon dioxide and vaporizing liquid type extinguishing agents may all be suitable for extinguishing fires involving this type of product, depending on size or potential size of fire and circumstances related to the situation. Plan fire protection and response strategy through consultation with local fire protection authorities or appropriate specialists.

The following procedures for this type of product are based on the recommendations in the National Fire Protection Association's "Fire Protection Guide on Hazardous Materials", Eighth Edition (1984):

Use water spray, dry chemical, foam or carbon dioxide to extinguish the fire. Use water to keep fire-exposed containers cool. If a leak or spill has not ignited, use water spray to disperse the vapors and to provide protection for men attempting to stop a leak. Water spray may be used to flush spills away from exposures. Minimize breathing of gases, vapor, fumes or decomposition products. Use supplied-air breathing equipment for enclosed or confined spaces or as otherwise needed.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS
Fumes, smoke, carbon monoxide, aldehydes and other decomposition products, in the case of incomplete combustion.

"EMPTY" CONTAINER WARNING
"Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All other containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. For work on tanks refer to Occupational Safety and Health Administration regulations, ANSI Z49.1, and other governmental and industrial references pertaining to cleaning, repairing, welding, or other contemplated operations.

E HEALTH AND HAZARD INFORMATION

VARIABILITY AMONG INDIVIDUALS
Health studies have shown that many petroleum hydrocarbons and synthetic lubricants pose potential human health risks which may vary from person to person. As a precaution, exposure to liquids, vapors, mists or fumes should be minimized.

EFFECTS OF OVEREXPOSURE (Signs and symptoms of exposure)
Inhalation of high vapor concentrations may have results ranging from dizziness, headache, and respiratory irritation to unconsciousness and possibly death.

NATURE OF HAZARD AND TOXICITY INFORMATION
Prolonged or repeated skin contact may cause skin irritation.

Product contacting the eyes may cause eye irritation.

Inhalation of high vapor concentrations may cause upper respiratory tract irritation.

USE CAUTION WHEN HANDLING THIS MATERIAL.

Components of this product (2-butoxyethanol) may be absorbed through the skin and could produce blood and kidney damage. Symptoms of overexposure include paleness and red discoloration of the urine.

PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE
Petroleum Solvents/Petroleum Hydrocarbons - Skin contact may aggravate an existing dermatitis.

Glycol ethers - Persons with a history of blood and/or kidney disease should avoid exposure to this product.

F. PHYSICAL DATA

The following data are approximate or typical values and should not be used for precise design purposes.

BOILING RANGE
Not determined

SPECIFIC GRAVITY (15.6 C/15.6 C)
0.996 at 25°C

MOLECULAR WEIGHT
Approximately 190

pH
5.0-6.8

POUR, CONGEALING OR MELTING POINT
11°C

VISCOSITY
250 cSt @ 20°C

VAPOR PRESSURE
10 mm Hg @ 20°C
~~30mm Hg~~ 760 milibars

VAPOR DENSITY (AIR = 1)
Not determined

PERCENT VOLATILE BY VOLUME
Not determined

EVAPORATION RATE @ 1 ATM. AND 25 C (77 F)
(n-BUTYL ACETATE = 1)
Not determined

SOLUBILITY IN WATER @ 1 ATM. AND 25 C (77 F)
100%

G. REACTIVITY

This product is stable and will not react violently with water. Hazardous polymerization will not occur. Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite.

H. ENVIRONMENTAL INFORMATION

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Shut off and eliminate all ignition sources. Keep people away. Recover free product. Add sand, earth or other suitable absorbent to spill area. Minimize breathing vapors. Minimize skin contact. Ventilate confined spaces. Open all windows and doors. Keep product out of sewers and watercourses by diking or impounding. Advise authorities if product has entered or may enter sewers, watercourses, or extensive land areas.
Assure conformity with applicable governmental regulations.

THE FOLLOWING INFORMATION MAY BE USEFUL IN COMPLYING WITH VARIOUS STATE AND FEDERAL LAWS AND

REGULATIONS UNDER VARIOUS ENVIRONMENTAL STATUTES:

REPORTABLE QUANTITY (RQ), EPA REGULATION 40 CFR 302 (CERCLA Section 102)
No RQ for product or any constituent greater than 1% or 0.1% (carcinogen).

THRESHOLD PLANNING QUANTITY (TPQ), EPA REGULATION 40 CFR 355 (SARA Sections 301-304)
No TPQ for product or any constituent greater than 1% or 0.1% (carcinogen).

TOXIC CHEMICAL RELEASE REPORTING, EPA REGULATION 40 CFR 372 (SARA Section 313)
No toxic chemical is present greater than 1% or 0.1% (carcinogen).

HAZARDOUS CHEMICAL REPORTING, EPA REGULATION 40 CFR 370 (SARA Sections 311-312)

	Acute Hazard	Chronic Hazard	Fire Hazard	Pressure Hazard	Reactive Hazard	Not Applicable
EPA HAZARD CLASSIFICATION CODE:	XXX	XXX				

I. PROTECTION AND PRECAUTIONS

VENTILATION
Use only with ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air. No smoking, flame or other ignition sources.

RESPIRATORY PROTECTION
Use supplied-air respiratory protection in confined or enclosed spaces, if needed.

Use approved organic vapor respirator for concentrations of 2-butoxyethanol in excess of 25 ppm.

PROTECTIVE GLOVES
Use chemical-resistant gloves to avoid prolonged and repeated skin contact.

EYE PROTECTION
Use splash goggles or face shield when eye contact may occur.

OTHER PROTECTIVE EQUIPMENT
Use chemical-resistant apron or slicker suit and chemically resistant boots to avoid contaminating regular clothing, which could result in prolonged or repeated skin contact.

WORK PRACTICES / ENGINEERING CONTROLS
Keep containers closed when not in use. Do not store near heat, sparks, flame or strong oxidants. To prevent fire or explosion risk from static accumulation and discharge, effectively ground product transfer system in accordance with the National Fire Protection Association standard for petroleum products.

In order to prevent fire or explosion hazards, use appropriate equipment.

Information on electrical equipment appropriate for use with this product may be found in the latest edition of the National Electrical Code (NFPA-70). This document is available from the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.

PERSONAL HYGIENE
Minimize breathing vapor or mist. Avoid prolonged or repeated contact with skin. Remove contaminated clothing; launder or dry-clean before re-use. Remove contaminated shoes and thoroughly clean and dry before re-use. Cleanse skin thoroughly after contact, before breaks and meals, and at end of work period. Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water.

J. TRANSPORTATION AND OSHA RELATED LABEL INFORMATION

TRANSPORTATION INCIDENT INFORMATION
For further information relative to spills resulting from transportation incidents, refer to latest Department of Transportation Emergency Response Guidebook for Hazardous Materials Incidents, DOT P 5800.3.

DOT IDENTIFICATION NUMBER
Not applicable

OSHA REQUIRED LABEL INFORMATION

In compliance with hazard and right-to-know requirements, the following OSHA Hazard Warnings should be found on a label, bill of lading or invoice accompanying this shipment.

WARNING!

MATERIAL MAY BE ABSORBED THROUGH THE SKIN

PROLONGED AND REPEATED EXPOSURE MAY CAUSE
EYE AND SKIN IRRITATION AND MAY CAUSE
BLOOD AND KIDNEY DAMAGE

Note: Product label will contain additional non-OSHA related information.

The information and recommendations contained herein are, to the best of Exxon's knowledge and belief, accurate and reliable as of the date issued. Exxon does not warrant or guarantee their accuracy or reliability, and Exxon shall not be liable for any loss or damage arising out of the use thereof.

The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal council should be consulted to insure proper health, safety and other necessary information is included on the container.

The Environmental Information included under Section H hereof as well as the Hazardous Materials Identification System (HMIS) and National Fire Protection Association (NFPA) ratings have been included by Exxon Company, U.S.A. in order to provide additional health and hazard classification information. The ratings recommended are based upon the criteria supplied by the developers of these rating systems, together with Exxon's interpretation of the available data.

FOR ADDITIONAL INFORMATION ON HEALTH EFFECTS CONTACT:
DIRECTOR OF INDUSTRIAL HYGIENE
EXXON COMPANY, U.S.A.
P. O. BOX 2180 ROOM 3157
HOUSTON, TX 77252-2180
(713) 656-2443

FOR OTHER PRODUCT INFORMATION CONTACT:
MANAGER, MARKETING TECHNICAL SERVICES
EXXON COMPANY, U.S.A.
P. O. BOX 2180 ROOM 2355
HOUSTON, TX 77252-2180
(713) 656-5949

29 CFR 1910.120 Hazardous Waste Operations and Emergency Response

(a) Scope, application, and definitions

(b) Safety and health program

(c) Site characterization and analysis

(d) Site control

(e) Training

(f) Medical surveillance

(g) Engineering controls

(h) Monitoring

(i) Informational programs

(j) Handling drums and containers

(k) Decontamination

(l) Emergency response by employees at uncontrolled hazardous waste sites

(m) Illumination

(n) Sanitation at temporary workplaces

(o) New technology programs

(p) Certain operations conducted under the Resource Conservation and Recovery Act of 1976 (RCRA)

(q) Emergency response to hazardous substance releases

29 CFR 1910.38 Employee emergency plans and fire prevention plans

(a) Emergency action plan

(1) Scope and application–must be written

(2) Elements include (as a minimum)
- (i) emergency escape procedures and emergency escape route assignments
- (ii) procedures for employees left behind to perform critical operations
- (iii) procedure to perform head count after evacuation
- (iv) assignments for rescue and medical duties
- (v) preferred means of reporting fires and other emergencies
- (vi) names or regular job titles of persons to contact for further info on plan

(3) Alarm system

(4) Evacuation

(5) Training
- (i) train a sufficient number to respond
- (ii) review with the employee initially, when employees responsibility change or when plan is changed
- (iii) review parts of the plan which employee must know to protect the employee

29 CFR 1910.38 Employee emergency plans and fire prevention plans (continued)

(b) Fire prevention plan

(1) Scope and application--plan in writing

(2) Elements

(i) list of hazards, sources of ignition, control procedures

(ii) names and titles of persons who maintain systems

(iii) names and titles of persons responsible for control of fuel source hazards

(3) Housekeeping--control accumulations of waste

(4) Training

(i) apprise employees of fire hazards

(ii) review parts of the fire prevention plan which employee must know to protect the employee in the event of an emergency

(5) Maintenance--procedures shall be added to written plan

29 CFR 1910.165

EMPLOYEE ALARM SYSTEMS

- GENERAL USE
- SPECIFIC USE – DISTINCTIVE SIGNALS
- VISIBLE ALARMS AND AUDIBLE ALARMS
  - FIRST AID
  - BEAR ALERT
  - ASSEMBLY / EVACUATE
  - OTHER
- DAILY TEST OF SYSTEM

PLANNING AND ORGANIZATION

- Organizational structure
  - On site
  - Off site
- Work plan
- Site Safety Plan

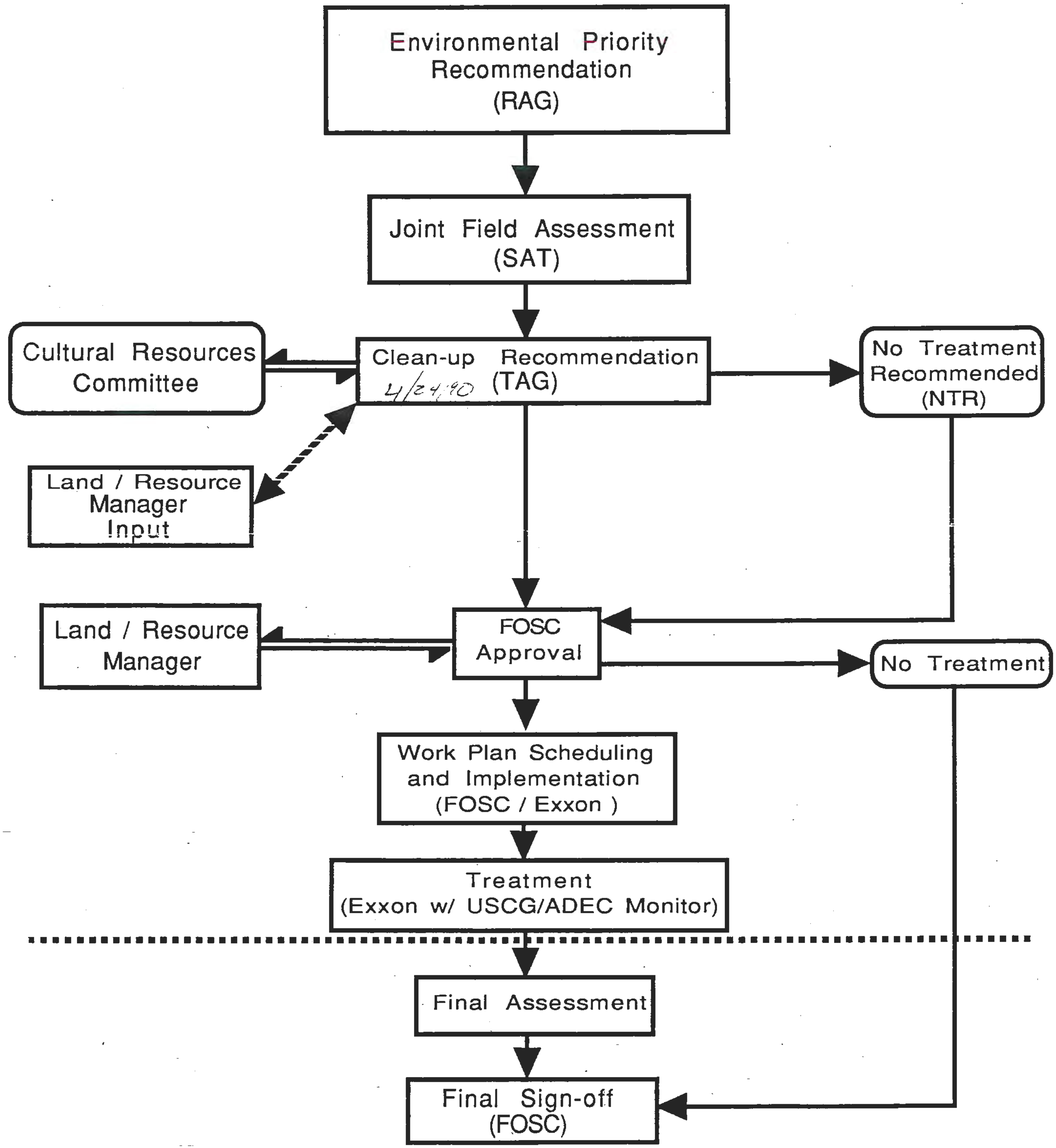
SITE CONTROL

- SITE MAP
- SITE PREPARATION
- SITE WORK ZONES
- BUDDY SYSTEM
- SITE SECURITY
- COMMUNICATION SYSTEMS
- SAFE WORK PRACTICES

SITE WORK ZONES

- Boundary of contamination
- Hot line
- Contamination control line
- Support zone
- Contamination reduction corridor

EXXON VALDEZ, Summer 1990
Shoreline Treatment Decision Chart



ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

BIOREMEDIATION AND 1990 EXXON VALDEZ CLEANUP
ADEC-SPONSORED WORKSHOP FOR REPRESENTATIVES OF
USER GROUPS, PUBLIC INTEREST GROUPS, AND LANDOWNERS

April 24, 1990
Anchorage, AK

AGENDA

I. 1:00 PM Introduction
Gary Hayden - ADEC Director
Workshop moderator

II. 1:15 PM State of Alaska:
Gary Hayden
ADEC's role in decision on use of bioremediation and current State position

III. 1:30 PM NOAA
Joseph Talbott - SSC, Exxon Valdez

Treatment Decision Matrix
Status of Treatment Advisory Group (TAG) process

ADEC handouts-shoreline treatment recommendations and map

IV. 2:00 PM EPA
John Baker - Field Ecologist
Lockheed Corp.
EPA, Las Vegas
John Glaser - Chemist
EPA Risk Reduction Engineering Laboratory
EPA, Cincinnati

Presentation of research data

V. 3:00 PM EXXON
Russ Chianelli - Exxon Corporate Research
Clinton, New Jersey

Presentation of research data

VI. 4:00 PM QUESTIONS AND GENERAL DISCUSSION

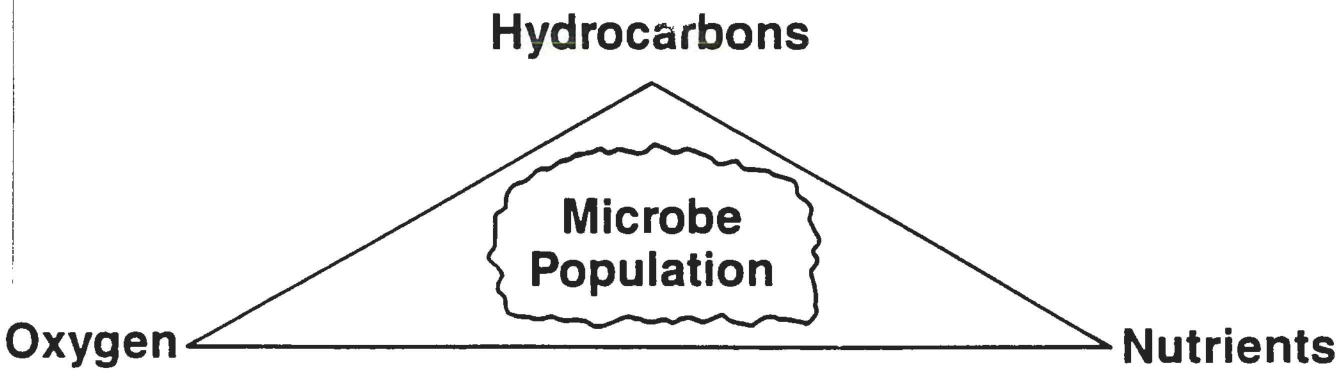
VII. 5:00 PM Adjourn

Bioremediation in Prince William Sound 1989

Mineralization

$$\text{Hydrocarbon} \longrightarrow [\text{oxygenates}] \begin{cases} \xrightarrow{50\%} \text{Biomass} \\ \xrightarrow{50\%} \text{Carbon dioxide} \end{cases}$$

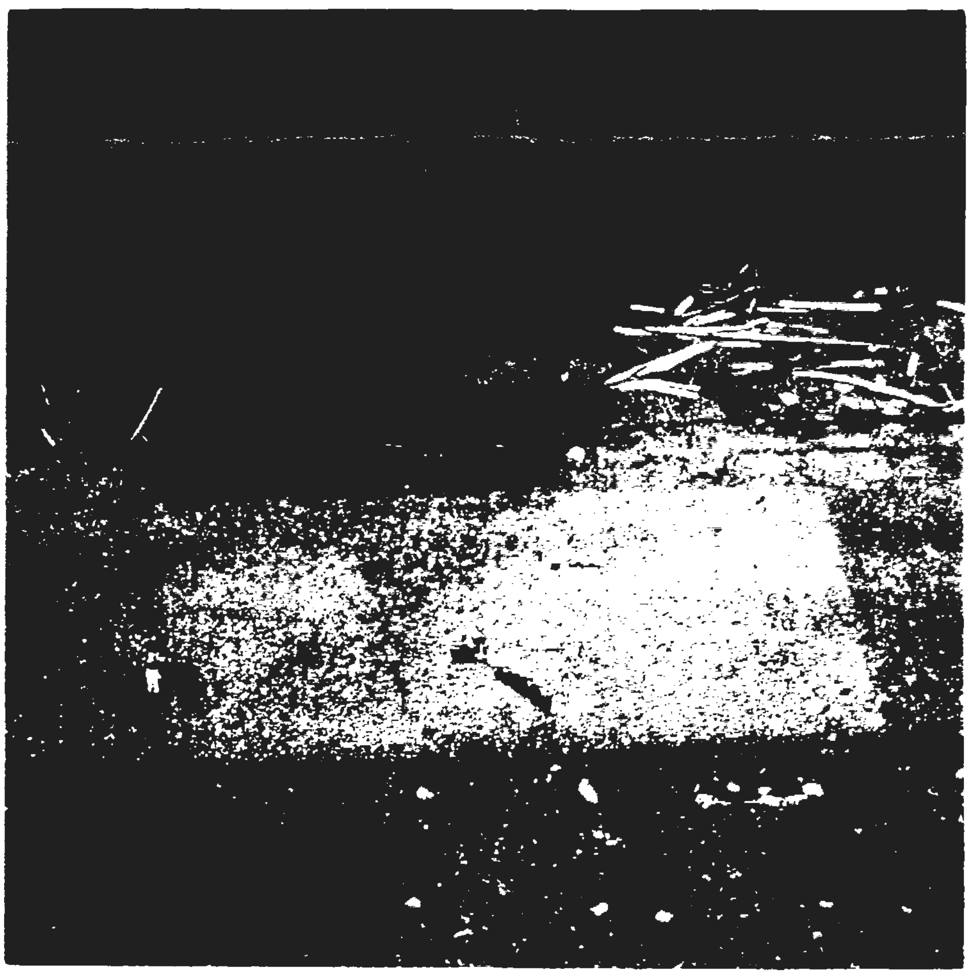
- Biodegradation is a natural process in which bacteria consume petroleum and break it down to biomass and carbon dioxide.
- Laboratory studies show that the water soluble intermediates generated during biodegradation are short-lived and low (ppm) in concentration.



- On beaches such as those in Prince William Sound microbes exist naturally. Less than 0.1% of these microbes can be classified as "Hydrocarbon oxidizing bacteria", which means that they break down hydrocarbons such as crude oil by adding oxygen to them.
- After the Valdez oil spill, the percentage of oil-degrading bacteria increased to over 10% of the total microbe population.
- By adding nutrients such as nitrogen and phosphorus the population of these oil-degraders can be increased even more, which increases the rate at which the oil is consumed and therefore enhances the natural process of biodegradation.

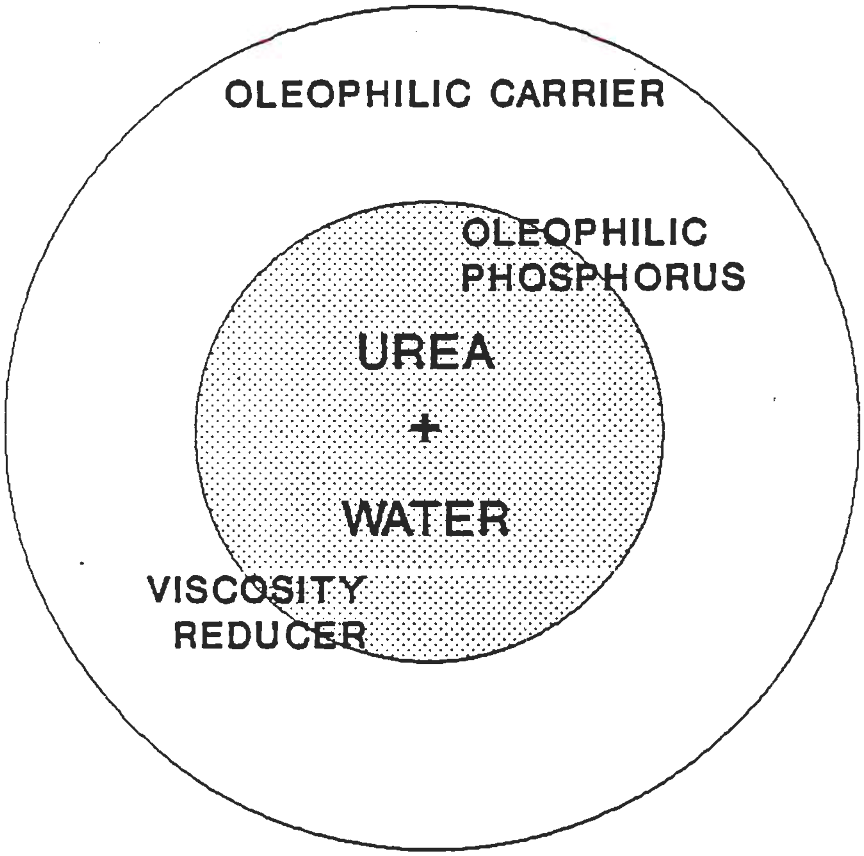
- Three types of nutrients were tried in the 1989 beach tests:
  - Oleophilic (Inipol EAP22)
  - Slow Release (Customblen)
  - Soluble Spray
- In each of these tests every effort was made to keep the nutrients out of the water during application.

- EPA/Exxon beach and laboratory tests showed that all three nutrients were effective in enhancing the natural process of biodegradation, but Inipol EAP22 showed the most dramatic effect.
- There were no adverse effects observed during these studies.
- Inipol EAP2_ was applie_ to almost 73 miles of beaches with similar effects on the rate of biodegradation.



- Inipol EAP22 was developed in France as a result of the AMOCO Cadiz oil spill.
- Inipol is designed to stick to the oil and release nutrients where they are needed.
- Inipol holds the oil on the rocks; it is NOT a rock-washing agent.

INIPOL COMPOSITION
MICROEMULSION

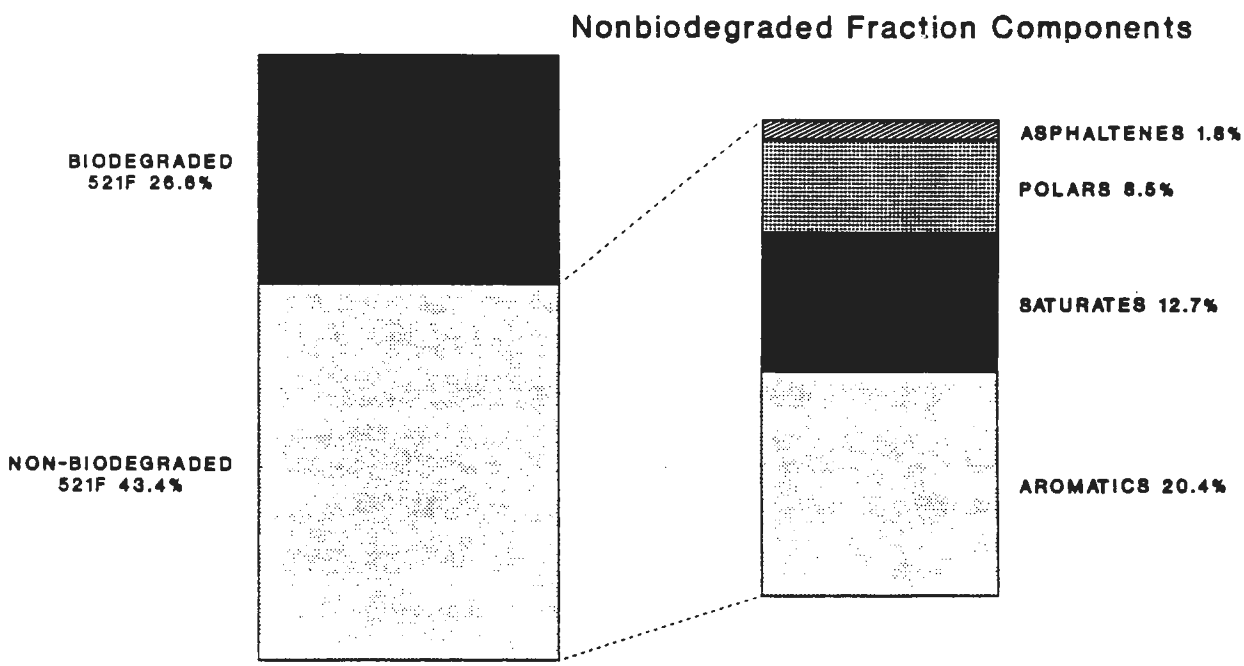


CHEMICAL	OTHER COMMON USES
OLEOPHILIC CARRIER	SALAD OIL
OLEOPHILIC PHOSPHORUS	COSMETICS
VISCOSITY REDUCER	INDUSTRIAL CLEANERS
UREA (NITROGEN)	AGRICULTURAL FERTILIZERS

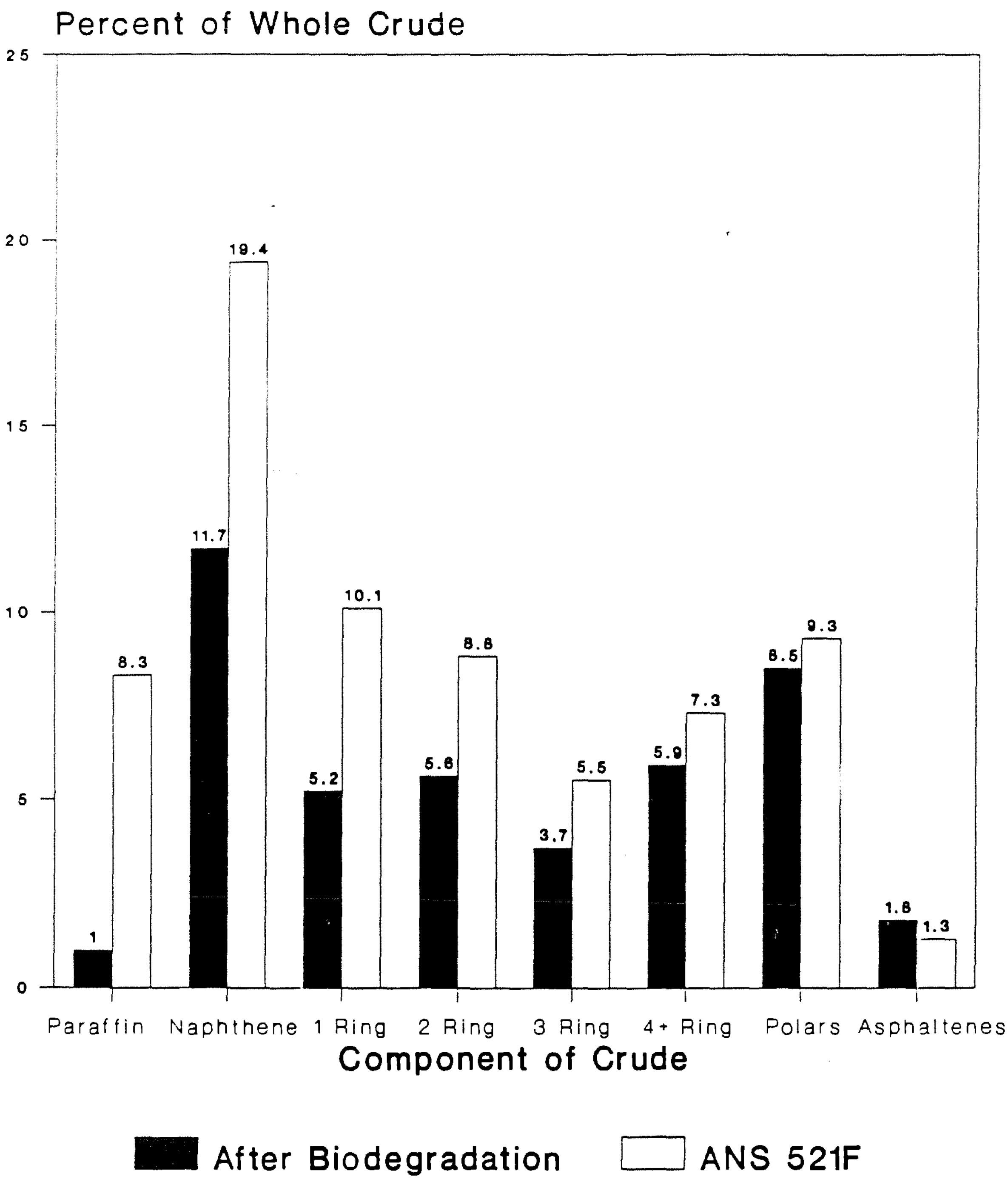
- Laboratory studies (EPA/Exxon, French) have shown that Inipol-accelerated biodegradation can mineralize up to 90% of the oil approximately five times faster than the natural-occurring rate. This rate depends on the oil loading and beach surface.

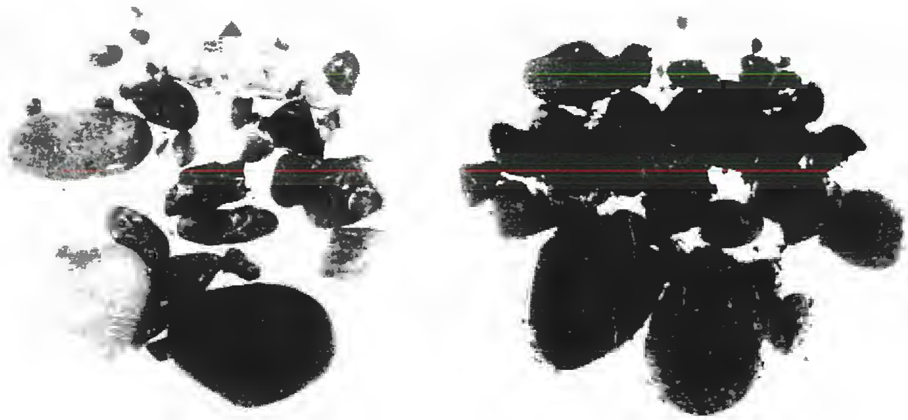
- Closed system mass balance experiments have shown that nearly all the components of crude oil are biodegradable. The only exception found to date is the asphaltene component, which makes up about 2% of the total crude oil.

Biodegraded vs. Nonbiodegraded Fractions



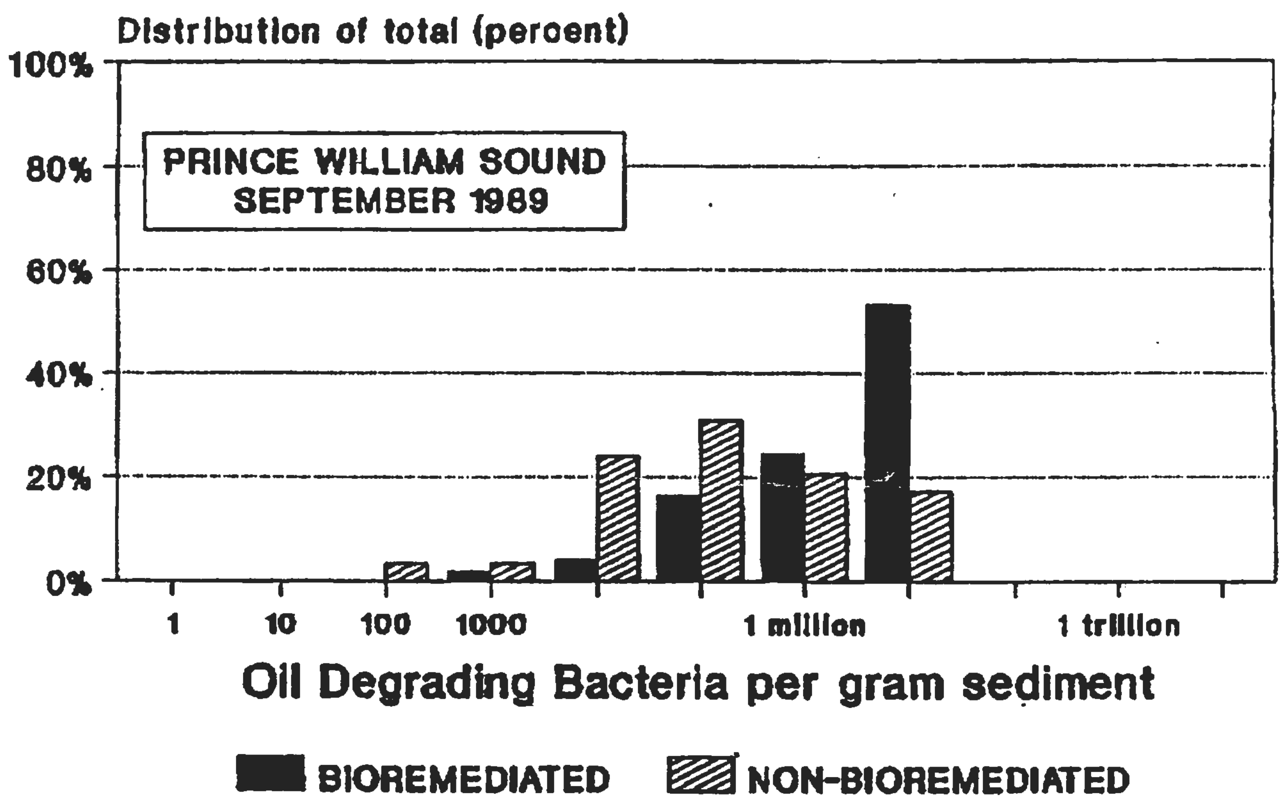
In addition, different molecules will degrade at different rates, depending upon their chemistry. Larger, more complex molecules will take longer to biodegrade than smaller molecules.



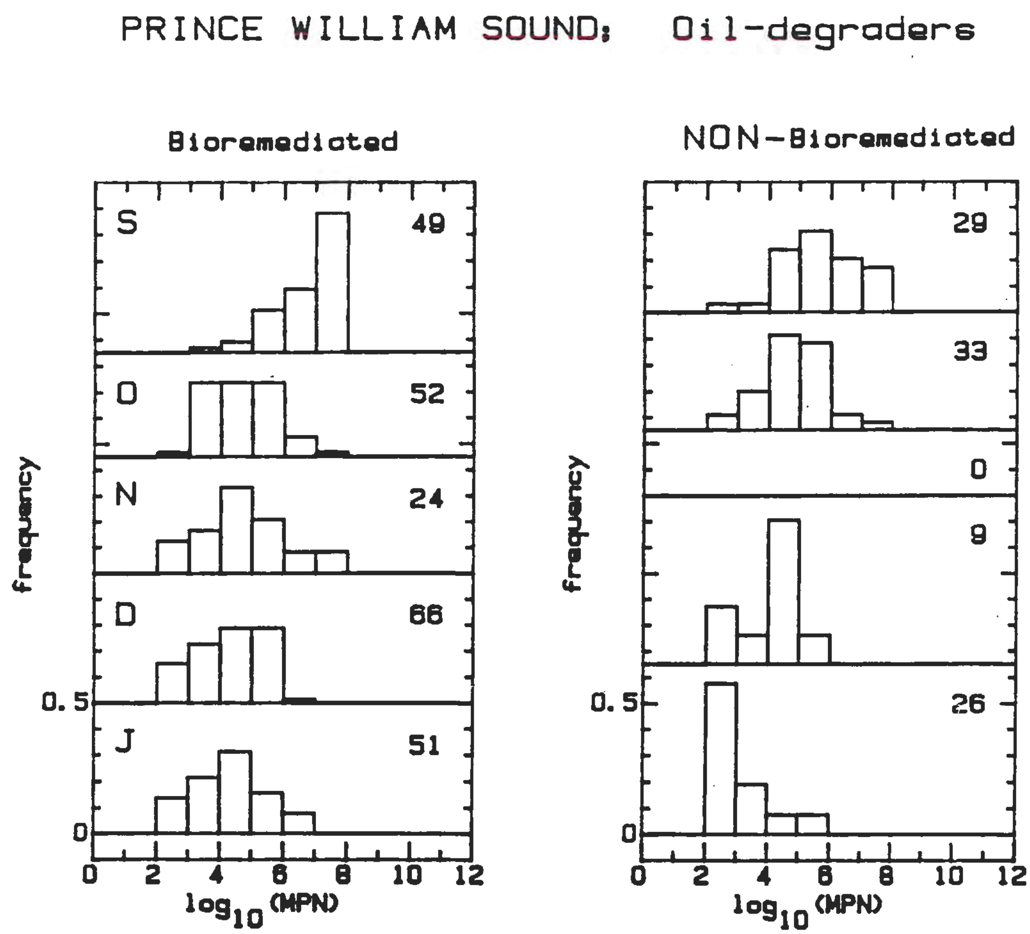


- The rocks become clean after a period of time depending upon oil loading / Inipol EAP22 loading.
- This cleaning occurs exclusively by means of bioaction causing biodegradation.
- The bioaction proceeds to degrade the oil. With wave action small packets of oil / microbes are removed from the rocks and continue to biodegrade.

The number of hydrocarbon-degrading microbes dramatically increased on the treated beaches.

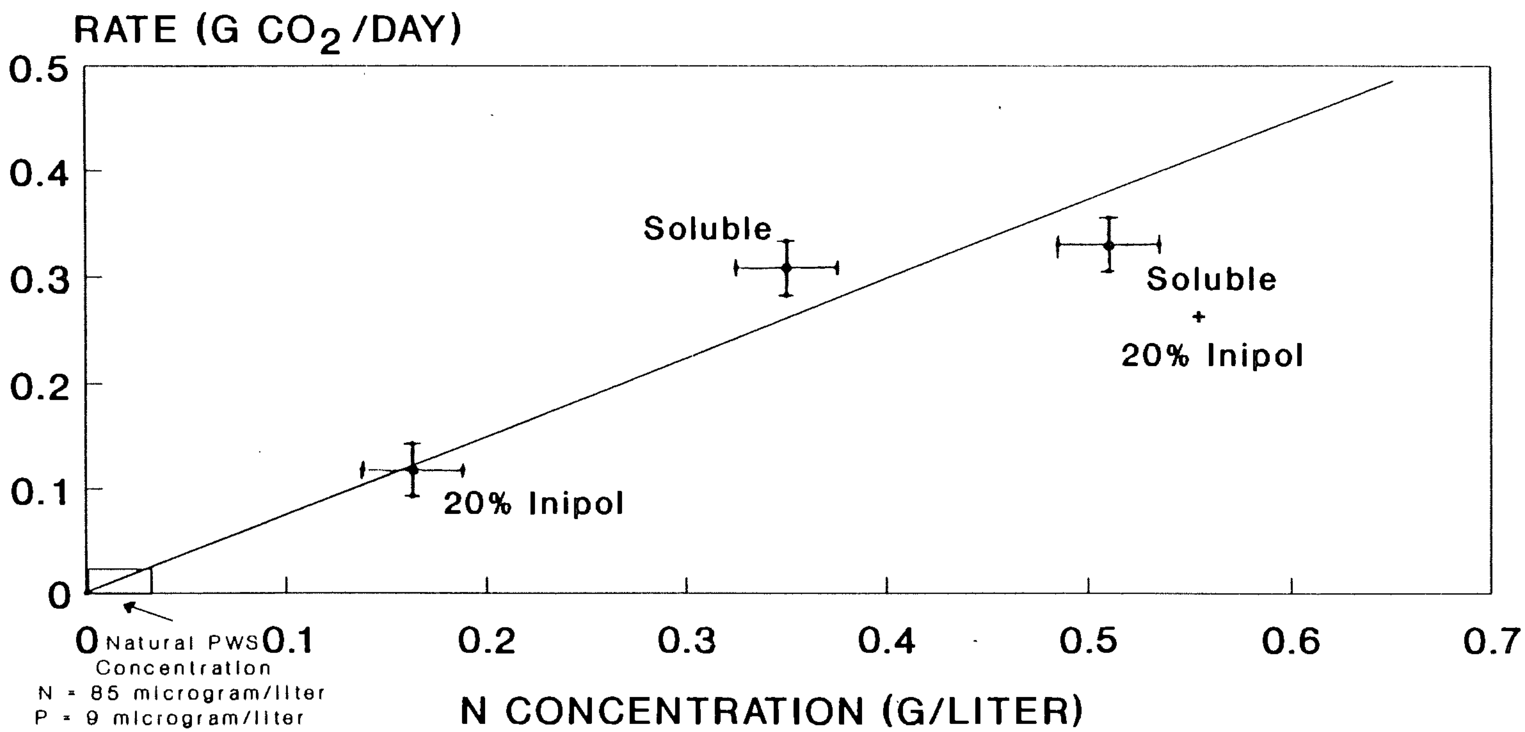


INIPOL TREATMENT EFFECTIVE OVER FIVE MONTH PERIOD



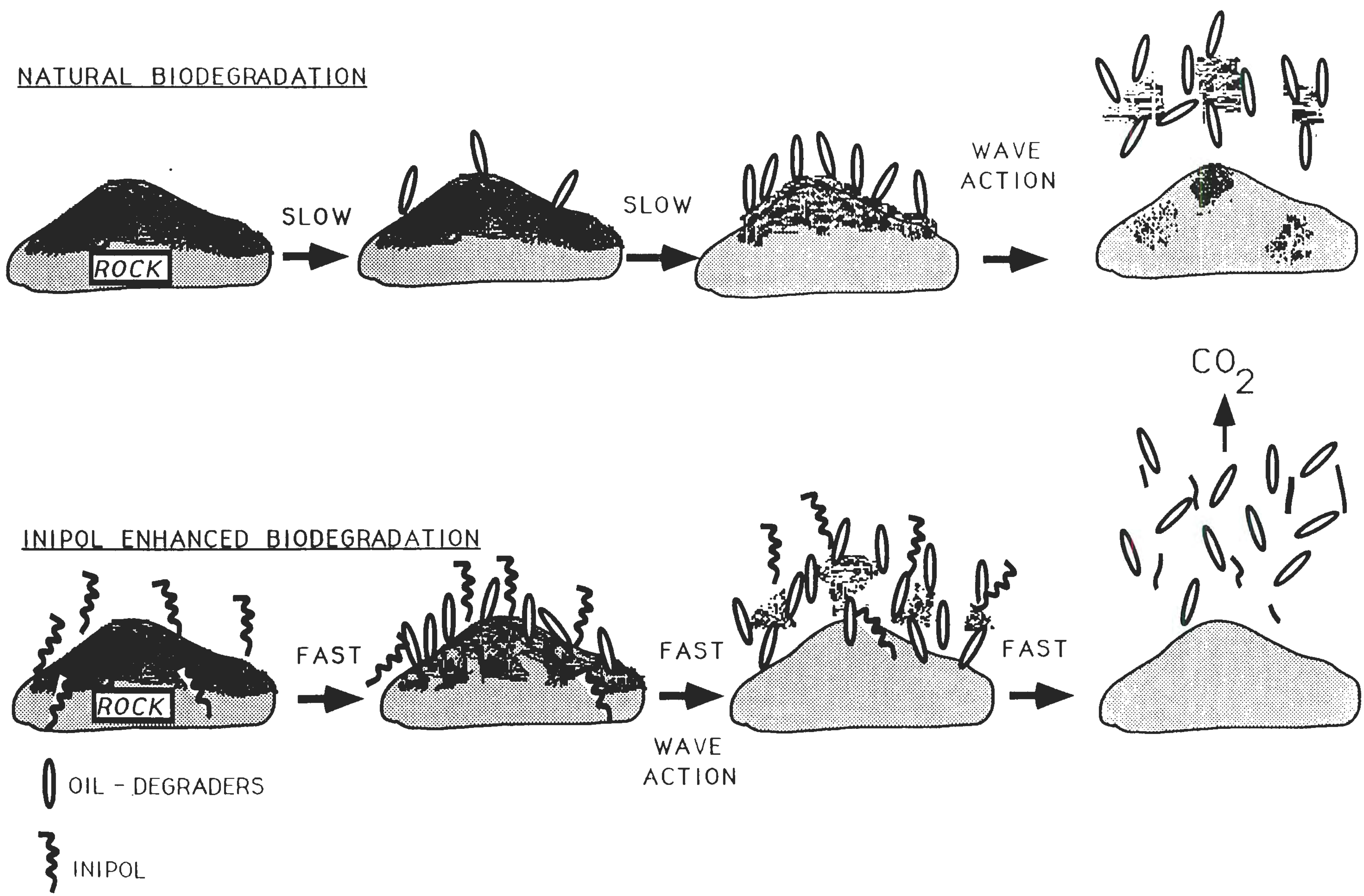
- MFN (MOST FREQUENT NUMBER) OF OIL DEGRADERS ON TREATED BEACHES APPROXIMATELY 100X GREATER THAN UNTREATED BEACHES
- HETEROTROPH NUMBERS CONSTANT OVER SAME PERIOD

CO_2 EVOLUTION VS NITROGEN CONCENTRATION

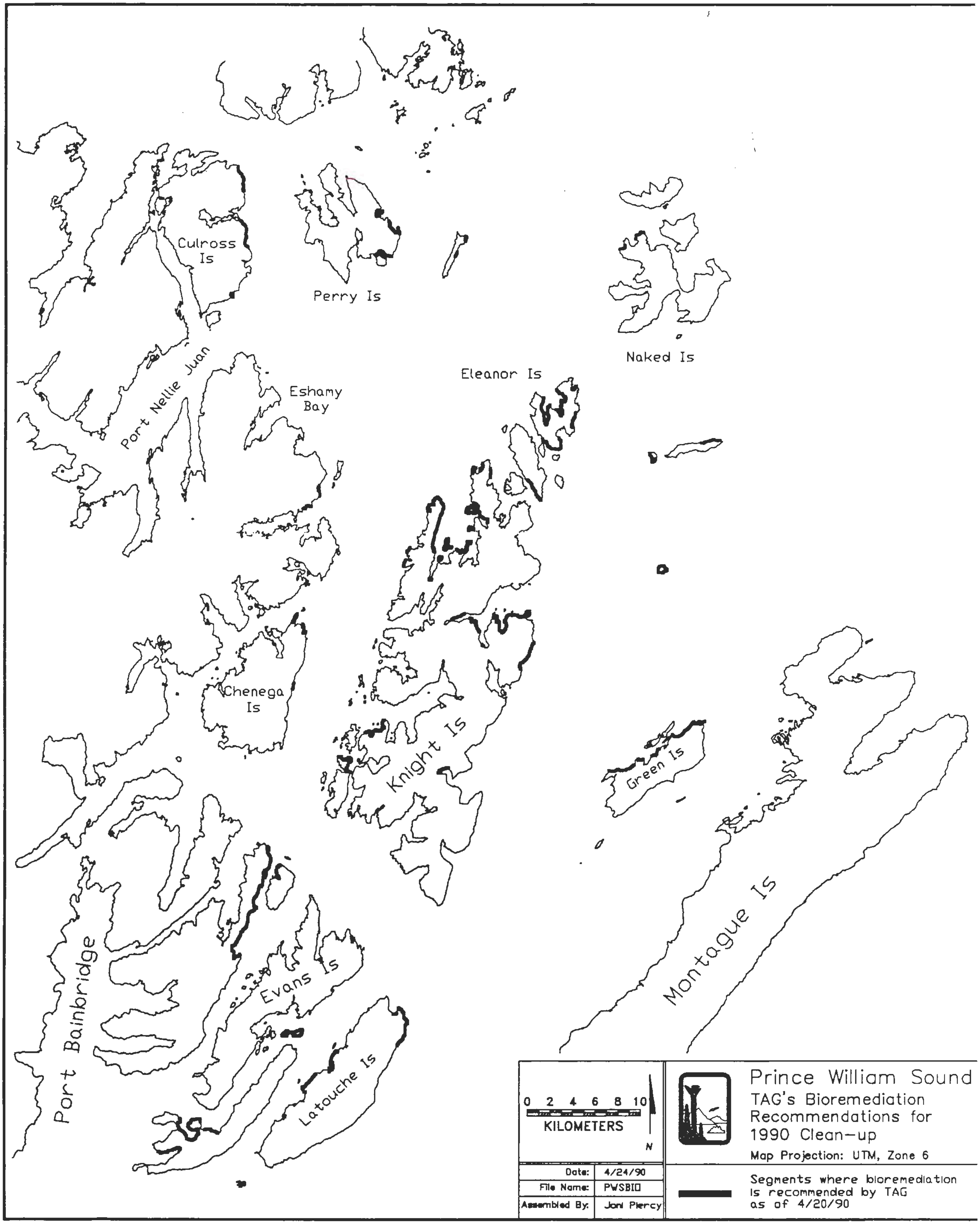


- INITIAL RATES CALCULATED FOR 16 DAY PERIOD
- NATURAL RATE TOO SMALL TO MEASURE IN LABORATORY TIMESCALE
- DURING 16 DAY PERIOD (32 TIDAL CYCLES) 0.003G/LITER DELIVERED NATURALLY
- 20% INIPOL TREATMENT APPROXIMATELY 60X
- ~ 1000 DAYS TO DELIVER SAME AMOUNT OF NUTRIENT NATURALLY

INIPOL ACCELERATES NATURAL PROCESS



In conclusion, by applying an oleophilic nutrient, Inipol EAP22, the natural biodegradation process can be enhanced which results in a faster breakdown of the crude oil components. Once these components have finished the biodegradation process, the bacterial population ratios will return to the pre-spill levels, leaving no lasting impact on the coastline.


Culross Is
Perry Is
Naked Is
Eleanor Is
Port Nellie Juan
Eshamy Bay
Chenega Is
Knight Is
Green Is
Montague Is
Port Bainbridge
Evans Is
Latouche Is
0 2 4 6 8 10
KILOMETERS
N
Prince William Sound
TAG's Bioremediation Recommendations for 1990 Clean-up
Map Projection: UTM, Zone 6
Date: 4/24/90
File Name: PWSBIO
Assembled By: Joni Piercy
Segments where bioremediation is recommended by TAG as of 4/20/90

ADEC TAG REPORT STATUS FOR 04/24/90

REGION	SEGMENT	SUBDIV	STAGDATE	STAGPOS	TAGDATE	TAGPOS	N N D P T S B T E O T P P P W R L X
PWS	BA001	C	04/12/90	A	04/13/90	tarmat removal, bio	- - - X - - X - -
PWS	BA001	E	04/12/90	M	04/13/90	pickup tar patties,bio	- - - - X - X - -
PWS	BA002	-0-	04/04/90	M	04/05/90	pickup tarmats,debris,bio	- - X X - - X X -
PWS	CH001	-0-	04/10/90	M	04/11/90	rake UITZ bio	- - - - - - X X -
PWS	CH002	A	04/11/90	A	04/12/90	manual, bio	- - - X X - X - -
PWS	CH002	B	04/11/90	M	04/12/90	manual,bio	- - - X - - X - -
PWS	CH009	B	04/12/90	M	04/13/90	manual,rake,spot wash,bio	- - X X X X X X -
PWS	CH012	-0-	04/19/90	A	04/20/90	manual,bio	- - X X - - X - -
PWS	CH013	-0-	04/18/90	M	04/19/90	manual,bio,till	- - X X - - X X -
PWS	CU007	-0-	04/12/90	A	04/13/90	manual,bio,monitor reassess	- - X - X - X - -
PWS	CU013	-0-	04/14/90	M	04/15/90	manual,bio	- - - X X - X - -
PWS	CU014	-0-	04/12/90	M	04/13/90	manual,spot wash,rake,bio	- - X X X X X X -
PWS	CU017	-0-	04/13/90	M	04/14/90	manual, bio	- - X X - - X - -
PWS	DA001	-0-	04/07/90	M	04/09/90	manual,rework under tar, bio	- - X X - - X X -
PWS	EB001	A	04/18/90	A	04/19/90	bio	- - - - - - X - -
PWS	EB006	-0-	04/16/90	M	04/17/90	manual,bio	- - - X X - X - -
PWS	EL010	-0-	04/19/90	M	04/20/90	manual,spot wash,till,bio	- - - X - X X X -
PWS	EL052	A	04/15/90	M	04/16/90	manual,bio,rake	- - - - X - X X -
PWS	EL052	B	04/15/90	M	04/16/90	manual,bio	- - - X X - X - -
PWS	EL053	A	04/15/90	A	04/16/90	rake,bio	- - - - - - X X -
PWS	EL054	-0-	04/16/90	M	04/17/90	rake,bio,reassess SUTZ	- - - - - - X X -
PWS	EL056	A	04/07/90	M	04/09/90	spot wash, bio	- - - - X X X X -
PWS	EL056	B	04/07/90	M	04/09/90	spot wash,bio w/granular	- - - - X X X X -
PWS	EL056	C	04/07/90	M	04/09/90	spot wash,manual,till,b	- - - - X X X X -
PWS	EL056	D	04/07/90	M	04/09/90	manual, bio	- - X X X X X X -
PWS	EL057	-0-	04/18/90	M	04/19/90	till,bio,spot wash	- - - - - X X X -
PWS	EL058	A	04/16/90	A	04/17/90	manual,bio	- - - - X - X - -
PWS	EL058	B	04/16/90	A	04/17/90	manual,bio	- - X - X - X - -
PWS	EL058	C	04/16/90	M	04/17/90	manual,rake,bio	- - X - X - X X -
PWS	EL058	D	04/16/90	A	04/17/90	manual,bio	- - X - X - X - -
PWS	EL105	-0-	04/15/90	M	04/16/90	bio	- - - - - - X - -
PWS	EL107	A	04/14/90	M	04/15/90	manual, spot wash, bio	- - X - - X X - -
PWS	EL107	B	04/14/90	M	04/15/90	manual,rake,bio	- - X - X - X X -

NO=NoOil NT=NoTreatment DP=DebrisPickup PP=PavementPickup
TP=TarPickup SW=SpotWash BR=BioRemediate TL=Till EX=EXcavate

REGION	SEGMENT	SUBDIV	STAGDATE	STAGPOS	TAGDATE	TAGPOS	NO	NT	DP	PP	TP	SW	BR	TL	EX
PWS	EL107	C	04/14/90	M	04/15/90	manual,spot wash,rake,bio	-	-	-	-	X	X	X	X	-
PWS	EL110	A	04/15/90	A	04/16/90	manual,bio,rake	-	-	-	X	-	-	X	X	-
PWS	EL110	B	04/15/90	A	04/16/90	bio	-	-	-	-	-	-	X	-	-
PWS	ER005	-0-	04/11/90	A	04/12/90	manual, bio	-	-	-	X	X	-	X	-	-
PWS	ER006	-0-	04/16/90	M	04/17/90	manual,bio	-	-	-	X	-	-	X	-	-
PWS	ER008	-0-	04/15/90	A	04/16/90	manual,bio	-	-	-	X	-	-	X	-	-
PWS	ER009	-0-	04/18/90	M	04/19/90	manual,bio	-	-	X	X	X	-	X	-	-
PWS	ER010	-0-	04/11/90	A	04/12/90	manual, bio	-	-	-	X	X	-	X	-	-
PWS	ER011	-0-	04/12/90	A	04/13/90	manual, bio	-	-	X	X	-	-	X	-	-
PWS	ER018	-0-	04/11/90	M	04/12/90	bioremediation	-	-	-	-	-	-	X	-	-
PWS	EV014	-0-	04/15/90	A	04/16/90	manual,bio	-	-	-	X	-	-	X	-	-
PWS	EV025	-0-	04/19/90	M	04/20/90	manual, bio	-	-	X	X	-	-	X	-	-
PWS	EV050	B	04/12/90	A	04/13/90	manual, spot wash,bio	-	-	-	X	-	X	X	-	-
PWS	EV050	C	04/12/90	A	04/13/90	bioremediation	-	-	-	-	-	-	X	-	-
PWS	EV051	-0-	04/14/90	M	04/15/90	manual,bio	-	-	-	X	-	-	X	-	-
PWS	EV052	-0-	04/10/90	A	04/11/90	manual,raking,bio	-	-	-	-	X	X	X	X	-
PWS	EV053	B	04/10/90	M	04/11/90	manual,bio	-	-	-	X	-	-	X	-	-
PWS	FL001	-0-	04/18/90	A	04/19/90	manual,bio	-	-	X	X	-	-	X	-	-
PWS	FL002	-0-	04/19/90	M	04/20/90	manual,bio,relocate UITZ to MI	-	-	X	X	-	-	X	X	-
PWS	GR001	A	04/04/90	A	04/05/90	manual, bio, monitor sheens	-	-	X	X	X	X	X	X	-
PWS	GR001	B	04/18/90	M	04/19/90	manual,bio	-	-	X	-	X	-	X	-	-
PWS	GR002	-0-	04/09/90	A	04/10/90	bio	-	-	-	-	-	-	X	X	-
PWS	GR007	-0-	04/09/90	A	04/10/90	bio	-	-	-	-	-	-	X	X	-
PWS	GR008	-0-	04/10/90	M	04/11/90	bio,till	-	-	-	-	-	-	X	X	-
PWS	GR009	-0-	04/04/90	A	04/05/90	manual, bio	-	-	X	X	X	X	X	X	-
PWS	GR010	-0-	04/09/90	M	04/10/90	manaul,spot wash,bio	-	-	X	-	-	X	X	-	-
PWS	GR103	A	04/18/90	M	04/19/90	manual,bio	-	-	X	X	X	-	X	-	-
PWS	GR103	B	04/18/90	M	04/19/90	manual,spot wash,bio	-	-	X	-	X	X	X	-	-
PWS	GR103	C	04/18/90	A	04/19/90	manual,bio	-	-	-	-	X	-	X	-	-
PWS	IN032	-0-	04/19/90	a	04/20/90	manual,bio	-	-	X	X	-	-	X	-	-
PWS	KN004	-0-	04/09/90	M	04/10/90	manual,bio	-	-	-	X	-	-	X	-	-
PWS	KN005	B	04/16/90	M	04/17/90	manual,bio	-	-	X	X	X	-	X	-	-
PWS	KN011	-0-	04/09/90	M	04/10/90	bio,spot wash	-	-	-	-	-	X	X	-	-
PWS	KN014	-0-	04/14/90	M	04/15/90	manual,reassess SUTZ,bio	-	-	-	X	-	-	X	-	-

NO=NoOil NT=NoTreatment DP=DebrisPickup PP=PavementPickup
TP=TarPickup SW=SpotWash BR=BioRemediate TL=Till EX=EXcavate

REGION	SEGMENT	SUBDIV	STAGDATE	STAGPOS	TAGDATE	TAGPOS	N N D P T S B T E O T P P P W R L X
PWS	KN016	-0-	04/07/90	M	04/09/90	manual, bio	- - - - X X X X -
PWS	KN024	-0-	04/16/90	M	04/17/90	manual,bio	- - X - X - X - -
PWS	KN102	-0-	04/19/90	M	04/20/90	manual,bio,till	- - - X X - X X -
PWS	KN109	-0-	04/14/90	A	04/15/90	manual,bio	- - X - - - X - -
PWS	KN111	-0-	04/18/90	M	04/19/90	manual,bio,spot wash,till	- - X X - X X X -
PWS	KN115	-0-	04/18/90	M	04/19/90	manual,bio	- - X X - - X - -
PWS	KN116	-0-	04/18/90	A	04/19/90	manual,bio	- - X - - - X - -
PWS	KN117	-0-	04/16/90	A	04/17/90	manual,bio	- - - X - - X - -
PWS	KN118	-0-	04/16/90	A	04/17/90	bio	- - - - - - X - -
PWS	KN119	-0-	04/16/90	M	04/17/90	manual,bio	- - X - X - X - -
PWS	KN122	-0-	04/11/90	M	04/12/90	manual,spot wash,rake,bio	- - X - - X X X -
PWS	KN123	B	04/13/90	M	04/14/90	spot wash,bio	- - - - - X X - -
PWS	KN124	-0-	04/13/90	M	04/14/90	bioremediaiton	- - - - - - X - -
PWS	KN129	A	04/16/90	M	04/17/90	rake,manual,bio	- - - X - - X X -
PWS	KN129	B	04/16/90	M	04/17/90	manual,bio	- - X - X - X - -
PWS	KN132	B	04/12/90	M	04/13/90	manual,bio	- - - X - - X - -
PWS	KN132	C	04/12/90	A	04/13/90	bioremediation	- - - - - - X - -
PWS	KN132	D	04/12/90	M	04/13/90	manual, bio	- - - X - - X - -
PWS	KN133	-0-	04/12/90	A	04/13/90	manual,rake,bio	- - X X - - X X -
PWS	KN134	-0-	04/05/90	M	04/06/90	pickup,raking,bio, spot wash	- - X X X X X X -
PWS	KN135	A	04/09/90	M	04/10/90	manual,spot wash,bio,till	- - - X - X X X -
PWS	KN135	B	04/09/90	M	04/10/90	manual,bio,spot wash	- - - X X X X - -
PWS	KN136	-0-	04/11/90	M	04/12/90	manual,bio,spot wash	- - X X - X X - -
PWS	KN141	A	04/11/90	M	04/12/90	rake,bio	- - - - - - X X -
PWS	KN145	-0-	04/11/90	M	04/12/90	bioremediation	- - - - - - X - -
PWS	KN206	-0-	04/16/90	M	04/17/90	manual,bio	- - - X X - X - -
PWS	KN207	B	04/18/90	A	04/19/90	bio	- - - - - - X - -
PWS	KN208	-0-	04/05/90	A	04/06/90	spotwash,bio,manual,resurvey	- - - - X X X X -
PWS	KN213	B	04/19/90	M	04/20/90	manual,bio	- - - X X - X - -
PWS	KN213	E	04/19/90	M	04/20/90	bio	- - - - - - X - -
PWS	KN300	-0-	04/18/90	M	04/19/90	manual,bio	- - X X X - X - -
PWS	KN301	A	04/12/90	M	04/13/90	manual,bio	- - - - X - X - -
PWS	KN301	B	04/12/90	A	04/13/90	manual,bio	- - X - - - X - -
PWS	KN401	A	04/18/90	A	04/19/90	manual,bio	- - - - X - X - -

NO=NoOil NT=NoTreatment DP=DebrisPickup PP=PavementPickup
TP=TarPickup SW=SpotWash BR=BioRemediate TL=Till EX=EXcavate

REGION	SEGMENT	SUBDIV	STAGDATE	STAGPOS	TAGDATE	TAGPOS	N N D P T S B T E O T P P P W R L X
PWS	KN401	B	04/18/90	A	04/19/90	manual,bio	- - X X X - X - -
PWS	KN500	A	04/19/90	M	04/20/90	manual,bio,till	- - X X - - X X -
PWS	KN500	B	04/19/90	M	04/20/90	manual,bio,till	- - X X - - X X -
PWS	KN506	-0-	04/19/90	A	04/20/90	manual,bio	- - - - X - X - -
PWS	KN508	-0-	04/18/90	M	04/19/90	manual,bio,till	- - - X - - X X -
PWS	KN576	B	04/16/90	M	04/17/90	bio	- - - - - - X - -
PWS	LA015	C	04/14/90	M	04/15/90	manual,spotwash,rake,bio	- - - X X X X X -
PWS	LA015	D	04/14/90	M	04/15/90	manual,bio	- - - X - - X - -
PWS	LA015	E	04/14/90	M	04/15/90	bioremediation	- - - - - - X - -
PWS	LA018	-0-	04/19/90	M	04/20/90	manual,bio,spot wash	- - X - X X X - -
PWS	LA036	A	04/18/90	A	04/19/90	bio	- - - - - - X - -
PWS	LA038	-0-	04/13/90	A	04/14/90	manual,bio	- - - X - - X - -
PWS	LN002	-0-	04/12/90	A	04/13/90	manual,bio	- - - - X - X - -
PWS	LN005	-0-	04/13/90	M	04/14/90	manual,bio	- - - - X - X - -
PWS	LS048	-0-	04/13/90	M	04/14/90	manual,bio	- - X - - - X - -
PWS	LS060	-0-	04/12/90	A	04/13/90	manual,bio	- - - - X - X - -
PWS	MA002	-0-	04/18/90	M	04/19/90	manual,bio,till	- - - X - - X X -
PWS	NA021	B	04/12/90	M	04/13/90	manual,bio	- - - - - - X - -
PWS	NA023	-0-	04/13/90	A	04/14/90	manual,bio	- - - - X - X - -
PWS	PR003	A	04/05/90	A	04/06/90	pickup pavement, bio	- - X X - - X X -
PWS	PR003	B	04/05/90	A	04/06/90	remove tarmat, bio	- - X X - - X X -
PWS	PR003	D	04/05/90	A	04/06/90	bioremediate	- - - - - - X X -
PWS	PR005	A	04/12/90	A	04/13/90	manual,bio	- - X - - - X - -
PWS	PR005	B	04/12/90	A	04/13/90	manual,bio	- - - X - - X - -
PWS	PR005	C	04/12/90	M	04/13/90	bioremediation	- - - - - - X - -
PWS	PR007	-0-	04/09/90	M	04/10/90	manual,spot wash,bio	- - X X - X X - -
PWS	SE041	-0-	04/09/90	M	04/10/90	manual,bio,spot wash,till	- - X - - X X X -
PWS	SE042	-0-	04/15/90	M	04/16/90	manual,rake,spot wash,bio	- - - - - X X X -
PWS	SM005	A	04/15/90	M	04/16/90	manual,till,bio	- - X - - - X X -
PWS	SM005	B	04/15/90	M	04/16/90	manual,till,bio	- - X - - - X X -
PWS	SQ002	-0-	04/13/90	M	04/14/90	manual,bio	- - X - - - X - -
KOD	PI003	-0-	04/13/90	M	04/14/90	manual,bioremediation	- - - - X - X - -
KOD	SB006	-0-	04/09/90	M	04/10/90	spot wash, bioremediation	- - - - X X X - -
KOD	SI003	-0-	04/13/90	A	04/14/90	manual,bioremediation	- - - - X - X - -

NO=NoOil NT=NoTreatment DP=DebrisPickup PP=PavementPickup
TP=TarPickup SW=SpotWash BR=BioRemediate TL=Till EX=EXcavate

REGION	SEGMENT	SUBDIV	STAGDATE	STAGPOS	TAGDATE	TAGPOS	NO	NT	DP	PP	TP	SW	BR	TL	EX
KOD	SI005	-0-	04/14/90	M	04/16/90	manual,till,bio	-	-	-	-	X	-	X	X	-
KOD	SI007	B	04/13/90	A	04/14/90	bioremediation	-	-	-	-	-	-	X	-	-
KOD	SL008	-0-	04/13/90	M	04/14/90	manual,bioremediation	-	-	-	-	X	-	X	-	-
KOD	SS002	B	04/14/90	A	04/16/90	p/u mousse,oil, bio	-	-	-	-	X	-	X	-	-
KEN	BC002	A	04/17/90	M	04/18/90	manual,bioremediation	-	-	X	X	X	-	X	X	-
KEN	BC002	B	04/17/90	A	04/18/90	manual,bioremediation	-	-	X	X	X	-	X	-	-
KEN	HR003	-0-	04/19/90	A	04/20/90	bioremediation	-	-	-	-	-	-	X	-	-
KEN	NK001	-0-	04/13/90	M	04/14/90	pickup asphalt,reassess u	-	-	-	X	-	-	X	-	-
KEN	NK002	A	04/16/90	M	04/17/90	manual,bioremediate	-	-	-	X	X	-	X	-	-
KEN	PY006	A	04/12/90	M	04/13/90	pickup,bioremediation	-	-	X	-	X	-	X	-	-
KEN	PY008	B	04/16/90	A	04/17/90	manual,bioremediation	-	-	-	X	X	-	X	-	-
KEN	PY008	C	04/16/90	M	04/17/90	manual,bioremediation	-	-	-	-	X	-	X	-	-
KEN	PY008	E	04/16/90	A	04/17/90	manual,bioremediation	-	-	-	-	X	-	X	-	-
KEN	PY011	B	04/16/90	M	04/17/90	manual,till,bio	-	-	-	-	X	-	X	X	-
KEN	PY015	B	04/16/90	A	04/17/90	manual,bioremediation	-	-	-	X	X	-	X	-	-
KEN	US001	-0-	04/19/90	M	04/20/90	manual,bioremediation	-	-	X	X	X	-	X	-	-
KEN	US008	-0-	04/17/90	A	04/18/90	manual,bioremediation	-	-	X	X	X	-	X	-	-
KEN	WB001	A	04/19/90	M	04/20/90	manaul,bioremediation	-	-	X	X	X	-	X	X	-
KEN	WB002	A	04/18/90	M	04/19/90	manual,bio,spot wash	-	-	-	X	X	X	X	-	-
KEN	WB002	B	04/18/90	M	04/19/90	manual,bio,spot wash	-	-	X	X	X	X	X	-	-
KEN	WB002	C	04/18/90	M	04/19/90	manual,bio,spot wash	-	-	X	X	X	X	X	-	-
KEN	WB002	D	04/18/90	M	04/19/90	manual,bio	-	-	X	X	X	-	X	-	-
KEN	WB006	-0-	04/18/90	M	04/19/90	manual,bioremediation	-	-	-	X	-	-	X	-	-
KEN	WB007	-0-	04/18/90	A	04/19/90	manual,bioremediation	-	-	-	X	X	-	X	-	-
KEN	WB009	-0-	04/17/90	A	04/18/90	manual,bioremediation	-	-	X	X	X	-	X	-	-

NO=NoOil NT=NoTreatment DP=DebrisPickup PP=PavementPickup
TP=TarPickup SW=SpotWash BR=BioRemediate TL=Till EX=EXcavate

Out of a total of 409 sites that have been through the TAG process:
Number of sites requiring treatment type of:
BioRemediation=160 Tilling= 54 Excavation= 2 SpotWash= 38

Numer of sites requiring pickup of:
Pavement=101 Tar/Mousse=105 Debris= 90

Number of sites with NoOil and requireing no treatment= 94
Number of sites with Oil but with NoTreatment recommended=158

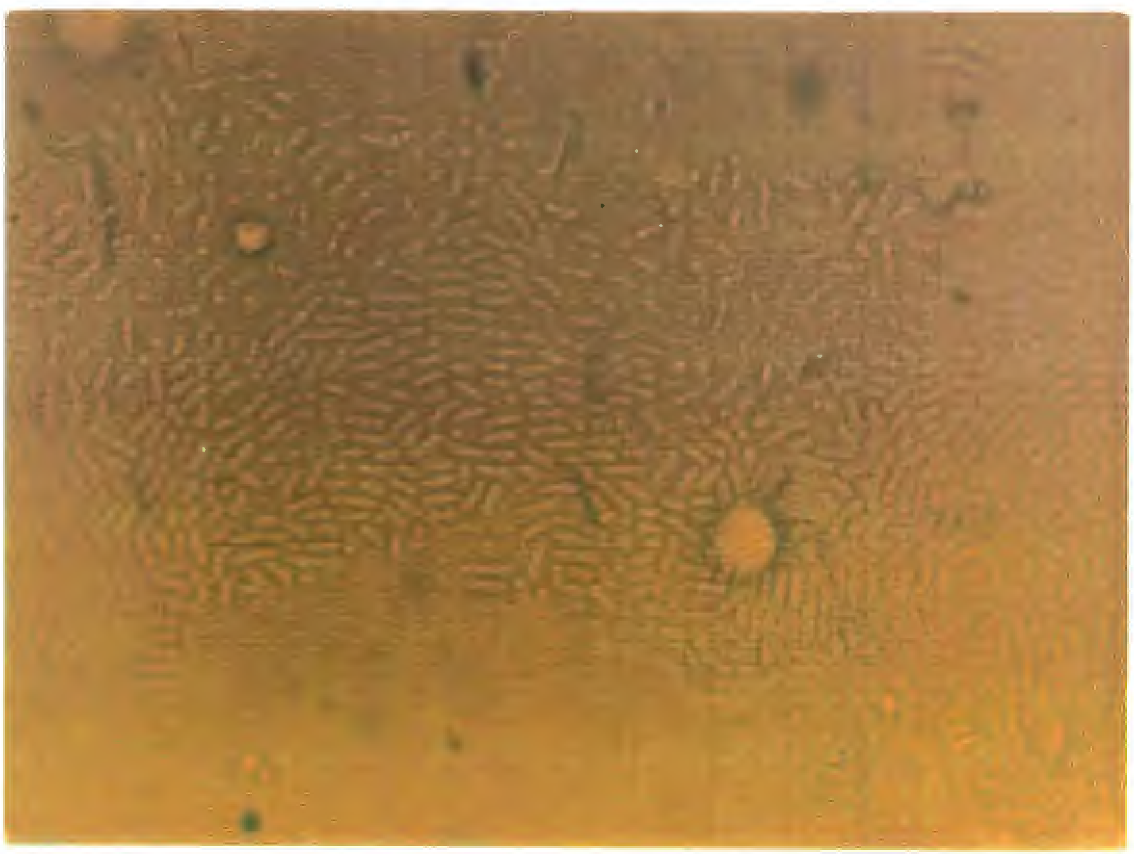
SALLARD
~~EPA~~

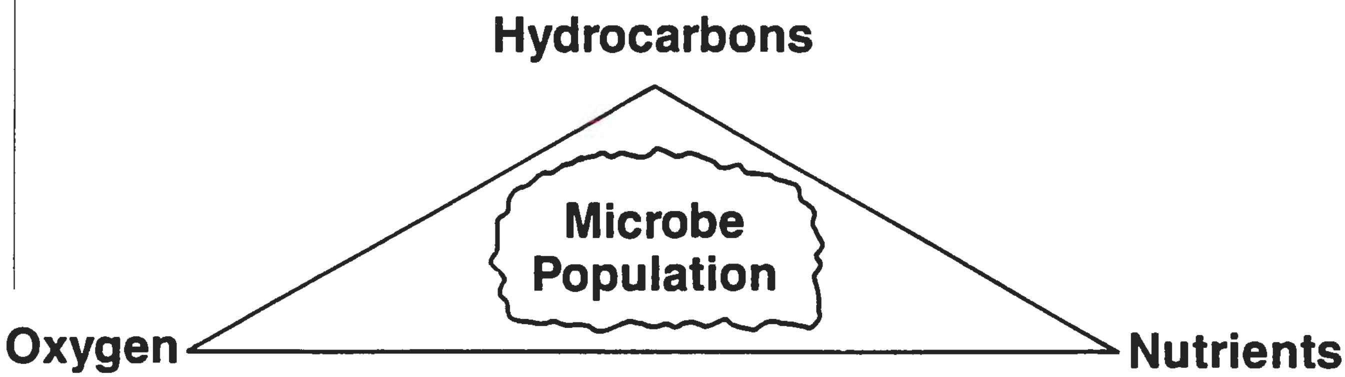
Bioremediation in Prince William Sound 1989

Mineralization

$$\text{Hydrocarbon} \longrightarrow [\text{oxygenates}] \begin{cases} \xrightarrow{50\%} \text{Biomass} \\ \xrightarrow[50\%]{} \text{Carbon dioxide} \end{cases}$$

- Biodegradation is a natural process in which bacteria consume petroleum and break it down to biomass and carbon dioxide.
- Laboratory studies show that the water soluble intermediates generated during biodegradation are short-lived and low (ppm) in concentration.





- On beaches such as those in Prince William Sound microbes exist naturally. Less than 0.1% of these microbes can be classified as "Hydrocarbon oxidizing bacteria", which means that they break down hydrocarbons such as crude oil by adding oxygen to them.
- After the Valdez oil spill, the percentage of oil-degrading bacteria increased to over 10% of the total microbe population.
- By adding nutrients such as nitrogen and phosphorus the population of these oil-degraders can be increased even more, which increases the rate at which the oil is consumed and therefore enhances the natural process of biodegradation.

N-P- Potash

- Three types of nutrients were tried in the 1989 beach tests:
  - Oleophilic (Inipol EAP22)
  - Slow Release (Customblen)
  - Soluble Spray
- In each of these tests every effort was made to keep the nutrients out of the water during application.

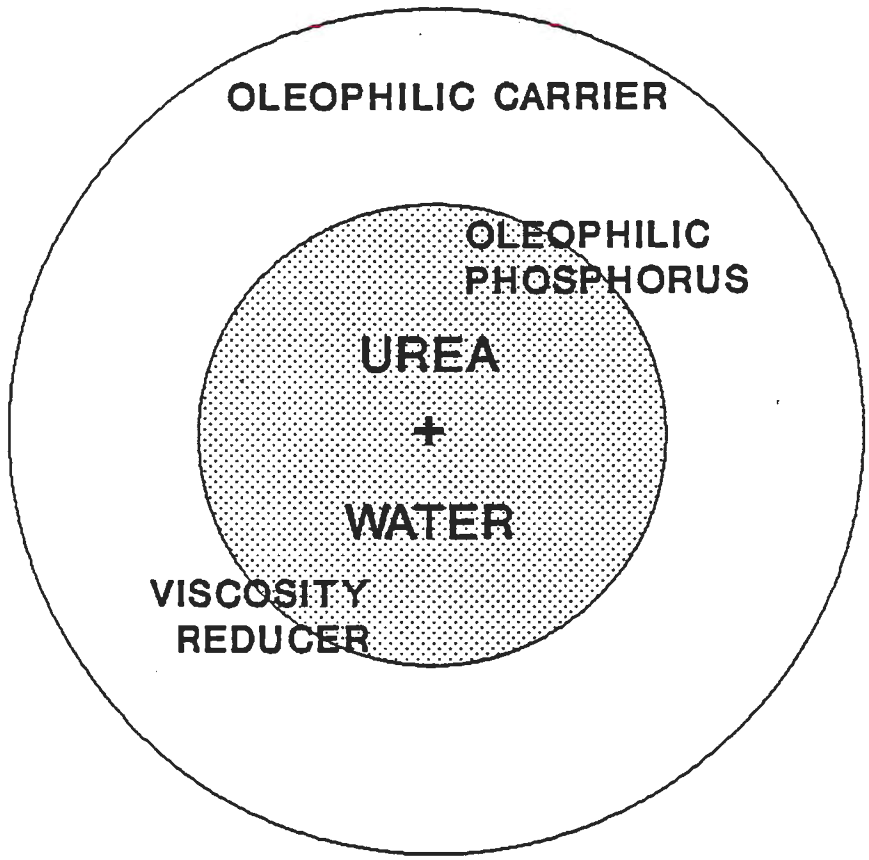
HOW

- EPA/Exxon beach and laboratory tests showed that all three nutrients were effective in enhancing the natural process of biodegradation, but Inipol EAP22 showed the most dramatic effect.
- There were no adverse effects observed during these studies.
- Inipol EAP22 was applied to almost 73 miles of beaches with similar effects on the rate of biodegradation.

- Inipol EAP22 was developed in France as a result of the AMOCO Cadiz oil spill.
- Inipol is designed to stick to the oil and release nutrients where they are needed.
- Inipol holds the oil on the rocks; it is NOT a rock-washing agent. oil

INIPOL COMPOSITION

MICROEMULSION

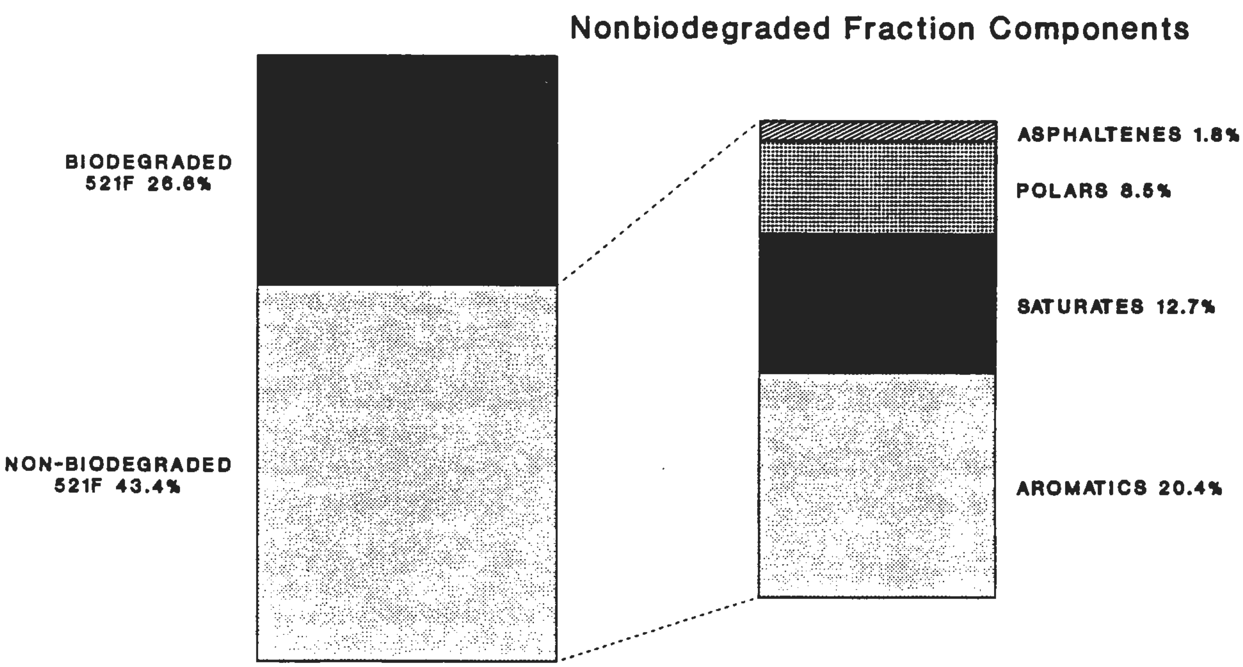


CHEMICAL	OTHER COMMON USES
OLEOPHILIC CARRIER	SALAD OIL
OLEOPHILIC PHOSPHORUS	COSMETICS
VISCOSITY REDUCER	INDUSTRIAL CLEANERS
UREA (NITROGEN)	AGRICULTURAL FERTILIZERS

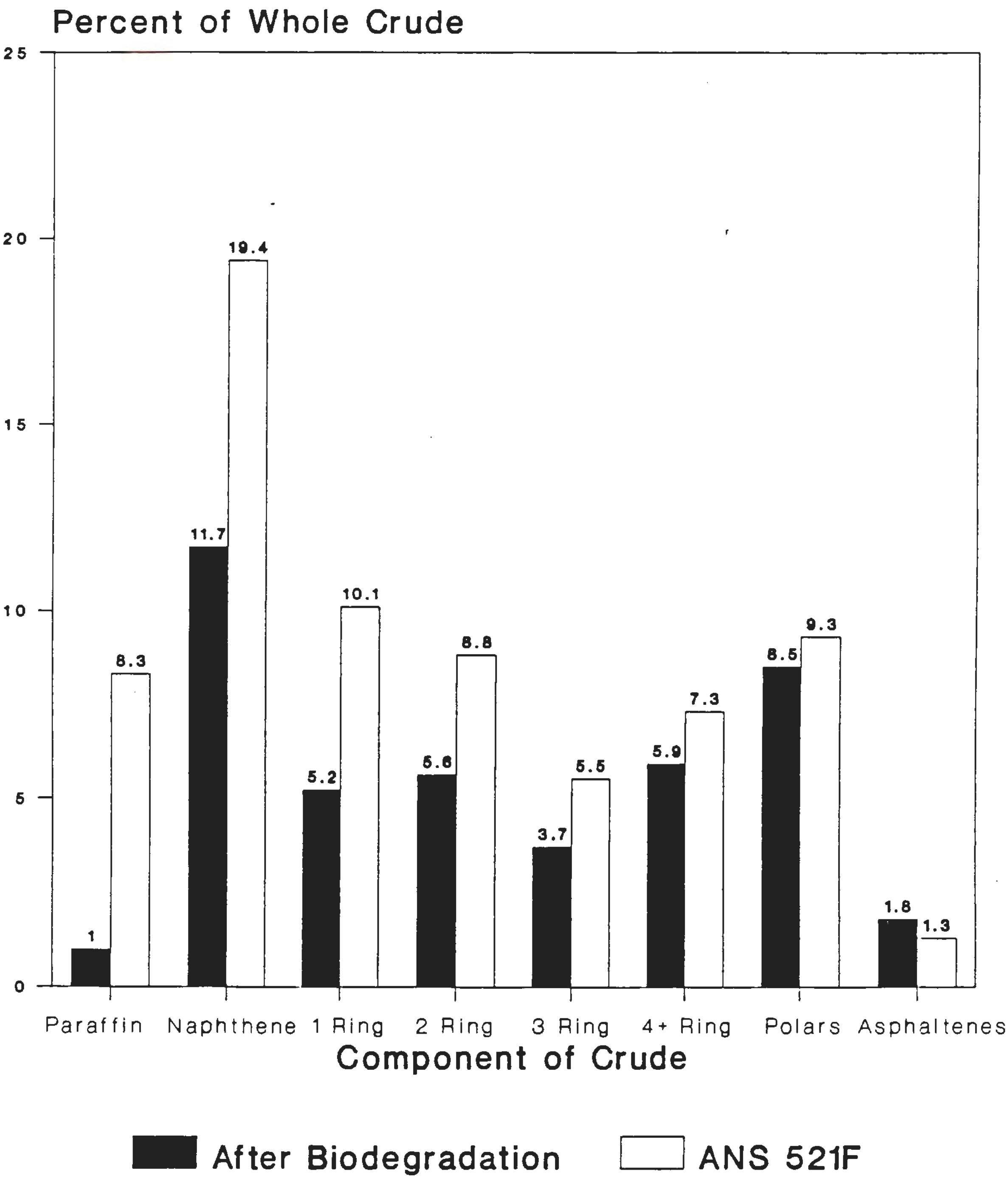
- Laboratory studies (EPA/Exxon, French) have shown that Inipol-accelerated biodegradation can mineralize up to 90% of the oil approximately five times faster than the natural-occurring rate. This rate depends on the oil loading and beach surface.

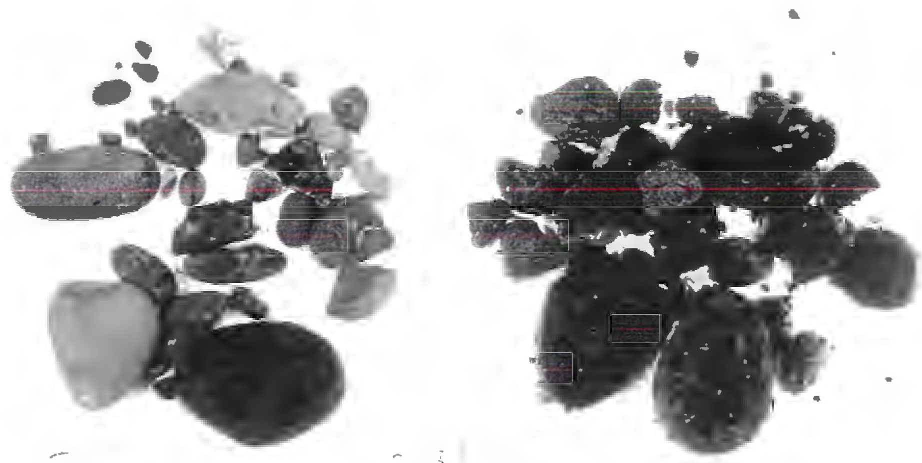
- Closed system mass balance experiments have shown that nearly all the components of crude oil are biodegradable. The only exception found to date is the asphaltene component, which makes up about 2% of the total crude oil.

Biodegraded vs. Nonbiodegraded Fractions



In addition, different molecules will degrade at different rates, depending upon their chemistry. Larger, more complex molecules will take longer to biodegrade than smaller molecules.





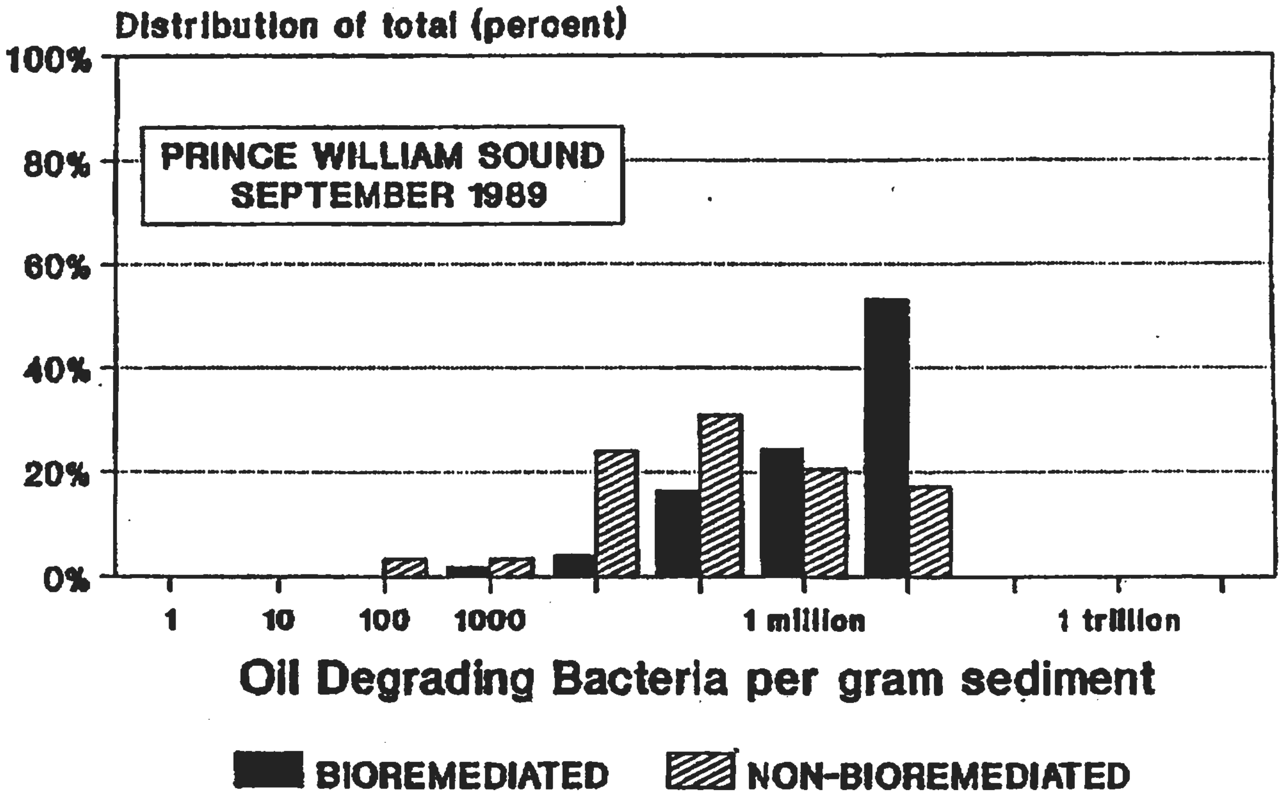
Rocks Treated with Oleophilic Fertilizer | Untreated Rocks from Ingot Sound

where from

- The rocks become clean after a period of time depending upon oil loading / Inipol EAP22 loading.
- This cleaning occurs exclusively by means of bioaction causing biodegradation. How
- The bioaction proceeds to degrade the oil. With wave action small packets of oil / microbes are removed from the rocks and continue to biodegrade.

∴ does not hold it to the rocks

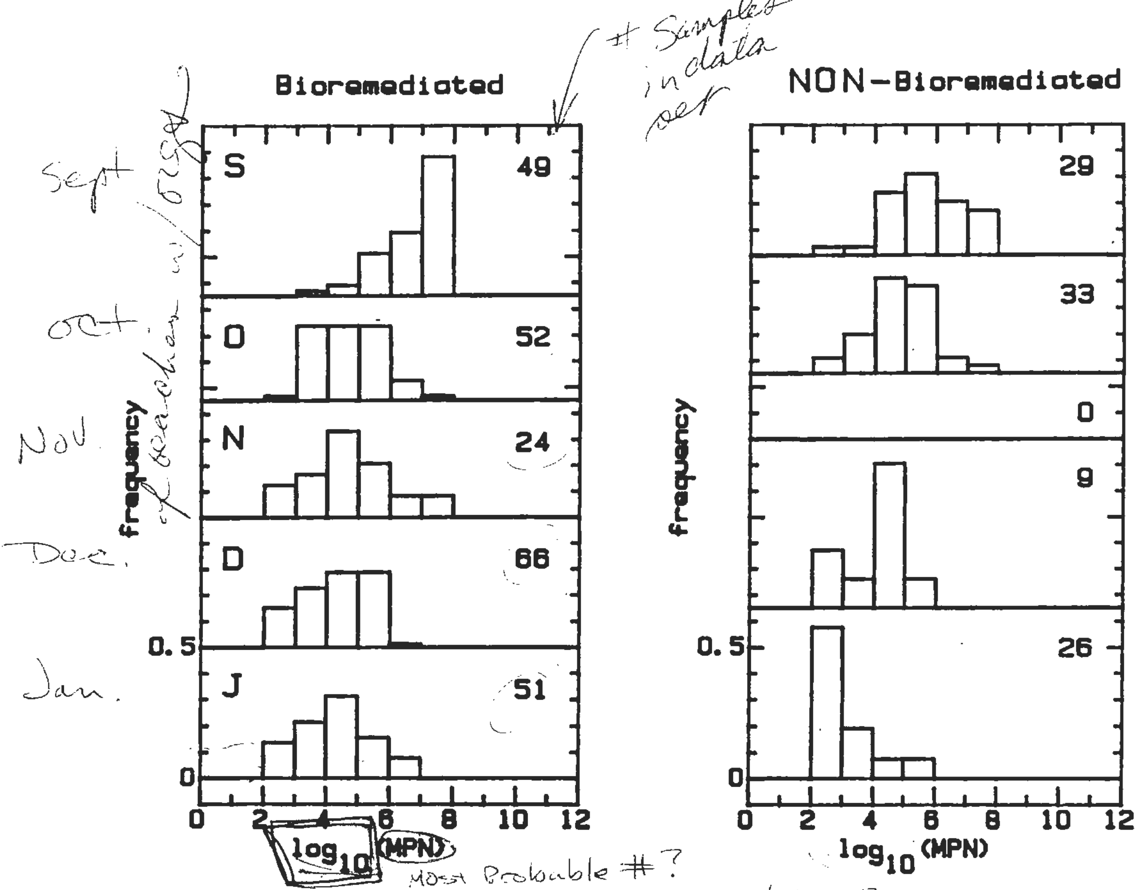
The number of hydrocarbon-degrading microbes dramatically increased on the treated beaches.



65% in field
as effective
as lab tests

INIPOL TREATMENT EFFECTIVE OVER FIVE MONTH PERIOD

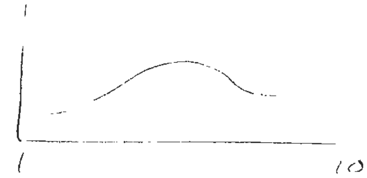
PRINCE WILLIAM SOUND: Oil-degraders

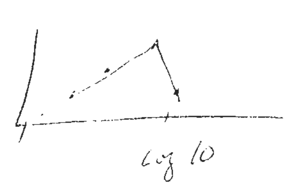


of type?

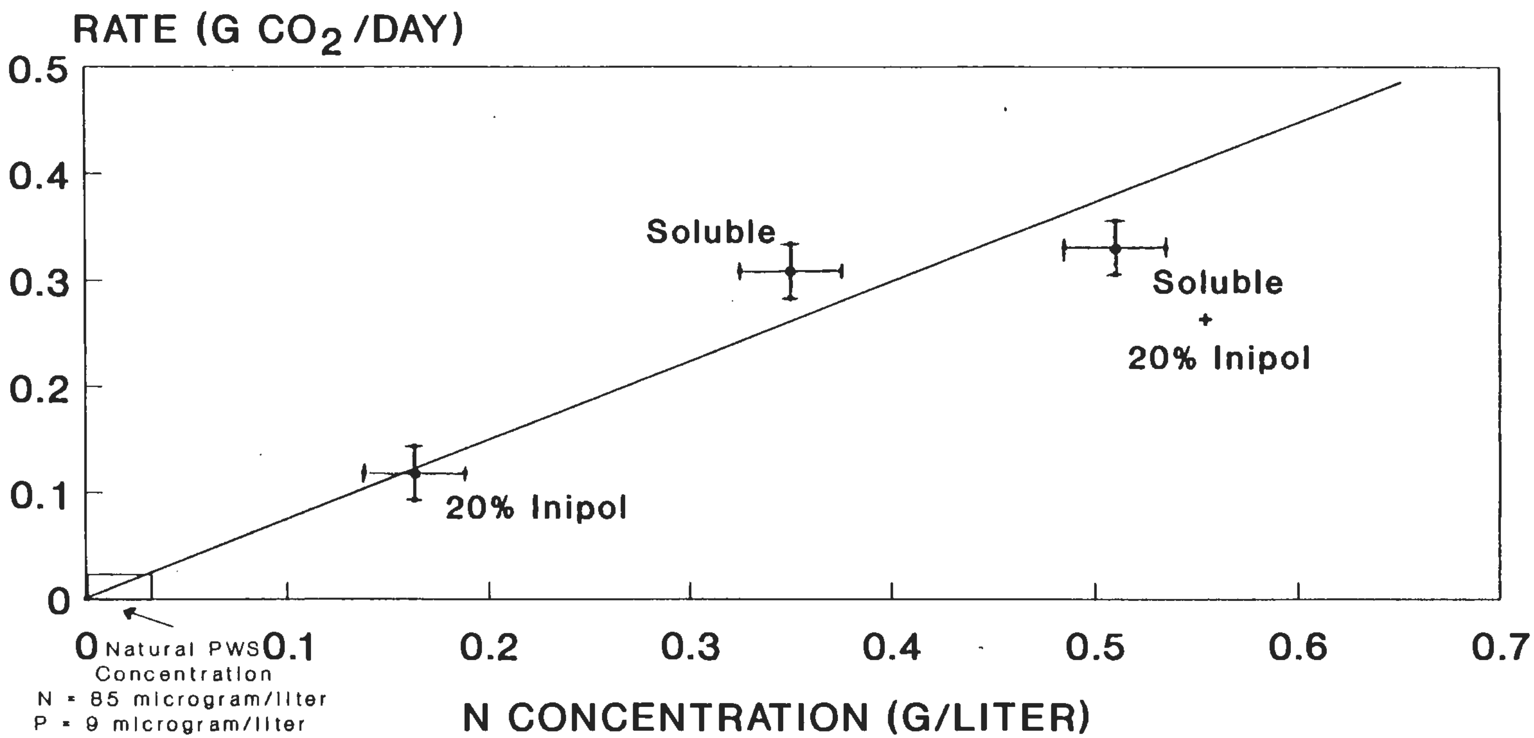
- MFN (MOST FREQUENT NUMBER) OF OIL DEGRADERS ON TREATED BEACHES APPROXIMATELY 100X GREATER THAN UNTREATED BEACHES

- HETEROTROPH NUMBERS CONSTANT OVER SAME PERIOD



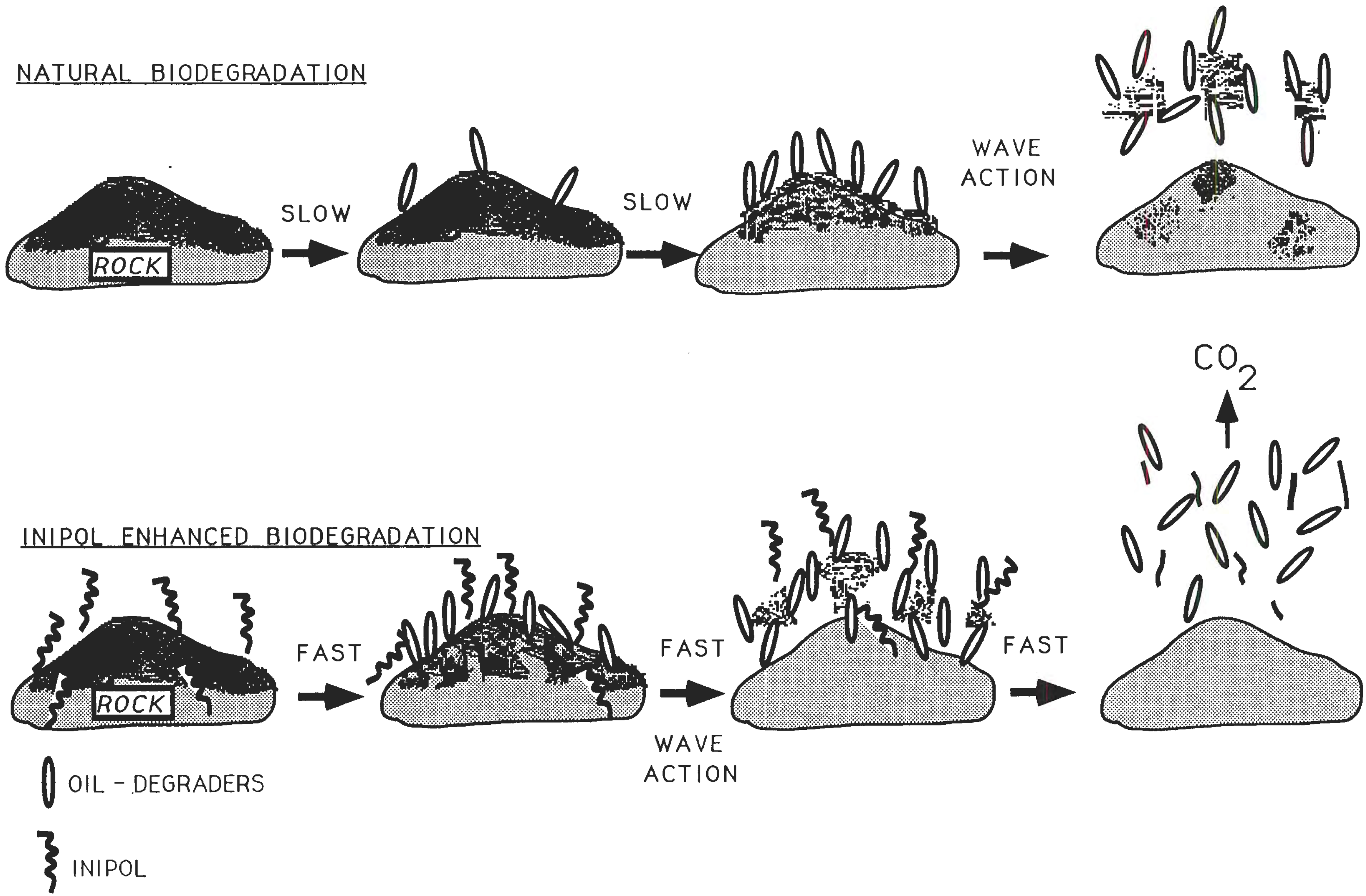


CO_2 EVOLUTION VS NITROGEN CONCENTRATION



- INITIAL RATES CALCULATED FOR 16 DAY PERIOD
- NATURAL RATE TOO SMALL TO MEASURE IN LABORATORY TIMESCALE
- DURING 16 DAY PERIOD (32 TIDAL CYCLES) 0.003G/LITER DELIVERED NATURALLY
- 20% INIPOL TREATMENT APPROXIMATELY 60X
- ~ 1000 DAYS TO DELIVER SAME AMOUNT OF NUTRIENT NATURALLY

INIPOL ACCELERATES NATURAL PROCESS



In conclusion, by applying an oleophilic nutrient, Inipol EAP22, the natural biodegradation process can be enhanced which results in a faster breakdown of the crude oil components. Once these components have finished the biodegradation process, the bacterial population ratios will return to the pre-spill levels, leaving no lasting impact on the coastline.

Weekly activity report for week of 7/17 - 7/22
Submitted 7/18/90

To: Sonny Mayer, ERL/GB
Hap Pritchard, Bioremediation Project
Carl Lautenburger, Reg X/AOO
Tom Baugh, OEET

From: Jim Clark JRC
Rod Parrish

The laboratory tests with NETAC products are underway at ERL/GB under Rod's guidance. Results will be used to support their safe use during demonstration tests in Valdez as part of the over-all EPA oil spill bioremediation program. I have arranged with MEC, Inc in Tiburon, CA to conduct toxicity tests with Rhepoxinia, an benthic amphipod, using sediments treated in test plots in Alaska. The amphipod tests are part of a screen requested by the State. We have not worked with this west coast species at ERL/GB, so we have to rely on a contract lab. Costs will be about $10 K if we actually get approval to do the tests in Alaska. We do have a microcosm system set up to evaluate them and will run microtox tests and nutrient analyses on microcosm effluents.

All the monitoring sites received a second application of nutrients last week. The 3 to 4 day post-application samples for monitoring nutrients, microbial activity, oil characteristics, and eutrophication effects have been collected and sent for analyses. A final sampling is scheduled for July 30 through August 1, at which time the control side of the test sites will be fertilized as part of the operational clean-up effort. All the sites still look heavily oiled in subsurface sediments with surface oil in thin, light patches on large cobbles at KN-132 and KN-135. I remain confident that the second application of Inipol at these two sites will lead to the window-pane effect, the noticeable difference between treated and untreated areas before the first of August. The differences between treated and untreated is noticeable now, but only upon close inspection.

The EPA bioremediation project received a "notice of violation" from Alaska DNR for not having an approved land use permit for the research activities at Disk and Elrington Island. Clark spent all day Monday and most of Tuesday working with DNR and the bioremediation team to obtain the permits. This citation may be an embarrassment when Mr. Reilly visits next week. We had approval from all parties actively involved in the spill cleanup, but DNR wanted us to assume legal liability for the site through the permit. The permit will say that we are operating under Exxon's general permit, and will be included under the liability coverage provided by Exxon for other test sites. I really got an education in permitting and paperwork crammed into a day.

Clark will leave Anchorage on 7/18 and be in the office at ERL/GB on 7/20. Parrish will travel to Anchorage on 7/31 for the final sampling and the winding down things in Anchorage. Clark tentatively is scheduled to return for two weeks the end of August/early September to review all data with contractors, compile final data tables, and draft the final report on Bioremediation Monitoring.

CC/
R. Menzer, ERL/GB
R. Wilhour, ERL/GB

Weekly Activity Report for Week of July 1, 1990
Submitted 7/5/90

Kirstin
I faxed a copy to AOO for Carl
This copy for you.
JClark

To: Sonny Mayer, ERL/GB
Hap Pritchard, Bioremediation Projec
Carl Lautenburger, Reg X, AOO
Tom Baugh, OEET

From: Jim Clark JRC
Rod Parrish
EPA Bioremediation Monitoring Progra

The final set of samples (Day 32) was coll
sites KN-211 and KN-132 on Saturday, 6/30,
America North crew in charge of the sampli
for us; there have been only one or two mi
field for the entire monitoring program. Results continue to roll in to Anchorage. We now have the complete data base for toxicity tests, ammonia in nearshore waters to accompany the toxicity data, all the chlorophyll data, all the dissolved oxygen data from the interstitial wells, microbial activity data through Day 16 at all sites, and nutrient concentrations in interstitial water through Day 16 at all sites. Oil chemistry and microbial abundance data are only now beginning to come in.

EXXON has agreed to continue to support the monitoring program through August 1 if we can get approval to reapply fertilizer at the sites. Roger Prince and I put together the attached memo for Bob Mastracchio to support EXXON's request for retreatment at the sites. We should know by 7/9 if the request will be approved by the state. Parrish should plan on coming up to Anchorage the end of July to help coordinate the final data package. I'm not sure at this time if I'll need to come back the end of August or early September to consolidate data for the final report. We should know after this interim report has been reviewed.

ADEC has not yet formalized their plans for reviewing the monitoring data. They are trying to put together a panel to review a report from the monitoring project, but they will not commit to a date or deadline. I am taking the lead for the monitoring team to work with ADEC to organize the final review. Jon Lindstrum, the ADEC representative on the monitoring program, has been working in Fairbanks on our microbial samples and has not been involved within ADEC. We are still shooting for having the report submitted to ADEC by 7/10, with a panel review on the 15 or 16. Roger Prince and I met with Hap and Ed Brown of Univ.

Weekly Activity Report for Week of July 1, 1990
Submitted 7/5/90

To: Sonny Mayer, ERL/GB
Hap Pritchard, Bioremediation Project
Carl Lautenburger, Reg X, AOO
Tom Baugh, OEET

From: Jim Clark JRC
Rod Parrish
EPA Bioremediation Monitoring Program

The final set of samples (Day 32) was collected at monitoring sites KN-211 and KN-132 on Saturday, 6/30, and Sunday, 7/1. The America North crew in charge of the sampling has done a fine job for us; there have been only one or two minor problems in the field for the entire monitoring program. Results continue to roll in to Anchorage. We now have the complete data base for toxicity tests, ammonia in nearshore waters to accompany the toxicity data, all the chlorophyll data, all the dissolved oxygen data from the interstitial wells, microbial activity data through Day 16 at all sites, and nutrient concentrations in interstitial water through Day 16 at all sites. Oil chemistry and microbial abundance data are only now beginning to come in.

EXXON has agreed to continue to support the monitoring program through August 1 if we can get approval to reapply fertilizer at the sites. Roger Prince and I put together the attached memo for Bob Mastracchio to support EXXON's request for retreatment at the sites. We should know by 7/9 if the request will be approved by the state. Parrish should plan on coming up to Anchorage the end of July to help coordinate the final data package. I'm not sure at this time if I'll need to come back the end of August or early September to consolidate data for the final report. We should know after this interim report has been reviewed.

ADEC has not yet formalized their plans for reviewing the monitoring data. They are trying to put together a panel to review a report from the monitoring project, but they will not commit to a date or deadline. I am taking the lead for the monitoring team to work with ADEC to organize the final review. Jon Lindstrum, the ADEC representative on the monitoring program, has been working in Fairbanks on our microbial samples and has not been involved within ADEC. We are still shooting for having the report submitted to ADEC by 7/10, with a panel review on the 15 or 16. Roger Prince and I met with Hap and Ed Brown of Univ.

Alaska while we were in Valdez prior to last weekends's sampling. We discussed the monitoring report and the role the research program will have in our presentation to ADEC. Everyone has a lot to work up and write up. We are shooting for a first draft of the report to be ready by COB Friday, 7/6, with internal reviews ongoing over the weekend.

On Tuesday, 7/3, Roger Prince and I accompanied Commander Rome of the Coast Guard to Prince William Sound to meet with ADEC, ADF&G, EXXON, and USCG monitoring teams to advise them on the degree of site clean-up necessary to prepare a site for bioremediation. We visited Sleepy Bay, LA15, KN-211, and another anadromous stream site. Hap Pritchard and Chuck Costa were there for the discussions at Sleepy Bay. State monitors have complained that EXXON crews are doing a poor clean-up job, then saying bioremediation will get the rest. The ADEC monitors at LA15 were adamant as they believed that bioremediation did not work. We joined a heated discussion, their view was that they saw where Inipol was applied last year and there is still oil there so it does not work. Most people came to agree on the proposed plan of cleaning up all pooled oil and spreading out heavily oiled substrate prior to bioremediation. I expect we will still have trouble with the LA15 crew, they just don't want to believe.

In the course of the week, I also reviewed a proposal for Brian Ross of the Restoration Planning Office submitted to them by NOAA for restoration monitoring in PWS. I also will be reviewing a copy of the "Net Environmental Benefit Analysis" report of the ADEC endorsed "Rock Washer", their mechanical device to ensure cleanup of subsurface oil. We are waiting on delivery of the report today, to have comments in by Sunday.

The plans for the upcoming week will be centered around the report and panel review. We have reserved a spot on the 7/10 operations meeting agenda to review bioremediation monitoring results and for Hap to present an overview of the research program. I am aware that John Skinner will be in town next week and will try to keep him apprized of the ongoing activities.

There are several attachments to this report that further summarize our efforts.

Attachments

CC
R. Menzer - ERL/GB
R. Wilhour - ERL/GB

Bioremediation Monitoring Results for KN-135 as of July 1, 1990

Summary

Application of Inipol and Customblen have stimulated and sustained microbial activity in surficial and subsurface sediments by a factor of 2 - 3. Nutrient concentrations in interstitial water increased to a maximum of 200 uM nitrogen from a background of 1 - 3 uM for the first 2 - 4 days after treatment, then slowly deceased to pretreatment concentrations over 32 days. Dissolved oxygen in interstitial waters decreased by 2 - 3 ppm for the first 15 days after application, then returned to background concentrations. Dissolved oxygen concentrations never approached anoxic conditions. No adverse ecological effects were observed following fertilizer application. Reapplication is considered a viable option to enhance the cleaning of cobble surfaces and provide additional nutrients for microbiota.

Field Observations - All samples have been collected from this site. Visual observations at the site show some relative enhancement in the thinning of surface oil on the cobbles on the fertilized side of the monitoring site.

Interstitial Water Analyses - Results of analyses of interstitial waters for dissolved oxygen and nutrients have been completed through Day 32. Dissolved oxygen concentrations were decreased 2 - 3 mg/l on the fertilized side relative to the untreated area for Days 4, 8, and 15. There was no difference in dissolved oxygen concentrations for fertilized and reference areas on Day 32. Nitrogen nutrients were elevated from pretreatment and reference concentrations of 1 - 3 micromolar (uM) nitrogen to concentrations of 100 - 200 uM in the fertilized area of the monitoring plot on Days 2 and 4. By day 8, concentrations had decreased to 100 - 150 uM; by Day 15, to 25 - 50 uM, and by Day 32 there was no difference between fertilized and reference areas of the shoreline.

Sediment Analyses - Analyses of the sediments for microbial activity in degrading radio-labeled hexadecane and phenanthrene have shown an increase by 2 - 3 fold in the fertilized side of this site, which has been sustained from Day 2 through Day 32. Measurements on the numbers of bacteria and relative abundance of hydrocarbon degraders have not been completed.
Results of quantification of the oil residues in the sediments and characterizations of the oil by GC/MS analytical techniques and only now becoming available for evaluation.

Ecological Effects - Toxicity tests conducted with Mysids, a shrimp-like crustacean, showed no toxicity in 6 samples of water collected at sites immediately over the treated shoreline. These samples were collected over 3 days following fertilizer application. Quantification of ammonia concentrations in neashore waters over the same time period showed a maximum of 0.3 ppm, which occurred 57 hours after application. A concentration of 1 ppm is considered the threshold for acute toxicity to many marine biota. Measurements of the chlorophyll content of nearshore waters to detect potential algal blooms showed no differences between fertilized and reference areas of the site as well as samples from an unfertilized reference site remote from the treatment area. Total petroleum hydrocarbons in nearshore areas remained at or below detection limits (0.2 ppm) throughout the study.

Bioremediation Monitoring Results for KN-132

Summary

Field Observations - All samples have been collected at this site. Visual observations have recorded no extreme differences in treated and control areas, as surface oiling has decreased in both areas. However, on the fertilized side, surface oiling was more patchy and thin.

Interstitial Water Analyses - Results of analyses of interstitial waters for dissolved oxygen have been completed through Day 29 (the last day of sampling. Dissolved oxygen concentrations were decreased 1 - 2 mg/l on the fertilized side relative to the untreated area for Days 0, 2, 4, and 8. There was no difference in dissolved oxygen concentrations for fertilized and reference areas on Day 16 and 29. Nitrogen nutrients were elevated from pretreatment and reference concentrations of 1 - 3 micromolar (uM) nitrogen to concentrations of up to 100 uM in the fertilized area of the monitoring plot on Days 2 and 4. Data from subsequent samples are not available.

Sediment Analyses - Microbial activity in surface and subsurface sediments was stimulated 2 fold over the unfertilized area by Day 4 following Inipol and Customblen application at this site. No subsequent data on microbial activity or abundance of bacteria are available. Analyses of oil residues and characterizations of oil by GC/MS are not yet available.

Ecological Effects - Toxicity tests conducted with Mysids, a shrimp-like crustacean, showed no toxicity in 6 samples of water collected at sites immediately over the treated shoreline. These samples were collected over 3 days following fertilizer application. Quantification of ammonia concentrations in nearshore waters over the same time period showed a maximum of 0.04 ppm, which occurred 19 hours after application. A concentration of 1 ppm is considered the threshold for acute toxicity to many marine biota. Measurements of the chlorophyll content of nearshore waters to detect potential algal blooms showed no differences between fertilized and reference areas of the site as well as samples from an unfertilized reference site remote from the treatment area. Total petroleum hydrocarbons in nearshore areas remained at or below detection limits (0.2 ppm) throughout the study.

Bioremediation Monitoring Results for KN-211 as of July 1, 1990

Summary

Application of Customblen to this subsurface only oiled site has stimulated microbial activity in surface and subsurface (30 cm) samples. Nutrient concentrations were increased following fertilizer addition, although not to the extent or duration seen at other sites. No adverse ecological effects were observed at this site. Reapplication is considered a viable option based on the short duration of sustained nutrient enrichment and the beneficial results of enhanced microbial activity

Field Observations - All samples have been collected at this site. Visual observations have recorded no changes in the extent of subsurface oiling, no surface oil was present at this site at the beginning of the monitoring program. Customblen pellets were observed in the surficial sediments on day 31.

Interstitial Water Analyses - Dissolved oxygen concentrations of interstitial waters at this site have been analyzed through the last day of sampling (Day 31). These data show no consistent trends in differences between fertilized and untreated areas. Oxygen concentrations have ranged between 2 and 5 ppm for the durations of the test. Nutrient concentrations were 10 times greater in the treated area for Days 2 and 4. By Days 8 and 16, ammonia approached background concentrations, however, nitrate was still elevated by 2 to 5 fold on the fertilized area.

Sediment Analyses - Microbial activity in surface and subsurface sediments was stimulated 2 fold over the unfertilized area by Day 4 following Customblen application at this site. No subsequent data on microbial activity or abundance of bacteria are available. Analyses of oil residues and characterizations of oil by GC/MS are not yet available.

Ecological Effects - Toxicity tests conducted with Mysids, a shrimp-like crustacean, showed no toxicity in 6 samples of water collected at sites immediately over the treated shoreline. These samples were collected over 3 days following fertilizer application. Quantification of ammonia concentrations in nearshore waters over the same time period showed a maximum of 0.6 ppm, which occurred 7 hours after application. A concentration of 1 ppm is considered the threshold for acute toxicity to many marine biota. Measurements of the chlorophyll content of nearshore waters to detect potential algal blooms showed no differences between fertilized and reference areas of the site as well as samples from an unfertilized reference site remote from the treatment area. Total petroleum hydrocarbons in nearshore areas remained at or below detection limits (0.2 ppm) throughout the study.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
JUNE 24-30, 1990

Shoreline Survey Assessments

Plans continue to be formulated for the post-treatment surveys on segments where some form of clean-up occurred this year. Some beaches that were not worked on may also be included. The **A**ugust **S**horeline **A**ssessment **P**rogram should begin by August 15 at the latest, with some assessment to begin in July.

Shoreline Treatment (also see report of June 17-23)

TREATMENT PROGRESS STATUS AS OF JUNE 24

Method	Total to be Treated	Treated to Date	Remaining
Bioremediation	411	95	316
Manual & Mechanical	559	264	295

- The third Inipol bioremediation squad began work on June 22, 1990.
- Of the 67 anadramous streams designated as requiring treatment, approximately 37 have been completed. Anadramous stream clean up has a deadline of July 10, 1990.
- Heavy equipment is being tested on KN-26 for storm-berm relocation. Oily storm berms are being moved by a Hitachi track loader to the mid-tidal zone. The material is then surrounded by booms (absorbent, snare and then harbor types in a triple layer) and washed by hot water. The results look promising. The Exxon/USCG/State of Alaska Quality Control team will be deciding the extent that this technique will be used.
- Manual treatment is being enhanced by the application of Custombien after tarmat removal. Efficiency is reported to be improving with the addition of this treatment.

Corexit 9580 Shoreline Chemical Cleaner

The field demonstration for Corexit was conducted on June 23, 1990. Weather conditions precluded the on-time arrival of the aircraft which was transporting agency personnel. Exxon videotaped the test. ADEC, EPA, NOAA and other agency personnel did not witness the test, and could not render judgement based on "visual science".

Others have reported a significant difference. Videotape by Exxon shown at a Corexit meeting showed the rock face the day after application (when the rock had dried) and declared the test a success. Another test application is scheduled (tentatively) for June 30.

Rock Washer Research and Development Update

- Release of draft NEBA (Net Environmental Benefit Analysis) report has been extended to July 5, 1990. The FOSC has assured that EPA will receive a copy of the draft NEBA report for review and comment before the final report is published.

USF&WS Activities

- Seabird colony restrictions for the Katmai area have been relaxed. USF&WS continue to provide wildlife monitors at cleanup locations.

- A Bald Eagle nest failure has been reported in Tonsina Bay. USF&WS continues to implore aircraft to observe restricted areas. It is not conclusive, however, if the nest failure is due to oil spill related aircraft. Many helicopter and aircraft tours, as well as natural factors, could have resulted in this nest failure.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE

-- CC LIST --

EPA HEADQUARTERS

___ Fields, T. (OS-120)

___ Grubbs, G. (WH-553)

___ Makris, J. (OS-120)

EPA REGION 10

REGIONAL OFFICE

___ RA's Office (SO-121)

___ Courson, B. (ES-096)

___ Findley, C. (HW-111)

___ Fox, J. (SO-125)

___ Gaulding, C. (MD-101)

___ Gearheard, M. (HW-112)

___ Kellogg, G. (WD-135)

___ Larsen, D. (MD-109)

___ O'Neal, G. (AT-081)

___ Gangmark, C. (MD-102)

___ Schmidt/Pirzadeh (HW-114)

___ Winsett, F. (SO-122)

SRIS

___ Everts, J.

___ OSCs

___ Tapang, V.

___ SRIS/Valdez File

OPERATIONS OFFICES

✓ AOO: Ewing, A.
Lautenberger, C.

___ IOO: McKee, L.
Fruetel, W.

___ OOO: Brooks, K.
Culver, R.

___ WOO: Hagenson, J.

Date : June 18, 1990

To: Corexit Advisory Team

Gary Reiter (USCG)
Joe Talbott (NOAA)
Carl Lautenberger (EPA)
Al Kegler (ADEC)

From: Hans Jahns

Subject: Corexit 9580 Field Demonstration

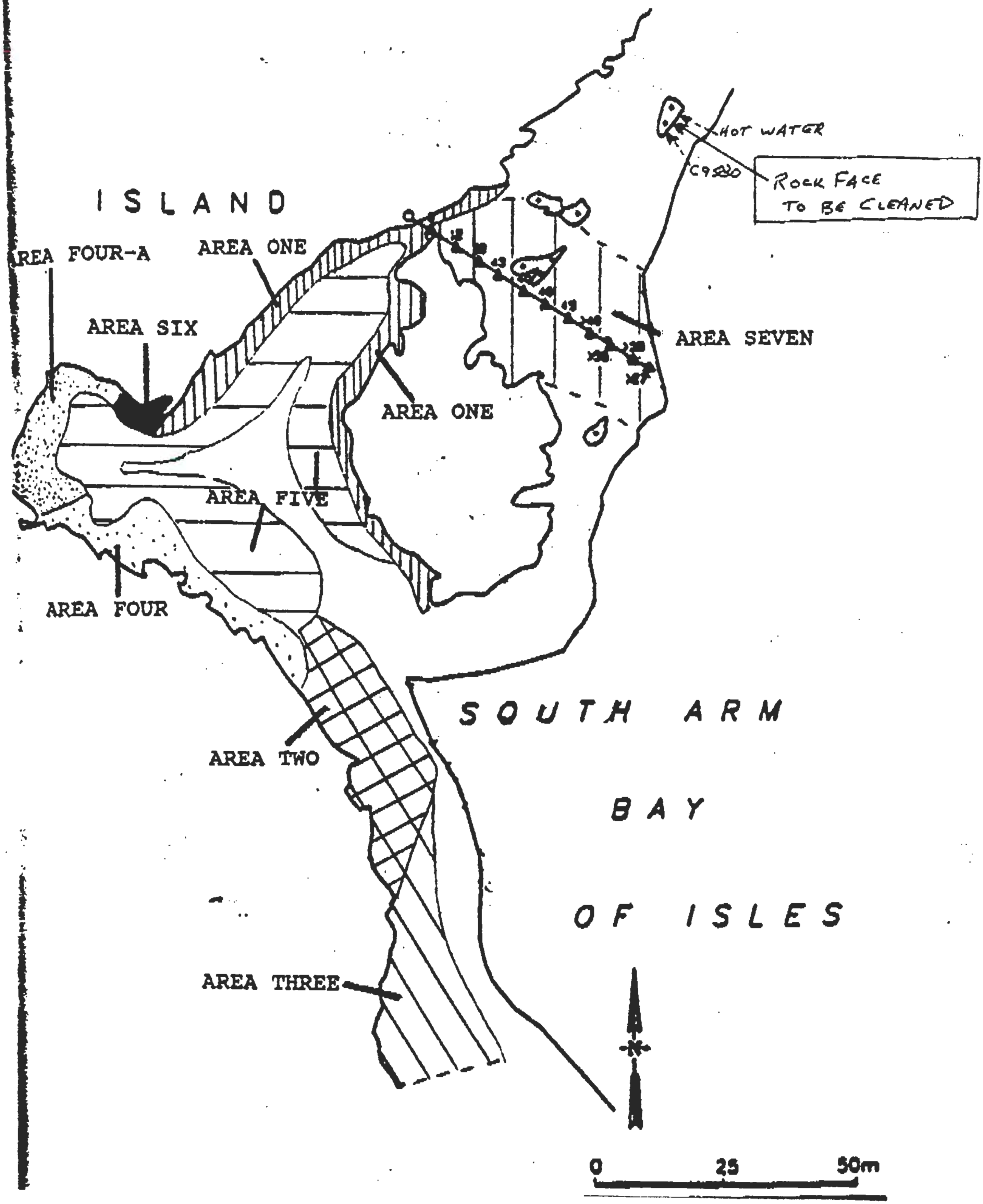
Exxon Operations is scheduling the first demo of spotwashing with the beachcleaner for Tuesday, June 19, 1990, afternoon in the Bay of Isles. The selected spot is an oil-coated rock outcrop on the outside portion of KN 136 (facing the open bay rather than the lagoon). The location is indicated on the attached map. For purposes of the demo, one side of the rockface will be presoaked with Corexit; both sides will then be washed, using warm water on the treated side and hot water on the untreated side. Water temperature will be measured at the nozzle. The area to be treated is about 60 square feet - which calls for about 6/10th of a gallon of Corexit.

As you recall, we selected three potential sites for the trials on our field trip last Friday: LA 20B in Sleepy Bay, EV 39 on Evans Island, and KN 136 in Bay of Isles. We were able to visit only KN 136 yesterday because of bad flying weather. However, LA 20 has tentatively been selected as the second site for a demo later this week. This test would involve the oil-coated seaward facing side of a single large boulder which would require less than a quart of the beachcleaner.

Please give me a call to confirm whether you will be able to attend the exercise tomorrow. We are scheduling a Twin Otter to leave here shortly after noon - weather permitting. In addition to our group, we hope to have a CAC representative present.

cc: Adm. D. E. Chiancaglini
Randy Bayliss (ADEC)
Peter Nagel (CAC)
Otto Harrison
Don Carpenter
Bob Mastracchio

KN-136
AREA LOCATIONS



Memo to:

Sonny Mayer, ERL/GB
Hap Pritchard, Valdez
Tom Baugh, OEET
Carl Lautenburger, AOO

Re: Weekly Activity Report, 6/25 - 6/29

From: Jim Clark JRC 6/28/90
Rod Parrish
Bioremediation Monitoring Team, Anchorage

Data are beginning to develop an encouraging story on the effectiveness of the fertilizer applications to two beach sites in PWS, the KN-135 and KN-132 monitoring sites. Both sites had surface and subsurface oiling and were treated with Inipol and Customblen and are showing microbial activity 2 - 3 times the rate of their respective reference sites. Nutrients in interstitial water also have been elevated. Dissolved oxygen concentrations in the interstitial water have been depressed 2 - 3 mg/l in the treated areas, reflecting enhanced microbial activity, but have not approached anaerobic conditions. At the KN-211 site where there was subsurface oil only, microbial activity has been stimulated but the nutrient concentrations have not remained elevated. This is probably due to the high energy nature of the site and the porus nature of the substrate. Results of day 32 sampling at KN-135 are beginning to show that it may be appropriate to reapply fertilizers at this site. There is still oil at the site, but another treatment of Inipol should lead to the visual cleaning effect as the surface rocks have only a thin layer of oil now.

All results of toxicity tests with site water and Mysids have been reported by the MEC lab in Tiburon, CA. No toxicity was seen in any samples taken from the nearshore zone of any of the monitoring sites. Measurements of ammonia in water samples collected at the same time and analyzed by the University of New Hampshire, the contract lab for our nutrient samples, have shown maximum concentrations of ammonia at 0.6 mg/l for both the KN-135 and KN-211 sites. These concentrations are at the threshold of acute toxic effect concentrations for the most sensitive species reported in the literature, and are an order of magnitude less than acutely toxic concentrations for most fish and invertebrates.

Preliminary results from the Bioremediation Monitoring Program were presented to the Operations Steering Committee, Chaired by Admiral Ciancaglini, on Tuesday, 6/26, at 5:30 PM.

The 20-minute progress report was shared by Roger Prince of EXXON, Jon Lindstrom of ADEC, and me. We received few comments from the audience, and compliments from the Admiral. I requested that the committee inform us as to the exact nature of the expected format of our 6-week report and any panel review. ADEC is preparing their response. A tentative date of July 10 had been discussed before, but this is still not firm. I followed up my request at the Wednesday morning FOSC briefing with Admiral Ciancaglini. ADEC is represented at that meeting as are all federal agencies working on the spill clean-up. The ADEC rep will inform the admiral and us as soon as the format for reviewing the monitoring data has been established. They are expecting to put together a panel of experts to review the results, so some form of report and oral presentation by the bioremediation monitoring team is anticipated. The state has said that they would not approve requests for reapplication at any sites until a final decision on bioremediation has been made upon review of the monitoring data. Admiral Ciancaglini is sending a letter to the ADEC Commissioner informing him that they intend to continue using bioremediation while the state ponders the results of the monitoring program.

The bioremediation monitoring team has asked EXXON to continue to support the monitoring effort past the 32-day program, which ends this weekend with the final scheduled sampling at KN-211 and KN-132. EXXON is working out the logistics and should make a decision soon. We would request that the untreated reference sites be left untreated while we continue to monitor and retreat at the sites. This may be a problem with the state, but will be worked out through normal channels. When I informed the staff attending the FOSC briefing of our plans, all were highly supportive and saw no real problems. Sites would be sampled once every two or three weeks until September 1 under our draft plan, but this could change as we analyze the data coming in from our current study.

Roger Prince of EXXON and I will be in Valdez Friday through Sunday working with Hap on the research program and visiting the monitoring sites as the field crews sample them. We plan to travel to Fairbanks to meet with Jon Lindstrom and the Univ. of Alaska Fairbanks staff who are processing the microbiology samples for the monitoring program. Since all the UAF crew will be there processing the weekends samples, we will ask them to stay Monday and Tuesday to discuss results to date and to begin serious preparation of the document to be reviewed.

CC
R. Menzer - ERL/GB
R. Wilhour - ERL/GB

DATE: June 25, 1990

TO: Rear Admiral D. E. Ciancaglini, FOSC
R. Bayliss, ADEC
C. Lautenberger, USEPA
Otto Harrison, Exxon
J. Whitney, NOAA

FROM: J. R. Clark JRC
J. Lindstrom RAM for JL
R. C. Prince RCP
R. A. Major RAM

SUBJECT: Weekly Report, 6/18-24/90, Joint ADEC/EPA/Exxon Bioremediation Monitoring Program

A presentation of the results of data analysis available to date will be made on Tuesday, June 26, at the regular bi-weekly Operations Steering Committee meeting. The following is a summary of the last week's activities.

FIELD ACTIVITIES

KN-132B, Herring Bay

Day 16 samples were collected on KN-132B, Herring Bay, on Monday, June 18. The high tide was particularly low, and only some of the wells were submerged at high tide. Nevertheless, all wells were essentially full of water. The salinity of the interstitial water in all three wells on the reference beach was low (0.1-4.5 ppt), indicating the presence of a fresh water lens under this portion of the beach. Notwithstanding, the interstitial water was aerobic. There is still heterogeneity on both reference and treated beaches, with remnants of surface oil on both sides. Large rocks on the treated side seem to be cleaned on top where they were coated with Inipol, but still have oil stains remaining on their sides. Customblen granules remain evident on the treated side, but none have washed over to the reference side. Samples were delivered by air through Cordova because the Portage Pass was closed to flying.

KN-135B, Bay of Isles

The sampling program was completed on KN-135B, Bay of Isles, with the final (day 32) samples taken on Friday, June 22. Sampling began at 4:00 am on a falling near-spring tide (range 18 ft, high +14.6 ft). A lot of Customblen pellets were evident higher on the beach (e.g., well B) while fewer pellets were seen at mid-tide (e.g., well C). Very low salinities were noted at well B (4 ppt) which may have been due to heavy rain run-off. One of the nine surface sediment samples collected on the treated beach showed no visible oil. Since this was the last day of sampling under this program, the boom dividing the beach into treated and reference sections was removed. Survey tapes marking pit locations and the sampling wells were left in place, however, in case of the need for further sampling. Time lapse cameras were left in place for removal Sunday, July 1, on completion of all sampling. Sample pick-up occurred at 12:30 pm.

SAMPLE ANALYSES

Toxicity Tests

No significant toxicity was associated with the application of fertilizer to KN-211 and KN-132. Water samples were collected in the nearshore zone immediately before fertilizer application and 1 hour post-application. Samples were then collected at the mid-point of the next 1, 2, 3, 5, and 7 out-going tides; approximately 7, 19, 32, 57, and 82 hours post-application. Samples from an untreated site remote from the test beaches were also collected and tested. Toxicity tests were conducted with mysids, a shrimp-like crustacean which is a standard laboratory test animal. Mysids were the most sensitive of 7 marine fish and invertebrate species previously tested with Inipol, and thus were selected as a sensitive surrogate for indigenous biota. Concentrations of ammonia and nitrates in the nearshore waters at the test sites peaked within the first two days following application, at concentrations an order of magnitude less than concentrations reported to be acutely toxic to marine biota. These test results agree with those previously reported for the KN-135 test site.

Water Quality Measurements

No evidence of increased algal productivity, which might result in algal bloom, has been observed offshore of any of the beaches. Total petroleum hydrocarbon levels remain below or near detectable limits (0.2 mg/l) off both test and remote reference beaches, indicating no significant effect of fertilizer application on total petroleum hydrocarbon release.

Oil Analysis

Chromatographic analysis of the oil on the three test sites, collected before the application of fertilizer, has now been completed. All show significant biodegradation, but substantial amounts of biodegradable material remain. The presence of significant amounts of paraffins in the oils suggests that the mineralization of hexadecane (see below) is an appropriate measure of the effect of fertilizer application on these beaches. Gravimetric measurements of the initial oil will be complete within the next five days.

Nutrient Analysis

Measurements of dissolved nutrients in the interstitial water on the treated side of KN-135 indicate that these reached a maximum between days 2 and 4 at approximately 150uM nitrate and 150uM ammonia, and subsequently declined to about 40uM nitrate by day 16. If this trend is repeated on the other beaches, it will provide important information on when to reapply fertilizer for maximum benefit. Data through day 4 on KN211 and day 2 on KN132 show significant increases following fertilizer application. Nutrient levels remain at background levels in the unfertilized portions of all three monitoring beaches.

The trend towards lower dissolved oxygen levels in interstitial water on the fertilized portions of the test beaches has continued. This trend is consistent with increased microbial activity on the treated portions of the beach. Nevertheless, the beaches remain aerobic, and there have been no hints of anaerobic activity by sulfate reducing bacteria.

Microbial Hydrocarbon Degradation

Measurements of hexadecane mineralization have now been completed on all beaches through day 16. All show substantially more activity on the fertilized portions of the beach when these are compared to the unfertilized portions. The ratio of activities on fertilized compared to unfertilized beaches is approximately 3.3 on KN-132, 3.1 on KN-135, and 2.2 on KN-211. Consistent with expectations from laboratory experiments, this order parallels the levels of soluble nutrients in the interstitial water on the three beaches.

cc: R. E. Bare - Exxon
B. Beathard - Exxon
E. Brown - UAF
E. Butler - ANI
D. Carpenter - Exxon
C. Costa - USEPA
L. C. Dash - Exxon
M. J. Grossman - Exxon
H. O. Jahns - Exxon
J. Kennedy - ANI
C. Loggie - Exxon
R. Mastracchio - Exxon
S. McMillen - Exxon
P. Nagel - CAC
P. R. Parrish - USEPA
P. H. Pritchard - USEPA
B. Rome - USCG
M. Smith - Exxon
D. Stanczuk - Exxon
A. Weiner - ADEC
J. B. Wilkinson - Exxon

EXXON COMPANY, U.S.A.
ALASKA OPERATIONS
POST OFFICE BOX 240409 • ANCHORAGE, ALASKA 99524-0409

B. L. MASTRACCHIO
TECHNICAL MANAGER

Date: June 29, 1990

To: Gary Reiter/ Buzz Rome (USCG)
Joe Talbott (NOAA)
Carl Lautenberger/ Ken Gaylord/ Kirsten Ballard (EPA)
Al Kegler (ADEC)

From: Bob Fiocco/Hans Jahns

Subject: Second COREXIT 9580 Field Demonstration

Exxon Operations is scheduling the second field demonstration of spot-washing with COREXIT 9580 beach cleaner for Sunday afternoon, July 1 , 1990 in Sleepy Bay. This is in followup to the initial demonstration at the Bay of Isles (KN-136) on June 23. The location selected for this demo is a zone on LaTouche Island (LA 20C) comprised primarily of oil-coated boulders and large cobble. The attached maps indicate the specific location.

Two equivalent areas of up to 1000 square feet each will be marked off in this zone. This size is consistent with the upper bound of approximately 33 feet by 33 feet indicated in the FOSC's May 18 letter to the RRT requesting approval for COREXIT 9580 use. Both areas will be spot-washed at the same time, one with hot wash water (target temperature 160° F, range 145-175° F) and the other with warm water (target temperature 110° F, range 100-135° F). Water temperature will be measured at the discharge nozzle. COREXIT 9580 beach cleaner will be applied 15-30 minutes prior to the warm water wash at a rate of 1 gallon per 100 square feet. Sorbent (snare) boom will be used in each area to recover released oil. As directed in the FOSC's June 8 approval letter (attached), efficiency in comparison to the hot water washed area will be determined by visual science only and no sophisticated sampling programs are required. We understand that ADEC will attempt a quantative assessment of each area, such as by extracting oil from snare boom samples and counting barnacles.

We are scheduling a Twin Otter to leave Anchorage at 1:30 PM on Sunday to go to Sleepy Bay. Another flight is scheduled for 2 PM on Monday, July 1, to bring the team out for follow-up visual determinations. Please give Hans Jahns or myself a call to confirm your flight plans and passenger names. In addition to our team, we hope to have representatives from CAC and CVC present, as well as those agencies also mentioned in the FOSC's June 8 letter.

cc: Adm. D. E. Chiancaglini
Colleen Burgh (ADEC)
Peter Nagel (CAC)
Gail Evanoff (CVC)
Paul Gates (DOI)
Bill Copeland (ADNR)
Otto Harrison
Don Carpenter
Bob Mastracchio

of Transportation
United States
Coast Guard

Coordinator
U. S. Coast Guard

601 W 5th Ave.
Suite 300
Anchorage, AK 99501
(907) 277-3833

16465
8 June 1990

Mr. Otto Harrison
Exxon Company U.S.A.
P.O. Box 240409
Anchorage, AK 99524-0409

Dear Mr. Harrison:

Enclosed is the Regional Response Team's reply to the application of Corexit 9580 for spot washing. Please note that the following conditions must be met prior to wide area application:

a. Five sites must be chosen for test application. Selection will be determined by Exxon, USCG, ADEC and EPA.

b. Operational recovery measures using sorbents and lower water temperatures need to be proven effective.

c. An opportunity will be given for one representative each from DOI, DOC, EPA, NFS, DNR and CAC to observe a test.

d. Efficiency will be determined by visual science only and no sophisticated sampling programs are required.

I would like to get this issue resolved as quickly as possible. In doing so, it is important that we keep the entire testing and other processes simple!! CDR Reiter of my staff will contact your staff to set up a meeting and work out the details. If you have any questions, please contact me.

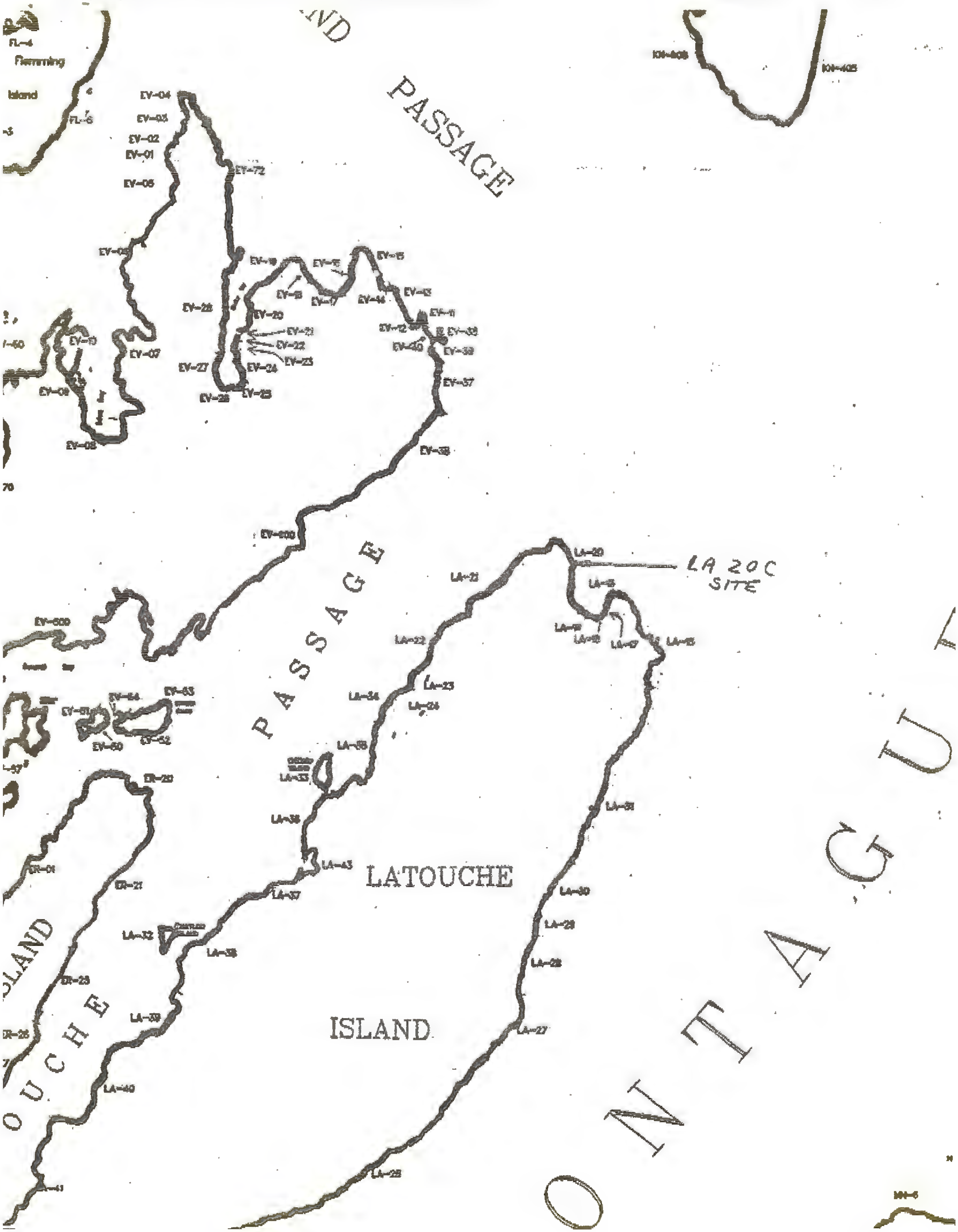
Sincerely,

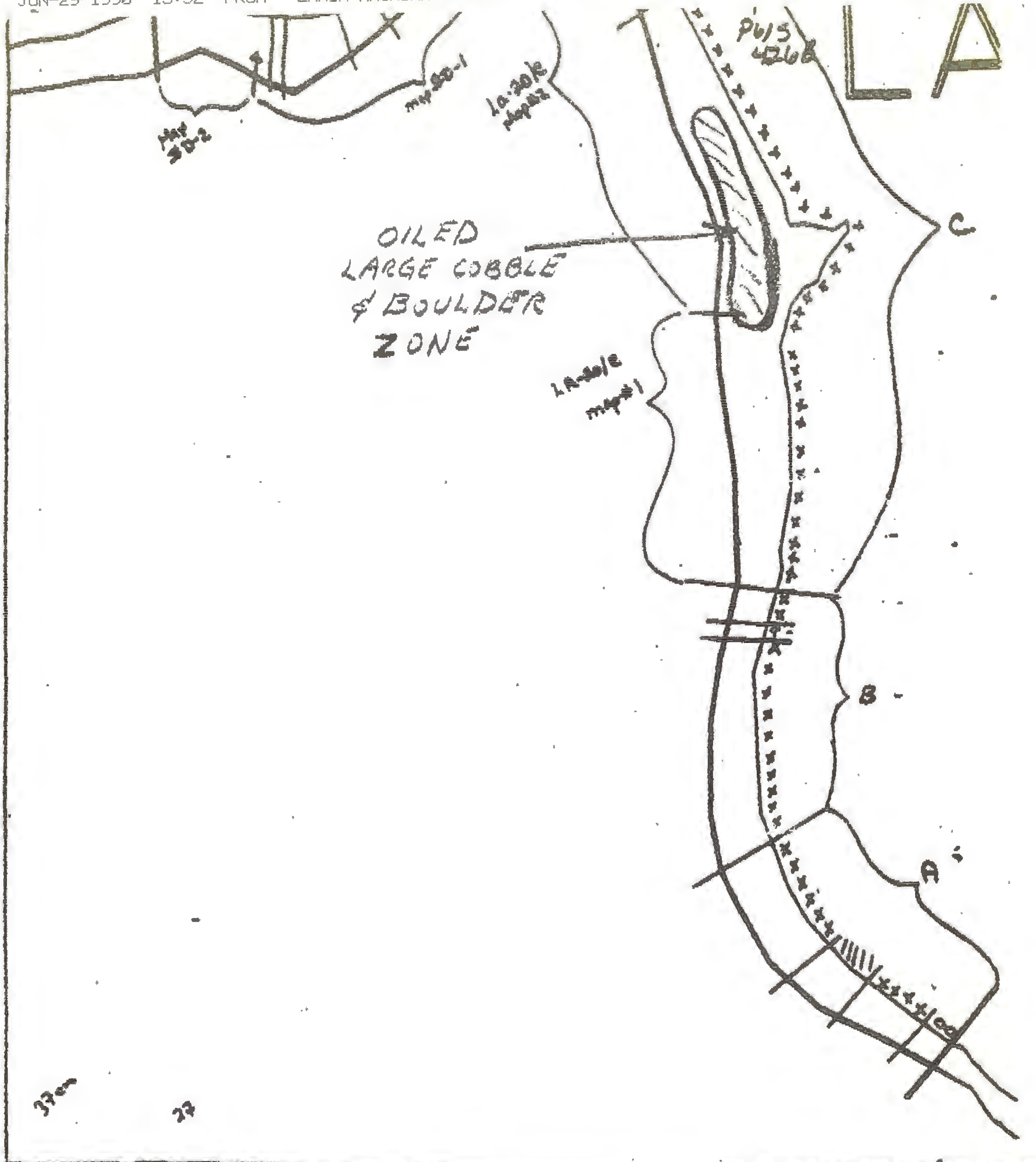
D. E. Ciancaglini

D. E. CIANCAGLINI
Rear Admiral, U.S. Coast Guard
Federal On Scene Coordinator

Encl: (1) AK RRT ltr of 7 Jun 1990

cc: ADEC, Mr. Randy Bayliss


PASSAGE
Flemming
Island
FL-4
EV-04
EV-03
EV-02
EV-01
EV-72
EV-05
EV-07
EV-08
EV-20
EV-21
EV-22
EV-23
EV-24
EV-25
EV-26
EV-27
EV-15
EV-17
EV-44
EV-43
EV-41
EV-40
EV-37
EV-38
EV-600
EV-500
EV-54
EV-53
EV-52
EV-50
KN-405
PASSAGE
LA-20
LA 20C
SITE
LA-21
LA-22
LA-23
LA-24
LA-34
LA-35
LA-33
LA-36
LA-43
LA-37
LA-32
LA-38
LA-39
LA-40
LA-31
LA-30
LA-29
LA-28
LA-27
LA-25
LA-15
LA-17
LA-18
LA-19
ER-20
ER-01
ER-21
ER-23
LATOUCHE
ISLAND
MONTAGUE



XXXX Wide
//// Medium
---- Narrow
TTTT Very Light
0000 No Oil

LA-20

ADEC Segment Length: 2114m

0 100 200 300
METERS

Map Key: PWS-426a
Name: Reimer
Date: 4/8/90
Date Entered:

FACSIMILE COVER SHEET

EXXON COMPANY, U.S.A.
ALASKA OPERATIONS – TECHNICAL DEPT.
FAX #: (907)564–3260

Mailing Address:
P.O. Box 240409
Anchorage, AK 99524–0409

Physical Address:
3301 "C" Street, 3rd Floor
Anchorage, AK 99503

DATE: 6-29-90

TO: Kirsten Ballard FAX #: 271-2467

COMPANY: EPA LOCATION:

FROM: Bob Fiocco WK #: (907)564- 3712

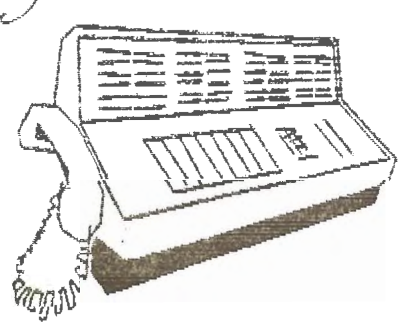
COMPANY: Exxon, U.S.A. LOCATION: Anchorage, Alaska

NUMBER OF PAGES (INCLUDING COVER SHEET): 5

MESSAGE:

If you have any questions/problems with this transmittal please contact :

Sent by: [illegible]



EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
JUNE 17-23, 1990

Shoreline Survey Assessments

As reported last week, the spring assessments are complete. Plans are now being formulated to conduct post-treatment surveys on those segments where some form of clean-up occurred this summer. These assessments may begin as early as July, with the majority of surveys occurring in August.

Shoreline Treatment

- From the total area surveyed, 1,032 total subdivisions were identified as of June 17. Six hundred and one (601) subdivisions have been targeted for some type of treatment, while 431 require no further treatment.

- Out of 95 anadromous streams surveyed, 66 require treatment, leaving a balance of 29 streams with no further treatment required.

TREATMENT PROGRESS STATUS AS OF JUNE 17

Method	Total to be Treated	Treated to Date	Remaining
Bioremediation	410	63	347
Manual & Mechanical	540	224	316

- Presently, there are nine squads actively working in the Prince William Sound, Kenai Pennisula, and Kodiak/AK Peninsula areas. Two of these squads are dedicated to applying fertilizers associated with bioremediation. A third squad dedicated to bioremediation is being trained and will be activated shortly.

Corexit 9850 Shoreline Chemical Cleaner

A scheduled field demonstration designed to test the efficacy of the product on weathered oil remaining this year was canceled on Tuesday, June 19th because the land owner adjacent to the test site (Chugach Native Corporation) objected to the use of the product. Further demonstrations are on hold until an appropriate alternate site can be identified. Exxon has indicated that if use of 9580 is approved they plan to use it on only 20-30 of the 70 sites targeted for spot washing.

Rock Washer Research and Development Update

- Exxon awarded a contract to Northwest Enviro Services to build a full-scale prototype machine for testing in late July.
- NOAA is scheduled to release a report of the work group evaluating the Net Environmental Benefits Analysis of rock washing technology by June 27th.

USFWS Activities

USFWS, in consultation with AK Fish & Game, National Park Service and NMFS, continues to review access limitations and constraints. Shorelines located in the Barren Islands previously labeled "off limits" due to shore bird colonies are now accessible to clean-up crews as a result of USFWS's identification of alternate access routes.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
June 10-16, 1990

SHORELINE SURVEY ASSESSMENTS

Exxon submitted a final status report on June 12 regarding the following information on shoreline assessment:

	PWS	KENAI	KODIAK	TOTAL
Segments Assessed	492	106	125	723
Subdivisions Assessed	710	154	167	1031

OILING LENGTHS IN MILES

	PWS	KENAI	KODIAK	TOTAL
Wide	12.9	1.6	0.3	14.8
Moderate	28.5	4.8	3.2	36.5
Narrow	49.6	9.8	4.3	63.7
Very Light	169.1	53.2	58.9	281.2
No Oil	425.4	180.0	213.8	819.2
Total	685.5	249.4	280.5	1215.4
Total Number of Segments	492	106	125	723

(For surface oil definitions, refer to the Exxon Valdez Oil Spill Weekly Update of May 6-12, 1990.)

There are plans to conduct a post 1990 summer treatment survey in August.

SHORELINE TREATMENT (As of June 10, 1990)

PWS:
Bioremediation - 339 subdivisions require treatment; 47 subdivisions were treated; 292 remain to be treated.
Manual & Mechanical Treatment (includes manual pickup, tarmat removal & spot washing) - 372 subdivisions require treatment; 160 subdivisions were treated; 212 remain to be treated.

KENAI:
Bioremediation - 58 subdivisions require treatment; no treatment has begun to date.
Manual & Mechanical Treatment (includes manual pickup, tarmat removal & spot washing) - 84 subdivisions require treatment; 24 subdivision were treated; 60 remain to be treated.

KODIAK:
Bioremediation - 26 subdivisions require treatment; no treatment has begun to date.
Manual & Mechanical Treatment (includes manual pickup, tarmat removal & spot washing) - 65 subdivisions require treatment; 4 subdivision were treated; 61 remain to be treated.

COREXIT 9580 PROPOSAL

EPA, ADEC, USCG, NOAA, and Exxon met to discuss procedures and determine sites for field testing Corexit 9580 use in conjunction with spot washing. The objectives of the field tests are to determine if the use of Corexit 9580 improves oil removal efficiency and enables spot washing treatment at lower hot water temperatures, while not decreasing the ability to recover loosened oil.

No additional toxicity or water column oil concentration testing are anticipated. Alaska Regional Response Team agencies agreed that the review of last year's data and winter laboratory research on Corexit 9580 is sufficient to consider the proposed small scale, limited use of the product in this year's treatment activities.

BIOREMEDIATION

Monitoring of bioremediation sites continues. Concentrations of dissolved ammonia in the water column adjacent to treated plots are below toxic levels.

To date, the University of Alaska at Fairbanks has processed approximately 400 microbiological samples. Results of analyses designed to enumerate the number of heterotrophic and oil eating bacteria are pending.

EAGLE SURVEY

USF&W and ADF&G completed an assessment of all known eagle nests located within the spill area. USF&W was able to determine which nests were inactive, thus significantly reducing the number of locations which were unaccessible due to the 1/2 mile radius restriction around active eagle nests. USF&W has also reduced access restriction from 1/2 mile to 1/4 mile.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
June 3-9, 1990

SHORELINE SURVEY ASSESSMENTS

The spring shoreline assessments are complete. A total of 1,008 subdivisions in PWS, Kenai Peninsula, Gulf of Alaska and Kodiak areas were surveyed. Of the 1,008 subdivisions surveyed, treatment was recommended for 579 subdivisions.

SHORELINE TREATMENT

As of June 3, sixty-eight (68) of 579 subdivisions were treated. Subdivisions that were bioremediated will be reassessed and reevaluated based upon the results of the bioremediation monitoring program. Subdivisions with work orders involving manual removal, spotwashing, etc. will be reassessed in mid-August.

BIOREMEDIATION

Application of fertilizers continues. The following observations were reported based on preliminary results of the monitoring program regarding Inopol application: (1) Levels of dissolved ammonia in near shore waters peak at 19 hours, then fall back to background levels; (2) Concentrations of ammonia are below toxic levels. Water samples were taken and no harmful effects on oyster larvae were observed.

COREXIT 9580 SHORELINE CLEANER

RRT members, including EPA and ADEC, provided comments regarding the use of Corexit 9580 to the FOSC on June 4. Essentially, the Natural Resource Trustee agencies had no objections to the use of Corexit 9580 in conjunction with spotwashing at approximately 70 sites. EPA and ADEC's approval of Corexit 9580 use are contingent upon further testing of the product, in order to demonstrate its effectiveness in increasing oil removal and recovery.

ALASKAN FISHERIES

No oil/sheen have been observed in commercial fishing areas to date. The Kodiak salmon fisheries are scheduled to open June 7.

OTHER AGENCY ACTIVITIES

ADEC, NOAA, and EXXON are undertaking an engineering study and a net environmental benefit analysis study to determine if the use of conceptionally designed rock washing treatment should be pursued. Reports regarding this are expected by the end of July.

EXTERNAL/PUBLIC AFFAIRS

The Commandant of the Norwegian Coast Guard visit for this June has been cancelled. The Soviet delegation visit is scheduled for mid-June.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
May 20-26, 1990

SHORELINE SURVEY ASSESSMENTS

The spring shoreline assessments are essentially complete. The Shoreline Survey Assessment Team (SSAT) continues some survey work in the Kodiak and Alaska Peninsula areas on National Park Service and U.S. Fish and Wildlife lands.

Shoreline treatment was recommended for approximately 567 segments out of 976 subdivisions surveyed. Similarly, approximately 59 anadromous streams, out of 93 streams assessed, require treatment.

SHORELINE TREATMENT

As of May 20, the following types of treatment are planned:

Treatment Type	Area	Segment #
Manual Removal	PWS	300
	Kenai	74
	Kodiak	50
Bioremediation	PWS	340
	Kenai	58
	Kodiak	27
Tar Mat Removal	PWS	195
	Kenai	50
	Kodiak	2
Spot Wash	PWS	66
	Kenai	10
	Kodiak	3
Other/Misc. (To be determined, e.g., rock washing or tilling)	PWS	50
	Kenai	5
	Kodiak	0

ALASKAN FISHERIES

No oil/sheen was observed at Alaskan fishing areas to date. The salmon gill net drift fishery in the Eshamy District of PWS is scheduled to open on June 11.

BIOREMEDIATION

Application of Inipol EAP22 and Custom Blend began this week in PWS. The monitoring program (described in last week's update) commenced at one site, Bay of Isles, on Knight Island. Two additional monitoring sites are required. However, problems persist in locating sites with adequate oiling and without use restrictions due to wildlife or archaeological restraints.

COREXIT 9580 PROPOSAL

The Alaska Regional Response Team (ARRT) met on May 21 to consider Exxon's recommendation, endorsed by the FOSC and NOAA Scientific Support Committee (SSC), to use Corexit 9580 chemical beach cleaner in conjunction with spot washing shoreline treatment. The chemical will be applied in small amounts at nominal rates to small areas (shoreline segments approximately 10'X 10' to 33'X 33') to remove heavy concentrations of oil, in order to prepare the oiled surface for application of bioremediation nutrients.

The FOSC and NOAA SSC believe use of the chemical will be beneficial for the following reasons:

- Use of Corexit 9580 will allow use of lower hot water temperatures and smaller volumes of flush water.

- Use of Corexit 9580 does not appear to decrease the effectiveness of oil recovery by sorbents and oleophilic pompoms (the primary means of recovery this year).

- Use of Corexit 9580 presents no significant increase in the risk to the biological community.

WASTE MANAGEMENT PLAN

Exxon submitted a Waste Management Plan for 1990 operations to the FOSC. The primary disposal facilities mentioned in the plan are:

- Lower 48 landfill for oily solid wastes.
- Alyeska Terminal's Ballast Water Treatment Plant for oily waters.
- USCG approved Marine Sanitation Devices for sanitary wastes from vessels.
- Lower 48 facilities for hazardous wastes, if any.

PWS INTERAGENCY SHORELINE CLEANUP COMMITTEE (ISCC)

The PWS ISCC visited several cleanup work sites in PWS on Wednesday, May 23. Shoreline treatments observed included bioremediation, tar mat removal, oily debris removal, and spot washing.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
May 13-19, 1990

SHORELINE SURVEY ASSESSMENTS

The Shoreline Survey Assessment Team (SSAT) continues to assess segments in Kodiak. To date, approximately 80% of assessment activities in Kodiak have been completed.

SHORELINE TREATMENT

Shoreline treatment is in the initial stages. Eight cleanup squads, seven in PWS and one in the Gulf of Alaska, continue shoreline treatment activities--e.g., manual debris pickup, spot washing.

ALASKAN FISHERIES

There have been no closures of Alaska fishing areas to date. Federal/State agencies continue aerial surveillance and monitoring of fishing areas. The Copper River area salmon opening occurred without incident.

COREXIT 9580 PROPOSAL MEETING

A RRT meeting, regarding Exxon's proposal to use Corexit 9580 beach cleaner, is scheduled for May 21.

BIOREMEDIATION

The bioremediation, nutrient enhancement fertilizer will be applied on segments of Knight Island in PWS on May 18.

EPA ORD, in conjunction with ADEC and Exxon, finalized a monitoring program that will be carried out as a joint effort between these agencies, including scientists from the University of Alaska in Fairbanks. The detailed monitoring program proposes to show whether the bioremediation technique enhances the biodegradation of oil with minimal environmental risk. The effectiveness of bioremediation on surface and subsurface oil will be evaluated at low, moderate and high energy shorelines. During the six week program, water, sediment and oil samples will be analyzed for the presence of fertilizer, microbial populations changes in oil loading and chemistry, toxicity, and algal chlorophyll. Together, these measurements will be compared to control sites and will provide a basis to assess the effectiveness and safety of bioremediation treatments.

EPA ORD is also devising a 1990 research plan separate from the operational monitoring plan. The objectives of the research plan are:

- To supplement the summer monitoring program by demonstrating, through alternative methods and sampling designs, the extent of biodegradation enhancement over natural rates.
- To ensure fertilizer application rates in the field have been optimized.
- To develop further information that will support and direct fertilizer application strategies for the bioremediation of subsurface oil.
- To examine and apply alternative methods for measuring the biodegradation of oil in the field.
- To determine fertilizer application rates to shorelines which will effectively accelerate biodegradation without adversely affecting the natural biota.
- To field test different methods and approaches for the potential bioremediation of weathered oil.

EXTERNAL/PUBLIC AFFAIRS

The Commandant of the Norwegian Coast Guard and a Soviet delegation are scheduled to visit in June.

EXXON VALDEZ OIL SPILL
WEEKLY UPDATE
May 6-12, 1990

SHORELINE SURVEY ASSESSMENTS

There are four subdivisions of shoreline survey assessments, namely: Prince William Sound (PWS), Kenai, Kodiak, and anadromous fish streams (ANADSCAT).

The Shoreline Survey Assessment Team (SSAT) completed surveying all segments in PWS and the Kenai area, and continues to assess segments in Kodiak (70% completed).

A total of 1,061.9 miles were surveyed by SSAT. A summary of oiling data in miles is as follows:

	PWS	KENAI	KODIAK	SUBTOTAL
WIDE	12.8	1.7	.3	14.8
MODERATE	28.4	5.1	1.6	35.1
NARROW	49.5	9.8	3.4	62.7
VERY LIGHT	168.7	9.8	3.4	245.7
NO OIL	425.1	177.6	100.9	703.6
TOTALS	684.5	246.8	130.6	1,061.9

Surface Oil Definitions:

Wide - Greater than 6 meters wide and 50% or more oil cover.
Moderate - Greater than 6 meters wide and less than 50% oil cover or widths between 3-6 meters and greater than 10% oil cover.
Narrow - Less than 3 meters wide and greater than 10% oil cover.
Very Light - Less than 10% oil cover, including splashes.

SHORELINE TREATMENT

Shoreline treatment is still in the initial stages and is in progress. Cleanup vessels are on stand-by or underway.

COREXIT 9580 PROPOSAL MEETING

A RRT meeting is scheduled for May 21 regarding Exxon's proposal to use Corexit 9580 beach cleaner.

Cockpit test - Sat. AM - If looks good, there will be a bigger demo a few days later, to which Kuester should go.

Exxon Veldez
Meetings and Reports

John Wilkinson Exxon
264-3211
Cockpit + Biok Coordinator

Al Vinosa, ORD Cincinnatti - putting together research plan for NETAC.

Weekly briefing by FOSC - Adm Chaingli
Wed mornings 8:30 - 10
FOSC (3rd Floor Key Bank Bldg) Conf. Room

June 27th + unknown for first week in July since Wed falls on July
(I'm sure they will discuss this on 6/27)

Biweekly Operations Steering Committee Meeting
Tue June 26 evening 5:30pm - 7:30
Federal Bld ~~Ro~~ Conference Rooms C-135-137

NOAA rept due June 26-27 - not a decision
↳ need to ID if final, etc.

Reports

weekly briefing goes to Vicki Tapong in Reg X Superfund Emerg Resp Section
FTS 399-1196 by Thurs noon
0175 Fax

See attached reports for ~~fort~~ format
I use info recieved from weekly Wed meeting + biweekly steering committee meetings for information.

also

I have Gene Burton or his staff type it out on Wang and use the arbirater (compute E-mail system to get it to Vicki).

I also talk to Jim Clark for info on Bioremediation mon

DATE: June 25, 1990

TO: Rear Admiral D. E. Ciancaglini, FOSC
R. Bayliss, ADEC
C. Lautenberger, USEPA
Otto Harrison, Exxon
J. Whitney, NOAA

FROM: J. R. Clark JRC RAM for J.L.
J. Lindstrom
R. C. Prince RCP
R. A. Major RAM

SUBJECT: Weekly Report, 6/18-24/90, Joint ADEC/EPA/Exxon Bioremediation Monitoring Program

A presentation of the results of data analysis available to date will be made on Tuesday, June 26, at the regular bi-weekly Operations Steering Committee meeting. The following is a summary of the last week's activities.

FIELD ACTIVITIES

KN-132B, Herring Bay

Day 16 samples were collected on KN-132B, Herring Bay, on Monday, June 18. The high tide was particularly low, and only some of the wells were submerged at high tide. Nevertheless, all wells were essentially full of water. The salinity of the interstitial water in all three wells on the reference beach was low (0.1-4.5 ppt), indicating the presence of a fresh water lens under this portion of the beach. Notwithstanding, the interstitial water was aerobic. There is still heterogeneity on both reference and treated beaches, with remnants of surface oil on both sides. Large rocks on the treated side seem to be cleaned on top where they were coated with Inipol, but still have oil stains remaining on their sides. Customblen granules remain evident on the treated side, but none have washed over to the reference side. Samples were delivered by air through Cordova because the Portage Pass was closed to flying.

KN-135B, Bay of Isles

The sampling program was completed on KN-135B, Bay of Isles, with the final (day 32) samples taken on Friday, June 22. Sampling began at 4:00 am on a falling near-spring tide (range 18 ft, high +14.6 ft). A lot of Customblen pellets were evident higher on the beach (e.g., well B) while fewer pellets were seen at mid-tide (e.g., well C). Very low salinities were noted at well B (4 ppt) which may have been due to heavy rain run-off. One of the nine surface sediment samples collected on the treated beach showed no visible oil. Since this was the last day of sampling under this program, the boom dividing the beach into treated and reference sections was removed. Survey tapes marking pit locations and the sampling wells were left in place, however, in case of the need for further sampling. Time lapse cameras were left in place for removal Sunday, July 1, on completion of all sampling. Sample pick-up occurred at 12:30 pm.

SAMPLE ANALYSES

Toxicity Tests

No significant toxicity was associated with the application of fertilizer to KN-211 and KN-132. Water samples were collected in the nearshore zone immediately before fertilizer application and 1 hour post-application. Samples were then collected at the mid-point of the next 1, 2, 3, 5, and 7 out-going tides; approximately 7, 19, 32, 57, and 82 hours post-application. Samples from an untreated site remote from the test beaches were also collected and tested. Toxicity tests were conducted with mysids, a shrimp-like crustacean which is a standard laboratory test animal. Mysids were the most sensitive of 7 marine fish and invertebrate species previously tested with Inipol, and thus were selected as a sensitive surrogate for indigenous biota. Concentrations of ammonia and nitrates in the nearshore waters at the test sites peaked within the first two days following application, at concentrations an order of magnitude less than concentrations reported to be acutely toxic to marine biota. These test results agree with those previously reported for the KN-135 test site.

Water Quality Measurements

No evidence of increased algal productivity, which might result in algal bloom, has been observed offshore of any of the beaches. Total petroleum hydrocarbon levels remain below or near detectable limits (0.2 mg/l) off both test and remote reference beaches, indicating no significant effect of fertilizer application on total petroleum hydrocarbon release.

Oil Analysis

Chromatographic analysis of the oil on the three test sites, collected before the application of fertilizer, has now been completed. All show significant biodegradation, but substantial amounts of biodegradable material remain. The presence of significant amounts of paraffins in the oils suggests that the mineralization of hexadecane (see below) is an appropriate measure of the effect of fertilizer application on these beaches. Gravimetric measurements of the initial oil will be complete within the next five days.

Nutrient Analysis

Measurements of dissolved nutrients in the interstitial water on the treated side of KN-135 indicate that these reached a maximum between days 2 and 4 at approximately 150uM nitrate and 150uM ammonia, and subsequently declined to about 40uM nitrate by day 16. If this trend is repeated on the other beaches, it will provide important information on when to reapply fertilizer for maximum benefit. Data through day 4 on KN211 and day 2 on KN132 show significant increases following fertilizer application. Nutrient levels remain at background levels in the unfertilized portions of all three monitoring beaches.

The trend towards lower dissolved oxygen levels in interstitial water on the fertilized portions of the test beaches has continued. This trend is consistent with increased microbial activity on the treated portions of the beach. Nevertheless, the beaches remain aerobic, and there have been no hints of anaerobic activity by sulfate reducing bacteria.

Microbial Hydrocarbon Degradation

Measurements of hexadecane mineralization have now been completed on all beaches through day 16. All show substantially more activity on the fertilized portions of the beach when these are compared to the unfertilized portions. The ratio of activities on fertilized compared to unfertilized beaches is approximately 3.3 on KN-132, 3.1 on KN-135, and 2.2 on KN-211. Consistent with expectations from laboratory experiments, this order parallels the levels of soluble nutrients in the interstitial water on the three beaches.

cc: R. E. Bare - Exxon
B. Beathard - Exxon
E. Brown - UAF
E. Butler - ANI
D. Carpenter - Exxon
C. Costa - USEPA
L. C. Dash - Exxon
M. J. Grossman - Exxon
H. O. Jahns - Exxon
J. Kennedy - ANI
C. Loggie - Exxon
R. Mastracchio - Exxon
S. McMillen - Exxon
P. Nagel - CAC
P. R. Parrish - USEPA
P. H. Pritchard - USEPA
B. Rome - USCG
M. Smith - Exxon
D. Stanczuk - Exxon
A. Weiner - ADEC
J. B. Wilkinson - Exxon

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF OCEANOGRAPHY AND MARINE ASSESSMENT
OCEAN ASSESSMENTS DIVISION
Hazardous Material Response Branch
7600 Sand Point Way N.E. - Bin C15700
Seattle, Washington 98115

16 June 1990

Capt. David Zawadski
Federal OnScene Coordinator
U. S. Coast Guard
Anchorage, AK

Re: Report from ADEC on Corexit Use with Spot Washing

Dear Capt. Zawadski,

We have reviewed the letter report from ADEC on their decision to approve limited testing of Corexit 9850 at five sites, with the decision for unconditional approval to be based on the results of monitoring of the test sites. The test criteria that they require fall into three areas:

I. Effectiveness
   A. Comparison of visual estimates of percent oil removal for selected surfaces using Corexit 9580 at 100°F and hot water alone at 160°F
   B. Quantification of the recovery of oil on pom poms with and without use of Corexit. The measure they recommend looks very difficult to implement and is likely to give poor results. The test will have to be very well planned and implemented in the field in order to have definitive results.
   C. Quantification of the amount of oil penetration into the substrate for hot water alone versus with Corexit. This test also will suffer from the heterogeneous nature of the sediments and is likely to give poor results unless ideal situations are encountered in the field.

II. Environmental Impacts
   A. Intertidal videos before, just after, and 10 days later
   B. Intertidal surveys of organisms and selected analysis of tissues for oil contamination
   C. Sea urchin tests for fertilization and behavior. This test is not well defined. It is not clear whether the urchins are to collected elsewhere and then placed on the intertidal zone downstream of the test area, or if indigeneous animals are to be used.
   D. Deployment of caged salmon and testing for exposure to hydrocarbons through testing for mixed function oxidase. Again, this test will be difficult because of problems in survival, as well as how to place the cages to differentiate between the different treatments.

E. Histopathology of selected animals. The purpose of this test needs to be clarified.

III. Worker Safety Monitoring

They also require land owner consensus.

We question the value and likely success of the sea urchin, caged salmon, and histopathology monitoring requirements. However, all the other requirements could be useful comparisons once they have been agreed upon. These requirements are more than we would recommend but still within the realm of what would be required under a very rigorous monitoring plan.

Please let me know if you have any other questions.

Sincerely,

JMichel

Jacqueline Michel, Ph.D.

New Page 11 is due from AD

Alaska Department of Environmental Conservation
Oil Spill Response Center
2550 Denali St.
Suite 705
Anchorage, Ak. 99503

JUN 14 1990

Executive Summary

Decision

DEC approves limited testing of Corexit 9580 for testing in conjunction with spot washing at five sites, to be agreed upon by DEC, the FOSC and Exxon. Approval for Corexit 9580 on approximately 67 other sites is contingent on the following:

(1) testing at the five sites demonstrates that Corexit 9580 is significantly more effective than hot water;
(2) a serious monitoring program to corroborate laboratory research uncovers no significant problems;
(3) the appropriate land managers concur with application of Corexit 9580 in conjunction with spot washing as a general principle, or in each spot washing subdivision for which the land manager has jurisdiction; and
(4) all necessary precautions are taken to insure worker health and safety during application.

Summary of Key Points

Exxon's proposal of April 26, 1990 to use Corexit 9580 at an unspecified number of sites in conjunction with spot washing was rejected by the state in favor of a more limited approval for testing.

According to DEC's TAG status report, spot washing has been approved for use in 98 subdivisions at the supervisor's discretion; in requesting RRT consideration of Corexit in conjunction with beach cleaning, the Coast Guard said spot washing has been approved at 72 sites.

To demonstrate effectiveness, Exxon must show that:

(1) Corexit 9580 removes oil more effectively than hot water alone, that is, with water at a significantly lower temperature; and
(2) the oil/water mixture can and will be recovered entirely, or at least as effectively as recovery from hot water washing without Corexit.

Corexit 9580, a modification of a dispersant whose name it shares, was registered with EPA July 21, 1989. The elements of the active ingredient package are not known. The product has not undergone the extensive toxicology testing associated with most new products.

Last year permission to use Corexit 9580 was turned down after scientists from state and federal agencies unanimously concluded that tests had failed to demonstrate that Corexit 9580 significantly increased oil removal or could be effectively boomed and captured by skimmers.

Experts Consulted in the Decision

Dr. James Butler, Harvard University, Cambridge, Mass.
Dr. Judy Capuzzo, Senior Scientist, Biology, Woods Hole Oceanographic Institute, Woods Hole, Mass.
Dr. Merv Fingas, Environmental Emergencies Technology Division, Environment Canada, Ottawa, Ontario.
Julie Jordan, Project Manager for Scientex Corp., Rockville, Md.
Dr. Pat Lane, President, Pat Lane & Associates, Halifax, Nova Scotia.

Documents Reviewed in this Decision

Admiral D.E. Ciancaglini, FOSC, letter to Capt. D.E. Bodron, Co-Chair, Alaska Regional Response Team, May 18, 1990 (requesting RRT consideration of Exxon's application for permission to use Corexit 9580 in conjunction with spot washing during the 1990 cleanup).

Environmental Protection Agency, Technical Product Bulletin #D-38, "Corexit 9580 Shoreline Cleaner," EPA, Emergency Response Division, July 21, 1989.

Exxon, "Bioremediation: 1989/90 Winter Studies" 3 volumes, 1990.

Exxon, "Corexit 9580", 5 volumes, 1990 ("Field Test of Corexit 9580 Shoreline Cleaner Disk Island, July 17-24, 1989" [vol. 1]; "Large Scale Field Test of Corexit 9580 Smith Island, August 89-14, 1989" [vol. 2]; "Operational Field Test of Corexit 9580 Smith Island, August 29-September 6, 1989" [vol. 3]; "Corexit 9580 Beachcleaner 1989/90 Winter Studies" [vol. 4]; "Corexit 9580 Toxicity Evaluation" [vol. 5]).

Merv Fingas, Gord Stoodley, Gary Harris and Ariane Hsia, "Evaluation of Chemical Beach Cleaners" (Environment Canada, Ottowa [undated; circa November 1989])

Otto Harrison, General Manager of Alaska Operations, Exxon Co. USA, letter to Admiral D.E. Ciancaglini, March 17, 1990 ("SUBJECT: Beachcleaner Spot Applications").

Otto Harrison, General Manager of Alaska Operations, Exxon Co. USA, letter to Admiral D.E. Ciancaglini, April 26, 1990 ("SUBJECT: Corexit 9580 Beachcleaner").

Patricia A. Lane, Ph.D., letter to Eric P. Jorgensen, Staff Attorney, Sierra Club Legal Defense Fund, June 3, 1990 (with 10 pages of comments on Exxon's pending application to use Corexit 9580 in conjunction with spot washing).

J.A. Nichols and H.D. Parker, "Dispersants: Comparison of Laboratory Tests and Field Trials with Practical Experience at Spills," 1985 Oil Spill Conference, pp. 421-427.

Wayne K. Seim and Lawrence R. Curtis, "Toxicities to Larval Pink Salmon Associated with the Use of a Chemical Shoreline Cleaner on Aged Prudhoe Bay Crude Oil," Report to Alaska Department of Environmental Conservation, May 1, 1990 (Oregon State University).

Alex Viteri, "Review of Corexit Toxicity Data," Memorandum to: Steve Provant, OSC, August 12, 1989.

(N.A.), "Talking Notes -- Subject: Corexit, August 14," State of Alaska, August 14, 1989.

(N.A.), "Approval Criteria for Use of Corexit 9580M2," State of Alaska, July 19, 1989.

Corexit 9580: Report and Recommendation

Authority

Under Federal regulations (40 CFR 300.84), the Regional Response Team cannot approve the use of chemical agents for oil spill cleanup without DEC approval. State statutes (AS 46.03.020) and regulations (18 AAC 75.140[a] and 18 AAC 75.145) grant DEC the authority to insure the adequacy of cleanup efforts, and to insure appropriate deployment of containment equipment and appropriate removal efforts.

Proposal

Exxon formally requested approval from the Regional Response Team and the Federal On Scene Coordinator to use Corexit 9580 in the EXXON VALDEZ cleanup in connection with spot washing of specific shoreline areas in Prince William Sound and Gulf of Alaska on April 26, 1990. The proposal stressed that, unlike the large-scale, unsuccessful test applications last year, the proposed spot washing will cover areas "typically no more than several hundred square feet on any given shoreline subdivision," resulting in application of a maximum of "several gallons of beachcleaner in a given area" at the nominal application of one gallon per 100 square feet.

In a March 17, 1990 letter proposing the use of Corexit 9580, Exxon described spot washing as a technique for removing heavier concentrations of oil in isolated areas, notably in wave shadows on and behind large boulders on low energy beaches in preparation for bioremediation. In its April 26 formal request, Exxon said that by presoaking certain spot wash areas with Corexit 9580, wash water temperature could be reduced from 160 degrees fahrenheit to 100 degrees.

In Exxon's 1990 General Plan, the hardware associated with spot washing includes a landing craft with two Landa hot water units, each capable of producing 10 gallons per minute via high-pressure hose leading to a manually-operated hot water wand. Exxon's March 17 letter indicates that sorbent materials will be laid at the base of spot wash treatment areas, but that "[i]n view of the small quantities of oil and beachcleaner involved, skimming and booming equipment are not required."

According to the FOSC's May 18 letter requesting RRT consideration of Exxon's request, spot washing was recommended for use in parts of 72 subdivisions of 974 reviewed by the TAG. By June 6, DEC's TAG status report listed 98 subdivisions currently approved for spotwashing.

Issues

There are three basic issues to be decided: Would the application of Corexit 9580 do any good? Would the application of Corexit 9580 do any harm? Would the good outweigh the harm?

The answer to this set of questions depends, in turn, on three operational issues. The first is whether Corexit 9580 can remove oil from the shoreline more effectively and at a lower temperature than hot water alone.

An ancillary issue of effectiveness is this: The proposed application asserts that the proposal to use Corexit 9580 on small, predesignated segments with manual hot water units is an effective method of removing oil. Individuals using hot water spray units will have to learn to work with the Corexit 9580. In order to insure that this substance with its unknown active ingredients is not used to excess in certain areas due to unskilled or over-zealous application, it will be necessary to divert cleanup personnel from the relatively small number of operating teams for training in the proper application of Corexit 9580. Since there were only about eight cleanup teams and eight persons per team working directly on cleanup in each team during the first week of June, this could result in a significant decrease in work accomplished.

The second critical issue is whether Corexit 9580 and the oil it separates from the shoreline can be contained. Last year permission to use Corexit 9580 was turned down by scientists from all state and federal agencies unanimously concluded that extensive tests failed to demonstrate that the oil loosened from the shoreline by large-scale applications could be boomed and captured by skimmers.

The final issue concerns the possible effects on the environment immediately adjacent to the sites at which Corexit 9580 would be applied. Unlike last year, the proposed usage is in relatively small quantities – one gallon per 100 square feet with no more than "several gallons" at any one of less than 100 sites, according to the letters requesting approval. Nevertheless, Corexit 9580 is a relatively untested chemical whose active ingredients are held secret by Exxon and are not known to DEC. Moreover, the sites where Corexit might be used are unspecified, having been identified only as "parts of 72 subdivisions" where spot washing has been recommended (May 18 letter to Coast Guard Captain D.E. Bodron, Co-Chair of the Regional Response Team, from Adm. David Ciancaglini, FOSC). In view of this unusual situation, monitoring of the environmental impacts of the test application is warranted.

Background

Corexit 9580 (identified last summer as Corexit 9580M2) was listed on the EPA's Technical Products Bulletin July 21, 1989. Although the surface active agents of Corexit 9580 are listed in the bulletin as a trade secret, the active package has been described by Exxon scientists as comparable to a "cake mix."

In August 1989, extensive testing of this product was abandoned after state and federal scientists unanimously agreed, over Exxon's vociferous objection, that the tests had failed to demonstrate that the 9580/oil mixture could be contained by booms and captured by skimmers after widespread application.

Exxon and DEC have separately completed laboratory tests that were still in preliminary stages in mid-August 1989, when the science committee unanimously decided to reject Exxon's application for widespread use of Corexit 9580. Highlights of these research efforts and suggestions for research necessary to ensure full protection of Prince William Sound and the Gulf of Alaska are discussed below.

Reports of respiratory problems associated with use of Corexit 9580 last summer were received and workers' compensation claims were filed in this connection.

Alternatives

For this report, a range of alternative responses to Exxon's renewed application to use Corexit 9580 were developed for consideration. These are:

(1) Reject the use of Corexit 9580 outright.

(2) Approve use of Corexit 9580 for spot washing unconditionally, as requested.

(3) Approve use of Corexit 9580 for spot washing conditionally for all spot washing sites, with continued use dependent on the presumed demonstrated success of the outcome of initial usage.

(4) Approve use of Corexit 9580 for test spot washing at a specific number of sites, withholding approval for use on the remaining sites until the results of the test demonstrate that the gain from using Corexit 9580 will outweigh the harm of introducing a relatively new and unknown chemical agent into specific areas of Prince William Sound and other oil spill-contaminated areas.

(5) Approve use of Corexit 9580 for test spot washing at a specific number of sites, granting conditional approval for use on the remaining sites in stages as soon as the results of the test demonstrate efficiency of using Corexit 9580. Unconditional approval will be granted only after monitoring data demonstrate that the gain from using Corexit 9580 will outweigh the harm of introducing a relatively new and unknown chemical agent into the specific areas of Prince William Sound and other oil spill-contaminated areas.

Interviews

Dr. James Butler, Harvard University marine pollution specialist and the lead author of the National Academy of Sciences 1989 dispersant reference book, Using Oil Spill Dispersants on the Sea, provided general background. Butler has focused primarily on open-water dispersants and had no substantive information on Corexit 9580.

Dr. Judy Capuzzo, Senior Scientist, Biology, Woods Hole Oceanographic Institute, is a zoologist with background in environmental toxicology and biological oceanography who has been at Woods Hole for 15 years. She reviewed the first four volumes of Exxon's data and concluded that:

(1) Studies of the responses of intertidal and subtidal communities following application with Corexit 9580 are inconclusive due to lack of comparable reference and test study sites.
(2) From a toxicological perspective limited use of Corexit 9580 would be warranted if it provided improved efficiency in cleanup operation.
(3) Application of Corexit 9580 should be field tested for assessment of its efficiency prior to approval because its success is highly dependent on weather conditions, field experience and the condition of the weathered crude oil with which we are dealing.
(4) Field testing should include a pilot program of perhaps two weeks of monitoring intertidal and tidal areas in the test area to determine whether the Corexit/oil mixture is washing into those areas.

Dr. Merv Fingas, Environmental Emergencies Technology Division, Environment Canada, Ottawa, Ontario, is widely recognized for his work in laboratory and field testing of dispersants. The oil industry has funded some of Fingas' research for Environment Canada. Such associations are not uncommon in the Canadian scientific community because government-industry relations are generally less adversarial, and respected scientists feel that such occasional funding should not affect their objectivity.

With a team from Environment Canada, Fingas recently developed a test to measure the effectiveness of 100 products as beachcleaners. On the basis of that study, he said "I feel fairly comfortable using 9580, as opposed to most other chemical measures, which I am opposed to." Of 21 possible beachcleaners, Corexit 9580 was the most effective and least toxic. While Fingas did find that some surface washing agents were more effective, in his estimation the extreme toxicity of these agents eliminated them as possible candidates for shoreline use.

Of particular significance were these findings:

(1) Corexit 9580 removed 45% of the oil in saltwater, compared with 20 other products that removed from one percent to 36%.

(2) Corexit 9580's toxicity on rainbow trout (96-hour LC 50) was >5600 mg/l, compared with 20 other products whose toxicity ranged from 9 to 1500 mg/l. This means it took more than 5,600 milligrams per liter of Corexit 9580 to kill one-half of the rainbow trout exposed to Corexit 9580 for 96 hours, compared to a range of 9 to 1500 mg/l for 20 other products. In other words, Corexit 9580 was significantly less toxic to the test organism than other beachcleaners.

(3) Corexit 9580 was significantly more effective than other possible beachcleaners at lower wash water temperatures.

Fingas suggested that the following requirements should be attached to approval of Corexit 9580:

(1) The site should be set up for optimal recovery of the Corexit/oil run-off, including, where the Corexit/oil run-off enters the water, several layers of booming;

(2) The stipulations should state clearly that the user will use only as much as necessary, and only on specifically approved sites; and

(3) The only formulation that can be used is Corexit 9580 (precluding the temptation to experiment with different versions of the beachcleaner that might have different characteristics and different effects).

Julie Jordan, Project Manager for Scientex Corp., Rockville, Md., reviews product applications for the Environmental Protection Agency. Ms. Jordan was familiar with Exxon's product application to EPA and discussions regarding Corexit 9580 – generally favorable – in the testing community. However, she had no first-hand information and provided references to some of the persons conducting those tests, including Fingas.

Dr. Pat Lane of Halifax, Nova Scotia, is an aquatic ecologist specializing in risk analysis, marine modeling and environmental effects of oil production and development. She and her associates have done research on the effects of the dispersant Corexit 9527 on East Coast salt marshes for the last four years. After a cursory review of the five volumes submitted by Exxon and the three major application letters for the Sierra Club Legal Defense Fund, Dr. Lane remains unconvinced that Exxon has presented sufficient information to justify even limited use on the basis of effectiveness or the absence of adverse environmental effects.

Dr. Lane also expressed concern about the lack of rigorously designed field experiments. According to Dr. Lane, regulators are being asked to approve this product without the standard scientific and statistical research data necessary to validate hypotheses involving both the efficacy and the environmental effects of this formulation. If Corexit 9580 is going to be used on the limited scale proposed by Exxon and the Coast Guard, Dr. Lane advocates preliminary, site-specific testing, much of which can and should be done on a short turn-around basis prior to approval of the remaining 67 sites.

In addition, numerous contacts were made with persons with DEC, other spill-related state and federal agencies, Exxon and the environmental community. A listing of the principal contacts follows.

DEC: J. Bauer, R. Grabbe, M. Kendziorek, J. Kitagawa, R. Morris, A. Viteri.

Other agencies:
M. Kuwada, Alaska Department of Fish & Game
W. Copeland, Alaska Department of Natural Resources
J. Talbot, NOAA
C. Lautenberger, Environmental Protection Agency
Cdr. B. Rome, U.S. Coast Guard

Exxon USA: John Wilkenson, Exxon USA

Other individuals interviewed:

David Hall, Exec. Director, Prince William Sound Conservation Alliance
Eric Jorgensen and Tom Waldo, Sierra Club Legal Defense Fund
R. Ott, Ph. D., President, Oil Reform Alliance, Cordova
Mike Wenig, Trustees for Alaska
G. Zemansky, Ph. D., environmental consultant, Lawrence, Kansas

With the exception of John Wilkenson (Exxon) and Cdr. Rome (Coast Guard), none of the individuals listed above viewed the use of Corexit 9580 with great enthusiasm at this stage of the cleanup. Positions ranged from firm opposition to an attitude near neutrality, with most DEC personnel opposed. Mark Kuwada, Alaska Department of Fish & Game habitat biologist assigned to the EXXON VALDEZ cleanup, summarized his department's opposition in these words.

"The department does not support approval of Corexit 9580 with the limited information that is currently available. Although data appear to indicate that Corexit is of low toxicity for several marine species that were tested, it still could be toxic in concentrated applications and in all likelihood will cause contact-related mortalities to recolonizing organisms (similar to Inipol). Moreover, it has not been shown to be effective in making oil easier to remove and/or recover, and may in fact cause oil to penetrate deeper into beach substrates. We also question whether it is really needed for the applications that Exxon seems to be promoting (coated oil in rocky/boulder habitats). At a minimum, further tests should be required to demonstrate that Corexit is needed in the first place, and that it is an effective agent for both removing and recovering oil."

Document Review

The documents identified on Page 2 of the Executive Summary of this report were reviewed. With one exception (Zemansky), the individuals interviewed were familiar with some portions of these documents. Due to the recent completion of the Exxon and DEC laboratory tests, however, few of the persons interviewed had reviewed all of the listed documents.

Decision

Based on the record assembled for this report, it is recommended that DEC approve limited testing of Corexit 9580 for test spot washing at five sites, to be agreed upon by DEC, the FOSC and Exxon. Conditional approval for use on the remaining sites will be granted in stages, beginning as soon as the results of the test applications demonstrate the efficiency of using Corexit 9580. Unconditional approval will not be granted until monitoring data demonstrate that the gain from using Corexit 9580 will outweigh the harm of introducing a relatively new and unknown chemical agent at this stage of the cleanup.

The record supports approving limited testing only if approval for the remaining 67 sites will not proceed unless the following criteria are satisfied:

(1) testing at the five sites demonstrates that Corexit 9580 is effective and that hot water washing alone is comparatively ineffective;

(2) a serious monitoring program to corroborate laboratory research uncovers no significant problems;

(3) the appropriate land managers concur with application of Corexit 9580 in conjunction with spot washing as a general principle, or in each spot washing subdivision for which the land manager has jurisdiction; and (4) [illegible] safety during application.

For purposes of deciding whether to grant approval beyond the five tests, effectiveness means that the tests demonstrate that

(a) Corexit 9580 removes oil more effectively than hot water alone, that is, it removes oil that hot water washing cannot remove.

(b) pom-poms and sorbent materials will pick up all or large portions of the oil/water/Corexit mixture, and

(c) the application of Corexit 9580 will not increase the percolation of petroleum products into the substrate.

It is anticipated that effectiveness can be demonstrated by test data within a week of the application on the test site. Then, if initial field monitoring results indicate no problems and if work is proceeding satisfactorily on the field monitoring data, then conditional, site-specific approval should be granted for application at the remaining 67 sites.

To complement the acute toxicity laboratory data gathered by Exxon and DEC to this point, field monitoring of the five test sites should focus on gathering data to provide indication that sublethal and chronic toxicity effects of the application of Corexit 9580 will be minimal. The measures in the monitoring program will be determined by DEC. Standard research measures that can be used include:

(a) Intertidal video surveys before, immediately after and ten days after in the intertidal areas below the application;

(b) Population surveys before, immediately after and ten days after, augmented with analyses of some of the dominant organisms for petroleum hydrocarbons and polyaromatic hydrocarbons;

(c) Local sea urchin fertilization and behavioral tests (such as the ability to right themselves when turned over);

(d) Place juvenile pink salmon immediately adjacent to the test site and assay them for Mixed Function Oxidase (good control collections are necessary); and

(e) Histopathological analyses of key benthic invertebrates.

Land manager approval should be granted in writing before the proposed application and should be filed with the DEC.

To insure worker health and safety, application procedures should be reviewed by the State Department of Labor representatives. Workers' compensation claims and other reports of respiratory problems associated with application of Corexit 9580 last year underscore the necessity for this precaution.

Rationale

A. Alternatives

This subsection discusses the alternatives that were considered in formulating this recommendation (numbers refer to the subsections in the section on Alternatives, above):

(1) Outright rejection would avoid the necessity of monitoring the effects of introducing a relatively new and little-understood chemical to Alaska's shorelines. Rejection would also allow the crews to keep cleaning without the distraction of learning a new application technique. In view of the fact that there were only eight crews of eight workers each in the field during the first week of June, with approximately eight weeks remaining until the August 1 date currently scheduled for cleanup termination, it is not clear that experimentation with a beachcleaner is a particularly worthwhile endeavor. On the other hand, rejection seems unwarranted in view of the fact that Exxon believes in its product and very much wants to try it out. It seems inconsistent to ask for better results without also allowing Exxon to try a product it believes will help achieve those results.

(2) The problems containing and collecting Corexit 9580 runoff last year and the gaps in sublethal toxicity data discussed above make unconditional approval unthinkable at this time. Moreover, such a decision would be inconsistent with the net environmental benefit test that is being applied to other cleanup proposals.

(3) Unless the conditions for approval of the remaining sites are clearly spelled out, conditional approval for all sites creates a situation in which test results tend to become irrelevant. For this reason, the third alternative is not preferred.

(4) In view of the short time remaining for work this summer, withholding approval for the remaining sites until all test results are completed would cause delays that would seem to negate the ostensible value of using this chemical product.

(5) By elimination, the alternative that seems most appropriate under the circumstances is to approve the five test sites immediately, with the understanding that conditional approval will be given for the remaining sites if:

- the product performs according to Exxon's expectations;
- preliminary biological data do not uncover any significant problems;
- the land manager for the specific sites agree to the use of Corexit 9580 as specified in Exxon's application letters; and
- all precautions necessary to insure worker health and safety are taken.

In view of the amount and variety of shoreline to be cleaned up before the end of this summer, Exxon should consider adding personnel to accomplish the testing and training for use of Corexit 9580, rather than diverting personnel to this new task who are already productively engaged in cleanup operations.

B. Discussion of Test Criteria

The following subsection further delineates the kind of tests that appear warranted in view of the limited data available on Corexit 9580 at this time.

In his letter of April 26, Exxon's Otto Harrison states that use of Corexit will speed removal and will reduce risks to the environment and to workers posed by the use of an extremely hot water wash. Before introducing unknown chemicals and additional petroleum hydrocarbons into the oil spill area, these assertions should be demonstrated in field application by testing a wash at 100 degrees fahrenheit with Corexit 9580 against a wash at 160 degrees without Corexit 9580. To demonstrate effectiveness,
(a) the runoff of the Corexit test should contain total petroleum hydrocarbons one gallon greater (assuming a one gallon application of Corexit 9580) than the runoff from the hot water control or
(b) the rock face washed with Corexit should be noticeably cleaner than the control rock face.

Some observers do not believe that sorbent pads and booms beneath the area to be spot washed will prevent the Corexit/oil mixture stripped from the rocks from migrating downward, ultimately reaching the water column. Field tests last year conclusively demonstrated that Corexit 9580 solutions were difficult to collect on the water. A test should therefore be devised to measure the total petroleum hydrocarbons (TPH) on the booms and sorbents collecting runoff at the base of the test site. If the Landa unit has sprayed 100 square feet with one gallon of Corexit, the pom-poms and sorbents at the base of the test site should contain at least one gallon of total petroleum hydrocarbons. Alternatively, if a similar rock face can be found nearby for washing with hot water alone, the TPH in the boom below the Corexit site should equal one gallon plus the TPH in the boom beneath the control face.

To demonstrate that spot washing with Corexit 9580 will not introduce significantly quantities of the mixture into the substrate than spot washing with hot water alone, a test site should be selected above an area with enough uniform substrate material to allow samples to be taken before, immediately after and ten days after the application. These samples would be used to measure the total petroleum hydrocarbons in the substrate with and without the use of Corexit 9580.

Exxon further asserts that Corexit 9580 "has no significant impact on the environment." While it is not clear that Exxon's test data fully support this far reaching claim, neither do the data demonstrate serious environmental harm. It should be noted that the asserted intertidal environmental benefit of reducing wash water temperature from 160 degrees to 100 degrees fahrenheit has not been shown.

Several experts said they believe more significant environmental risk may be posed by sublethal and chronic effects than by acute mortality. Most of Exxon's research focuses on lethal effects. In the absence of convincing laboratory test data on sublethal effects and information on the active agents, blanket approval of this new agent does not seem warranted until biological monitoring has at least begun to demonstrate the Exxon assertion.

If preliminary monitoring results are indicative of potential net environmental harm, or if the field monitoring program is not being executed with dispatch, DEC should call for cessation of spot washing with Corexit 9580.

Randy Bayliss

Randy Bayliss
State On Scene Coordinator

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 10
ALASKA OPERATIONS OFFICE
ROOM 537, FEDERAL BUILDING
222 W. 7TH AVENUE, #19
ANCHORAGE, ALASKA 99513

June 4, 1990

REPLY TO ATTN OF: AOA/A

Captain Donald E. Bodron, USCG
Co-Chair Alaska Regional Response Team
c/o Commander (m)
Seventeenth Coast Guard District
P.O. Box 3-5000
Juneau, Alaska 99802-1217

Dear Captain Bodron:

In response to Admiral Ciancaglini's recommendation and request to the Alaska Response Team (RRT) to use Corexit 9580 in the clean up of the Exxon Valdez oil spill this year, I offer the following comments and the position of the Environmental Protection Agency (EPA). After reviewing Exxon's reports on the product and revisiting all available information assembled in last years testing of the product we concurs with Admiral Ciancaglini's recommendation. If 9580 appears to be effective in increasing removal efficiency without decreasing recovery abilities EPA will support use as outlined in Exxon's letter of March 11, 1990.

Our approval is contingent upon the following conditions:

1. Initial use of 9580 is limited to several sites which should be selected to be representative of common types of shorelines and degrees of oiling likely to be encountered in wide scale use.

2. Agencies with primary monitoring oversight authority i.e. USCG and ADEC, as well as RRT member agencies with direct or indirect authority over chemical product use, i.e. EPA and Natural Resource trustee agencies shall be provided the opportunity to witness on site, use of the product during initial trials.

3. Upon completion of these demonstrations and assuming there is still a consensus regarding the use of the product, individual land owners/managers shall be provided the opportunity to review and comment on the respective work orders to be modified for the use of Corexit.

Should you have any questions regarding this matter please feel free to contact me or Carl Lautenberger at 271-5083.

Sincerely,

Alvin L. Ewing
Assistant Regional Administrator

cc: Admiral Ciancaglini, FOSC
Randy Balysis, SOSC
Jim Everts, EPA REG X

STATE OF ALASKA

STEVE COWPER, GOVERNOR

DEPT. OF ENVIRONMENTAL CONSERVATION

OIL SPILL RESPONSE CENTER
3550 DENALI ST., SUITE 705
ANCHORAGE AK 99503

(907) 265-4600

June 5, 1990

Captain D.E. Bodron
Co-Chair, Alaska Regional Response Team
P.O. Box 3-5000
Juneau, AK 99802

Dear Captain Bodron:

This letter responds to Exxon's April 26, 1990 request for Regional Response Team approval of the use of Corexit 9580 beach cleaner. Exxon wants to use Corexit 9580 at an unspecified number of sites in conjunction with spotwashing at about 72 sites during 1990 cleanup of the EXXON VALDEZ oil spill.

At this time DEC approves the limited use of Corexit 9580 for testing at five sites to be agreed upon by DEC, the FOSC and Exxon. The application should be accompanied by testing to demonstrate that the application of Corexit 9580 (1) will remove weathered oil at a significantly lower temperature than with hot water alone and (2) that the loosened Corexit/oil mixture will be captured by the sorbent materials or other measures.

Provided that Corexit 9580 increases removal efficiency and can be picked up, and that monitoring does not indicate significant problems, we anticipate that approval for use of Corexit 9580, as specified in Exxon's proposal letters of April 26 and March 17, will be granted for the remaining 67 sites. Approval would be contingent on the concurrence of land managers for the specific sites.

In developing this position, we have reviewed Exxon's reports and last year's test results. Additionally, we have discussed the proposed application with specialists and interested parties.

We intend to issue a more detailed statement of DEC's position on Corexit 9580 by the end of this week. In the meantime, if you have any questions on our position, please call.

Sincerely,

Randy Bayliss

Randy Bayliss
State On Scene Coordinator

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ 1

To P. CHRISTIANSON	From R. BAYLISS
Co. USCG/RRT	Co. DEC

of Transportation

United States
Coast Guard

Coordinator
U. S. Coast Guard

601 W 5th Ave.
Suite 300
Anchorage, AK 99501
(907) 277-3833

16465
8 June 1990

Mr. Otto Harrison
Exxon Company U.S.A.
P.O. Box 240409
Anchorage, AK 99524-0409

Dear Mr. Harrison:

Enclosed is the Regional Response Team's reply to the application of Corexit 9580 for spot washing. Please note that the following conditions must be met prior to wide area application:

a. Five sites must be chosen for test application. Selection will be determined by Exxon, USCG, ADEC and EPA.

b. Operational recovery measures using sorbents and lower water temperatures need to be proven effective.

c. An opportunity will be given for one representative each from DOI, DOC, EPA, NFS, DNR and CAC to observe a test.

d. Efficiency will be determined by visual science only and no sophisticated sampling programs are required.

I would like to get this issue resolved as quickly as possible. In doing so, it is important that we keep the entire testing and other processes simple!! CDR Reiter of my staff will contact your staff to set up a meeting and work out the details. If you have any questions, please contact me.

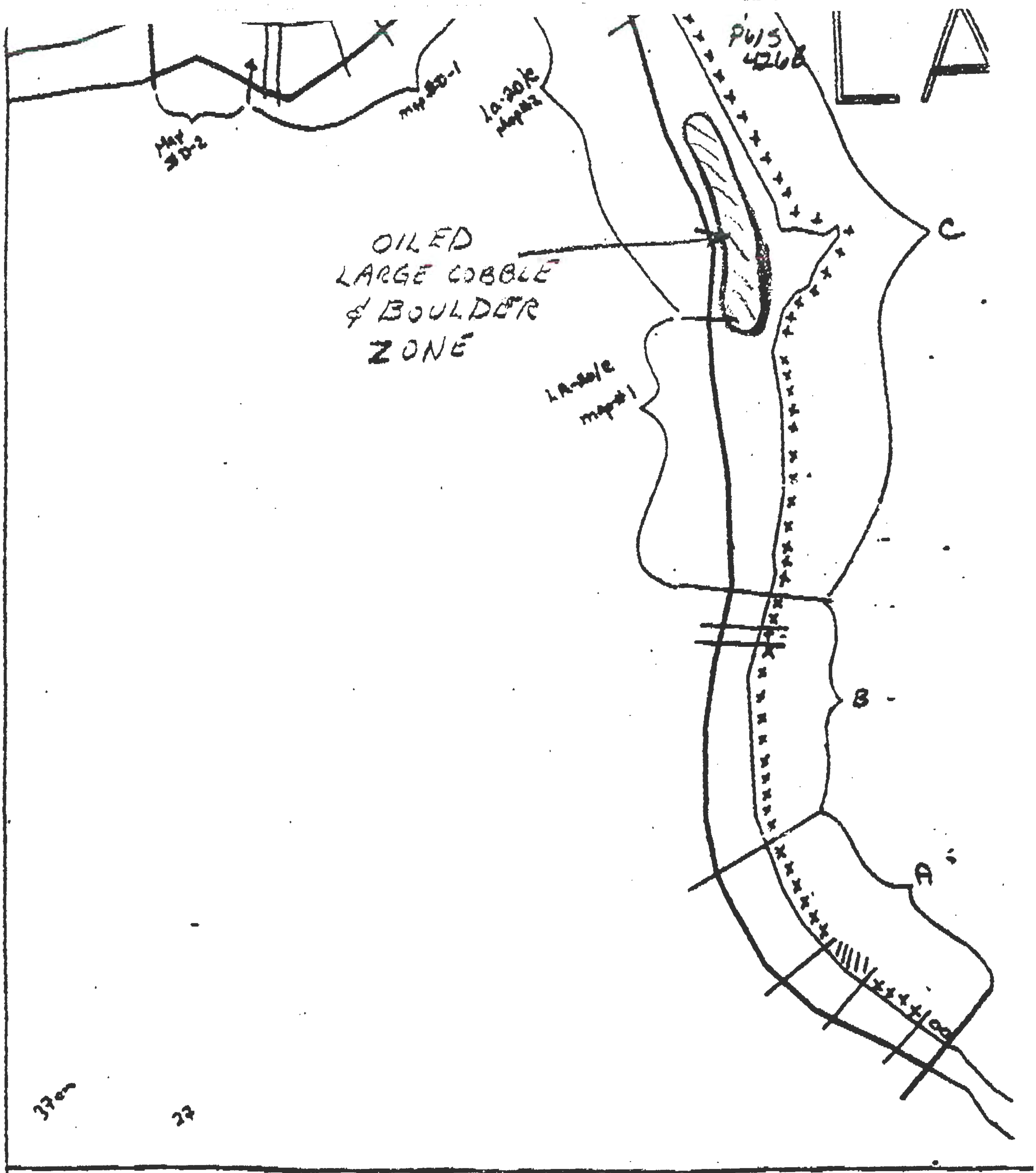
Sincerely,

D. E. Ciancaglini

D. E. CIANCAGLINI
Rear Admiral, U.S. Coast Guard
Federal On Scene Coordinator

Encl: (1) AK RRT ltr of 7 Jun 1990

cc: ADEC, Mr. Randy Bayliss



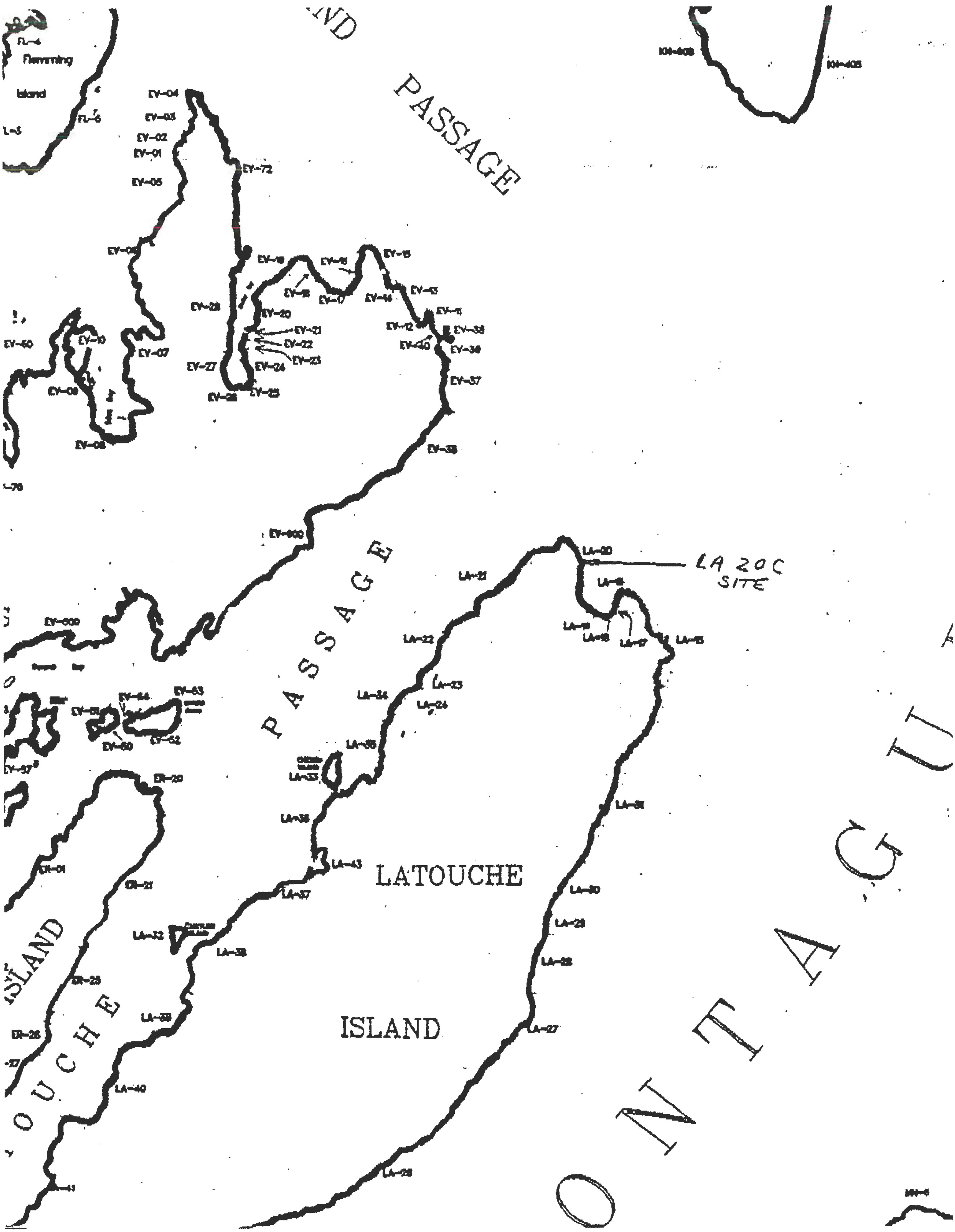
XXXX Wide
//// Medium
---- Narrow
TTTT Very Light
0000 No Oil

LA-20

ABEC Segment Length: 2114m

0 100 200 300
METERS

Map Key: PWS-426a
Name: Reimer
Date: 4/8/90
Date Entered:



PASSAGE
PASSAGE
LA 20C SITE
LATOUCHE
ISLAND
MONTAGUE
EV-04
EV-72
EV-600
LA-20
LA-21
LA-22
LA-23
LA-24
LA-27
LA-28
LA-33
LA-37
LA-43
EV-27
EV-37

EXXON COMPANY, U.S.A.
ALASKA OPERATIONS
POST OFFICE BOX 240409 • ANCHORAGE, ALASKA 99524-0409

Date: June 29, 1990

R. L. MASTRACCHIO
TECHNICAL MANAGER

To: Gary Reiter/ Buzz Rome (USCG)
Joe Talbott (NOAA)
Carl Lautenberger/ Ken Gaylord/ Kirsten Ballard (EPA)
Al Kegler (ADEC)

From: Bob Fiocco/Hans Jahns

Subject: Second COREXIT 9580 Field Demonstration

Exxon Operations is scheduling the second field demonstration of spot-washing with COREXIT 9580 beach cleaner for Sunday afternoon, July 1 , 1990 in Sleepy Bay. This is in followup to the initial demonstration at the Bay of Isles (KN-136) on June 23. The location selected for this demo is a zone on LaTouche Island (LA 20C) comprised primarily of oil-coated boulders and large cobble. The attached maps indicate the specific location.

Two equivalent areas of up to 1000 square feet each will be marked off in this zone. This size is consistent with the upper bound of approximately 33 feet by 33 feet indicated in the FOSC's May 18 letter to the RRT requesting approval for COREXIT 9580 use. Both areas will be spot-washed at the same time, one with hot wash water (target temperature 160° F, range 145-175° F) and the other with warm water (target temperature 110° F, range 100-135° F). Water temperature will be measured at the discharge nozzle. COREXIT 9580 beach cleaner will be applied 15-30 minutes prior to the warm water wash at a rate of 1 gallon per 100 square feet. Sorbent (snare) boom will be used in each area to recover released oil. As directed in the FOSC's June 8 approval letter (attached), efficiency in comparison to the hot water washed area will be determined by visual science only and no sophisticated sampling programs are required. We understand that ADEC will attempt a quantative assessment of each area, such as by extracting oil from snare boom samples and counting barnacles.

We are scheduling a Twin Otter to leave Anchorage at 1:30 PM on Sunday to go to Sleepy Bay. Another flight is scheduled for 2 PM on Monday, July 1, to bring the team out for follow-up visual determinations. Please give Hans Jahns or myself a call to confirm your flight plans and passenger names. In addition to our team, we hope to have representatives from CAC and CVC present, as well as those agencies also mentioned in the FOSC's June 8 letter.

cc: Adm. D. E. Chiancaglini
Colleen Burgh (ADEC)
Peter Nagel (CAC)
Gail Evanoff (CVC)
Paul Gates (DOI)
Bill Copeland (ADNR)
Otto Harrison
Don Carpenter
Bob Mastracchio

AGENDA FOR

OPERATIONS STEERING COMMITTEE

MEETING

JULY 24, 1990 - 5:30 P.M.

GSA/FEDERAL BLDG, 222 W. 7TH ST., ROOMS 133-137, ANCHORAGE, AK

---

1. OPENING REMARKS - *CDR ROME*

2. GENERAL OPERATIONS PROGRESS REPORT - *(ADEC/USCG/EXXON)*

   SPECIFIC TOPICS - *GENERAL OPERATIONS REPORT *(EXXON)*
   *PROGRESS MEASUREMENT REPORT *(EXXON)*
   *TECHNICAL ISSUES - *(EXXON)*
   *BIOREMEDIATION USE - *(ADEC)*

3. BIOREMEDIATION MONITORING PROGRAM STATUS - *(EPA/ADEC/EXXON)*

4. FISHERIES - SURVEILLANCE, STUDIES - *(EXXON)*
   SHEENING STUDIES/REPORTS *(EXXON)*

5. FALL REASSESSMENT PROGRAM - *(EXXON)*

6. CLOSING REMARKS - *REAR ADMIRAL CIANCAGLINI*

OPERATIONS STEERING COMMITTEE
SUMMARY OF MEETING
10 JULY 1990
1730

CAPT David Zawadzki, FOSC Chief of Staff, opened the meeting by mentioning the events since the last meeting and stating that the progress on the anadromous fish streams is outstanding.

Mr. Randy Buckley, Exxon, mentioned that the last two anadromous fish streams in Kodiak have been demobilized. A total of 70 streams in all areas have been treated. He stated that Exxon will be putting resources into the nonstream areas. Today an additional squad has been added and will be focusing on storm berm relocations. One week was spent at Yalik Glacier and it should be done within a few days. Exxon is on schedule in the Kodiak area and will finish up around 1 August. Exxon is ahead of schedule on bioremediation and overall productivity is good and progress is continuing.

Mr. Hans Jahns, Exxon, discussed Corexit 9580 demonstration. The first Corexit 9580 demonstration was done at Knight Island 136. It showed that the side of the rock treated with Corexit 9580 was cleaner than the side washed only with hot water Subsequent to the test, the mussels and barnacles at the bottom of the rockface appeared alive and healthy. A second testing site had been selected and was turned down by CVC. A third site on Knight Island has been indentified. Exxon thinks the demonstration on Knight Island will be the last because time is running out for meaningful application, and the time required to set up and conduct demonstrations detracts from the ongoing cleanup operations.

Mr. Jim Clark, EPA, presented a joint report for ADEC, EPA, and Exxon. The six week report on the bioremediation shoreline monitoring program was turned into FOSC this morning. This report showed that bioremediation is an effective technology for surface and subsurface oiling with minimal environmental effects. He discussed the topics of the report. Acute toxicity tests have been done and none of the tests have come back positive. The report addressed the monitoring of off shore algae growth. The leaking of nutrients into the surrounding waters does not stimulate the algae growth. Relative to rates of degradation he said,"When looking at sites that have oiling in the range of 5 grams of oil per kilogram of sediment, we can stimulate the baseline activity of two grams per year up to five or more. We suspect that bioremediation is a very effective technique to show that or to achieve degradation to clean up that site." Refertilizing of the beaches was discussed. He stated that refertilizing is needed about every 30 days to maintain the high degree of biodegradation.

Question from RADM Ciancaglini: If you were to apply Custom Blen at the 16 day point what type of toxicity effect would it have on the shoreline.

Mr. Jim Clark: I predict none.

Mr. Marshall Kendziorek, State of Alaska, discussed projected oil degradation over a 12 month period. In areas where fertilizer is applied there is significantly less oil. The State of Alaska is encouraged by the results of the toxicity tests.

Mr. Dennis Kelso, State of Alaska, discussed the application of bioremediation over the next year. State of Alaska feels that one year is a reasonable time period to remove the remaining oil. He mentioned that bioremediation has been one of the main tools used in the past year. Bioremediation is very effective if it is applied in a particular way and overall, the State feels that bioremediation can be used as a very effective tool. Over the next year, the State of Alaska would like to use bioremediation as the main technique on beaches that have 5 grams of oil per kilogram of beach or less. On beaches with over 5 grams of oil per kilogram the State of Alaska would like other techniques to be considered, in addition to bioremediation.

Mr. Hap Pritchard, Environmental Protection Agency, discussed the bioremediation research project. He praised the collaboration between EPA, DEC, UAF, and Exxon on this research project. He went over some of the objectives. The main objectives of the testing are to provide additional information on the rates of biodegradation and to look at further technology development in fertilizer application. Tests are being conducted at three locations: Passage Cove, Disk Island, and Elrington Island. Passage Cove, last years test site, acted as a definitive test site in the use of bioremediation. On return to the site this Spring positive results could be seen on the beach surface. The chemistry results from the sites show significant statisitical differences from the application of the fertilizer. Results from the sites where fertilizer was applied suggest biodegradation rates on the order of 10 to 15 milligrams per kilogram of beach material (Total Oil). The addition of the fertilizer primed a biological effect that enhanced a 2 to 3 fold increase of oil degradation over the control site, which was degrading oil at a rate of 5 milligrams per kilogram of beach material per day. Physically making the oil more available to the bacteria through tilling can further enhance the total effect of the biodegradation process. At Elrington Island a "pulse" method of fertilizer application is being tested at this time. Further technology is being sought to optimize fertilizing and potential new bioremediation methods are being looked at. He stated that adding fertilizer has had a significant long term effect on both surface and subsurface oil.

Question from the Audience: The beach where you tested the subsurface oil, was this a high energy beach or a low energy beach?

Mr. Hap Pritchard: I would call that beach moderate to low energy.

Question from the Audience: You are using the term biodegradation very losely. You're talking about total removal of material. Have you done any studies to show how much has actually been washed away?

Mr. Hap Pritchard: Yes, there are changes in the chemistry of the oil that can not be accounted for any other way than biodegradation.

Mr. John Robinson, NOAA, discussed the summer monitoring program. NOAA is establishing ecological sites that are unoiled, heavily oiled or lightly oiled, and trying to see if recolonization is taking place on these sites. He mentioned that the data for the monitoring program will be publicly available and feels that this is very important for future oil spills.

Ms. Nina Springer, Exxon, mentioned that she is speaking on behalf of both Exxon and ADEC. Ms. Springer gave an update on rock washers. She stated that preparation of the test site is complete and presently they are cleaning up around the site. The construction of the primary structural framework for the equipment will be done by Friday, 13 July. She discussed the design of the cleaning process. At this point the oil separation process design has been completed, however there are still a few aspects that need to be worked out such as the design of the nozzles and boilers. The hydraulic system still needs to be designed. The contractor doesn't expect to start the first test until late July or early August. She pointed out that Exxon and the contractor have put in a lot of overtime to speed up progress.

Mr. John Robinson, NOAA, stated that during the past week the Net Environmental Benefit Analysis has been completed. Copies of the analysis are available at the Department of Justice. This study involved the efforts of 24 people, 8 from NOAA, 7 from the State of Alaska, 8 from Exxon, and 1 from the Coast Guard. The report contains all original unedited papers. This report has been forwarded to RADM Ciancaglini, Federal On Scene Coordinator, so he can make a final decision on rock washing. NOAA feels that the damage from rock washing outweighs the damage done by the subsurface oil. The major concern with rock washing was the gross disruption of the shoreline in that it would require quite some time to come back. None of the methods approved for this year cause such destruction of the the shoreline as would be caused by excavation.

Question from the Audience: Does the rock washing technique affect microbe population?

Mr. John Robinson: This was not considered in the study.

Mr. Rick Eichner, Exxon, stated that fishing season has gone very well so far this year. Fishing is underway at all 5 of the ADF&G management areas. There have not been any reports of oil in these areas or in the fish. At this point, Mars Cove in Port Dick is the only site that is closed, but it is not a prime fishing area. The fish have not yet returned to Port Dick. Exxon hopes to have this area open soon. He discussed the test fishing program Exxon did with ADF&G on the more heavily oiled beaches in Prince William Sound. A total of 42 sets were done in Point Helen, Bishop Rock, Fox Farm, and Sleepy Bay. The nets used had small strips of white webbing that were closely examined in order to determine contamination. Thirty eight small stains from hydrocarbons were found during testing. Thirty six of them tested positive for refined products, and 2 of them tested positive for ANS crude. In all cases the level of oiling was very light.

Mr. Dan Egging, Exxon, summarized the sheens that have been observed in the past few weeks. Seven surveillance overflights for sheens were conducted. Three were conducted to support the downed aircraft near Seward. The number of sheens related to the Exxon Valdez spill still remains very small. The trend still shows a decrease in Exxon Valdez related sheens. During the past two weeks 6 sheens related to the Valdez spill or undetermined sources were sighted. The amount of oil from these sheens was less than 6 cups. The number and volumes of sheens from vessels is much greater than from sheens attributed to the Exxon Valdez.

RADM David Ciancaglini, Federal On Scene Coordinator, mentioned that the anadromous fish streams are completed. He thanked everyone for the extraordinary efforts that were put into cleaning the streams. He gave a special thanks to Alaska Fish and Game. He mentioned that in approximately 7 days he will make a decision on the rock washer. Kodiak will be finished in early August. The survey assessment team will begin around 1 - 15 August. From 15 August to 15 September cleaning will be done as necessary. On 15 September operations for this season will be terminated. The next Operations Steering Committee meeting will be held on Tuesday 24 July at 5:30 p.m.

STATE OF ALASKA

STEVE COWPER, GOVERNOR

DEPT. OF ENVIRONMENTAL CONSERVATION

OIL SPILL RESPONSE CENTER
2550 DENALI ST., SUITE 705
ANCHORAGE AK 99503

(907) 265-4600

July 20, 1990

Captain D.E. Bodron
Co-Chair, Alaska Regional Response Team
P.O. Box 3-5000
Juneau, AK 99802

On May 1, 1990 ADEC gave conditional approval for use of nutrients for bioremediation on the EXXON VALDEZ oil spill. Those conditions included strict adherence to the Technical Advisory Group (TAG) process, adherence to 1990 operational procedures and close scientific monitoring.

We are encouraged by the results of the joint DEC/Exxon/EPA Bioremediation Monitoring Program. We now know the advantages, environmental limitations, and operational constraints for application, and reapplication, of Inipol and Customblen on our shorelines contaminated by the EXXON VALDEZ oil spill. Please refer to Commissioner Kelso's July 18 letter to Admiral Ciancaglini, attached.

From the results of the studies completed to date, we now approve bioremediation with the attached stipulations in place. These stipulations supplement existing operational guidelines in place for bioremediation.

Compliance with these stipulations and guidelines will ensure that this oil discharge will be cleaned up pursuant to 18 AAC 75.140(a) and 40 CFR 300.

Randy Bayliss

Randy Bayliss
State Representative
EXXON VALDEZ Oil Spill
Alaska Regional Response Team

attachments (2)

cc: Federal On-Scene Coordinator, USCG
Otto Harrison, Exxon Company USA

1990 Supplemental Bioremediation Operational Stipulations

These stipulations supplement 1989 and 1990 Bioremediation Operational Guidelines currently in place.

Site Preparation

Manual, mechanical, or other approved cleanup techniques, as prescribed in the Work Order, shall be used to remove tar mats, mousse, pooled oil, and residual oil in sediments down to a "mid-OR" condition, which is equivalent to five grams per kilogram.

Nutrients may be added to areas with oil concentration no greater than mid-OR or 5 g/kg. Where consensus based on visual assessment on-site cannot be reached by cleanup monitors and operators, DEC will take representative sample(s) of the sediment and analyze them for oil concentration.
Results can be available within 24 hours of sampling.

Reapplication

Reapplication of bioremediation, where necessary, at properly prepared sites shall occur no sooner than 3 days after initial or previous application. For optimum results, reapplication should occur at 15 to 30 days after initial or previous application.

Deterrence

Deterrent measures and notice must be used to keep wildlife and humans away from newly treated beaches for at least 24 hours after application.

ADEC/OSRC 7/20/90 RBB:cdb
RBB

STATE OF ALASKA

STEVE COWPER, GOVERNOR

DEPT. OF ENVIRONMENTAL CONSERVATION

OIL SPILL RESPONSE CENTER
2550 DENALI ST., SUITE 705
ANCHORAGE AK 99503

(907) 265-4600

July 18, 1990

Captain D.E Bodron
Co-Chair, Alaska Regional Response Team
P.O. Box 3-5000
Juneau, Ak 99802

On June 5, 1990 I authorized five sites to be tested for Corexit 9580 use in the 1990 T/V Exxon Valdez oil spill cleanup. Exxon has since requested approval based on results from two test sites.

On June 23 Exxon tested Corexit at Bay of Isles, Knight Island. No attempt was made to recover loosened oil/Corexit mixture at this site. Furthermore temperature controls at this site did not approach the target temperature of 110 degrees F.

On July 14 Exxon again tested Corexit at Herring Bay, Knight Island. Results varied with the smoothness and angle of the rocks washed. While solvent action did enhance the oil removal efficiency, hot water alone also proved to be effective. Recovery methods used with Corexit failed to prove to be more effective than with hot water alone.

Therefore, I cannot at this time approve use of Corexit 9580. If further testing is proposed this decision will be reconsidered as authorized in the June 5, 1990 conditional approval.

This decision has been made in consultation with the Alaska Department of Fish and Game, the Alaska Department of Natural Resources (the intertidal land owner), Chenega Village Corporation, Prince William Sound Conservation Alliance, and others.

Randolph Bayliss

Randolph Bayliss
State Representative
Exxon Valdez Oil Spill
Alaska Regional Response Team

STATE OF ALASKA

STEVE COWPER, GOVERNOR

DEPT. OF ENVIRONMENTAL CONSERVATION

July 18, 1990

RADM D.E. Ciancaglini
United States Coast Guard
Federal On-Scene Coordinator
601 West Fifth Ave, Suite 300
Anchorage, Alaska 99501

Dear Admiral Ciancaglini:

Governor Cowper has asked me to respond to your letter of June 22. Since then you and I have had several opportunities to discuss the progress and some of the problems associated with this year's response. This letter will serve to clarify some positions, re-enforce others, and provide constructive direction to the response through the end of the summer.

Following is a list of goals, strategies, and policy statements that will, the state agencies believe, provide a roadmap for the response through the 1990 season.

1. **Bioremediation guidelines**

The results of the recent bioremediation monitoring study are encouraging for several reasons:

* When properly applied and monitored, bioremediation causes less environmental damage than the spilled oil;

* The process degrades most kinds of oil a maximum of two to three times faster than natural degradation;

* The data give us a benchmark for determining the limits of the technology.

Therefore, a continuing program of state- and federal-directed bioremediation is consistent with the State's 1990 response. The monitoring studies confirm our earlier determination that bioremediation is a useful tool that can be safe and effective within its performance limits.

Bioremediation is best used as a polishing, or secondary treatment; every effort must be made first, by other methods, to get the concentrations of oil down to a level where bioremediation will finish the job in a reasonable amount of time. Based on what we have learned, the following state policy on bioremediation will help ensure effective treatment:

a) Where concentrations of oil exceed five grams per kilogram of beach material, mechanical or manual techniques must be used. These techniques have already been shown to clean beaches down to this concentration (equal to a mid-OR range, which reflects current protocol).

b) At 5g/kg or less, bioremediation can be applied, using State of Alaska guidelines, with periodic reapplications. (Specific conditions for field operations using bioremediation will be contained in ADEC correspondence to the Regional Response Team at the beginning of next week.)

c) We have no objection to the use of mechanical/manual methods concurrent with bioremediation as long as worker safety can be maintained, and concentrations can be brought to the 5g/kg threshold before reliance on the fertilizers as the polishing agent.

d) If any areas have oil that cannot be removed with bioremediation, we expect cleanup to continue with appropriate mechanical/manual techniques as long as oil can be recovered.

e) The work at a given site should not be considered complete until the limit of the technology has been reached. We now have a useful formula for judging the limits of bioremediation under favorable conditions (5g/kg over the course of a year). If that target range is not met everywhere by this year, more work will be required in 1991.

2. **Wider use of mechanical support**

Use of mechanical equipment should be substantially increased to improve the efficiency and effectiveness of every cleanup team. Use of small backhoes or tracked vehicles has been extremely effective, and more of these machines should be deployed with cleanup crews.

This is particularly important in light of the fact that rockwashing technology will not be available during the 1990 season. The State of Alaska response team was encouraged to note your willingness to employ other mechanical methods to speed removal of subsurface oil (July 16 letter to Randy Bayliss, SOSC). Persistence of oil in the subsurface of state-owned tidelands continues to be a principal concern of the State of Alaska.

3. **Post-treatment assessment program**

Assessment teams from the state, the federal government and Exxon should begin surveying sites now and continue through the end of the season. A priority list of segments developed by the principal response entities should be reviewed each week. After priority segments have been inspected, there should be random inspections of demobilized segments. The state will probably use some independent citizen oversight as a part of its assessment.

4. State authority

Based on documented field reports, the statutory authority of the State of Alaska to oversee response and to require certain actions is not fully understood by some U.S. Coast Guard personnel.

Authority to take action regarding oil spill response and natural resource management can be found generally in Title 46 (ADEC), Title 16 (ADF&G), Title 41 (ADNR), and other sections of State of Alaska statutes and the Alaska Administrative Code.

The state requests that the FOSC instruct his staff to respect the authority, directions and suggestions of state monitors exercising their responsibility to ensure proper cleanup, protect state resources, or mitigate further damage to those resources. Based on our recent conversations, you have expressed a clear intent to stick to the management structure agreed to last year, when Admiral Yost made the commitment to make all decisions "in concert and in consonance" with the State of Alaska. The State of Alaska is the principal owner of tidelands, the principal fisheries manager, and the principal wildlife manager in the spill area. State resources received the most damage. Clearly, Admiral Yost was sensitive to that and made his commitment with that in mind. This commitment must be expressed at the top and fully implemented in the field.

5. State standards

In addition to the technology-based standard for cleanup set by ADEC under its authority, ADNR and ADF&G may set additional standards based on their authority and responsibility.

The "net environmental benefit" process employed to assess the use of a rockwashing machine was incomplete. However, you seem to recognize the need to more fully integrate into the cleanup calculus considerations of high human use (July 16 letter to Randy Bayliss), socioeconomic needs, and other factors that are not necessarily based on technology, biology, or environmental health and safety.

For example, ADNR has particular requirements concerning visible oil or oiled debris in state parks, regardless of the threat to the biota. ADF&G may set stricter standards for areas in special legislative designations, in subsistence use areas, or areas of high commercial value. Though ADEC is the lead state agency in oil spill response, we expect the standards of other state agencies to be fully applied in determining when cleanup has reached its effective limit. A general standard of "more harm that good" is not necessarily restricted to environmental or biological considerations, and in some cases it is appropriate to value human use above certain biological or environmental considerations.

6. Timetable and deadlines

The State of Alaska has never recognized August 15 as a deadline for completion of work during 1990. The type of work, the size of crews and the deployment of the equipment in 1990 are on a considerably smaller scale -- by several orders of magnitude -- than the 1989 season. Therefore, a demobilization period as long as the one in 1989 is not needed.

September 1 is an appropriate date to begin scaling back, and September 21 is a better target for completion of most work in the 1990 season, depending, of course, on weather, worker safety, extent of oiling, and the limits of the technologies at our disposal.

Looking ahead, we should set a goal of September 15, 1991 to complete the response to the T/V Exxon Valdez oil spill.
The State of Alaska and the Coast Guard should require Exxon's commitment to undertake the work necessary to reach that goal.

To accomplish this goal, both the state and the Coast Guard must work with Exxon, while remembering that the government -- not the corporation -- has the authority and responsibility to determine when shoreline treatment has reached its effective limit. Exxon's views should be considered, but it is not Exxon's decision.

The State of Alaska will conduct Fall 1990 and Spring 1991 shoreline surveys. They will be similar to those done last fall and spring. We will concentrate on treated shoreline, but we will also survey a small number of shoreline segments that were not treated.

7. **Conclusion of work**

Without the direct concurrence of the State of Alaska, no segment may be demobilized, no segment may be officially released, and no work may be deemed complete. This authority rests on the statutory grounds cited above, as well as the management agreement reached with Admiral Yost last summer.

We believe that state standards do not differ substantially from the National Contingency Plan, and concurrence is likely as long as the state is a full partner in all determinations made by the FOSC in the future.

I hope this letter clarifies our position and increases the effectiveness of the response to the T/V Exxon Valdez oil spill. Your cooperation in this matter is greatly appreciated.

Sincerely,

Dennis D. Kelso

Dennis D. Kelso
Commissioner

STEVE COWPER, GOVERNOR

FOSC ✓9-1
OPS
NOAA ——
HIST ——

DEPT. OF ENVIRONMENTAL CONSERVATION
OFFICE OF THE COMMISSIONER
P.O. BOX O
JUNEAU, AK 99811
(907) 465-2600

August 31, 1990

Admiral David E. Ciancaglini
Federal On-Scene Coordinator
U.S. Coast Guard
Key Bank Building
501 West 5th Avenue Suite 300
Anchorage, AK 99501

Dear Admiral Ciancaglini:

The State of Alaska is on record against the proposed relocation of heavily oiled subsurface sediments on Ushagat Island in the Barren Islands (US-010 A). The proposed relocation of the oiled sediments to the face of the summer storm berm will only redistribute the oil back into the marine environment. This activity will not attempt to contain or recover any of the large quantity of oil present at this site. In Exxon's proposal dated August 9, 1990, which was approved by the FOSC on August 20, Exxon considers a specific advantage of relocation to be the fact that they "do not have to recover sheen." Repeated oil release, far greater than "sheen", will occur from this site based on the known quantity of oil-saturated subsurface sediments.

The Barren Islands are an important haul out area for over a thousand sea lions and support resident populations of sea otters and harbor seals. Sea lions have recently been listed as a threatened species under the Endangered Species Act due to severely declining population numbers. It is very important to the State of Alaska that the heavily contaminated oiled sediments be removed in order to reduce the risk of harm to these wildlife resources and the surrounding marine environment.

The proposed activity assumes that severe winter storm activity and severe tidal flushing will work on the newly oiled berm face, causing an intermittent release and dissipation of oil. In fact, in addition to the severe weather events referenced by Exxon, the oiled spring/summer berm will actually break down during the routine higher tidal cycles that occur in the fall and winter, creating a persistent oiling to the shoreline and a continued oiling threat to the resident wildlife in the area. The relocated oiled sediments will consequently be distributed back up onto the higher beach area and remain as a source of further contamination.

The proposed activity, in effect, creates an oil spill. The oil dispersion into the lower intertidal area and the nearshore water constitutes a discharge of a harmful quantity of oil into the navigable waters of the U.S. in violation of the federal Clean Water Act. The discharge of a hazardous substance is also a violation of State of Alaska water quality standards, 18 AAC 70, promulgated under the authority of the federal Clean Water Act. Oil pollution is prohibited by Alaska Statutes 46.03.740.

The planned relocation activity at US-010 A would allow the transfer of the contamination from one area on a beach to another - with no recovery of the spilled oil. In our view, this is intolerable. It is particularly unacceptable in this situation because Exxon has the ability to remove the heavily oiled sediments, as they have done at other sites. The FOSC-approved relocation method allowing oil to be simply spread around on a beach to be agitated, picked up, and carried by tidal action --with no requirement to recover oil-- sets an alarming precedent.

On behalf of the three state resource agencies, we request that you rescind approval of the proposed sediment relocation on Ushagat Island (US-010 A). As you know the Alaska Department of Natural Resources is the intertidal lands manager. We believe that Exxon should be required to remove the oil saturated sediments for offsite disposal. Therefore, we further request that the FOSC so direct Exxon.

Dennis Kelso

Dennis D. Kelso
Commissioner
Department of Environmental Conservation

Don W. Collinsworth ww

Don W. Collinsworth
Commissioner
Department of Fish and Game

Rod Swope

Rod Swope
Commissioner
Department of Natural Resources

DC:DC:RS:tdg
cc: Otto Harrison, Exxon
Doug Bailey, Attorney General
Jerome Selby, Kodiak Is. Borough
Don Gilman, Kenai Peninsula Borough

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
AE001A	A	6/9/90	X	6/9/90	6/9/90	X	5/17/90	5/17/90	NFS
AE002A	A	8/2/90	X	6/9/90	8/2/90	X	6/6/90	6/6/90	NFS
AE004A	A	8/2/90	X	6/14/90	8/2/90	X	6/1/90	6/4/90	NFS
AE004B	A	8/2/90	X	6/9/90	8/2/90	X	6/2/90	6/3/90	NFS
AE005A	A	8/2/90	X	6/15/90	8/2/90	X	5/17/90	5/23/90	NFS
AE005B	A	8/28/90	X	7/8/90	8/28/90	X	6/3/90	6/3/90	NFS
AE005C	A	8/2/90	X	6/15/90	8/2/90	X	6/5/90	6/6/90	NFS
AE007A	A	5/23/90				X	5/23/90	5/23/90	NFS
AG001A	D	8/10/90	X	7/15/90	8/10/90				NFS
AG009A	D	8/12/90	X	7/14/90	8/12/90	X	5/13/90	5/13/90	NFS
AG009B	D	5/13/90				X	5/13/90	5/13/90	NFS
BA001B	A	6/22/90				X	6/22/90	6/22/90	NFS
BA001C	A	6/22/90	X	6/22/90	6/22/90	X	6/22/90	6/22/90	NFS
BA001E	A	6/23/90				X	6/23/90	6/23/90	NFS
BA002A	A	8/27/90	X	6/23/90	8/27/90	X	5/5/90	5/7/90	NFS
BA006C	A	8/11/90	X	8/11/90	8/11/90	X	7/26/90	7/27/90	NFS
BA007A	A	5/29/90				X	5/29/90	5/29/90	NFS
BA008A	A	6/23/90				X	6/23/90	6/23/90	NFS
BC002A	F	8/18/90	X	8/18/90	8/18/90	X	8/14/90	8/18/90	DNR
BC002B	F	8/18/90	X	8/18/90	8/18/90				DNR
BL012A	B	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	NFS
BM005A	F	7/11/90				X	7/10/90	7/11/90	NPS
BM006A	F	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NPS
CB001A	F	8/10/90	X	8/10/90	8/10/90	X	7/13/90	8/10/90	PG
CB002A	F	7/19/90				X	7/18/90	7/19/90	EB
CB003A	F	5/20/90				X	5/16/90	5/20/90	GVC
CB003B	F	8/9/90	X	8/9/90	8/9/90	X	5/26/90	8/9/90	GVC
CB003C	F	7/19/90				X	6/19/90	7/19/90	GVC
CB004A	F	8/10/90	X	6/25/90	8/10/90	X	5/20/90	8/10/90	ER
CB004B	F	8/10/90	X	6/25/90	8/10/90	X	5/24/90	8/10/90	EB
CB004C	F	6/25/90	X	6/25/90	6/25/90	X	6/17/90	6/17/90	EB
CB004D	F	6/25/90	X	6/25/90	6/25/90	X	6/17/90	6/17/90	EB
CB004E	F	8/9/90	X	8/9/90	8/9/90	X	7/20/90	8/9/90	EB
CH001A	A	8/27/90	X	7/3/90	8/27/90	X	6/16/90	6/16/90	CVC
CH002A	A	8/27/90	X	7/3/90	8/27/90	X	6/14/90	6/14/90	CVC
CH002B	A	8/7/90	X	7/3/90	8/7/90	X	6/15/90	6/17/90	CVC
CH003A	A	8/7/90	X	7/3/90	8/7/90				CVC
CH008A	A	8/7/90	X	7/3/90	8/7/90	X	6/17/90	6/17/90	CVC
CH009A	A	7/4/90				X	7/4/90	7/4/90	CVC
CH009B	A	8/7/90	X	7/19/90	8/7/90	X	7/19/90	7/19/90	CVC
CH010A	A	8/7/90	X	7/19/90	8/7/90	X	7/19/90	7/19/90	CVC
CH010B	A	8/7/90	X	7/3/90	8/7/90	X	6/19/90	6/19/90	CVC
CH010C	A	7/19/90				X	7/19/90	7/19/90	CVC
CH011A	A	8/7/90	X	7/19/90	8/7/90	X	7/19/90	7/20/90	CVC
CH012A	A	8/7/90	X	7/20/90	8/7/90	X	6/21/90	7/20/90	CVC
CH013A	A	8/27/90	X	7/20/90	8/27/90	X	7/20/90	7/20/90	CVC
CH015A	A	6/20/90				X	6/20/90	6/20/90	CVC
CH016A	A	7/3/90	X	7/3/90	7/3/90	X	6/20/90	6/20/90	CVC
CH020A	A	8/27/90	X	7/3/90	8/27/90	X	6/20/90	6/20/90	CVC
CI001A	F	8/25/90	X	8/12/90	8/25/90	X	8/5/90	8/25/90	PG

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
CP001A	A	6/9/90				X	6/6/90	6/9/90	NFS
CR001A	A	6/5/90	X	6/5/90	6/5/90				NFS
CR002C	A	6/6/90	X	6/6/90	6/6/90	X	6/5/90	6/5/90	NFS
CR005A	A	6/6/90	X	6/6/90	6/6/90	X	5/28/90	5/28/90	NFS
CR005B	A	8/14/90	X	6/6/90	8/14/90	X	5/28/90	5/28/90	NFS
CR005E	A	5/27/90				X	5/27/90	5/27/90	NFS
CU001A	A	8/2/90	X	6/9/90	8/2/90	X	5/18/90	5/23/90	NFS
CU003A	A	6/9/90	X	6/9/90	6/9/90	X	5/29/90	5/29/90	NFS
CU007A	A	7/8/90	X	7/8/90	7/8/90	X	6/22/90	6/22/90	NFS
CU010A	A	7/14/90				X	7/12/90	7/14/90	NFS
CU011A	A	8/2/90	X	6/8/90	8/2/90	X	5/29/90	6/5/90	NFS
CU013A	A	8/2/90	X	6/7/90	8/2/90	X	6/2/90	6/3/90	NFS
CU014A	A	8/28/90	X	8/2/90	8/28/90	X	6/21/90	6/22/90	NFS
CU015A	A	6/21/90				X	6/21/90	6/21/90	CVC
CU017A	A	8/28/90	X	7/7/90	8/28/90	X	6/21/90	6/21/90	NFS
DA001A	C	8/31/90	X	7/18/90	8/31/90	X	5/13/90	7/17/90	NFS
DI059A	B	8/4/90	X	5/27/90	8/4/90	X	5/12/90	5/12/90	NFS
DI062A	B	5/27/90	X	5/27/90	5/27/90	X	5/12/90	5/13/90	NFS
DI063A	B	7/9/90	X	7/9/90	7/9/90	X	6/11/90	6/11/90	NFS
DI064A	B	5/29/90	X	5/29/90	5/29/90	X	5/29/90	5/29/90	NFS
DI064B	B	7/10/90	X	7/9/90	7/10/90	X	5/29/90	5/29/90	NFS
DI065A	B	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	NFS
DI066A	B	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	NFS
DI067A	B	5/10/90		9/1/90	9/1/90	X	5/9/90	5/10/90	NFS
DI068A	B	5/12/90				X	5/12/90	5/12/90	NFS
DI069A	B	9/1/90	X	5/27/90	9/1/90	X	5/13/90	5/14/90	NFS
EA001A	F	8/9/90				X	8/9/90	8/9/90	FWS
EB004A	A	5/25/90				X	5/25/90	5/25/90	NFS
EB006A	A	5/2/90				X	5/2/90	5/2/90	NFS
EB008A	A	5/26/90				X	5/26/90	5/26/90	CVC
EB010A	A	8/15/90	X	6/6/90	8/15/90	X	6/6/90	6/10/90	CVC
EB011A	A	8/15/90	X	6/3/90	8/15/90	X	6/3/90	6/3/90	CVC
EB013A	A	6/1/90				X	5/31/90	6/1/90	CVC
EB015A	A	5/31/90				X	5/31/90	5/31/90	CVC
EI001A	F	7/1/90				X	7/1/90	7/1/90	DNR
EL010A	B	8/6/90	X	7/5/90	8/6/90	X	5/5/90	5/5/90	NFS
EL011A	B	9/1/90	X	7/5/90	9/1/90	X	5/13/90	9/1/90	NFS
EL013A	B	8/29/90	X	7/13/90	8/29/90	X	7/13/90	7/14/90	CVC
EL013B	B	8/6/90	X	7/20/90	8/6/90	X	7/13/90	7/13/90	CVC
EL015A	B	5/25/90				X	5/24/90	5/25/90	NFS
EL052A	B	7/31/90	X	6/28/90	7/31/90	X	5/25/90	5/25/90	NFS
EL052B	B	8/21/90	X	6/28/90	8/21/90	X	5/22/90	5/22/90	NFS
EL053A	B	8/21/90	X	7/19/90	8/21/90	X	7/19/90	7/19/90	NFS
EL053B	B	7/12/90	X	7/12/90	7/12/90	X	7/12/90	7/12/90	NFS
EL054A	B	7/31/90	X	6/27/90	7/31/90	X	5/25/90	5/25/90	NFS
EL055A	B	7/31/90	X	6/24/90	7/31/90	X	6/8/90	6/8/90	NFS
EL055B	B	6/24/90	X	6/24/90	6/24/90	X	5/22/90	5/22/90	NFS
EL055C	B	7/31/90	X	6/24/90	7/31/90	X	6/8/90	6/8/90	NFS
EL056A	B	7/31/90	X	6/27/90	7/31/90				NFS
EL056B	B	7/14/90	X	7/14/90	7/14/90	X	7/14/90	7/14/90	NFS

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
EL056C	B	8/31/90	X	6/26/90	7/31/90	X	5/20/90	8/31/90	NFS
EL056D	B	7/31/90	X	6/27/90	7/31/90	X	5/20/90	5/20/90	NFS
EL057A	B	7/31/90	X	6/26/90	7/31/90	X	5/19/90	5/19/90	NFS
EL058A	B	8/21/90	X	6/27/90	8/21/90	X	5/19/90	5/19/90	NFS
EL058B	B	7/31/90	X	6/27/90	7/31/90	X	5/19/90	5/19/90	NFS
EL058C	B	7/31/90	X	6/27/90	7/31/90	X	5/20/90	5/20/90	NFS
EL058D	B	8/22/90	X	7/19/90	8/22/90	X	7/12/90	7/13/90	NFS
EL102A	B	7/14/90				X	7/14/90	7/14/90	NFS
EL102B	B	7/14/90	X	7/14/90	7/14/90	X	7/14/90	7/14/90	NFS
EL104C	B	8/22/90	X	6/18/90	8/22/90				NFS
EL105A	B	7/5/90	X	7/5/90	7/5/90				NFS
EL106B	B	8/21/90	X	7/12/90	8/21/90	X	6/25/90	6/28/90	NFS
EL106C	B	7/31/90	X	7/5/90	7/31/90				NFS
EL107A	B	8/22/90	X	7/12/90	8/22/90	X	6/23/90	6/25/90	NFS
EL107B	B	7/31/90	X	7/11/90	7/31/90	X	6/25/90	6/25/90	NFS
EL107C	B	9/1/90	X	7/11/90	9/1/90	X	5/23/90	9/1/90	NFS
EL108A	B	4/29/90				X	4/28/90	4/29/90	NFS
EL108C	B	7/11/90	X	7/11/90	7/11/90	X	6/26/90	6/26/90	NFS
EL109A	B	9/1/90	X	7/11/90	9/1/90	X	5/23/90	9/1/90	NFS
EL110A	B	8/22/90	X	7/5/90	8/22/90	X	5/23/90	5/23/90	NFS
EL110B	B	7/5/90	X	7/5/90	7/5/90				NFS
EN046A	B	8/14/90	X	7/12/90	8/14/90	X	6/26/90	6/26/90	NFS
EN046B	B	6/26/90				X	6/26/90	6/26/90	NFS
ER001A	C	5/30/90				X	5/30/90	5/30/90	DNR
ER002B	C	8/12/90	X	6/22/90	8/12/90	X	6/2/90	6/2/90	NFS
ER005A	C	6/21/90				X	6/21/90	6/21/90	NFS
ER006A	C	6/21/90				X	6/21/90	6/21/90	NFS
ER007A	C	8/30/90	X	6/14/90	8/12/90	X	6/2/90	8/30/90	DNR
ER008A	C	8/30/90	X	6/14/90	6/14/90	X	5/30/90	8/30/90	NFS
ER009A	C	9/1/90	X	6/15/90	9/1/90	X	5/31/90	5/31/90	NFS
ER010A	C	8/12/90	X	6/15/90	8/12/90	X	5/30/90	5/30/90	NFS
ER011A	C	8/12/90	X	6/15/90	8/12/90	X	5/30/90	6/1/90	NFS
ER012B	C	8/12/90	X	6/15/90	8/12/90	X	6/3/90	6/3/90	NFS
ER018A	C	6/19/90	X	6/19/90	6/19/90				NFS
ER020A	C	6/22/90	X	6/22/90	6/22/90		7/21/90		DNR
ER020B	C	5/10/90				X	5/7/90	5/10/90	NFS
ER020C	C	8/29/90				X	5/3/90	8/29/90	DNR
EV001A	C	6/27/90				X	6/27/90	6/27/90	CVC
EV002A	C	7/5/90	X	7/5/90	7/5/90	X	6/27/90	6/27/90	CVC
EV003A	C	8/11/90	X	6/19/90	8/11/90	X	6/10/90	6/10/90	CVC
EV005A	C	8/29/90	X	6/19/90	8/11/90	X	8/29/90	8/29/90	CVC
EV005B	C	9/1/90	X	6/19/90	9/1/90	X	6/9/90	8/29/90	CVC
EV005C	C	6/7/90				X	6/7/90	6/7/90	CVC
EV008B	C	6/2/90				X	6/2/90	6/2/90	CVC
EV009A	C	6/2/90				X	6/2/90	6/2/90	CVC
EV010A	C	6/3/90				X	6/2/90	6/3/90	CVC
EV010B	C	6/16/90				X	6/16/90	6/16/90	CVC
EV012A	C	8/31/90	X	6/6/90	8/31/90	X	5/2/90	8/31/90	CVC
EV014A	C	6/23/90	X	6/23/90	6/23/90	X	6/23/90	6/23/90	CVC
EV015A	C	8/31/90	X	6/6/90	8/31/90	X	6/3/90	8/31/90	CVC

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
EV016A	C	8/7/90	X	7/4/90	8/7/90	X	6/28/90	6/28/90	CVC
EV017A	C	5/15/90				X	5/15/90	5/15/90	CVC
EV018A	C	8/7/90	X	6/6/90	8/7/90				CVC
EV020A	C	7/5/90	X	7/4/90	7/5/90	X	6/28/90	6/28/90	CVC
EV021A	C	8/7/90	X	6/8/90	8/7/90	X	5/11/90	5/14/90	CVC
EV023A	C	5/10/90				X	5/9/90	5/10/90	CVC
EV024A	C	8/7/90	X	6/8/90	8/7/90	X	6/6/90	6/9/90	CVC
EV025A	C	8/31/90	X	8/7/90	8/31/90	X	5/15/90	8/7/90	CVC
EV026A	C	8/7/90	X	6/9/90	8/7/90	X	6/2/90	6/2/90	CVC
EV027A	C	5/16/90				X	5/16/90	5/16/90	CVC
EV028A	C	7/3/90	X	7/3/90	7/3/90	X	6/2/90	6/2/90	CVC
EV037A	C	7/19/90	X	7/4/90	7/19/90	X	6/15/90	7/19/90	CVC
EV039A	C	7/17/90	X	7/4/90	7/17/90	X	6/9/90	7/17/90	CVC
EV050B	C	6/13/90	X	6/9/90	6/13/90	X	6/5/90	6/5/90	NFS
EV050C	C	8/17/90	X	6/9/90	8/17/90				NFS
EV051A	C	6/13/90	X	6/9/90	6/13/90	X	6/5/90	6/5/90	NFS
EV052A	C	8/17/90	X	7/3/90	8/17/90	X	6/17/90	6/17/90	NFS
EV053B	C	8/31/90	X	7/3/90	8/31/90	X	6/18/90	6/18/90	NFS
EV053D	C	6/5/90				X	6/5/90	6/5/90	NFS
EV054A	C	8/17/90	X	6/13/90	8/17/90	X	6/4/90	6/4/90	NFS
EV060A	C	8/11/90	X	7/3/90	8/11/90	X	6/29/90	6/30/90	CVC
EV060B	C	7/3/90	X	7/3/90	7/3/90	X	6/30/90	6/30/90	CVC
EV070D	C	8/11/90	X	6/10/90	8/11/90	X	6/2/90	6/2/90	NFS
EV070E	C	6/28/90				X	6/27/90	6/28/90	NFS
EV070F	C	9/1/90	X	6/12/90	9/1/90				NFS
EV070G	C	8/11/90	X	6/11/90	8/11/90	X	6/10/90	6/11/90	NFS
EV070H	C	6/18/90				X	6/18/90	6/18/90	NFS
EV072A	C	6/29/90	X	6/29/90	6/29/90	X	6/28/90	6/29/90	CVC
FA002A	A	5/28/90				X	5/27/90	5/28/90	NFS
FL001A	C	6/11/90	X	6/11/90	6/11/90	X	5/2/90	5/2/90	CVC
FL002A	C	6/11/90	X	6/11/90	6/11/90	X	5/17/90	5/17/90	CVC
FL004A	C	8/11/90	X	6/29/90	8/11/90	X	6/19/90	6/21/90	CVC
FL004B	C	8/11/90	X	6/29/90	8/11/90	X	6/19/90	6/19/90	CVC
FL005B	C	6/30/90	X	6/30/90	6/30/90				CVC
GR001AA	E	8/16/90	X	7/13/90	8/16/90	X	6/28/90	6/29/90	NFS
GR001BA	E	8/15/90	X	7/15/90	8/15/90	X	6/28/90	6/29/90	NFS
GR002A	E	7/31/90	X	6/29/90	7/31/90	X	7/29/90	7/29/90	NFS
GR005A	E	7/29/90				X	7/29/90	7/29/90	NFS
GR007A	E	6/28/90	X	6/27/90	6/28/90	X	6/27/90	6/27/90	NFS
GR008A	E	7/31/90	X	6/25/90	7/31/90	X	6/25/90	6/25/90	NFS
GR009A	E	7/29/90	X	6/25/90	7/29/90	X	6/25/90	6/25/90	NFS
GR010A	E	7/29/90	X	6/27/90	7/29/90	X	6/27/90	6/27/90	NFS
GR015A	E	8/16/90	X	7/15/90	8/16/90				NFS
GR101A	E	7/30/90	X	7/30/90	7/30/90	X	7/29/90	7/29/90	NFS
GR101B	E	7/30/90	X	7/30/90	7/30/90	X	7/29/90	7/29/90	NFS
GR103A	E	8/31/90	X	6/24/90	8/31/90	X	6/24/90	6/24/90	NFS
GR103B	E	7/31/90	X	6/26/90	7/31/90	X	6/26/90	7/31/90	NFS
GR103C	E	8/1/90	X	6/25/90	8/1/90	X	6/25/90	6/26/90	NFS
GR104A	E	6/28/90	X	6/28/90	6/28/90				NFS
GR300A	E	6/27/90				X	6/27/90	6/27/90	NFS

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
GR301B	E	6/28/90				X	6/28/90	6/28/90	NFS
GR302A	E	8/1/90	X	6/27/90	8/1/90	X	6/27/90	6/27/90	NFS
IN020A	B	8/7/90	X	7/7/90	8/7/90	X	6/29/90	6/29/90	NFS
IN021A	B	8/7/90	X	7/7/90	8/7/90	X	6/29/90	6/29/90	NFS
IN022A	B	8/23/90	X	5/31/90	8/23/90	X	5/6/90	5/7/90	PG
IN022B	B	8/5/90	X	7/7/90	8/5/90	X	6/10/90	6/11/90	NFS
IN023A	B	8/6/90	X	7/7/90	8/6/90	X	6/10/90	6/10/90	NFS
IN024B	B	8/6/90	X	7/8/90	8/6/90	X	6/10/90	6/10/90	NFS
IN024C	B	6/10/90				X	6/10/90	6/10/90	NFS
IN028A	B	7/8/90	X	7/8/90	7/8/90				NFS
IN029A	B	7/10/90	X	7/10/90	7/10/90	X	6/30/90	6/30/90	NFS
IN030A	B	8/5/90	X	7/8/90	8/5/90				NFS
IN031A	B	5/8/90				X	5/6/90	5/8/90	NFS
IN031B	B	8/5/90	X	5/29/90	8/5/90	X	5/6/90	5/8/90	NFS
IN032A	B	8/23/90	X	7/9/90	8/23/90	X	6/9/90	6/9/90	NFS
IN033A	B	8/7/90	X	8/5/90	8/7/90	X	7/24/90	7/24/90	NFS
IN033B	B	8/23/90	X	7/20/90	8/23/90	X	7/20/90	7/20/90	NFS
K0101-SI011A	G	7/21/90	X	7/21/90	7/21/90	X	7/21/90	7/21/90	DNR
K0101-SI012B	G	7/2/90				X	6/29/90	7/2/90	DNR
K0101-SI012C	G	7/18/90				X	7/17/90	7/18/90	DNR
K0101-SI012F	G	7/18/90				X	7/17/90	7/18/90	DNR
K0101-SI012G	G	7/18/90				X	7/17/90	7/18/90	DNR
K0101-SI013A	G	7/3/90				X	7/3/90	7/3/90	DNR
K0102-SI014A	G	7/21/90				X	7/21/90	7/21/90	DNR
K0102-SI015B	G	7/18/90				X	7/18/90	7/18/90	DNR
K0103-SS002B	G	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	DNR
K0104-NB001B	G	7/22/90				X	7/22/90	7/22/90	DNR
K0104-NB001C	G	7/23/90				X	7/23/90	7/23/90	DNR
K0104-NB001D	G	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	DNR
K0110-SI003A	G	8/25/90	X	7/25/90	8/25/90	X	7/24/90	7/25/90	DNR
K0110-SI005A	G	7/20/90				X	7/20/90	7/20/90	DNR
K0110-SI100A	G	7/25/90				X	7/19/90	7/25/90	DNR
K0111-PI003A	G	7/20/90	X	7/20/90	7/20/90	X	7/13/90	7/13/90	DNR
K0119-SE002A	G	7/19/90				X	7/19/90	7/19/90	FWS
K0204-FB011A	G	6/8/90				X	6/8/90	6/8/90	FWS
K0204-FB013B	G	6/8/90				X	6/7/90	6/8/90	FWS
K0302-IB004A	G	6/5/90				X	6/5/90	6/5/90	FWS
K0302-IB005A	G	6/5/90				X	6/5/90	6/5/90	FWS
K0619-CK005A	G	8/5/90				X	8/5/90	8/5/90	FWS/BIA
K0619-SB006A	G	6/17/90				X	6/17/90	6/17/90	FWS
K0634-SL001A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL002A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL003A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL007A	G	6/17/90				X	6/17/90	6/17/90	DNR
K0634-SL015A	G	7/10/90				X	7/10/90	7/10/90	KIK
K0634-SL017A	G	6/30/90				X	6/30/90	6/30/90	KIK
K0906-CP002A	G	8/26/90	X	8/26/90	8/26/90				NPS
K0908-CD001A	G	7/16/90				X	7/16/90	7/16/90	NPS
K0908-CD002A	G	7/30/90				X	7/29/90	7/30/90	NPS
K0908-CD003A	G	8/14/90				X	8/6/90	8/14/90	NPS

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
K0908-CD003B	G	8/14/90				X	8/4/90	8/14/90	NPS
K0909-CD007A	G	8/28/90	X	7/30/90	8/28/90	X	7/30/90	7/30/90	NPS
K0909-CD008A	G	7/31/90				X	7/31/90	7/31/90	NPS
K0909-CD009A	G	8/20/90				X	8/12/90	8/20/90	NPS
K0910-CD010A	G	7/20/90				X	7/20/90	7/20/90	NPS
K0910-CD011A	G	7/20/90				X	7/20/90	7/20/90	NPS
K0910-CD012A	G	7/21/90				X	7/21/90	7/21/90	NPS
K0910-CD013A	G	7/21/90				X	7/21/90	7/21/90	NPS
K0910-CD014A	G	7/21/90				X	7/21/90	7/21/90	NPS
K0910-CD016A	G	6/8/90				X	6/8/90	6/8/90	NPS
K0910-CD100A	G	7/31/90				X	7/31/90	7/31/90	NPS
K0914-SK101A	G	8/18/90	X	8/18/90	8/18/90	X	8/10/90	8/18/90	NPS
K0917-CC001A	G	7/11/90				X	7/5/90	7/11/90	NPS
K0917-CC002A	G	7/3/90				X	7/3/90	7/3/90	NPS
K0917-CC005A	G	8/6/90				X	8/6/90	8/6/90	NPS
K0917-CC100A	G	7/11/90				X	7/11/90	7/11/90	NPS
K0918-CN001A	G	8/7/90				X	8/7/90	8/7/90	NPS
K0919-HB001A	G	6/14/90				X	6/12/90	6/14/90	NPS
K0919-HB002A	G	6/12/90				X	6/12/90	6/12/90	NPS
K0919-HB003A	G	7/30/90	X	6/27/90	7/30/90	X	6/27/90	7/30/90	NPS
K0919-HB050A	G	8/19/90				X	8/3/90	8/19/90	NPS
K0919-HB100A	G	6/26/90				X	6/25/90	6/26/90	NPS
K0920-CN002A	G	7/30/90				X	7/30/90	7/30/90	NPS
K0921-KU003A	G	7/22/90	X	7/22/90	7/22/90	X	7/20/90	7/20/90	NPS
K0921-KU004A	G	7/22/90	X	7/22/90	7/22/90	X	7/21/90	7/22/90	NPS
K0921-KU006A	G	6/24/90				X	6/16/90	6/24/90	NPS
K0922-CG001A	G	8/4/90				X	8/3/90	8/4/90	NPS
K0924-KU001A	G	6/20/90				X	6/19/90	6/20/90	NPS
K0924-KU002A	G	8/7/90	X	8/7/90	8/7/90	X	8/7/90	8/7/90	NPS
K0934-KB001A	G	7/25/90				X	7/25/90	7/25/90	NPS
K0935-KA002A	G	7/4/90				X	6/25/90	7/4/90	NPS
K0935-KA003A	G	8/13/90				X	6/27/90	8/13/90	NPS
K1002-AB002A	G	8/8/90				X	7/7/90	8/8/90	FWS
K1002-AS007A	G	7/15/90				X	7/15/90	7/15/90	FWS
K1002-AS008A	G	7/15/90				X	7/15/90	7/15/90	FWS
K1002-AS008B	G	8/28/90	X	7/15/90	8/28/90	X	7/15/90	8/28/90	FWS
K1005-AS002A	G	7/19/90				X	7/10/90	7/19/90	FWS
K1005-AS002B	G	7/19/90				X	7/5/90	7/19/90	FWS
K1005-AS004A	G	7/14/90				X	7/14/90	7/14/90	FWS
K1005-AS004B	G	8/29/90				X	7/14/90	8/29/90	FWS
K1007-PB001A	G	6/24/90				X	6/22/90	6/24/90	FWS
K1007-PB019B	G	8/5/90				X	7/25/90	8/5/90	FWS
KN0004A	E	8/2/90	X	6/21/90	8/2/90	X	5/29/90	5/29/90	CAC
KN0005B	E	8/30/90	X	6/22/90	8/2/90	X	5/23/90	8/30/90	CAC
KN0006A	E	5/30/90				X	5/30/90	5/30/90	NFS
KN0007A	E	6/21/90	X	6/21/90	6/21/90	X	6/8/90	6/8/90	CAC
KN0008A	E	8/30/90				X	5/30/90	8/30/90	CAC
KN0009A	E	6/23/90	X	6/22/90	6/23/90	X	6/6/90	6/9/90	CAC
KN0011A	E	6/21/90	X	6/21/90	6/21/90	X	6/5/90	6/5/90	CAC
KN0012A	E	6/21/90	X	6/21/90	6/21/90	X	6/3/90	6/4/90	CAC

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
KN0013A	E	6/21/90	X	6/21/90	6/21/90	X	6/3/90	6/4/90	CAC
KN0014A	E	6/21/90	X	6/21/90	6/21/90	X	6/1/90	6/1/90	CAC
KN0015A	E	7/23/90				X	7/23/90	7/23/90	CAC
KN0016A	E	8/19/90	X	7/21/90	8/19/90	X	5/9/90	7/21/90	NFS
KN0019A	E	8/30/90	X	6/22/90	8/30/90	X	6/4/90	6/4/90	NFS
KN0023A	E	6/22/90	X	6/22/90	6/22/90	X	6/9/90	6/9/90	CAC
KN0024A	E	8/30/90	X	7/22/90	8/19/90	X	7/22/90	8/30/90	CAC
KN0026A	E	8/19/90	X	7/21/90	8/19/90	X	5/17/90	8/4/90	CAC
KN0101A	B	9/1/90	X	7/5/90	9/1/90				NFS
KN0102A	B	8/5/90	X	5/22/90	8/5/90	X	5/5/90	5/7/90	NFS
KN0103A	B	7/12/90				X	5/11/90	7/12/90	NFS
KN0104A	B	8/24/90	X	7/13/90	8/24/90	X	5/4/90	7/11/90	NFS
KN0104B	B	7/10/90				X	7/10/90	7/10/90	NFS
KN0105A	B	5/11/90				X	5/11/90	5/11/90	NFS
KN0105B	B	8/24/90	X	5/26/90	8/24/90	X	5/11/90	5/11/90	NFS
KN0106A	B	5/26/90	X	5/26/90	5/26/90	X	5/16/90	5/16/90	NFS
KN0106B	B	5/16/90				X	5/16/90	5/16/90	NFS
KN0106D	B	5/16/90				X	5/16/90	5/16/90	NFS
KN0107A	B	8/23/90	X	7/5/90	8/23/90				NFS
KN0107B	B	9/1/90	X	7/13/90	9/1/90	X	7/12/90	7/13/90	NFS
KN0108A	B	8/4/90	X	8/4/90	8/4/90	X	8/4/90	8/4/90	NFS
KN0109A	D	9/1/90	X	5/25/90	9/1/90	X	5/25/90	5/25/90	NFS
KN0110A	D	8/24/90	X	7/5/90	8/24/90	X	7/5/90	7/5/90	NFS
KN0111A	D	8/24/90	X	7/17/90	8/24/90	X	7/15/90	7/18/90	NFS
KN0112A	D	7/29/90	X	7/2/90	7/29/90				NFS
KN0112B	D	7/29/90	X	7/2/90	7/29/90				NFS
KN0113A	D	8/9/90	X	5/24/90	8/9/90	X	7/17/90	8/7/90	NFS
KN0113B	D	8/9/90	X	7/19/90	8/9/90				NFS
KN0114A	D	7/30/90	X	7/1/90	7/30/90	X	5/3/90	5/3/90	NFS
KN0115A	D	8/24/90	X	7/17/90	8/24/90	X	7/17/90	7/17/90	NFS
KN0116A	D	7/30/90	X	5/23/90	7/30/90	X	5/3/90	5/3/90	NFS
KN0117A	D	7/30/90	X	5/23/90	7/30/90	X	5/2/90	5/2/90	NFS
KN0118A	D	6/1/90	X	6/1/90	6/1/90				NFS
KN0119A	D	7/30/90	X	6/1/90	7/30/90	X	5/2/90	5/2/90	NFS
KN0121A	D	7/30/90	X	7/1/90	7/30/90	X	5/31/90	5/31/90	NFS
KN0122A	D	8/24/90	X	7/14/90	8/24/90	X	7/13/90	8/9/90	NFS
KN0123B	D	5/31/90	X	5/24/90	5/24/90	X	5/31/90	5/31/90	NFS
KN0124A	D	5/20/90	X	5/19/90	5/20/90				NFS
KN0125A	D	7/29/90	X	6/30/90	7/29/90	X	5/31/90	5/31/90	NFS
KN0126A	D	6/30/90	X	6/30/90	6/30/90	X	5/30/90	5/30/90	NFS
KN0127A	D	5/30/90				X	5/30/90	5/30/90	NFS
KN0127B	D	7/30/90	X	7/15/90	7/30/90	X	7/15/90	7/15/90	NFS
KN0127C	D	7/30/90	X	6/30/90	7/30/90	X	5/29/90	5/29/90	NFS
KN0128A	D	7/29/90	X	6/30/90	7/29/90	X	5/9/90	5/9/90	NFS
KN0129A	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0129B	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0131A	D	7/30/90	X	6/1/90	7/30/90	X	5/9/90	5/9/90	NFS
KN0132A	D	5/29/90				X	5/29/90	5/29/90	NFS
KN0132B	D	8/24/90	X	6/2/90	8/24/90	X	5/26/90	5/29/90	NFS
KN0132C	D	6/19/90	X	6/19/90	6/19/90	X	5/29/90	5/29/90	NFS

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
KN0132D	D	7/29/90	X	6/30/90	7/29/90	X	5/29/90	5/29/90	NFS
KN0133A	D	7/30/90	X	6/30/90	7/30/90	X	5/10/90	5/13/90	NFS
KN0134A	E	8/30/90	X	6/23/90	8/30/90	X	5/23/90	5/26/90	NFS
KN0135A	E	6/23/90	X	6/23/90	6/23/90	X	5/18/90	5/21/90	CAC
KN0135B	E	8/31/90	X	5/21/90	8/3/90	X	5/15/90	8/31/90	CAC
KN0136A	E	8/14/90	X	7/4/90	8/3/90	X	6/9/90	8/14/90	CAC
KN0141A	D	7/29/90	X	7/1/90	7/29/90	X	5/3/90	5/3/90	NFS
KN0141B	D	5/3/90				X	5/3/90	5/3/90	NFS
KN0144B	D	6/30/90				X	5/30/90	6/30/90	NFS
KN0145A	D	7/30/90	X	5/25/90	7/30/90				NFS
KN0200A	E	6/20/90	X	6/20/90	6/20/90	X	5/14/90	5/14/90	CAC
KN0201A	E	6/21/90	X	6/20/90	6/21/90	X	5/31/90	6/1/90	CAC
KN0202A	E	6/1/90				X	5/31/90	6/1/90	CAC
KN0204A	E	6/1/90				X	6/1/90	6/1/90	CAC
KN0205A	E	7/23/90				X	7/23/90	7/23/90	CAC
KN0205B	E	8/30/90	X	6/1/90	8/30/90	X	6/1/90	6/4/90	CAC
KN0206A	E	6/22/90	X	6/22/90	6/22/90	X	6/4/90	6/6/90	CAC
KN0207B	E	7/22/90	X	7/22/90	7/22/90				CAC
KN0208A	E	7/22/90	X	7/22/90	7/22/90	X	7/22/90	7/22/90	NFS
KN0209A	B	8/30/90	X	8/5/90	8/30/90	X	7/29/90	8/1/90	NFS
KN0209B	B	7/12/90	X	7/12/90	7/12/90	X	6/26/90	6/26/90	NFS
KN0209C	B	8/31/90	X	8/14/90	8/31/90	X	8/10/90	8/10/90	NFS
KN0209D	B	8/30/90	X	8/2/90	8/30/90	X	6/27/90	7/29/90	NFS
KN0211E	E	8/27/90	X	5/30/90	7/13/90	X	5/30/90	8/27/90	NFS
KN0212A	E	7/22/90	X	7/22/90	7/22/90	X	5/15/90	5/15/90	CAC
KN0213B	E	8/30/90	X	8/30/90	8/30/90	X	8/7/90	8/27/90	CAC
KN0213D	E	7/29/90				X	7/29/90	7/29/90	CAC
KN0213E	E	8/2/90	X	8/2/90	8/2/90				CAC
KN0300A	D	8/14/90	X	7/11/90	8/14/90	X	5/2/90	5/2/90	NFS
KN0301A	D	7/28/90	X	7/1/90	7/28/90				NFS
KN0301B	D	7/28/90	X	7/1/90	7/28/90				NFS
KN0400A	E	8/31/90	X	7/24/90	7/24/90	X	5/9/90	8/31/90	NFS
KN0401A	E	7/26/90	X	7/26/90	7/26/90	X	7/26/90	7/26/90	NFS
KN0401B	E	8/13/90	X	8/13/90	8/13/90	X	8/9/90	8/9/90	NFS
KN0402A	E	8/31/90				X	7/14/90	8/31/90	NFS
KN0403A	E	8/30/90	X	7/24/90	8/30/90	X	5/11/90	7/25/90	NFS
KN0403B	E	7/14/90				X	7/14/90	7/14/90	NFS
KN0404A	E	8/12/90	X	7/25/90	8/12/90	X	8/11/90	8/11/90	CVC
KN0405A	E	8/12/90	X	7/25/90	8/12/90	X	7/17/90	7/20/90	CVC
KN0408A	E	8/14/90	X	8/14/90	8/14/90	X	8/8/90	8/12/90	NFS
KN0410A	E	7/20/90				X	7/20/90	7/20/90	CVC
KN0411A	E	7/20/90				X	7/20/90	7/20/90	CVC
KN0412A	E	7/25/90	X	7/25/90	7/25/90				CVC
KN0413A	E	5/13/90				X	5/13/90	5/13/90	CVC
KN0500A	D	8/24/90	X	7/7/90	8/24/90	X	7/7/90	7/7/90	NFS
KN0500B	D	8/24/90	X	7/5/90	8/24/90	X	7/5/90	7/20/90	NFS
KN0501A	D	7/30/90	X	7/12/90	7/30/90	X	7/10/90	7/10/90	NFS
KN0502A	D	8/24/90	X	7/12/90	8/24/90	X	7/10/90	7/11/90	NFS
KN0503A	D	7/30/90	X	7/11/90	7/30/90	X	7/11/90	7/11/90	NFS
KN0505A	D	7/30/90	X	7/13/90	7/30/90	X	7/11/90	7/12/90	NFS

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
KN0506A	D	8/9/90	X	7/13/90	8/9/90	X	7/12/90	7/12/90	NFS
KN0508A	D	8/24/90	X	7/11/90	8/24/90	X	5/6/90	5/6/90	NFS
KN0509A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0510A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0552A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0574A	D	5/13/90				X	5/13/90	5/13/90	NFS
KN0576B	D	7/16/90	X	7/16/90	7/16/90				NFS
KN0577B	D	7/16/90	X	7/16/90	7/16/90	X	7/13/90	7/13/90	NFS
KN0578A	D	7/16/90	X	7/16/90	7/16/90				NFS
KN0608A	D	7/20/90				X	7/20/90	7/20/90	CVC
KN0700A	E	7/24/90				X	7/24/90	7/24/90	CAC
KN0701A	E	5/25/90				X	5/25/90	5/25/90	CAC
KN0701B	E	8/24/90	X	7/28/90	8/24/90	X	5/26/90	7/28/90	CAC
KN0701C	E	5/26/90				X	5/26/90	5/26/90	CAC
KN0702A	E	8/24/90	X	7/26/90	8/24/90	X	7/24/90	7/26/90	CAC
KN0702B	E	8/24/90	X	7/24/90	8/24/90	X	7/25/90	7/26/90	CAC
KN0703A	E	8/24/90	X	7/27/90	8/24/90	X	7/24/90	7/26/90	CAC
KN0704A	E	7/26/90				X	7/26/90	7/26/90	CAC
KN5002A	D	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NFS
KN5002B	D	7/30/90	X	7/10/90	7/30/90	X	5/9/90	5/9/90	NFS
KN5012A	D	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NFS
LA015B	C	8/26/90	X	7/3/90	8/26/90	X	6/28/90	8/22/90	CVC
LA015D	C	6/14/90		9/1/90	9/1/90	X	6/12/90	6/14/90	CVC
LA016A	C	8/25/90	X	7/5/90	8/25/90	X	6/12/90	6/12/90	CVC
LA017A	C	8/25/90	X	7/6/90	8/25/90	X	6/16/90	6/17/90	CVC
LA018A	C	8/25/90	X	7/17/90	8/25/90	X	7/16/90	7/16/90	CVC
LA019A	C	8/26/90	X	8/26/90	8/26/90	X	7/16/90	8/26/90	CVC
LA020A	C	8/17/90	X	8/17/90	8/17/90	X	7/11/90	8/14/90	CVC
LA020B	C	8/17/90	X	7/17/90	8/17/90	X	5/23/90	5/24/90	CVC
LA020D	C	8/17/90	X	8/17/90	8/17/90	X	7/29/90	7/29/90	CVC
LA021A	C	8/17/90	X	7/6/90	8/17/90	X	6/13/90	6/13/90	CVC
LA021B	C	8/26/90	X	6/17/90	8/26/90				CVC
LA023A	C	5/25/90				X	5/25/90	5/25/90	CVC
LA024A	C	6/1/90				X	6/1/90	6/1/90	CVC
LA033A	C	8/25/90	X	7/17/90	8/25/90	X	5/9/90	5/12/90	NFS
LA038A	C	8/8/90	X	6/17/90	8/8/90	X	5/12/90	5/12/90	CAC
LA039A	C	8/30/90				X	5/23/90	8/30/90	CAC
LN001A	A	9/1/90	X	7/21/90	8/21/90	X	6/7/90	9/1/90	NFS
LN002A	A	9/1/90	X	6/28/90	8/22/90	X	6/23/90	9/1/90	NFS
LN004A	A	6/8/90				X	6/7/90	6/8/90	NFS
LN005A	A	6/28/90	X	6/28/90	6/28/90	X	6/8/90	6/8/90	NFS
LN006A	B	8/1/90	X	6/28/90	8/1/90	X	6/7/90	6/8/90	NFS
LN007A	A	8/1/90	X	6/28/90	8/1/90	X	6/7/90	6/7/90	NFS
LN008A	A	8/1/90	X	6/28/90	8/1/90	X	6/7/90	6/7/90	NFS
MA001A	A	7/20/90				X	7/20/90	7/20/90	DNR
MA002A	A	8/29/90	X	6/7/90	8/29/90	X	6/7/90	6/7/90	DNR
MA003A	A	5/3/90				X	5/3/90	5/3/90	DNR
MA004A	A	6/4/90	X	6/4/90	6/4/90	X	5/2/90	5/2/90	NFS
MA005A	A	5/2/90				X	5/2/90	5/2/90	DNR
MA006A	A	5/29/90				X	5/29/90	5/29/90	PG

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
MA009A	A	8/15/90	X	6/7/90	8/15/90	X	5/24/90	5/24/90	NFS
MA010A	A	8/14/90	X	6/4/90	8/14/90	X	6/1/90	6/2/90	NFS
MN001A	E	7/23/90				X	7/23/90	7/23/90	NFS
MN002A	E	8/31/90	X	7/21/90	8/31/90	X	7/21/90	7/21/90	NFS
MN003A	E	7/24/90				X	7/24/90	7/24/90	NFS
MN006A	E	7/24/90				X	7/24/90	7/24/90	NFS
MN007B	E	8/16/90	X	7/23/90	8/16/90	X	7/23/90	7/23/90	NFS
MN500B	E	8/16/90	X	7/22/90	8/16/90	X	7/22/90	7/22/90	NFS
MR001A	F	8/29/90	X	8/2/90	8/29/90	X	8/2/90	8/29/90	DNR/CAC
MR001B	F	8/28/90	X	8/3/90	8/3/90	X	8/3/90	8/28/90	NPS
MU001A	D	6/29/90	X	6/29/90	6/29/90	X	6/24/90	6/24/90	NFS
MU001B	D	8/10/90	X	6/29/90	8/10/90	X	6/24/90	6/24/90	NFS
MU001C	D	8/12/90	X	6/29/90	8/12/90	X	6/26/90	6/29/90	NFS
MU002A	D	6/27/90				X	6/26/90	6/27/90	NFS
MU002B	D	6/29/90	X	6/29/90	6/29/90	X	6/27/90	6/29/90	NFS
MU003A	D	8/10/90	X	6/29/90	8/10/90	X	6/27/90	6/27/90	NFS
MU900A	D	5/13/90				X	5/13/90	5/13/90	NFS
NA005A	B	7/9/90				X	7/9/90	7/9/90	DNR
NA006A	B	7/9/90				X	7/9/90	7/9/90	NFS
NA006B	B	7/9/90				X	7/9/90	7/9/90	NFS
NA006C	B	8/29/90	X	7/9/90	8/29/90	X	7/9/90	7/11/90	NFS
NA021B	B	7/8/90				X	7/8/90	7/8/90	NFS
NA023A	B	7/8/90				X	7/8/90	7/8/90	DNR
NA024A	B	7/8/90				X	7/8/90	7/8/90	NFS
NA024F	B	7/10/90	X	7/8/90	7/10/90	X	7/8/90	7/9/90	NFS
NA025A	B	7/8/90				X	7/8/90	7/8/90	DNR
NA026B	B	7/8/90				X	7/8/90	7/8/90	NFS
NA027A	B	7/9/90				X	7/9/90	7/9/90	DNR
NJ001A	A	5/4/90				X	5/3/90	5/4/90	DNR
NJ002A	A	7/20/90				X	7/20/90	7/20/90	PWS
NK001A	F	7/4/90				X	4/28/90	7/4/90	DNR
NK002A	F	8/18/90	X	7/3/90	8/18/90	X	7/3/90	7/4/90	DNR
NK004B	F	7/5/90				X	7/5/90	7/5/90	DNR
NK004C	F	5/13/90				X	5/12/90	5/13/90	DNR
PD001A	F	7/21/90	X	7/21/90	7/21/90	X	6/23/90	6/30/90	DNR
PD001B	F	6/29/90				X	6/29/90	6/29/90	DNR
PD002A	F	5/3/90				X	5/3/90	5/3/90	DNR
PD003A	F	5/5/90				X	5/5/90	5/5/90	DNR
PD004A	F	8/20/90	X	7/12/90	8/20/90	X	6/22/90	8/20/90	DNR
PD004B	F	7/14/90				X	7/14/90	7/14/90	DNR
PD005A	F	7/21/90				X	7/17/90	7/21/90	DNR
PD008A	F	6/20/90				X	6/20/90	6/20/90	DNR
PD010A	F	8/4/90	X	6/21/90	8/4/90	X	6/20/90	6/20/90	DNR
PE002A	F	8/13/90				X	8/13/90	8/13/90	PRV
PN001A	A	7/7/90	X	6/7/90	6/7/90	X	6/7/90	7/7/90	CVC
PN002A	A	8/10/90	X	8/10/90	8/10/90				CVC
PN004A	A	7/19/90	X	7/19/90	7/19/90	X	5/3/90	5/3/90	CVC
PN005A	A	7/19/90				X	7/19/90	7/19/90	CVC
PR002A	A	7/25/90	X	7/6/90	7/6/90	X	6/9/90	7/25/90	NFS
PR003A	A	8/1/90	X	7/6/90	8/1/90	X	6/6/90	6/6/90	NFS

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
PR003B	A	8/23/90	X	7/6/90	8/23/90	X	6/6/90	6/8/90	NFS
PR003C	A	6/8/90				X	6/8/90	6/8/90	NFS
PR003D	A	7/6/90	X	7/6/90	7/6/90				NFS
PR004A	A	8/23/90	X	7/6/90	8/23/90	X	7/26/90	7/29/90	NFS
PR005A	A	8/1/90	X	7/21/90	8/1/90	X	7/11/90	7/11/90	NFS
PR005B	A	8/23/90	X	6/8/90	8/23/90	X	6/8/90	6/8/90	NFS
PR005C	A	8/23/90	X	7/6/90	8/23/90				NFS
PR006A	A	7/11/90				X	7/11/90	7/11/90	NFS
PR007A	A	8/1/90	X	7/6/90	8/1/90	X	6/9/90	6/9/90	NFS
PR008A	A	8/1/90	X	7/6/90	8/1/90				NFS
PR008B	A	8/1/90	X	7/6/90	8/1/90	X	6/11/90	6/12/90	NFS
PR008C	A	8/1/90	X	7/6/90	8/1/90	X	6/11/90	6/12/90	NFS
PR012A	A	7/11/90				X	7/11/90	7/11/90	NFS
PR013A	A	8/1/90	X	7/7/90	8/1/90	X	6/13/90	6/13/90	NFS
PR016A	A	7/21/90	X	7/21/90	7/21/90	X	7/13/90	7/15/90	NFS
PY001A	F	7/13/90	X	7/13/90	7/13/90	X	7/13/90	7/13/90	FWS
PY002A	F	8/30/90		7/21/90	7/21/90	X	7/13/90	8/30/90	FWS
PY006A	F	5/8/90				X	5/8/90	5/8/90	FWS
PY007B	F	5/8/90				X	5/7/90	5/8/90	FWS
PY008B	F	7/28/90	X	7/28/90	7/28/90	X	5/6/90	7/28/90	FWS
PY008C	F	8/20/90	X	7/15/90	8/20/90	X	7/15/90	8/20/90	FWS
PY008E	F	7/28/90	X	7/28/90	7/28/90	X	7/28/90	7/28/90	FWS
PY008F	F	7/28/90				X	7/28/90	7/28/90	FWS
PY011B	F	7/22/90	X	7/22/90	7/22/90	X	5/10/90	5/10/90	FWS
PY012B	F	7/22/90	X	7/22/90	7/22/90	X	5/14/90	5/14/90	FWS
PY015B	F	7/22/90	X	7/22/90	7/22/90	X	5/9/90	5/9/90	FWS
PY015D	F	5/14/90				X	5/14/90	5/14/90	FWS
RB001A	F	8/18/90	X	7/25/90	8/18/90	X	7/25/90	7/25/90	DNR
RB003A	F	7/25/90				X	7/25/90	7/25/90	PG
RB004A	F	7/25/90				X	7/25/90	7/25/90	PG
RB005A	F	8/18/90	X	6/27/90	8/18/90	X	6/26/90	6/27/90	PG
RB005B	F	6/27/90				X	6/26/90	6/27/90	PG
SL001B	D	8/12/90	X	7/14/90	8/12/90				NFS
SL001C	D	8/24/90	X	7/15/90	8/24/90	X	7/15/90	7/15/90	NFS
SL001D	D	8/12/90	X	7/15/90	8/12/90				NFS
SL001E	D	7/14/90	X	7/14/90	7/14/90				NFS
SM005B	E	8/13/90	X	7/16/90	8/13/90	X	7/16/90	7/18/90	NFS
SM006A	E	8/13/90	X	7/19/90	8/13/90	X	7/19/90	7/19/90	NFS
SM006B	E	8/3/90	X	7/18/90	8/3/90	X	7/18/90	7/19/90	NFS
SM006C	E	8/21/90	X	7/19/90	8/21/90	X	7/19/90	6/29/90	NFS
SP019A	B	8/23/90	X	8/6/90	8/23/90	X	8/2/90	8/2/90	NFS
SP043A	B	8/14/90	X	5/31/90	8/14/90	X	5/13/90	5/13/90	NFS
SQ002A	D	7/16/90	X	7/16/90	7/16/90	X	7/16/90	7/16/90	NFS
SQ005A	D	7/15/90	X	7/15/90	7/15/90				NFS
TB002A	F	8/27/90	X	7/14/90	7/31/90	X	7/14/90	8/27/90	DNR
TB003A	F	8/27/90				X	6/20/90	8/27/90	DNR
TB004A	F	7/31/90	X	6/26/90	7/31/90	X	6/9/90	6/17/90	DNR
TB005A	F	7/15/90				X	7/15/90	7/15/90	DNR
TB005B	F	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	DNR
TB006A	F	8/27/90	X	7/31/90	8/27/90	X	7/31/90	7/31/90	DNR

Total Area Completed Subdivisions as of 9/2/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
US001A	F	8/17/90	X	8/17/90	8/17/90	X	6/2/90	8/13/90	FWS
US002A	F	8/17/90	X	8/17/90	8/17/90	X	6/2/90	8/17/90	FWS
US005A	F	6/3/90				X	6/3/90	6/3/90	FWS
US005B	F	8/17/90	X	8/17/90	8/17/90	X	6/3/90	8/17/90	FWS
US007A	F	8/7/90				X	8/2/90	8/7/90	FWS
US008A	F	8/7/90				X	7/31/90	8/7/90	FWS
US009A	F	8/7/90				X	8/6/90	8/7/90	FWS
US012A	F	8/8/90				X	8/8/90	8/8/90	FWS
WA001A	F	8/9/90				X	8/8/90	8/9/90	FWS
WA001B	F	8/8/90				X	8/8/90	8/8/90	FWS
WA002A	F	8/10/90				X	8/10/90	8/10/90	FWS
WB001A	F	6/19/90				X	5/16/90	6/19/90	PG
WB001B	F	5/18/90				X	5/16/90	5/18/90	PG
WB002A	F	7/29/90	X	6/23/90	7/29/90	X	6/2/90	6/3/90	PG/EB
WB002B	F	7/29/90	X	6/23/90	7/29/90	X	5/30/90	6/3/90	PG/EB
WB002C	F	8/25/90	X	6/23/90	8/25/90	X	5/24/90	8/25/90	PG/EB
WB002D	F	7/29/90	X	6/23/90	7/29/90	X	5/19/90	7/29/90	PG/EB
WB002E	F	8/8/90	X	8/8/90	8/8/90	X	5/18/90	8/8/90	PG/EB
WB002F	F	5/18/90				X	5/16/90	5/18/90	PG/EB
WB003A	F	6/8/90				X	6/8/90	6/8/90	PG
WB003B	F	7/22/90				X	6/19/90	7/22/90	PG
WB003C	F	8/7/90	X	8/7/90	8/7/90	X	6/27/90	7/25/90	PG
WB003D	F	8/22/90	X	8/21/90	8/22/90	X	6/27/90	6/28/90	PG
WB003E	F	6/8/90				X	6/8/90	6/8/90	PG
WB004A	F	6/29/90				X	6/29/90	6/29/90	EB/PG
WB006A	F	6/24/90	X	6/24/90	6/24/90	X	5/15/90	5/15/90	PG
WB007A	F	8/7/90	X	6/24/90	8/7/90	X	5/15/90	5/15/90	PG
WB008A	F	5/26/90				X	5/26/90	5/26/90	PG
WB009A	F	7/28/90	X	6/24/90	7/28/90	X	6/5/90	6/7/90	PG
YG002A	F	8/9/90	X	7/5/90	8/9/90	X	7/5/90	8/9/90	NPS
YP004A	F	8/9/90	X	7/11/90	8/9/90	X	7/11/90	8/9/90	DNR

Weekly Activity report for weeks of 8/27 - 9/7
Submitted 9/6/90

To: Sonny Mayer, ERL/GB
Hap Pritchard, Bioremediation Project
Carl Lautenburger, Reg X/AOO
Tom Baugh, OEET

From: Jim Clark JRC

Results of the bioremediation monitoring program were presented at the Region IX Workshop on Oil Spill Response Technology in SanDeigo on August 28-30, 1990. Most people were interested in the application techniques and effectiveness of the fertilizer additions in Alaska. I was questioned about the Alpha Biosea product used during the MEGA Borg spill in Galveston, so I discussed what we had done on our visit to the site in June. I presented the technical difficulties to be overcome in attempting at-sea bioremediation and my skepticism in the kinds of data presented to date from the field program. I was extremely careful to point out what kinds of data are needed to convince me, rather than say I didn't think it worked as stated in press releases.

Returned to Anchorage on 8/31, began reviewing data to go into the September update of the report by the joint ADEC/EPA/EXXON Bioremediation Monitoring Program. Saturday I attended a briefing that Hap presented to the EXXON staff on the Bioremediation Research Program in Valdez. Hap and the other research staff left Alaska that weekend. Finished the data audit and review over the weekend and began writing the report on Monday. A first draft of the September update will be finished by COB Friday, 9/7, and distributed for editorial review and comment. The deadline for the report is Tuesday, September 11, the day of the final public meeting held by the Coast Guard. The Admiral and EPA asked that we present a summary of the findings from the joint monitoring program at that meeting. Since I am the only EPA person involved with the project still in Alaska, I requested that my travel be extended to cover that meeting. Roger Prince of EXXON and I will present the summary.

Roger Prince and I wrote a short proposal (attached) that was submitted to the state and FOSC requesting approval to apply Inipol only to the monitoring station 211E. This site has no surface oiling and has been treated with Customblen alone twice. Bioremediation has been least successful here, so we requested a waiver from the bioremediation application guidelines to allow Inipol to be applied (guidelines state that Inipol be used only where surface oiling is present). We are still awaiting official approval, although initial responses were favorable.

I am planning on returning to Gulf Breeze on September 12, and will be in the office on the 13th.

cc
R. Menzer
R. Wilhour
R. Parrish

PROPOSAL FOR APPLYING INIPOL EAP22 TO BIOREMEDIATION MONITORING SITE KN-211E

The joint EPA/ADEC/Exxon Bioremediation Monitoring Program has monitored the progress of bioremediation on KN-211E since late May. Two applications of Customblen at a rate of 95 g/m^2 have been made to part of the site, but the unfertilized portion has not yet received any fertilizer. As reported in the Interim Report of the Monitoring Program, the Customblen treatments have stimulated microbial activity two- to three-fold on KN-211E, whereas the combined Customblen plus Inipol treatments at KN-132B and KN-135B have stimulated activity three- to six-fold.

The enhanced effectiveness at KN-132B and KN-135B may well be related to the particular properties of Inipol EAP22. As a microemulsion of urea in oleic acid, Inipol EAP22 associates with the oil and supplies nutrients at the oil/water interface. In the course of this association, Inipol EAP22 changes the physical properties of the oil, and this may be very important in providing increased access for the microbial community. Field observations substantiate that bioremediation has been visibly more effective, for surface and subsurface oil, at sites where Inipol EAP22 had been applied.

The final application of fertilizer to KN-211E in early September provides an opportunity to assess the effectiveness of Inipol EAP22 as a treatment for subsurface oil. We propose to treat the entire site with Inipol EAP22 alone at the standard operational application rate. This rate has been shown to be environmentally safe, and there is ample field and laboratory evidence that Inipol EAP22 adheres effectively to both oiled and unoiled surfaces. The objective is to evaluate changes in subsurface nutrient concentrations and microbial activity stimulated by this application. These measurements would be made within the framework of the joint EPA/ADEC/Exxon Bioremediation Monitoring Program, and will be incorporated into the Final Report of this program. The data will provide input for 1991 treatment options, and will help clarify the individual roles of Inipol EAP22 and Customblen in bioremediation.

The site will be sampled before the application of Inipol EAP22, and again 4 to 8 days later, depending on operational schedules. Such timing will allow ready comparison with data collected earlier in the program. The specific measurements to be made will include:

- visual assessment of the effectiveness of application, with particular emphasis on loss of Inipol from the cobble surface
- dissolved oxygen levels in the interstitial water
- fertilizer nutrients in interstitial water
- abundance of oil-degrading and heterotrophic bacteria
- hydrocarbon mineralization activity of the microbial populations

TAB B APP 4 TO ANNEX A OF FOSC/CGD17 EXXON VALDEZ TRANSITION-90 PLAN
FEDERAL AND STATE POINTS OF CONTACT

1. FEDERAL:

NOAA:

Burle Wescott
National Oceanic & Atmospheric Administration
c/o USCG FOSC
Suite 400
Key Bank Bldg
601 W. 5th Ave.
Anchorage, AK 99501
Off: 907-
FAX: 907-

DOI:

Paul Gates
US Department of the Interior
1689 C Street, Room 119
Anchorage, AK 99501
Off: 907-271-5011
FAX: 907-271-4102

DOI FWS:

Paul Gertler/Jill Parker
US Fish & Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
Off: 786-3579 or 786-3377
FAX:

DOI NPS:

Daniel M. Hamson
Chief, Office of Oil Spill Coordination
National Park Service
Alaska Regional Office
2525 Gambell Street
Anchorage, AK 99503
Off: 907-257-2527
FAX: 907-257-2523

DOA FS:

Bruce Van Zee

Forest Supervisor
Chugach National Forest
201 E. 9th Ave., Suite 206
Anchorage, AK 99501
Off: 907-271-2525
FAX:

US EPA:

Carl Lautenberger
US Environmental Protection Agency
222 W. 7th Ave., Box 19
Anchorage, AK 99513
Off: 907-271-5083

DOL OSHA:

Cindy Coe
Department of Labor - OSHA
222 W. 7th Ave., #29
Anchorage, AK 99513-7571
Off: 907-271-5152
FAX:

2. STATE:

ADEC

TAB C APP 4 TO ANNEX A OF FOSC/CGD17 EXXON VALDEZ TRANSITION-90 PLAN
FEDERAL AND STATE POINTS OF CONTACT

EXXON:

437 E Street, Suite 301
Anchorage, Alaska 99501
(907) 271-2461
FAX: (907) 271-2467

Oil Spill Restoration Planning Office

TO: R.A. Ciancaglini

OFFICE/PHONE: 77-586-7377

FROM: Kirsten K. Ballard, U.S. EPA
Environmental Protection Specialist

DATE: 10-2-90

PAGES (incl. cover):

MESSAGES:

Thought you might find this of interest

NOAA Revived for the Green Decade

After 8 years of being strangled by the Reagan Administration, the National Oceanic and Atmospheric Administration is coming back as the people's servant and Earth's protector

HERE'S A QUIZ FOR THE 1990s, the decade of the environment. Which federal agency directed the billion-dollar cleanup of the *Exxon Valdez* oil spill? Which agency considers itself "front and center in the environmental decade"? Which is "the leading federal science agency in global change"? No, not the Environmental Protection Agency. It's NOAA, the National Oceanic and Atmospheric Administration, the same multifaceted agency that forecasts the weather, protects sea turtles, and monitors Earth's rotation to the millisecond.

NOAA was never a household name, and it didn't help that it spent most of the 1980s trying to defend itself against the Reagan Administration's efforts to hack away major pieces of the agency in the name of economy and proper federal-state relations.

But now all that seems to be changing. Enter the environmental President and a highly respected new administrator at the helm and NOAA is suddenly rejuvenating itself. Its proposed budget is up, morale is sky high, and a sense of near-missionary zeal pervades the agency. "Everyone at NOAA is very excited," notes a NOAA watcher on Capitol Hill. "This is such a change: we're all so flabbergasted."

NOAA's sunny new outlook cannot entirely blot out some threatening clouds on the horizon. Aside from the federal budget deficit's looming threat, bureaucratic reorganization could carve up or even absorb NOAA. The agency, which was born in 1970 on the same day as the EPA, is a conglomeration of disparate scientific, regulatory, and service roles. That diversity makes it a prime target as the government considers how to best meet the challenge of the environment decade. For example, NOAA's regulation of ocean activities might fit better in the proposed department of environment than in the Department of Commerce, where the agency is now. Alternatively, NOAA could remain in Commerce, although it has always seemed a bit like a fish out of water there.

But today's uncertainty is nothing compared to the gloom that hung over NOAA during the Reagan years, especially the final 4 years when career bureaucrat Anthony Calio was administrator. Like his immediate predecessors, Calio, an 18-year veteran of NASA, did little to stave off the Administration's annual gutting of the NOAA budget, including the excision of entire programs that were, at the eleventh hour, reinstated by Congress.

NOAA

Morale booster. *NOAA's John Knauss starts off with the respect of his staff.*

Managers in the Sea Grant Program, which funds marine research at universities, spent most of the 1980s juggling budgets whose prospects changed from day to day. At the same time, the NOAA hierarchy was in turmoil as officials fought over shrinking budgets with little guidance from above about where the agency was going. Grumbles one underling about Calio's days at NOAA: "When they weren't fighting among themselves, they didn't know what they were doing."

The man who is credited with the turnaround in the agency's morale and who will be steering it through the still potentially turbulent winds of change is John A. Knauss, 64, who became the NOAA administrator last fall. Until then, he had been a physical oceanographer at the University of Rhode Island's Graduate School of Oceanography, a position he had held for only 2 years following his stepping down after 25 years as the Graduate School Dean.

After a few months to gauge the new man, his troops are nothing short of ecstatic. "He's really been a delight and a real surprise," says NOAA comptroller Rodney Weiher. "He's got a good sense of what this agency is and can be. He's already captured our imaginations." "We all think the world of him," adds Virginia Tippie, one of five assistant administrators. "John's range of knowledge is from physical oceanography to coastal zone management and meteorology. We can't brief him without his asking really tough questions. As a result, he has the respect and admiration of all his lieutenants. The morale is unbelievable."

In Washington, however, Knauss's administrative experience is perhaps of greater importance than his scientific expertise. One Hill staffer describes him as having been "an academic with half a foot in government." During his Rhode Island years, Knauss nurtured a small coastal laboratory into a major research and teaching institution. His frequent service in Washington included membership on the Stratton Commission, which in 1969 recommended the formation of an independent National Oceanic and Atmospheric Agency to ensure "full and wise use of the marine environment."

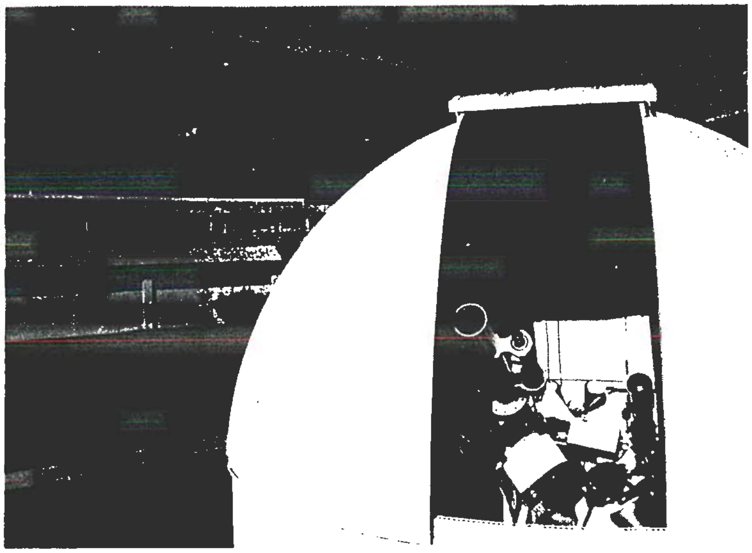
How this respected academic administrator will fare as a full-time participant in the rough and tumble politics of Washington remains to be seen. Among politicos having only a passing acquaintance with the perennially bow-tied Knauss, the most frequent comment is that "he's a nice man, but . . . ."

At first meeting, he comes across as a quiet, even retiring man. Thoughtful pauses mark his conversation; eyelids sometimes droop as he ponders his next words. "He doesn't seem to be a hard-charging guy," notes one observer, "not a dynamic leader." One of his staff concedes the obvious: "True, he's not another Bill Reilly," referring to the dashing head of EPA.

But supporters say first impressions are deceiving. Knauss "shouldn't be underestimated on his political skills," says a Rhode Island colleague who has watched him maneuver in university and state politics. "He has a shy style; he seems quiet, not listening, and then he comes through with the right political move."

Moreover, the staff Knauss is choosing may help make up for his own apparent lack of dynamism. "He's smart enough to know that he needs some scrappers," says assistant administrator Tippie, and she thinks he's got some in herself and Elbert "Joe" Friday of the National Weather Service, among others.

Knauss scored another coup when he landed marine botanist Sylvia Earle, who has just been nominated for the chief scientist position. Tippie, for one, hopes that Earle, a businesswoman, ardent conservationist, co-holder of a deep-diving submersible record, and a prolific writer and speaker, can do for NOAA and the oceans what Surgeon General Koop did for the Public Health Service and the nation's health.


NOAA

NOAA's long reach. *These telescopes help monitor solar disturbances that can disrupt radio communications and power transmission on Earth.*

But to many in NOAA, the most encouraging sign of the dawning epoch is embodied in the team spirit the new appointees are generating. Gone is the infighting that had been endemic for a decade or more. "The chemistry is fantastic," says Ned Ostenso, assistant administrator for research. "There are absolutely no turf battles."

But are there more concrete signs of a NOAA resurgence than high hopes? Nothing in Washington speaks louder than dollars, and there, too, things are looking up, thanks to the Bush Administration. "The important thing," says Knauss, "is that the [Administration's fiscal year 1991 budget] is 35% higher than the one submitted the year before" by the outgoing Reagan Administration. Congress, as usual, restored much of what Reagan cut out, but the 1991 budget proposal is even 9% higher than what Congress gave NOAA last year, Knauss notes.

Part of the big jump in the proposed budget comes in funding for programs that the Reagan Administration targeted for elimination year after year. Each year since 1982, for example, it had routinely zeroed out the Sea Grant Program, which supports marine research at over 200 universities and colleges through 29 institutions that have been designated sea grant colleges (including Knauss's University of Rhode Island), much as land grant colleges have been designated since the time of Lincoln for fostering agricultural research.

Then each year, after much delay and disruption, Congress would reinstate Sea Grant, as it did last year with $41 million. But aside from the chaos engendered by trying to run programs on money that might or might not soon arrive, Congress could never quite keep up. As a result, by the measure of the number of projects that could be supported or the number of graduate students participating, Sea Grant shrank by one-third during the Reagan years. NOAA's Coastal Zone Management Program, which guides states in setting up their own mechanisms for regulating coastal activities, suffered a similar fate.

To Hill staffer Tom Kitsos, the worst of this destructive budgetary seesaw may be past. "Under the Knauss administration," says Kitsos, "it looks positive. There's a feeling here that the budget proposals for the agency are much more in line with Congress's view of what NOAA should be doing than under Reagan."

Kitsos believes that NOAA's problems under Reagan derived from a combination of ideology and economics. On the economics side, cutting Sea Grant's $40 million, for example, meant that much more slashed from domestic spending, a favorite target of Reagan. And from an ideological point of view, Sea Grant and Coastal Zone Management made particularly attractive targets for abolition because they are grant programs to state governments and universities, Kitsos says. "That kind of outreach program through the states was not the kind the Administration wanted to support." If the states were going to benefit, they could pay for it, the reasoning went. Coastal Zone Management had the added burden of endowing states with power over federal activities, such as oil exploration, in their coastal waters.

The Administration also had a generic problem with NOAA, however. "It just felt that NOAA as an agency was largely a creation of the Congress. It was viewed as a kind of science pork-barrel agency," says Kitsos.

Congress itself no doubt contributed to that perception, when, in the absence of leadership by Reagan era NOAA appointees, it took a stronger hand in agency affairs, as in the case of NOAA's National Marine Fisheries Service (NMFS). "Congress has basically managed NMFS for 8 years," observes another Hill staffer. "That's absurd, but with no one else in charge, we came into it." Congress will back off, he adds, if NOAA reasserts its leadership, as it appears to be preparing to do.

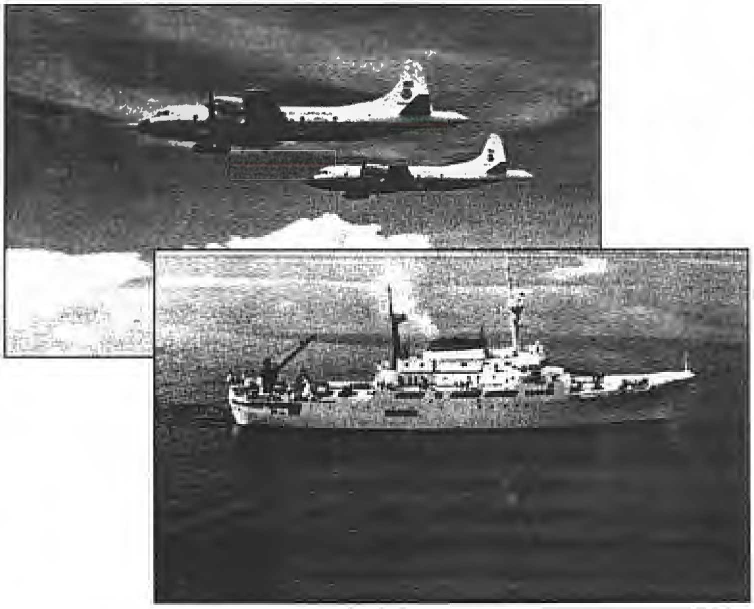
Since Knauss's arrival, much of the ideological baggage of the Reagan era has disappeared—most particularly from the fiscal year 1991 budget, the first the Bush Administration developed from scratch. There are still plenty of lesser examples of philosophical differences between the White House and the Congress. The President's budget slates for elimination everything from state weather modification grants to Alaska salmon enhancement activities. But Sea Grant and Coastal Zone Management are funded. The bad news is that proposed funding levels for 1991 are down $13 million and $5 million, respectively, from last year's appropriations, but as assistant administrator Ostenso notes, "It's not a philosophical issue now, it's just a pricing issue."

Although the Sea Grant and Coastal Zone Management victories loom large with NOAA staffers who spent the past decade in the trenches, two emerging areas —modernization of the Weather Service and research in climate and global change—could be the biggest winners of all in the annual fiscal sweepstakes. With $178 million in the proposed budget for systems acquisition, an increase of $76 million over this year's funding, the Weather Service could get serious about replacing outmoded weather radars (some of which still use vacuum tubes), automating surface weather observations, and integrating radar, satellite, and other data at forecast offices. The goal is to improve weather forecasts, especially those of short-lived severe weather like tornadoes, flash floods, and thunderstorms.

Climate and global change would gain even more, jumping from $18 million this year to $87 million in the coming fiscal year. This largess would go toward monitoring the globe's oceans and atmosphere, research to understand how they can change, and the prediction of that change. Projects involve all five line organizations making up NOAA and include everything from the absolute measurement of sea level change to computer modeling of greenhouse warming.

There is widespread agreement that the modernization and global change initiatives, which have been under way for several years or more, did so well this year on more than simple merit. "NOAA systematically made a plan," says Knauss, "sold it in the department, and sold it in OMB [Office of Management and Budget]." The rationale was that a comprehensive plan with a clearly stated goal would make more sense to the scientifically uninitiated—Department of Commerce higher-ups and OMB budget examiners—than would a seemingly haphazard basket of arcane research projects.

NOAA



By sea and by air. *NOAA operates heavily instrumented planes to investigate weather phenomena and 23 ships for oceanographic research.*

That NOAA's global change research program did so well in the budget process may not be surprising, given the President's call for more research rather than action on global warming. But the program had something else going for it as well. Instead of pitching it just to Commerce's OMB examiners, NOAA last year went into a room with the other agencies having a hand in global change and their respective OMB people.

The agencies had already gotten their act together through a novel organization, the Committee on Earth Sciences. It is an arm of the White House's Office of Science and Technology Policy through which federal agencies such as NOAA, NASA, the National Science Foundation, and others could not just coordinate but actually integrate their global change programs. OMB was so impressed that the four leading agencies all got hefty increases totaling $305 million. "It's a remarkable new mechanism," says Michael Hall, head of NOAA's Office of Global Programs. "It's working better than any committee I've been with."

NOAA's emerging role in studying global change has improved the agency's standing and enhanced its sense of mission, but it also highlights a perennial question—what is NOAA and where in the government does it belong? The climate and global change program is just the sort of endeavor, one involving environmental research, monitoring, and prediction, that many at NOAA see as the agency's bread and butter. And a prediction, whether it deals with tomorrow's weather or the effect of shrimping on sea turtles, can help both public and private decision-makers. Providing prediction services is another function NOAA seems comfortable with.

The rub comes when the science and predictions must lead to regulation, as they often do at NOAA, especially in the fisheries area. The agency's numerous regulatory functions include protecting marine mammals like whales, preserving endangered species like certain sea turtles, and controlling plastic pollution of the oceans. NOAA's regulatory role may loom large on the Hill, Congress having saddled the agency with many of its regulatory duties, but most inside the agency see regulation as something of a necessary evil. "Our theory is that science and regulation don't go hand in hand," says Gray Castle, Commerce deputy undersecretary for oceans and atmosphere and Knauss's deputy.

As an example of the hazards of combining science and regulation, Castle cites the controversy triggered by NOAA's recommendation that shrimpers be required to use turtle excluder devices or TEDs. Attached to shrimpers' nets, TEDs help keep sea turtles from being trapped and drowned. But it is NOAA that feels trapped. "If you're doing the science upon which the regulation is based," says Castle, "the perception can be, rightly or wrongly, that you're doing the science to justify your position." That is just the charge shrimpers, who say that using TEDs will reduce their catch and cost them money, are making against NOAA. That is no way to increase your credibility as a science agency, Castle says, something NOAA is anxious to do. The agency is content with carrying out its present mandates, but he adds, "we certainly aren't seeking any more regulatory responsibilities."

The perceived conflict between credible science and regulation, as well as NOAA's traditional stepchild status in Commerce, have long prompted discussion of whether part or all of NOAA should be moved. The latest talk, and it is only talk so far, is that perhaps NOAA should be incorporated into EPA if it moves up to Cabinet status, as proposed by the White House.

The reaction within NOAA to talk of such reorganization is predictably negative. First, EPA is the epitome of a regulatory agency, so a NOAA-EPA combination is generally frowned upon. Second, things are looking too good at Commerce to move now. "I'll go wherever Congress and the President say to go," says Knauss, "but I feel comfortable at Commerce."

One development making Commerce look good is the solution of the chronic problem of access. "I get to see the Secretary [of Commerce] and his deputy whenever I want to," says Knauss, "and we see each other every few weeks whether I have something in particular to discuss or not." The President even called Knauss in a few weeks ago for a one-on-one briefing prior to Knauss's heading of the U.S. delegation to a regional U.N. meeting on the environment and development. That seems to be a first for a NOAA administrator.

Another attraction of Commerce is the way its interests and NOAA's are melding, according to Knauss. "In a number of ways, NOAA fits better in Commerce than it did 20 years ago," he says. Development, a traditional Commerce interest, and the environment are linked, he says, "and they will be more so. So Commerce is well poised to be one of the key departments in the next century. I think we have just the right mix." If true, and if budget cuts allow, NOAA could well end up at the head of the pack in the environmental decade. ■ RICHARD A. KERR

September 10, 1990

D.E. Ciancaglini
Rear Admiral, U.S. Coast Guard
Federal On Scene Coordinator

Dear Admiral Ciancaglini:

Enclosed are six copies of the September update from the Joint Bioremediation Monitoring Program for distribution among members of the Regional Response Team. This document summarizes data available through September 7 for the monitoring program designed and directed jointly by scientists from the Alaska Department of Environmental Conservation, U.S. Environmental Protection Agency, and Exxon.

The report shows the effectiveness of bioremediation in stimulating the degradation of surface and subsurface oil and the lack of ecological effects following two fertilizer additions at each of three study sites. We provide an estimate of the rate of oil degradation in surface and subsurface sediments based on a number of field samples.

A final report that summarizes all of the 1990 bioremediation monitoring data will be sent to the Regional Response Team by January 1, 1991.

Sincerely,

Roger Prince

James Clark

Jon Lindstrom JRC

Roger C. Prince
Exxon

James R. Clark
USEPA

Jon E. Lindstrom
ADEC

BIOREMEDIATION MONITORING PROGRAM

September 1990 update

Roger C. Prince	James R. Clark	Jon E. Lindstrom
Exxon Research and Engineering	USEPA Bioremediation Program	Alaska Dept. Environmental Conservation
Annandale, NJ 08801	Gulf Breeze, FL 32561	Anchorage, AK 99503

<u>September 10, 1990</u>

EXECUTIVE SUMMARY

The joint ADEC/USEPA/Exxon biodegradation monitoring team has successfully organized and implemented a comprehensive program for assessing the utility of fertilizer amendments for enhancing the biodegradation of surface and subsurface oil, and for characterizing the associated ecological risks. This report presents monitoring data from three study sites showing the effectiveness of two fertilizer applications and serves as an interim assessment pending final analyses of all the data.

Results available to date allow the following conclusions to be drawn.

- The activity of oil-degrading bacteria in surface sediments and subsurface sediments sampled at a depth of 30 cm has been enhanced three to four fold and sustained for 32 days after an initial fertilizer application. A second application replenished nutrients and stimulated microbial activity five to ten fold.

- By employing ratios of degradable and undegradable fractions of the oil components, we have derived an estimate of the baseline oil degradation rate. Although preliminary in nature, several methods provide similar estimates of approximately
  2-5 g oil/Kg sediment/year on the surface
  0.5-2.5 g oil/Kg sediment/year in the subsurface.

- Fertilizer application resulted in no adverse ecological effects.

The report makes a convincing case that fertilizer application is an effective means to enhance oil degradation on surface and subsurface sediments with minimal environmental impact. Reapplication of fertilizers is warranted every 3-5 weeks, and provides an opportunity to capitalize on initial microbial enhancements.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

INTRODUCTION

The State of Alaska's approval for the widespread use of bioremediation as one of the cleanup tools for 1990 was contingent on a detailed monitoring program to show that the technique did indeed speed the biodegradation of oil, and without imposing a significant toxicological impact on the shoreline and nearshore biota. A team of scientists from the Alaska Department of Environmental Conservation, the United States Environmental Protection Agency and Exxon therefore designed such a program. A preliminary report which provided evidence that bioremediation is a safe and effective tool in removing oil from the shorelines of Prince William Sound and the Gulf of Alaska was provided to the Federal On Scene Coordinator on July 10. The report suggested that reapplication of fertilizer after 30 days would probably further stimulate biodegradation of the crude oil, and monitoring the effectiveness of reapplication was included as part of the program. The present report, presented to the Federal On Scene Coordinator on September 11, provides an update based on data available by September 7. A final report, including all the monitoring data, is scheduled for delivery by the end of 1990.

Bioremediation in Prince William Sound in 1990 involved the addition of oleophilic and slow release fertilizers to speed the biodegradation of oil by the indigenous microbial flora. The initial design of the monitoring program was to quantify seven effects of these fertilizer applications;

- the presence of fertilizer nutrients in the beach interstitial water.
- the stimulation of biodegradation, achieved by the addition of fertilizers, at the surface and in subsurface sediments.
- the changes in the amount and composition of oil in the sediments.
- the toxicity to aquatic biota following application of fertilizers.
- the nutrient loading in the water off the treated areas in order to address the potential for stimulating algal growth.
- the amount of dissolved petroleum hydrocarbon in the water off the treated beaches in order to address the potential that enhanced microbial activity on the shorelines might cause the release of petroleum into the water column.
- the rate of disappearance of 2-butoxy-ethanol from Inipol EAP22 treated shorelines.

The results presented in the July 10 Interim Report provided strong evidence that bioremediation was indeed a safe and effective treatment for removing oil from shorelines in Prince William Sound. The program was thus continued with the goal of measuring the following additional effect:

- the potential that additional applications of fertilizer would further stimulate biodegradation of oil.

The program used a variety of field and laboratory techniques. The presence of fertilizer nutrients in the interstitial water was measured in samples collected from perforated stainless steel wells driven into the beach material. These wells were perforated throughout their length, and sampled water from just below the surface to approximately 50 cm into the substrate. Additional wells were sealed so that they only sampled subsurface water collected from a depth of approximately 40-50 cm. Interstitial water samples were analyzed for dissolved oxygen, salinity and temperature on the beach. Additional samples were returned to the ship; some were analyzed for pH, while others were filtered to remove bacteria, preserved, and shipped to analytical laboratories for analysis of ammonia/ammonium, nitrate, nitrite, total Kjeldahl nitrogen and phosphate.

The stimulation of biodegradation achieved by the addition of fertilizers was assessed on both microbiological and chemical criteria. The number of heterotrophic and oil-degrading organisms was determined by most-probable number techniques, and the ability of the oil-degrading organisms to mineralize (convert to carbon dioxide) hydrocarbons was assessed using laboratory assays with radiolabelled hexadecane and phenanthrene. The amount of oil in shoreline sediments was also determined, and the chemical composition of this oil was quantified with gas chromatographic techniques.

The potential toxicity associated with fertilizer application was assessed by collecting samples of water as the tide receded from the treated area and sending the samples to a laboratory for toxicity tests. The toxicity tests followed standard methods employed for testing industrial effluents, and included standard dilution series. Samples were tested with Mysids, a shrimp-like crustacean that is the most sensitive of seven species tested when Inipol was screened in laboratory toxicity tests during the initial review last year. Toxicity was further assessed by quantifying ammonia and nitrate plus nitrite in nearshore waters for four days after application.

The potential for stimulation of algal growth was assessed by monitoring the concentrations of chlorophyll in nearshore waters over the several weeks following treatment. Nearshore waters also were monitored for total hydrocarbon concentrations to characterize the amount of oil leaving the treated shoreline.

Concerns had been raised about the potential hazard to wildlife exposed to the butoxy-ethanol present in Inipol EAP22. The rate of butoxy-ethanol disappearance from Inipol-treated shorelines was measured by collecting oil from the surface of cobbles with gauze swipes and quantifying butoxy-ethanol through GC/MS analyses.

ORGANIZATION

This program was a joint undertaking by USEPA, ADEC and Exxon, and as such was planned and directed by personnel from all three organizations. The responsibilities for the individual parts of the program were as follows.

The field teams were primarily personnel from America North Inc. under contract to Exxon; they made measurements on the beaches, collected samples, and shipped them to the analytical laboratories. Water samples for toxicological analysis were sent to Marine Environmental Consultants, Inc., Tiburon, CA. Water samples for organic nitrogen and total petroleum hydrocarbon analyses were sent to Chemical and Geological Laboratories, Anchorage, AK; those for inorganic nutrients were sent to Dr E. Loder, Institute for the Study of Earth, Oceans and Space, University of New Hampshire, Durham, NH. Sediment samples for microbiological analyses in the initial program were shipped to the laboratory of Dr. E. Brown, Water Research Center, University of Alaska, Fairbanks, AK. Subsequent microbiological analyses were performed in the Alaska Department of Environmental Conservation laboratory in Valdez, AK. Sediment samples for oil content and composition were sent to Battelle Ocean Sciences, Duxbury, MA. Time lapse photography was organized by Polar Alpine Inc., Berkeley, CA. These responsibilities are summarized in tabular form in Table 1.

Exxon chartered three vessels to support personnel at field sites. The 110 ft Jolly Roger served as the base vessel for housing field crews, their sampling gear and scientific equipment, and necessary laboratory space. A smaller vessel, The Three Bears, was used to house and transport field crews during the early part of the program when they were searching for appropriate sites, and when it was necessary to sample at more than one site on a single day. The Joint Operations Transport Command transported personnel to and from the sites, and transported samples to Anchorage for shipping to the analytical laboratories. A 36 ft fast-planing boat, the Inga Kristine, was used to transport samples from the field sites to Cordova for air shipment when air travel within the Sound was restricted. These arrangements ensured that the monitoring team continued operation despite adverse weather, and that all samples were collected and delivered on schedule.

MONITORING SITES

The first part of the program was to select representative shoreline segments that were suitable for monitoring. Key criteria in this selection process were the size of the segment, and the presence of two areas that appeared to be similar so that one could be treated with fertilizer while the other could be left as a reference. After extensive discussions with participants in the Interagency Technical Assessment Group, and examining more than thirty potential sites, three were selected as sites for monitoring; all are at the northern end of Knight Island, as shown in Figure 1.

KN-132B, Herring Bay. A low energy site near an anadromous stream with surface oil. It had not received bioremediation treatment in 1989.

KN-135B, Bay of Isles. A low energy site with surface and subsurface oil. It had not received bioremediation treatment in 1989.

KN-211E, Northeast coast of Knight Island. A high energy site with subsurface oil only. This site had received approximately 68 Kg of Inipol EAP22 and 8.3 Kg of Customblen on an area of 271 m^2 on September 15, 1989. This corresponds to an application of 251 g/m^2 of Inipol EAP22, and 31 g/m^2 of Customblen, but to only a portion of the beach.

Although more heavily oiled than the majority of shorelines receiving bioremediation treatment in 1990, they provided the opportunity to assess bioremediation of surface and subsurface oil, alone and in combination. They were chosen because each had appropriate sediment (small gravel), the appearance of reasonably uniform oiling throughout the oiled zone, an area large enough to be subdivided, and no substantial input of surface water from the supratidal zone. The experimental design focussed on assessing the benefits and risks associated with the addition of Inipol EAP22 and Customblen, so both portions of each site received similar manual treatment before fertilizer application.

TABLE 1
SAMPLING SCHEDULE FOR BIOREMEDIATION MONITORING PROGRAM

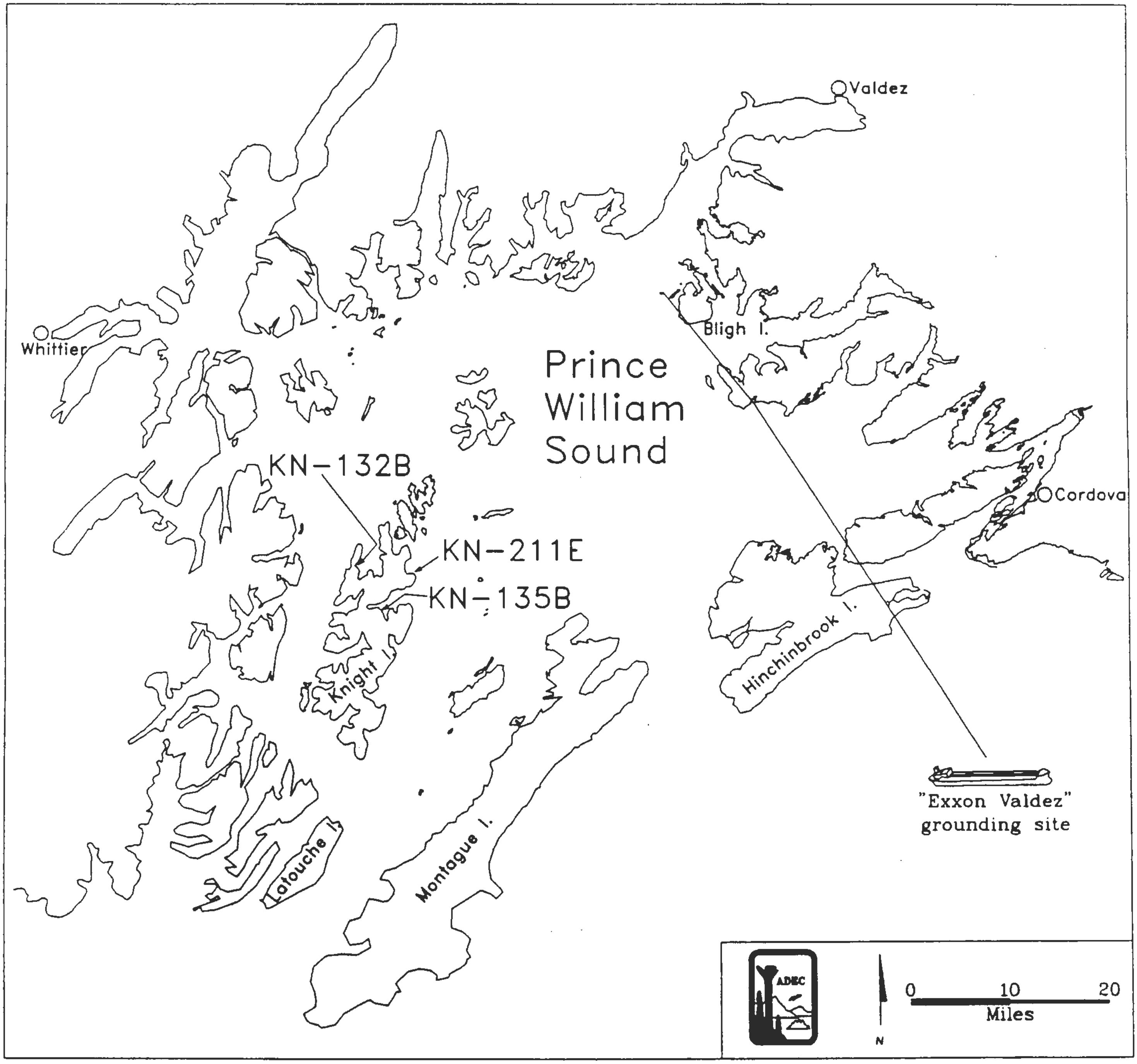
SAMPLE TYPE	ANALYSIS	SAMPLING DAY First application	SAMPLING DAY Second application	LABORATORY
Photography	time lapse video	0-42	-	PAI
Visual observation	Depth of oil	0,2,4,8,16,32	3,17	Field
	Surface oil	0,2,4,8,16,32	3,17	Field
	Fertilizer	0,2,4,8,16,32	3,17	Field
Sediment	Microbial counts	0,2,4,8,16,32	3,17	UAF & ADEC
	Respirometry	0,2,4,8,16,32	3,17	UAF & ADEC
Sediment	petroleum	0,8,16,32	3,17	BOS
	GC/MS	0,8,16,32	3,17	BOS
Interstitial water	dissolved oxygen	0,2,4,8,16,32	3,17	Field
	temperature	0,2,4,8,16,32	3,17	Field
	salinity	0,2,4,8,16,32	3,17	Field
	ammonia, nitrate	0,2,4,8,16,32,	3,17	UNH
	nitrite, phosphate	0,2,4,8,16,32	3,17	UNH
	Kjeldahl nitrogen	0,2,4,8,16,32	3,17	CGL
Water above beach	toxicology	0,1,7,19,32,57,82 hr	-	MEC
	ammonia, nitrate	0,1,7,19,32,57,82 hr	-	UNH
Water above beach	chlorophyll	0,2,4,8,16,32	3,17	Field
	petroleum	0,2,4,8,16,32	-	CGL
	ammonia, nitrate,	-	3,17	UNH
	nitrite, phosphate	-	3,17	UNH
Cobble surface	butoxy-ethanol	1,8,21,46 hr	-	ERE

Samples were collected as indicated, with the exception that KN-135B was sampled on Day 15 rather than 16, and KN-132B on Day 29 and KN-211E on Day 31, rather than Day 32. Additional sediment samples were collected on Day 52 from KN-135B. The second fertilizer application occurred on days 40, 53 and 44 for KN-132B, KN-135B and KN-211E respectively, and samples were collected 4 and 17 days later on KN-132B, 3 and 18 days later on KN-135B, and 3 and 20 days later on KN-211E. - indicates samples not taken.

KEY

Field	Field measurements by America North personnel
PAI	Polar Alpine Inc., Berkeley, CA
UAF	University of Alaska, Fairbanks, AK
ADEC	Alaska Department of Environmental Conservation, Valdez, AK
BOS	Battelle Ocean Sciences, Duxbury, MA
CGL	Chemical and Geological Laboratories, Anchorage, AK
UNH	University of New Hampshire, Durham, NH
MEC	Marine Environmental Consultants, Inc., Tiburon, CA
ERE	Exxon Research and Engineering, Annandale, NJ

FIGURE 1
BIOREMEDIATION MONITORING SITES



As part of the selection procedure for the sites, a large number of exploratory pits were dug on shorelines to determine the degree of oiling, and to delineate areas that seemed sufficiently similar and homogeneous to allow the comparison of fertilized to unfertilized areas. For sediment sampling, the surface was defined as the beginning of fine-grained sediment, and any overlying larger material, whether pebbles or cobbles, was removed prior to sampling.

On KN-132B the fine-grained sediment had little overlying armor, and substantial surface oil penetrating to 2-5 cm throughout the sampling area. Surface samples were taken after mixing the top 5 cm of sediment, and no subsurface sediment samples were taken.

On KN-135B the fine sediment was typically overlain by 10 cm of mixed pebble and cobble. There was substantial surface and subsurface oiling, and while the extent of oiling and depth of penetration was very variable within the segment, the areas chosen for sampling had heavy oiling to a depth of about 40 cm. Surface samples were taken after clearing away the pebble and cobble, and mixing the top 2-5 cm of fine sediment. Subsurface samples, again of fine sediment, were taken 30cm deeper.

KN-211E had no oil within the 15-25 cm of the well rounded surface armor, but substantial subsurface oil extended from immediately below this cobble for 20-50 cm. Surface samples were taken after clearing away the pebble and cobble, and mixing the top 2-5 cm of fine sediment. Subsurface samples were taken 30cm deeper unless this was below the oil horizon, in which case the samples were taken from a few centimeters above the bottom of the oil layer.

SAMPLING STRATEGY

Three undisturbed but apparently similar sampling areas were selected on the fertilized and unfertilized portion of each shoreline, and a perforated pipe (5 cm diameter, 70 cm long) was driven into the beach material at each sampling location; this allowed the gathering of interstitial water, and served as the center of the sediment sampling area. The wells on the area to receive fertilizer were designated A, B and C, while those on the area to remain unfertilized were designated D, E and F. The experimental design focussed on assessing the benefits and risks associated with the addition of fertilizers, so both portions of each site received similar manual treatment before fertilizer application. Samples of interstitial water were planned to be taken before and at 2, 4, 8, 16 and 32 days after the first fertilizer application, and at 3 and 17 days after the second application. These were analyzed for the presence of nitrogen and phosphorus nutrients, dissolved oxygen, salinity and temperature.

With the same frequency, surface and subsurface samples of sediment (approximately 200g) were taken near each well, in triplicate, for analysis of microbial populations and activity. Additional samples (500g) taken before and at 8, 16 and 32 days after the first application, and 17 days after the second application, were analyzed for oil loading and oil chemistry. Each sample came from previously undisturbed sediment.

As the sampling holes were dug, the beach material was placed in a large bucket so that it did not contaminate the surrounding area. After samples had been collected, the bucket was emptied into the hole, and the sampling location marked with a piece of surveyor's tape to exclude this area from subsequent sampling.

Additional wells were added to the fertilized side of each site to sample only subsurface interstitial water, one (Z) at KN-135B and two (Y and Z) at KN-132B and KN-211E. These wells were coated with silicone sealant so that only the bottom 10-15 cm remained permeable. Water samples were collected from these with the same frequency as from the fully perforated wells.

Toxicity issues were addressed during the first application of fertilizer only, using an accelerated sampling schedule. Samples were collected in the fertilized area of the site and at a reference site (control) uninfluenced by the fertilizer applications. The strategy (detailed in Appendix SOP, Section 1) was designed to obtain worst-case representations of fertilizer entering the nearshore environment by sampling at a place along the shoreline where there was minimal dilution, and at a time during the tide that allowed the maximum opportunity for fertilizer release into overlying water. Water samples were collected at 0.5 m depth in an area of the shoreline covered by overlying water to a depth of 1 m. Samples were collected 1 hour after fertilizer application and then at the mid-point of an outgoing tide, after the area had been flooded during high tide. The schedule of sampling at the fertilized site consisted of:

Pre-application sampling (1 to 2 hr before treatment)
(Fertilizer was applied at low tide)
1 hr post application
1st mid-tide outgoing (7-hr post application)
2nd mid-tide outgoing (19-hr post application)
3rd mid-tide outgoing (32-hr post application)
5th mid-tide outgoing (57-hr post application)
7th mid-tide outgoing (82-hr post application)

Water samples were collected at an untreated reference site nearby to minimize logistical problems. The reference site was out of the influence of the fertilizer applications and not immediately influenced by nearshore water flowing from the treated site. Samples from the reference site were collected on the following schedule:

Pre-application
2nd mid-tide outgoing (19-hr post application)
5th mid-tide outgoing (57-hr post application)

All samples were collected as scheduled, kept on ice, and shipped via air express to a testing laboratory in California. Testing began the day samples were received by the laboratory; this was one, two, or three days after collection in the field, depending on the collection schedule, weather conditions for transporting, and weekend shipping schedules. As will be discussed below, no toxicity was detected after the first application of fertilizer, despite over-application of fertilizer at KN-132B and KN-135B. Therefore toxicity testing was not continued when the monitoring program was extended to study a second fertilizer application at each site.

Nearshore water samples for ammonia and nitrate analyses were collected concurrently with the toxicity samples, using the same collection protocol and schedule, but with replicate samples. As with the toxicology assessment, this strategy was designed to characterize the exposures of nearshore biota to toxic components of the fertilizer nutrients under worst-case conditions.

Water samples for the analysis of chlorophyll and total petroleum hydrocarbons were collected concurrently following the first application of fertilizer. Water samples were collected in the nearshore zone of fertilized and unfertilized areas of the monitoring sites as well as in the nearshore zone of the reference site, which was remote from the fertilizer applications. Sampling occurred on the same schedule as the on-shore monitoring parameters. Water was collected at 0.5 m depth at a point over the shoreline where the total depth at the time of sampling was 1 m, following the generalized shoreline sampling scheme for locating sampling sites described in Appendix SOP, section 1. Three samples were taken offshore of the fertilized area, three offshore of the unfertilized area, and three at the reference site. Since no significant levels of petroleum hydrocarbons were detected in the nearshore water, this analysis was not continued after the second application of fertilizer. Analyses of chlorophyll were continued to monitor for the potential stimulation of algal growth.

Sampling for butoxy-ethanol residues on Inipol EAP22 treated surfaces was implemented after the initial monitoring program began, due to delays in method development. Samples were collected by Exxon's operational monitoring team at KN-134A, just south of KN-135B, following treatment on 6/23/90. Two areas were sampled, one in the mid-intertidal zone and one in the upper-intertidal zone. The mid-intertidal area was covered with seawater at each high tide, the upper-intertidal area was not. Several Inipol-treated cobble surfaces were wiped with gauze sponges to collect a minimum of 100 mg of oil, which was used as the basis of the analytical technique. This required wiping approximately 0.25 m^2 of surface. Samples were collected in each area approximately 1 hr after Inipol application and then after the first, second, and fourth high tides.

Schematic maps of the three monitoring beaches, showing the approximate locations of the sampling stations, are presented as Figures 2 to 4.

FERTILIZER APPLICATION

Two fertilizers were used in the 1990 bioremediation program in Prince William Sound. Customblen (TM) 28-8-0 (Sierra Chemicals, Milpitas, CA 95035) is a slow release formulation of soluble nutrients encased in a polymerized vegetable oil; it contains ammonium nitrate, calcium phosphate and ammonium phosphates with a nitrogen to phosphorus ratio of 28:8. Customblen was applied to all bioremediation sites, with the application rate reduced when it was applied in conjunction with Inipol EAP22. Inipol EAP22 (TM) (CECA S.A., 92062 Paris La Defense, France) is an oleophilic fertilizer designed to adhere to oil. It is a microemulsion of a saturated solution of urea in oleic acid, containing tri(laureth-4)-phosphate and butoxy-ethanol. It was applied only where there was surface oil.

Exxon Operations Bioremediation teams applied fertilizers as follows:

KN-132B was treated on June 2, 1990. After manual cleaning and rock-turning, it received 34 g/m^2 Customblen and 302 g/m^2 of Inipol EAP22. A second application, of 17 g/m^2 of Customblen and 302 g/m^2

of Inipol EAP22, was made on July 12. At the request of the Alaska Department of Fish and Game, there was no final application at the end of the monitoring program .

KN-135B was treated on May 21, 1990. After manual cleaning and rock-turning, it received 103 g/m^2 of Customblen and 361 g/m^2 of Inipol EAP22. A second application, of 17 g/m^2 of Customblen and 303 g/m^2 of Inipol EAP22, was made on July 13. The entire segment was treated with Customblen at an application rate of 91 g/m^2 on August 1, 1990. A final application of Inipol at 361 g/m^2 and Customblen at 17 g/m^2 was applied to the entire segment on September 5, 1990.

KN-211E was treated on May 30, 1990. It had no surface oil, and received no manual treatment before fertilizer application; it received only Customblen, at a rate of 95 g/m^2. A second application, at a similar rate, was made on July 13. Finally, the entire segment was treated, on an experimental basis, with Inipol EAP22 at 361 g/m^2 on September 8, 1990

The applications were intended to follow the application guidelines being used for the 1990 cleanup program, but in fact the initial application of Customblen on KN-132B was double the recommended amount, while that on KN-135B was six-fold higher. In terms of available nitrogenous nutrients, KN-132B thus received approximately 115% of the recommended amount, and KN-135B received 200%. All other applications conformed to the application guidelines.

FIGURE 2
SITE MAP OF KN-132B

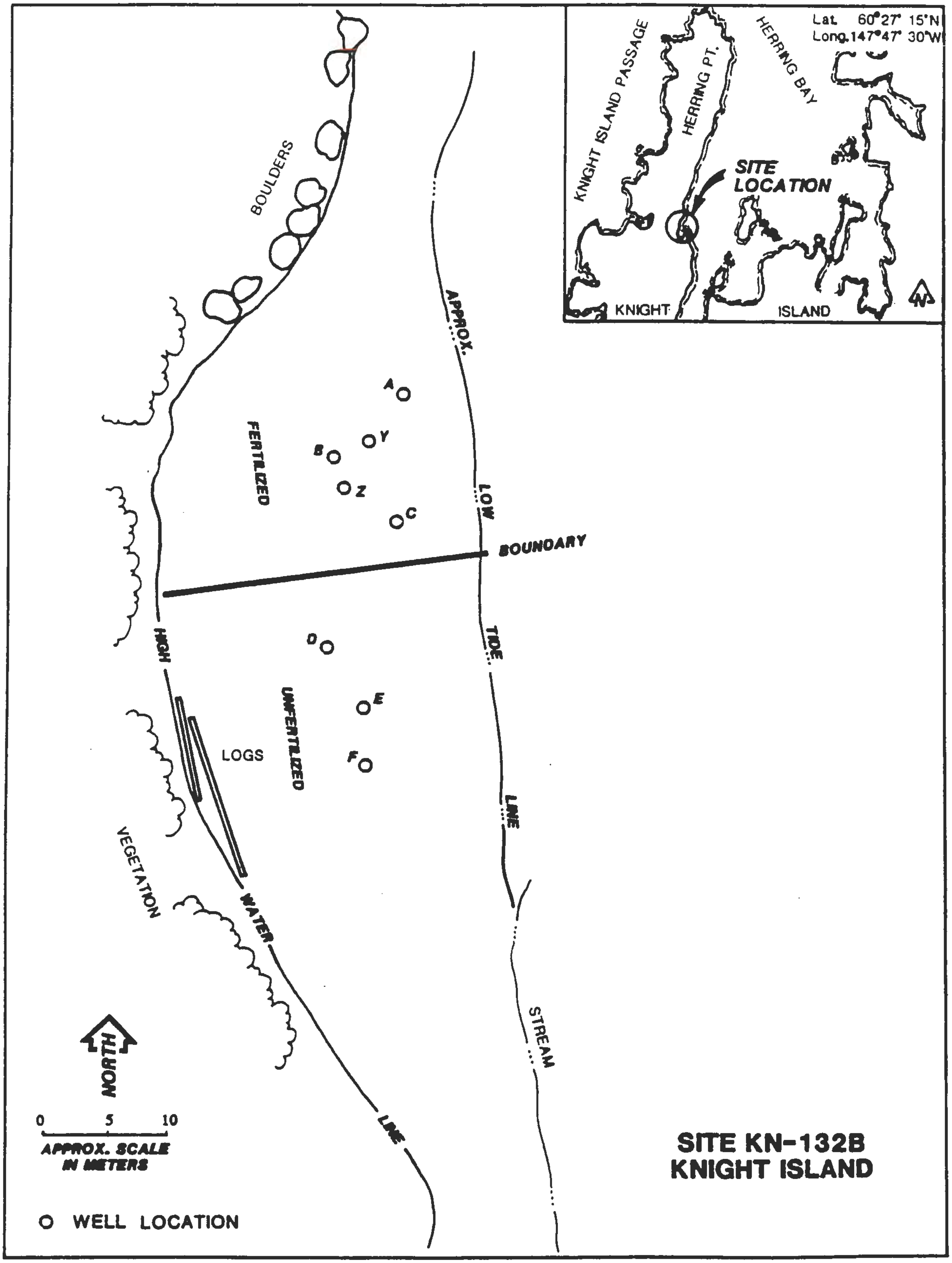


FIGURE 3
SITE MAP OF KN-135B

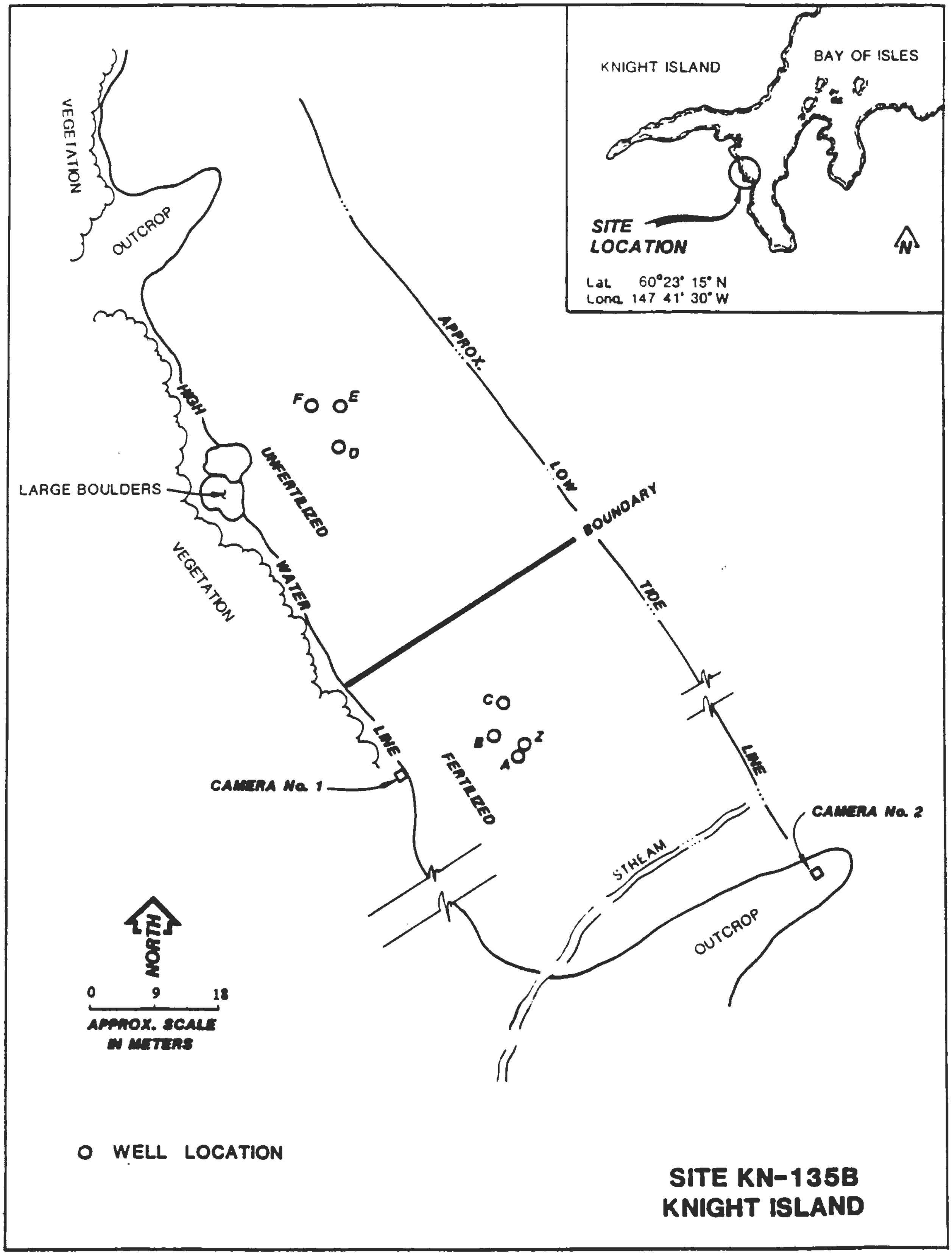
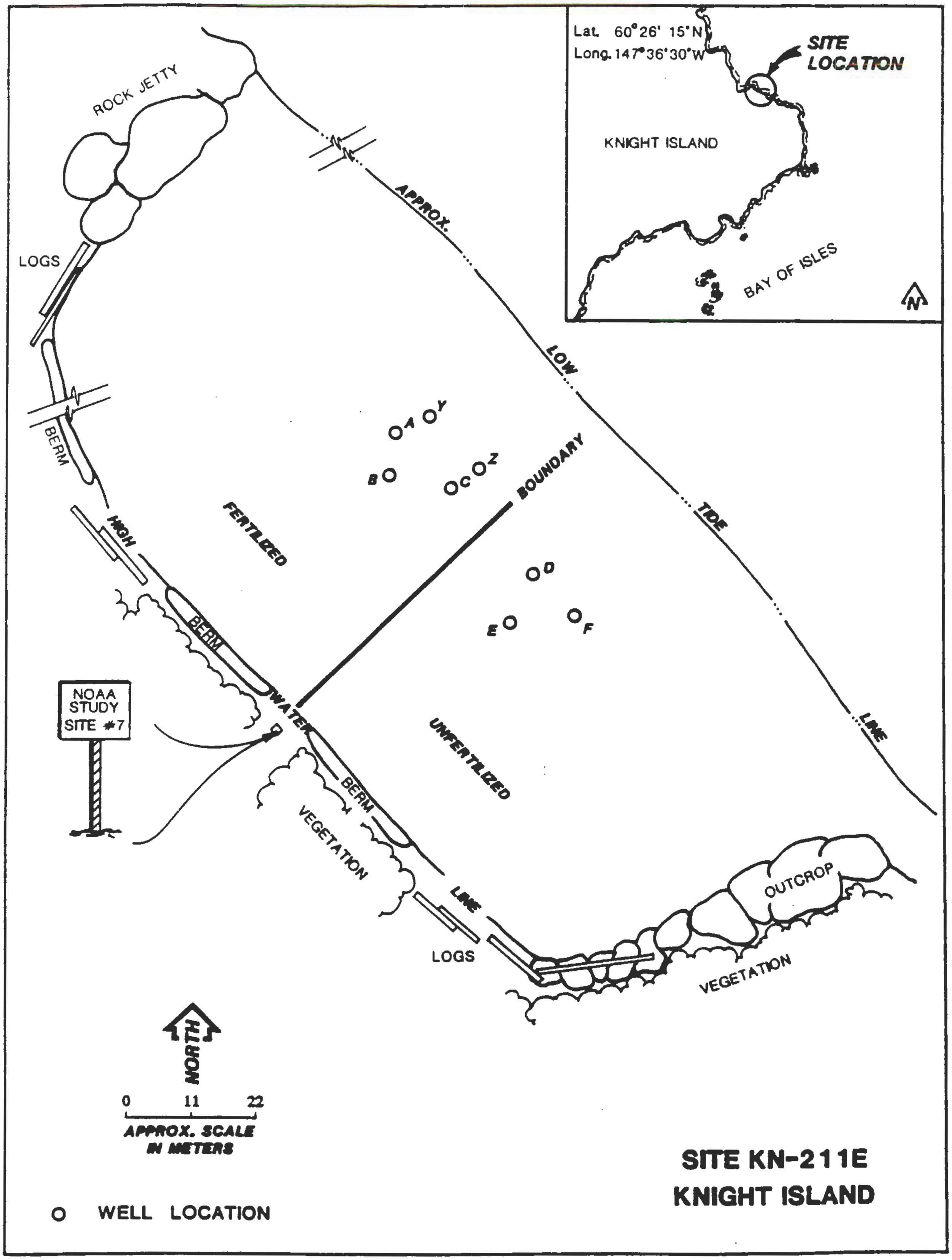


FIGURE 4
SITE MAP OF KN-211E



METHODS

INTERSTITIAL WATER: Interstitial water samples were collected from the surface and the bottom of the wells with a peristaltic pump. Temperature and salinity were determined with a YSI 33 portable meter on the beach, as soon as the samples were collected. Dissolved oxygen was measured with CHEMetrics K-7512 ampules. pH was measured with a portable Hach pH meter on board the support ship. Samples for nutrient analysis were returned to the ship, filtered to remove bacteria, and preserved prior to shipment. They were analyzed using the established protocol attached [Appendix SOP, Section 2]. Detection limits for ammonia and nitrate+nitrite were 0.02 micromolar (uM) nitrogen. Kjeldahl Nitrogen was measured using the established protocol [Appendix SOP, Section 3]. Kjeldahl Nitrogen includes organic nitrogen plus ammonia; the concentration of ammonia determined in the inorganic analyses was thus subtracted from the Kjeldahl Nitrogen to yield the concentration of organic nitrogen. The data following the first application of fertilizer indicated no differences in water samples collected from the surface and the bottom of the wells, so sampling of the surface water was discontinued following the second application of fertilizer.

SEDIMENT SAMPLES: Sediment samples of relatively homogeneous small gravel, with dimensions in the 2-5 mm range, were collected with a clean stainless steel spoon and placed into I-CHEM jars for oil analysis, and into sterile whirlpacks for microbial analyses. Samples for oil analysis were frozen prior to shipment. The microbial samples were shipped in coolers with chilled ice to the University of Alaska at Fairbanks, or the Alaska Department of Environmental Conservation laboratory in Valdez, so that they arrived within 12 hours of collection.

MICROBIAL ANALYSES: A weighed portion of each sediment sample was mixed with sterile seawater to extract the microorganisms into the aqueous phase. The number of heterotrophic and oil-degrading microorganisms was determined with most-probable-number techniques as outlined in the attached protocol [Appendix SOP, Section 4]. Hydrocarbon oxidation potentials were determined with radiolabelled hexadecane and phenanthrene by trapping and quantifying the amount of radiolabelled CO_2 evolved [Appendix SOP, Section 4].

OIL ANALYSES: The gravimetric estimation of oil in the sediment samples was planned to be determined after extraction with methylene chloride and acetone, using the protocol of Appendix SOP, Section 5. As discussed in this report, this procedure neglected to filter the extracts adequately to remove silts and fine particles. An additional filtration step, using a Gelman A/E glass fiber filter, was added to section 5.1.6 of the protocol. Gas chromatographic analyses for alkanes, polyaromatic hydrocarbons and hopanes followed the established protocols attached [Sections 6 and 7 in Appendix SOP].

NEARSHORE WATER: Samples were collected into I-CHEM bottles and returned to the boat. Chlorophyll was assayed fluorometrically (excitation at 430 nm, emission at 670 nm) with a Turner 10-05 fluorometer. Reference samples were filtered and the filter extracted for quantitative standards. Total petroleum hydrocarbons were estimated after freon extraction by infra-red spectroscopy using the established protocol included as Section 8 of Appendix SOP. Results are reported as mg total petroleum hydrocarbon/liter of water with a detection limit of 0.20 mg/l. Samples for the assessment of ammonia and nitrate plus nitrite were filtered aboard ship, frozen and shipped to the University of New Hampshire for analysis as above. For toxicity assessments, the ammonia reported by the laboratory as uM concentrations of nitrogen have been converted to ppm concentrations of ammonia. For the combined nitrate plus nitrite results, uM concentrations were converted as if all nitrogen was in the nitrate form. The conversion to mg/l allows for direct comparison with published data on the toxicity of ammonia and nitrate to marine biota.

TOXICITY TESTS: The protocol for toxicity testing is attached as Section 1 of Appendix D4. All samples were tested with juvenile (5 to 12 day old) mysids (Mysidopsis bahia), a shrimp-like crustacean that is a standard organism for marine toxicity tests. Mysids were the most sensitive of 7 marine invertebrate and fish species previously tested with Inipol EAP22, and thus were selected as a sensitive surrogate for indigenous biota. The testing protocol followed ASTM guidelines for conducting static, acute toxicity tests (96-hr) with crustaceans and fishes. Three groups of 10 animals (3 replicates) were tested for each of the test concentrations, which were 100% field sample, 50% field sample, 25% field sample, 12.5% field sample, 6.25% field sample, and a control using only the dilution water from the testing laboratory. This dilution schedule was selected to allow calculations of the degree of dilution necessary to determine non-toxic concentrations, based on tests conducted during the 1989 bioremediation research/demonstration program.

BUTOXY-ETHANOL ANALYSES: Gauze samples were placed in I-CHEM jars, sealed with tape, stored in a cooler, and shipped to Exxon Research and Engineering laboratories for quantification. Samples were extracted with a solvent and quantified by GC/MS techniques, as outlined in Section 9 of Appendix SOP. Results are expressed per gram of oil in the sample.

RESULTS AND DISCUSSION

VISUAL OBSERVATIONS

General Observations

KN-132B had substantial oiling on upper intertidal boulders (20 to 50 cm), and fairly continuous surface oiling on the middle intertidal zone. By day 30 following the first application of fertilizer, the surface of the middle intertidal zone appeared substantially cleaner. This was true for both the fertilized and unfertilized portions of the beach, with subtly more improvement on the fertilized side. By the end of August the surfaces of the intertidal zone of both fertilized and unfertilized portions of the site were substantially cleaner than they had been in May, but the large angular cobbles and boulders near the high tide mark on the fertilized area still retained an obvious coating of oil. A time-lapse camera taking pictures once every six minutes detected no wildlife on the beach during the time when the wildlife deterrents were in place following the first application. The camera was not installed for the second application of fertilizer.

KN-135B had substantial oiling on upper intertidal boulders (20 to 50 cm), and continuous surface and subsurface oiling on the middle intertidal zone. The surface of the fertilized portion of the beach was substantially cleaner 32 days after application, as shown in Figure 5. The field of view of this figure precludes a comparison of the fertilized and unfertilized portions of the beach, but there was widespread agreement amongst site visitors that this improvement was more extensive than that seen on the unfertilized portion. This difference was still apparent by the end of August, although the surface of both portions of the shoreline was substantially improved from their appearance in May. Two time-lapse cameras taking pictures once every six minutes detected no wildlife on the beach during the period when the wildlife deterrents were in place following the first application of fertilizer. The cameras were not in place for the second fertilizer application.

KN-211E had clean surface cobble armor, but was heavily oiled below this. No visual change occurred during the monitoring period.

Fertilizer Pellets

Customblen pellets were consistently visible through the last day of sampling on the fertilized portions of all three beaches after the first application of fertilizer, although there was an apparent decrease in their abundance through time. Thirty days after the first application, none were observed on the unfertilized sections. Forty days after the second application of fertilizer, a few Customblen granules were found on the unfertilized portion of KN-132B, but none were found on the unfertilized portion of KN-211E at this time. No pellets were noted on the unfertilized portion of KN-135B following either the first or second application, but the entire beach was fertilized with Customblen 19 days after the second application, precluding longer-term observations.

As the time since application increased, the fertilizer pellets became less obvious. Nevertheless, careful inspection invariably found them. At KN-211E, for example, pellets appeared sparse in the vicinity of the well heads as early as Day 8 (6/7/90), but pellets were noted during the sediment sampling on this and all other dates. It is likely that some pellets washed away from the more open areas surrounding the well heads, particularly on

FIGURE 5
(Following Page)
PHOTOGRAPH DEMONSTRATING LOSS OF SURFACE OIL AT KN-132B

Photograph (a) Site: KN-135, Camera #1 Photograph Number: 99635:07
Date: 21 May 1990, Julian Day: 141, Time of Photograph: 1006 ADT
Time to Application of Inipol EAP-22: 5 hours

Photograph (b) Site: KN-135, Camera #1 Photograph Number: 99148:11
Date: 22 Jun 1990, Julian Day: 173, Time of Photograph: 1106
Time since Application of Inipol EAP-22: 764 hours

Note: The white line in each of the photographs delineates the treated and untreated sections of beach. The treated section is in the foreground.

high energy sites such as KN-211E. Nevertheless, pellets often were found under the large cobble armor when it was removed for sediment sampling. Pellets were noted in high concentrations in the upper intertidal areas of KN-132B and KN-135B, particularly at KN-135B on Day 32.

Fertilizer pellets appeared to remain on the surface of the beach; at no time was it noted that they were found at depth. As discussed above, pellets were frequently found beneath the larger cobbles on the beach. However, they did not appear to mix into the surface sediments subject to wave action on the beach. They were also noted adhering to the surfaces of large oiled cobble, particularly the sides of rocks with surface oiling. They apparently stuck to the overturned rocks which initially had soft oil on their lower surfaces. The Inipol EAP22 coating may have softened the oil, and further cemented the Customblen granules to the large cobble.

Oil Penetration

KN-132B was selected as a surface-oil only site since reconnaissance showed oil penetration of 2 to 5 cm. For this reason, only surface samples of the top 0 to 5 cm were collected here. In fact, sample collection over the monitoring period showed oil penetration of up to 10 cm. Degree of oiling varied a great deal at this site. In addition, it was noted that although the oiling appeared to be limited to the surface (0 to 5 cm), the actual surface of the fine-grained sediment was not always oiled. In a few cases, oiling began just below (2 cm) this surface. In other instances the overlying armor (larger pebbles and cobble) exhibited oiling, but there was little evidence of oiling in the sediment just below.

KN-135B had both surface and subsurface oiling. Oil penetration appeared to be greater than 50 cm during the initial site reconnaissance. Excavations at the end of the monitoring program indicated penetration to a depth of 43 to 47 cm, although the transition from oiled to clean sediments was not very distinct. Subsurface samples were collected from this site at depths ranging from 26 to 36 cm, with most collected in the 28 to 30 cm range. All of these samples were collected within the depth of oil penetration on the beach.

KN-211E was selected as a high energy site with only subsurface oiling. The site has a large cobble armor that is uniform over the entire site. Reconnaissance showed oil penetration of approximately 40 cm from just below the armor. Sample collection at this site during the monitoring program revealed oil penetration to a maximum of 47 cm. Documented oil penetration actually varied from 20 to 47 cm, with sample collection occurring at depths of 17 to 35 cm. Oiling was usually apparent in the fine grained sediment immediately beneath the armor. The degree of oiling varied with depth, with some subsurface samples noted as having minimal, and others very heavy oiling.

FERTILIZER NUTRIENTS IN THE INTERSTITIAL WATER

Customblen contains ammonium nitrate and ammonium phosphate, while Inipol EAP22 contains urea and tri(laureth-4)phosphate, so the nutrients of interest were phosphate, ammonium, nitrate and urea. Ammonium was assayed as ammonia, and the amount of urea was calculated as Kjeldahl Nitrogen minus the ammonia measured in the inorganic assays. Nitrate was measured with nitrite, and the latter was then estimated individually, and the nitrate level determined by subtraction. Since the nitrite levels were very low in the initial samples (always <2 uM), this additional assay was eliminated; the nitrate plus nitrite measurements presented here are essentially nitrate alone.

The addition of fertilizer substantially increased the concentrations of available nitrogen in the interstitial water at all three sites. The data are presented in Tables 1 and 2 of Appendix D1, and are summarized in Tables 3-5 of Appendix D1. Microorganisms can utilize ammonia, nitrate, nitrite and urea as nitrogen sources; the total of these nutrients, and the contributions from the individual species, is plotted in Figures 6 to 8. Measurements after the first application indicated similar nutrient levels in samples from the surface and from the bottom of the wells, and in wells sealed except for the lowest 10 cm. Subsequent measurements were therefore made only on samples from the bottom of the wells.

On KN-132B the total nitrogenous nutrients peaked at 340 uM on the second day after application of fertilizer in June (Figure 6). Approximately half of this was organic nitrogen, presumed to be urea from the Inipol EAP22; ammonia peaked at 103 uM and nitrate at 79 uM. Organic nitrogen dropped to zero for days 4 and 8, and then increased to 30-40 uM on the entire site until late July. This may have been due to the substantial tilling that occurred on approximately Day 15 upstream of the monitoring area, which may have liberated significant amounts of organic material into the nearshore water. These may then have become incorporated into the sediment throughout the segment. The second application used the same amount of Inipol EAP22 as the first, but only half as much Customblen. Because of the difference in compositions and application rates of Inipol EAP22 and Customblen, total nitrogenous nutrients applied to the site were thus only 86% of those applied in the first application. Nevertheless, total nitrogenous nutrient levels on the fourth day after the second application were similar to those measured four days after the first application, particularly after subtracting the 41 uM background organic nitrogen found after the second application. Levels of nitrogenous nutrient on the fertilized portion of the beach remained substantially above those on the unfertilized portion of the beach throughout the monitoring period, indicating that the fertilizer application has an effect for at least 30 days.

Figure 7 presents the nitrogenous nutrient data obtained from KN-135B. The total peaked at 383 uM on the second day after the first application, and declined to 50 uM by approximately Day 20. The application of Inipol EAP22 was at the same rate as that used on KN-132B, but the application of Customblen was three fold greater. This is reflected in the relative contributions of the different nutrients to the total; on KN-135B the inorganic nutrients are the predominant species on Day 2, together accounting for 76% of the nitrogenous nutrients. The second application used one-sixth the initial rate of Customblen, and the same amount of Inipol EAP22. This was the same as that used for the second application on KN-132B, and the measured nutrients were very similar at the two sites. Customblen was applied to the entire site on August 1 at a rate equivalent to that used on the fertilized portion of the beach in the first application, and inorganic nutrient levels on the fertilized portion of the beach 8 days after this third application were very similar to those measured 8 days after the first. Nutrient levels did not increase to this extent on what previously had been the unfertilized portion of the beach, suggesting that the application was not as effective in the area of these sampling wells.

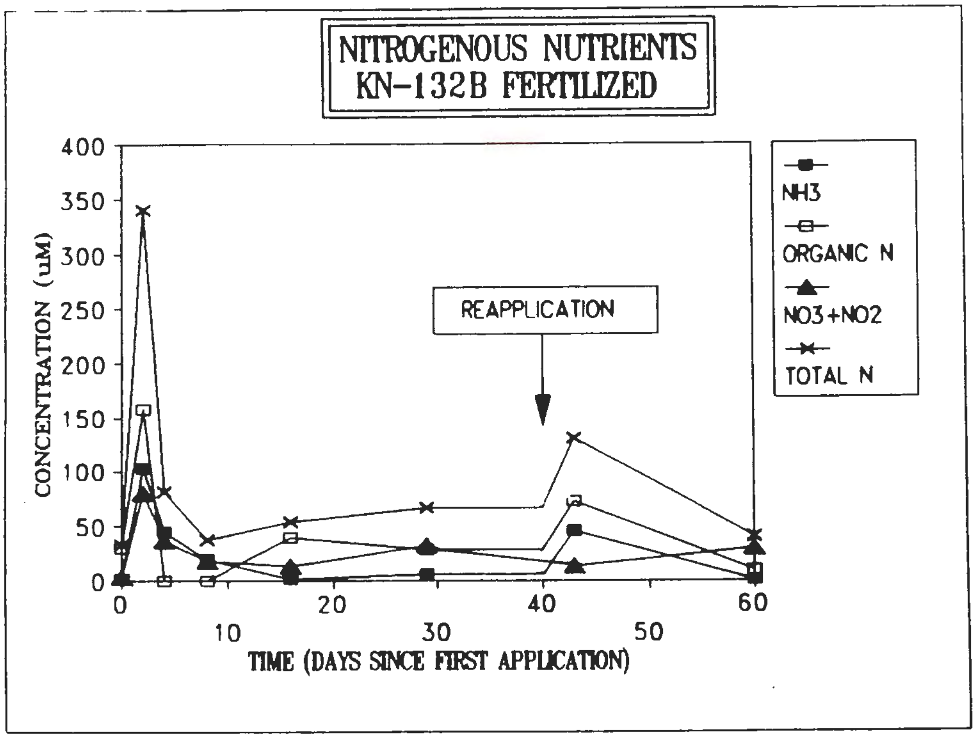
Figure 8 shows that nutrient levels in the interstitial water of KN-211E following the first application of fertilizer were only 12% of those measured on KN-135B, despite the application of similar rates of Customblen. This was most probably due to the rather densely packed beach matrix beneath the cobble armor at KN-211E, which was not disturbed during the pre-application preparation, as had been done at KN-132B and KN-135B. Some evidence in favor of this notion is provided by the very low dissolved oxygen levels in this beach (Figure 12). The much more effective second application of fertilizer, at the same application rate as the first, may perhaps be attributable to the increased permeability of the 18 disturbed areas in the vicinity of the sampling wells where sediment samples had been taken. Nevertheless, the first application of fertilizer did increase the levels of inorganic nutrients some 15-fold to at least Day 8, and following the second application this increase was some 44-fold on Day 3.

Figures 6-8 indicate that the fertilizers behaved very much as predicted. Inipol EAP 22 provided a burst of urea into the interstitial water for a few days after application, while Customblen provided a burst of inorganic nutrients, followed by a continued slow release. Inipol EAP22 is formulated to provide nutrients at the oil:water interface by associating with the oil; as such it should release only a small portion of its nutrients into the interstitial water. While we did not measure nutrients immediately after application, the data suggest that this was indeed the case. Those nutrients that were released were distributed to at least 50 cm into the sediment. Customblen is formulated to provide a slow and continued release of nutrients; the data suggest that this was indeed achieved. The additional burst of nutrient soon after application perhaps was due to damaged fertilizer beads, or beads with very thin coatings or pinholes. In any case, the fertilizer applications were successful in providing substantial nitrogenous nutrients to at least 50 cm into the shoreline sediment at significantly elevated concentrations for at least 30 days.

It is perhaps noteworthy that there was a substantial increase in organic nitrogen in mid June to early July on both fertilized and unfertilized portions of both KN-132B and KN-211E. As will be discussed below, this organic nitrogen did not stimulate microbial activity, and its source and nature is obscure. As we discussed above, the effect on KN-132B may have been correlated with upstream tilling, but no activity of this nature occurred on KN-211E. An onshore source, perhaps Ursus in the woods, is possible, but further speculation seems pointless in the absence of additional information.

In contrast to the behavior of the nitrogenous components of the fertilizer, the levels of phosphate in the interstitial water only marginally increased after fertilizer application (Figure 9). This is not surprising, given the relative insolubility of phosphates in seawater due to the presence of divalent cations such as Ca^{2+}. Inorganic phosphate in Customblen probably precipitates once it leaves the Customblen vesicle, or perhaps remains inside the polymerized vegetable oil. In either case, the phosphate would be available if microorganisms depleted the soluble phosphate in the interstitial water. The phosphate in Inipol EAP22 is present as

FIGURE 6
NITROGENOUS NUTRIENTS IN INTERSTITIAL WATER
KN-132B



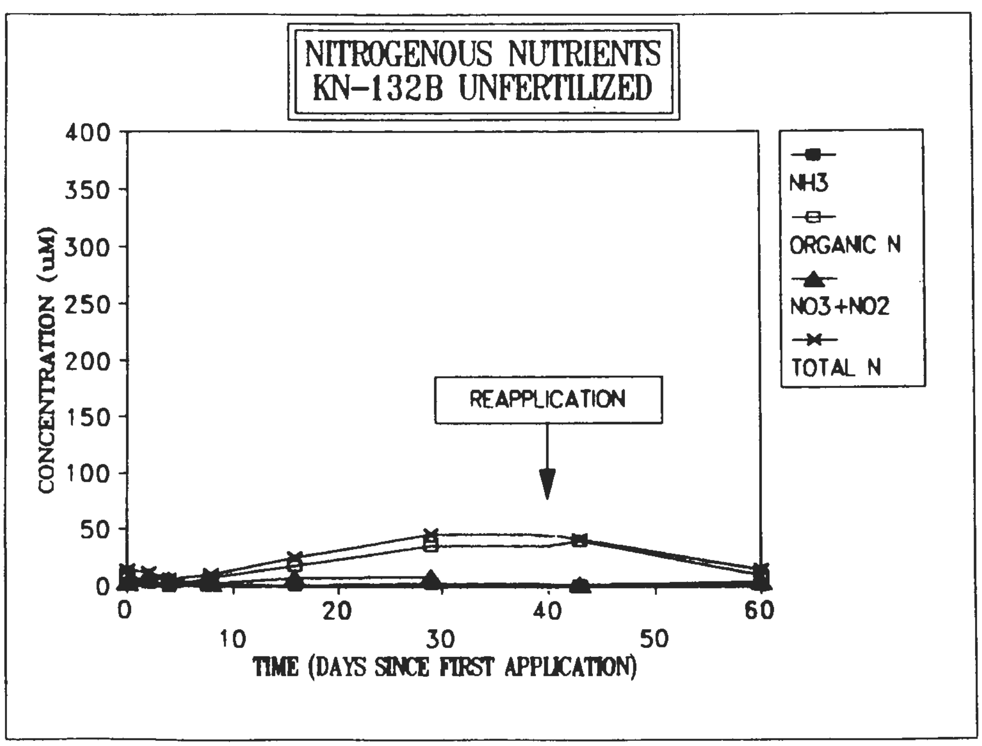
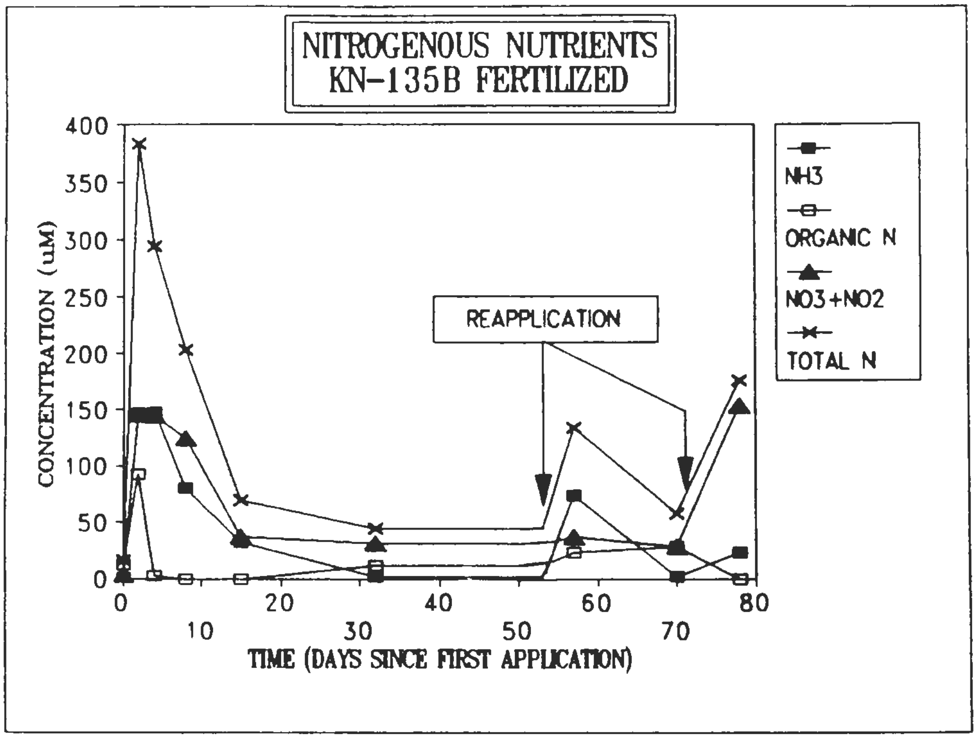


FIGURE 7
NITROGENOUS NUTRIENTS IN INTERSTITIAL WATER
KN-135B



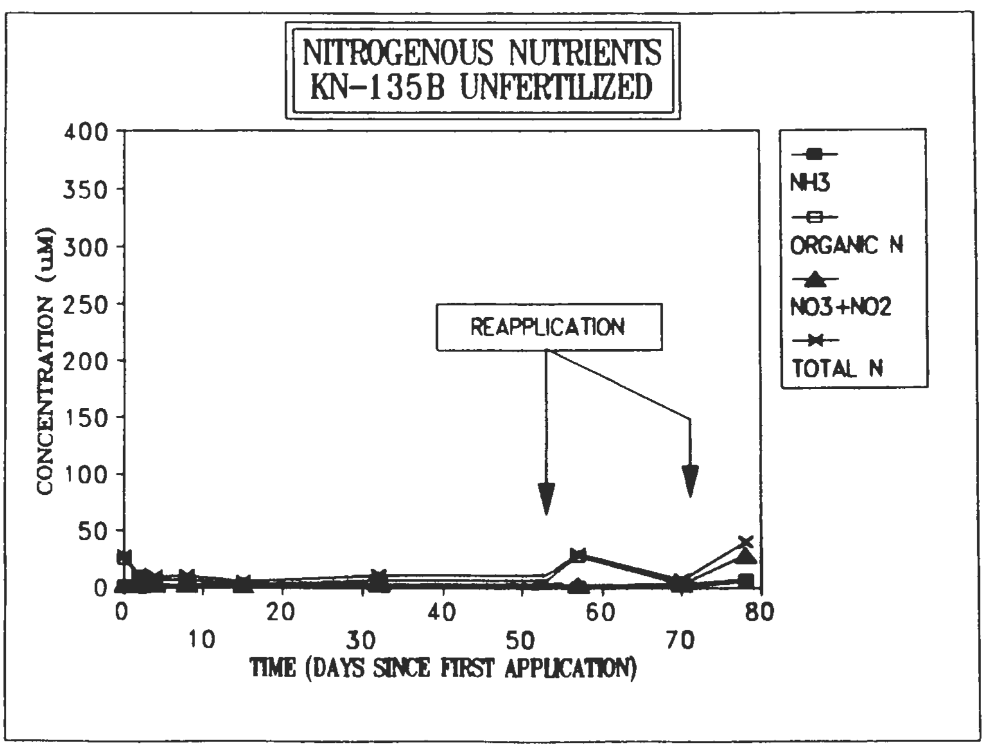
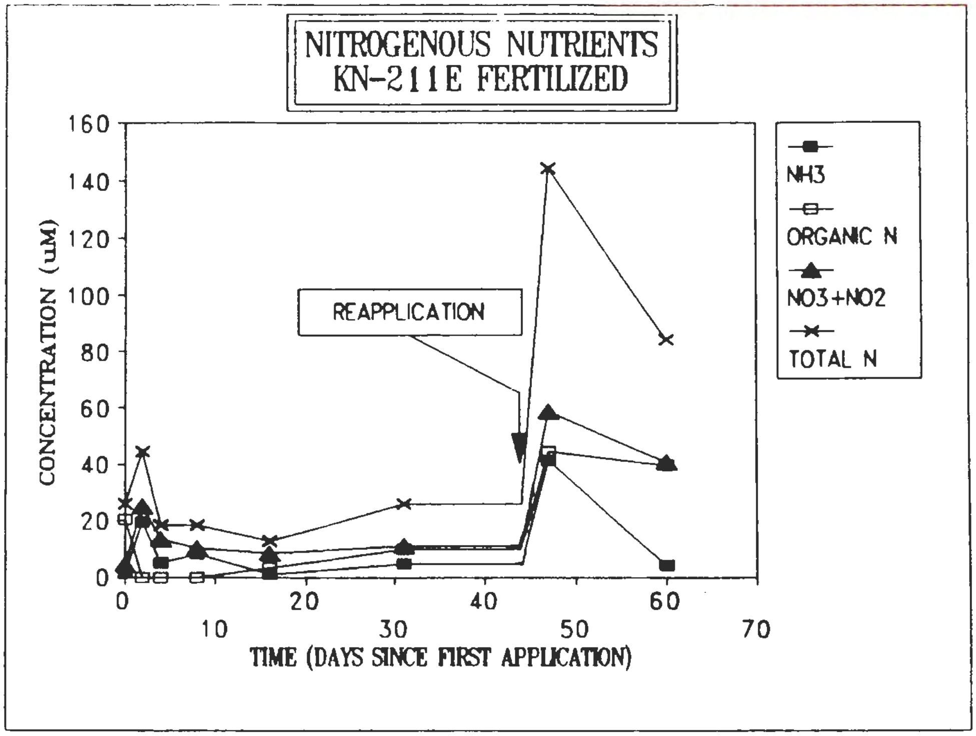


FIGURE 8
NITROGENOUS NUTRIENTS IN INTERSTITIAL WATER
KN-211E



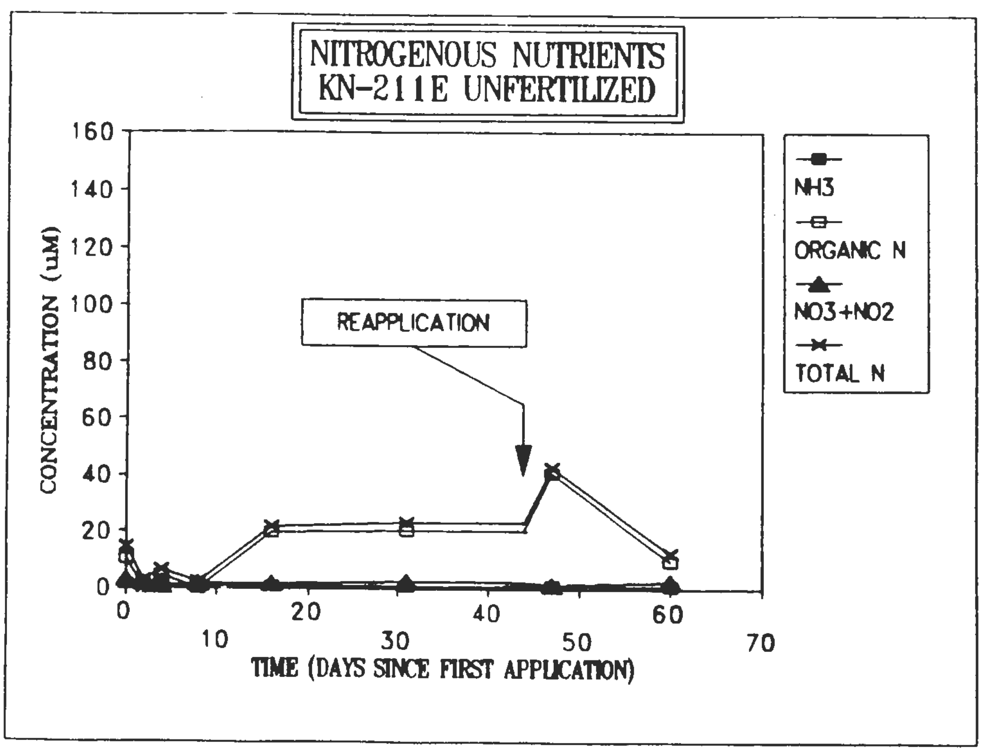
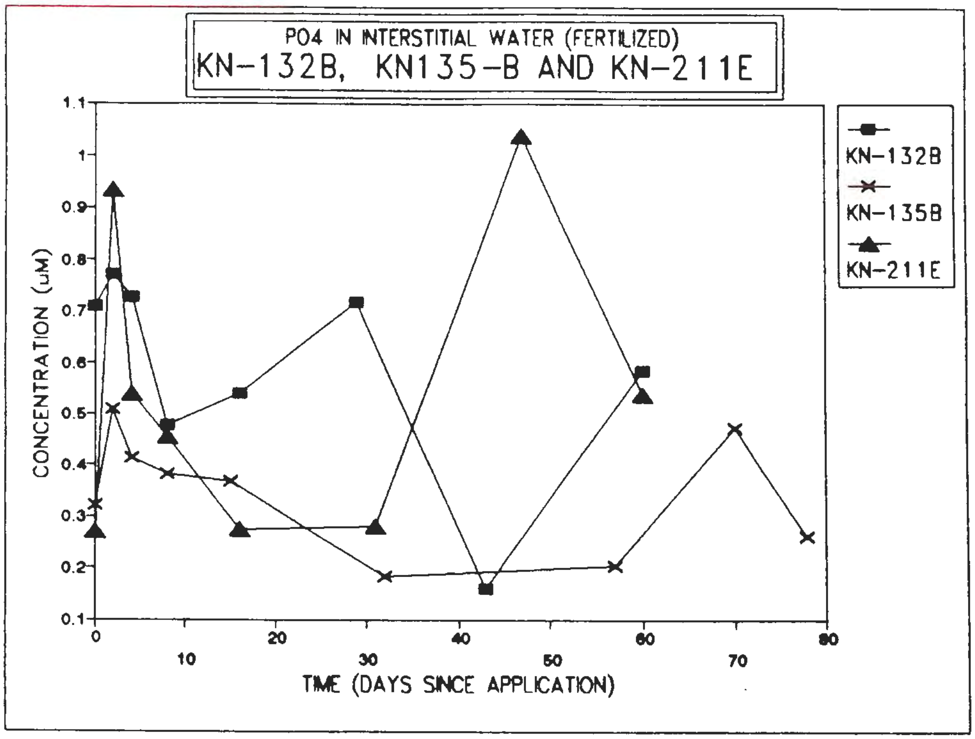
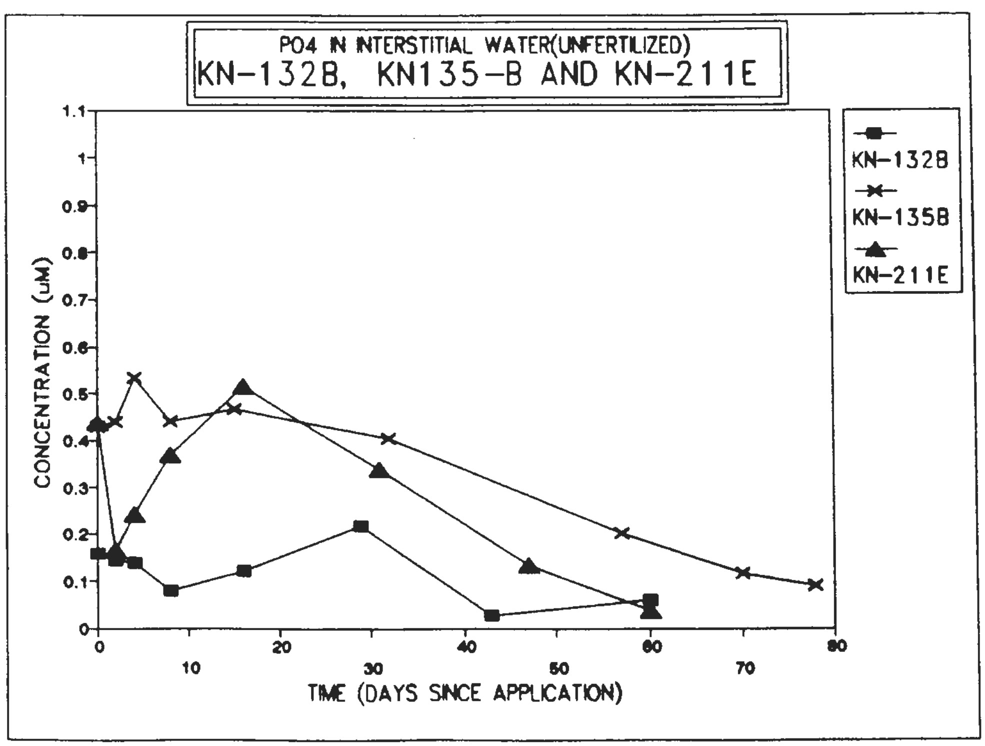


FIGURE 9
PHOSPHATE IN INTERSTITIAL WATER
KN-132B, KN-135B AND KN-211E





tri(laureth-4) phosphate, an organic form that may be taken up by microorganisms before release of the phosphate moiety.

DISSOLVED OXYGEN, SALINITY, TEMPERATURE AND pH IN INTERSTITIAL WATER

Tables 6-8 of Appendix D1 list the measured values of dissolved oxygen, salinity and temperature for the three sites monitored in this program, and Tables 9-11 of Appendix D1 provide average values for each site. The data are presented graphically in Figures 10-12.

The complexity of the physical and biological processes occurring in the beach make it hard to draw simple conclusions from measurements of dissolved oxygen, salinity and temperature. Dissolved oxygen concentrations are affected by temperature and salinity, which affect saturation capabilities. Furthermore, interstitial oxygen concentrations depend not only on the consumption of oxygen by biological processes, but also on the rate of replenishment of the interstitial water by aerated water from the Sound, from surface streams and from other groundwater. Nevertheless, none of the sites showed evidence of being anaerobic before or after fertilizer application, and the measured levels were always adequate for substantial microbial respiration. Indeed, compared to water in the unfertilized portion of the beach, the dissolved oxygen on the fertilized parts of KN-132B and KN-135B were lower for several days after each application of fertilizer, suggestive of increased microbial activity following fertilizer application. This trend was not seen on KN-211E, although the dissolved oxygen measured in the fertilized portion of the beach did drop proportionally more than the drop on the unfertilized portion following each application. Taken together, the dissolved oxygen measurements provide strong, albeit indirect, evidence that microbial respiration is stimulated at depth by fertilizer application at the surface.

The interrelationship between the interstitial water and beach hydraulics is far too complicated for simplistic quantitative analysis, but an indication of the relative importance of freshwater sources can be seen in the dynamic range of the salinity measurements. KN-132B in particular, but all three sites to some extent, receive substantial inputs of fresh water which dilute the salinity of the shoreline interstitial water. KN-132B has an obvious source, since the study site is at the mouth of a salmon stream, but all three sites receive groundwater input, especially after rain.

The temperature of the interstitial water ranged from 8 to 18 C, with most values close to 15 C. As these measurements were taken during a falling tide, the range does not include potentially higher temperatures during low tides on warm, sunny days. The warmest site was KN-132B, followed by KN-211E and then KN-135B. Interpretation of the temperature changes is just as complex an issue as the salinity dynamics, and the two are interrelated. The temperatures observed in the field provide a justification for the use of 15 C as an appropriate laboratory temperature for mimicking field conditions.

Measurement of the pH of the interstitial water was begun on the last scheduled day of sampling at each site before the second application of fertilizer, and continued as a monitoring parameter through the end of the program, but only for sampling dates when interstitial water was analyzed. The data are presented in Table 12 of Appendix D1. There were no consistent differences between samples collected on fertilized and unfertilized portions

FIGURE 10
DISSOLVED OXYGEN, SALINITY AND TEMPERATURE OF INTERSTITIAL WATER

KN-132 MEAN VALUES ALL WELLS

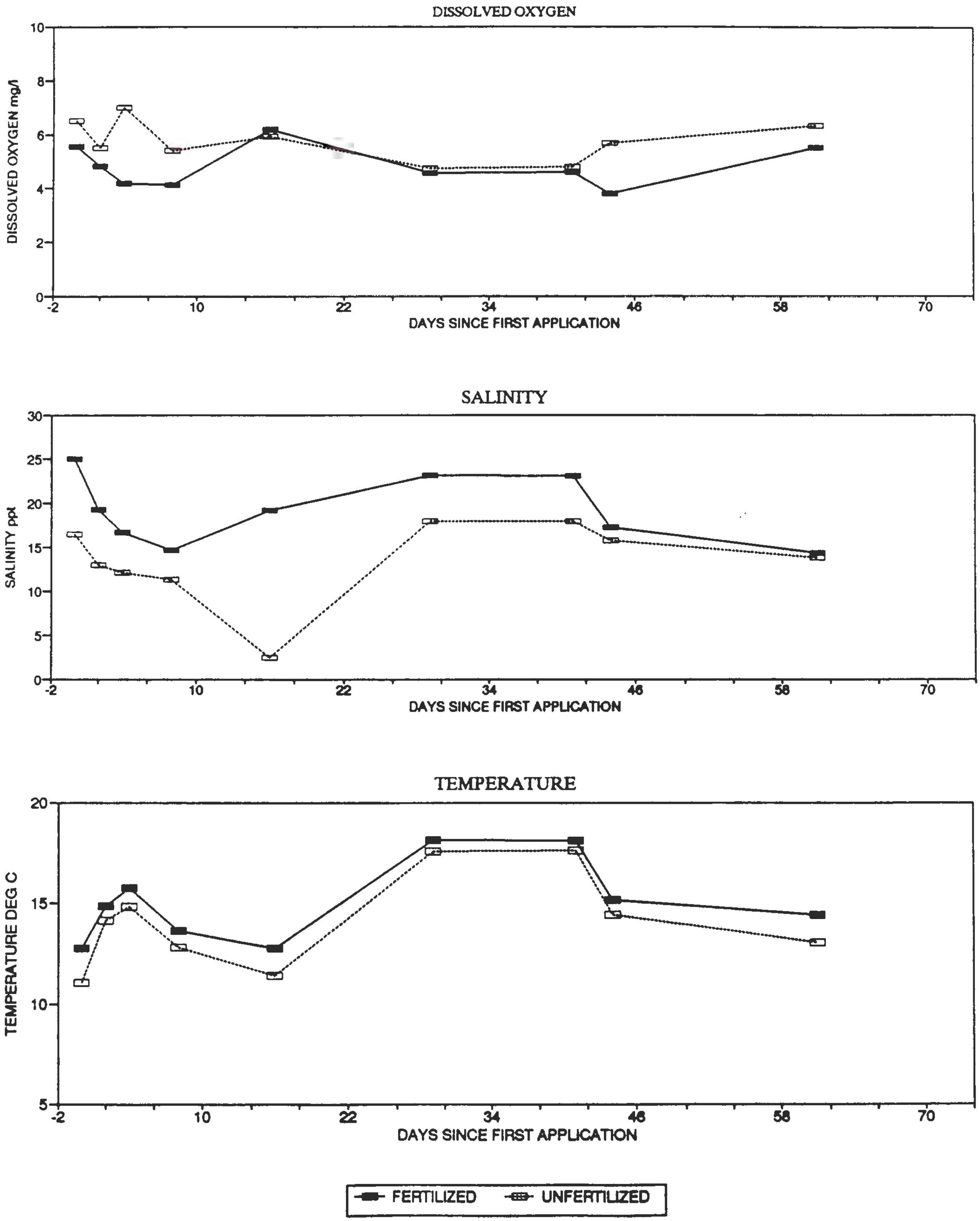


FIGURE 11
DISSOLVED OXYGEN, SALINITY AND TEMPERATURE OF INTERSTITIAL WATER

KN-135 MEAN VALUES ALL WELLS

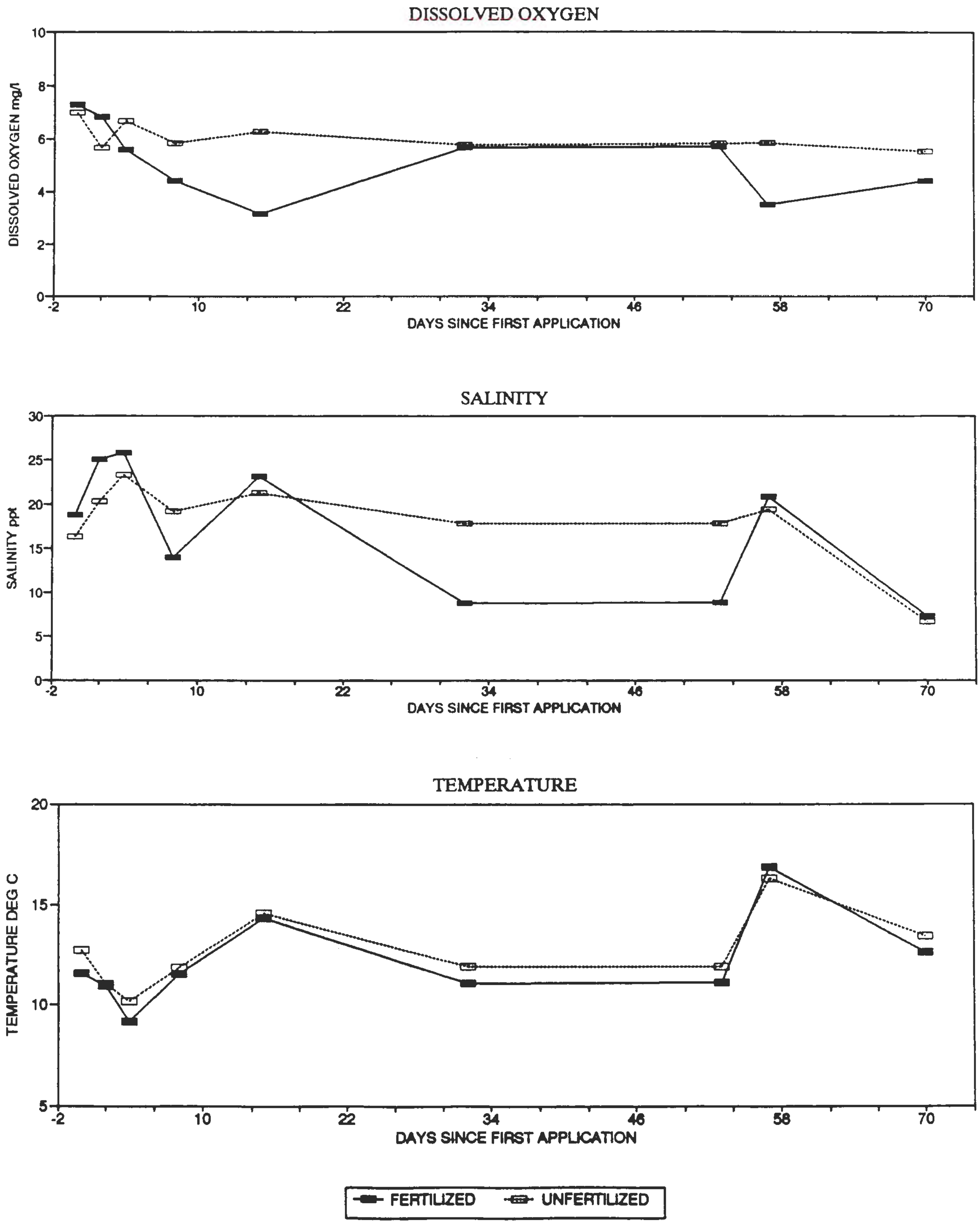
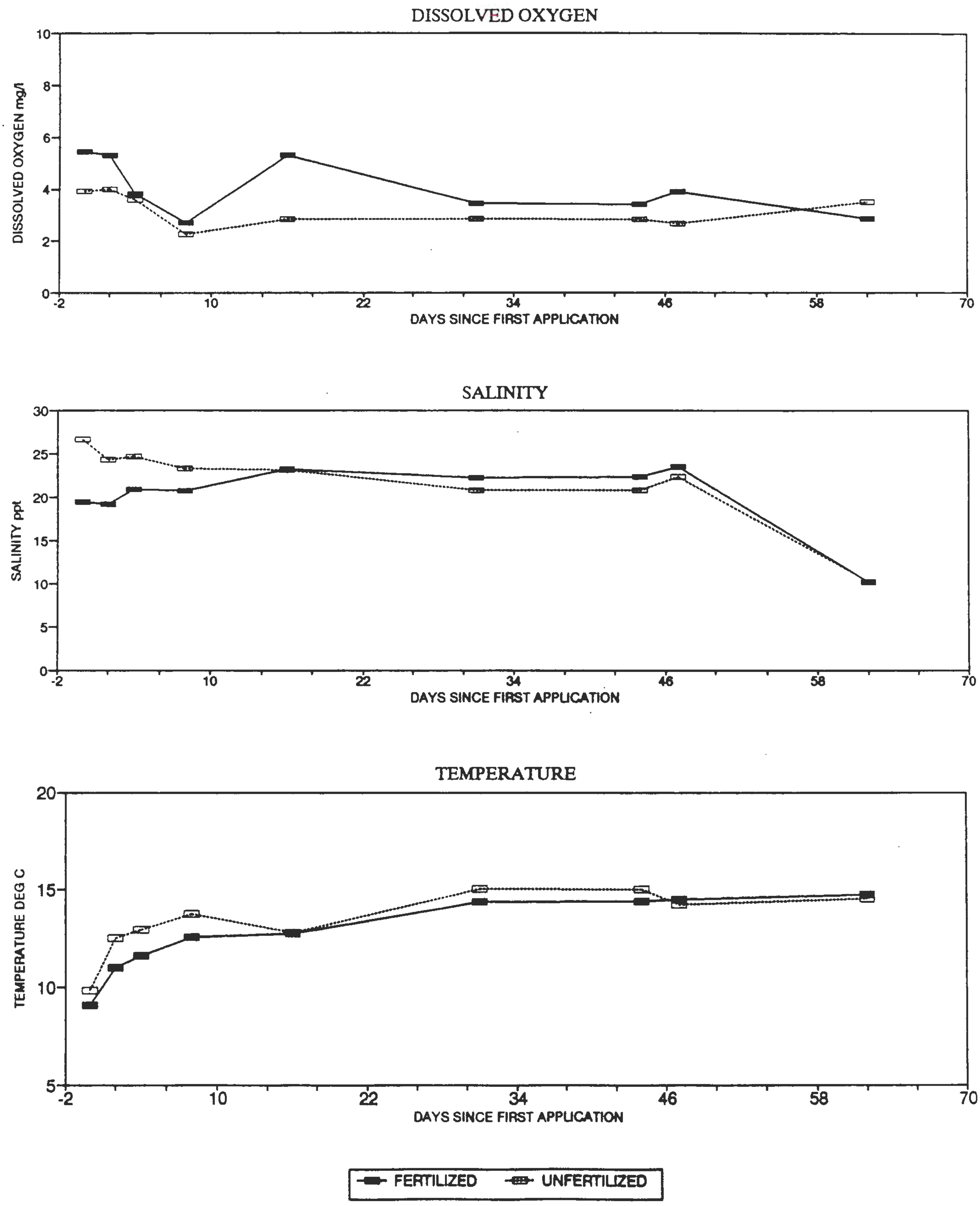


FIGURE 12
DISSOLVED OXYGEN, SALINITY AND TEMPERATURE OF INTERSTITIAL WATER

KN-211 MEAN VALUES ALL WELLS



of the sites. The values range from 6.9 to 7.9, in the range expected for marine systems with some freshwater input. Measurements of offshore water varied from pH 8.0 to 8.4, as expected for seawater, while the pH of a small stream discharging onto KN-211E was 7.3. There is no evidence that fertilizer additions or enhanced microbial activity changed the pH of interstitial water.

MICROBIOLOGY

The rationale of the fertilizer applications in Prince William Sound and the Gulf of Alaska was that they would stimulate the metabolism of the indigenous oil-degrading microorganisms. This should be reflected by changes in the rate of hydrocarbon degradation, and perhaps by an increase in the number of microbes.

Microbial oil degradation activity was measured by radiorespirometry. The microbes were provided with a ^{14}C-radiolabelled hydrocarbon, and microbial metabolic activity was assessed by measuring the amount of ^{14}C-radiolabelled carbon dioxide that was produced. This is thus an assay of the mineralization of the substrate. Since the various components of crude oil are biodegraded at different rates by the microbial population, hexadecane was used as a representative paraffin, and phenanthrene was used as a representative polynuclear aromatic compound.

Microbial populations were enumerated by standard Most Probable Number (MPN) techniques; these are repetitive serial dilutions of a sample until no organisms could be detected. The total aerobic heterotrophic microbial population was estimated using a marine broth as the growth substrate. To assess that portion of this population that could degrade hydrocarbons, the assay was repeated using weathered crude oil as the growth substrate.

Mineralization of Hexadecane and Phenanthrene.

The results of the biomineralization assays are presented in Appendix D2 Tables 1 and 2. As discussed in the Introduction, this program was designed to assess the efficacy of bioremediation by comparing treated areas that differed only in that one received fertilizer while the other did not. The mineralization data are thus presented as the ratio of the activity on the fertilized to unfertilized portion of each site in Figures 13-15.

Within two weeks of the initial application, at every site, both at the surface and at the subsurface, and with hexadecane and with phenanthrene, the mineralization in samples from the fertilized portion was substantially increased over that in samples from the unfertilized area. The figures show that the ratios increased with time, and high values were sustained over several weeks. The following table (Table 2) provides an estimate of the approximate enhancement of mineralization activity that was attained and sustained from day 15 following the first application of fertilizer until the last sample taken before the second application.

TABLE 2
ENHANCEMENT OF MICROBIAL MINERALIZATION AFTER FIRST FERTILIZER APPLICATION

	Hexadecane		Phenanthrene	
	Surface	Subsurface	Surface	Subsurface
KN-132B	4-fold	-	3-fold	-
KN-135B	4-fold	5-fold	4.5-fold	4-fold
KN-211E	2-fold	3-fold	1.5-fold	1.3-fold

Reapplication of fertilizer caused a further increase in microbial activity on the fertilized portions of KN-135B and KN-211E, whilst sustaining enhanced activities on KN-132B. This is illustrated in the following table, which also compares the activity on the fertilized area with that on the unfertilized area.

TABLE 3
ENHANCEMENT OF MICROBIAL MINERALIZATION AFTER SECOND FERTILIZER APPLICATION

	Hexadecane		Phenanthrene	
	Surface	Subsurface	Surface	Subsurface
KN-132B	4.5-fold	-	2-fold	-
KN-135B	10-fold	15-fold	4.5-fold	8-fold
KN-211E	3-fold	5-fold	8-fold	10-fold

Figure 14 includes data from six days after the third application at KN-135B, which was of Customblen only to the entire site, both the previously fertilized and previously unfertilized portions. The activities on the two portions of the beach had become more similar, so that the ratio of activities on the two portions was 3 for hexadecane and 2 for phenanthrene, both at the surface and at the subsurface. These data, along with those from additional samples that have just been collected, will be evaluated further in the final report.

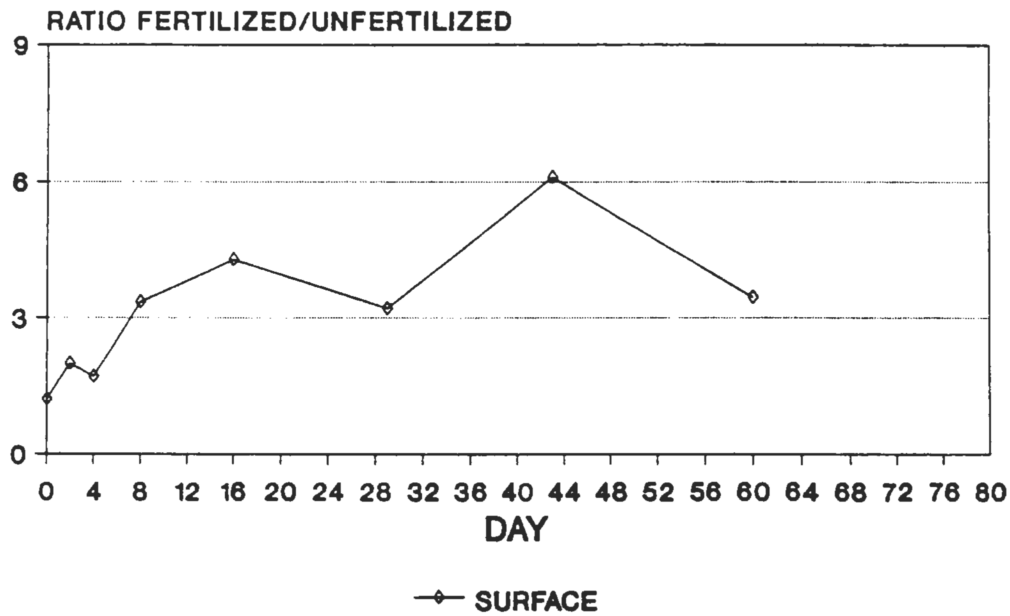
Enumeration of Microbes

The most probable numbers (MPN) of heterotrophic and oil-degrading microbes are presented in Appendix D2, Tables 3-6. Median values are the most appropriate for initial assessments of microbial abundance, since the range of numbers is so large. Figures 16-18 present the median values in graphical form.

The initial populations of heterotrophic and oil-degrading microorganisms within the two areas of each site were similar, and both populations changed by approximately an order of magnitude during the study, which is close to the resolution of the technique. Of course the size of the microbial populations depends on more than nutrient levels, and comparisons between sites are complicated by the lack of knowledge of the abundance of predatory organisms that consume the bacteria, and are themselves consumed by ever higher trophic levels. Nevertheless, there is a general trend that the fertilized portions of the sites had more oil-degrading and heterotrophic bacteria than the unfertilized portions, especially on the surface at KN-132B and in the subsurface of KN-135B. Little change was seen on KN-211E.

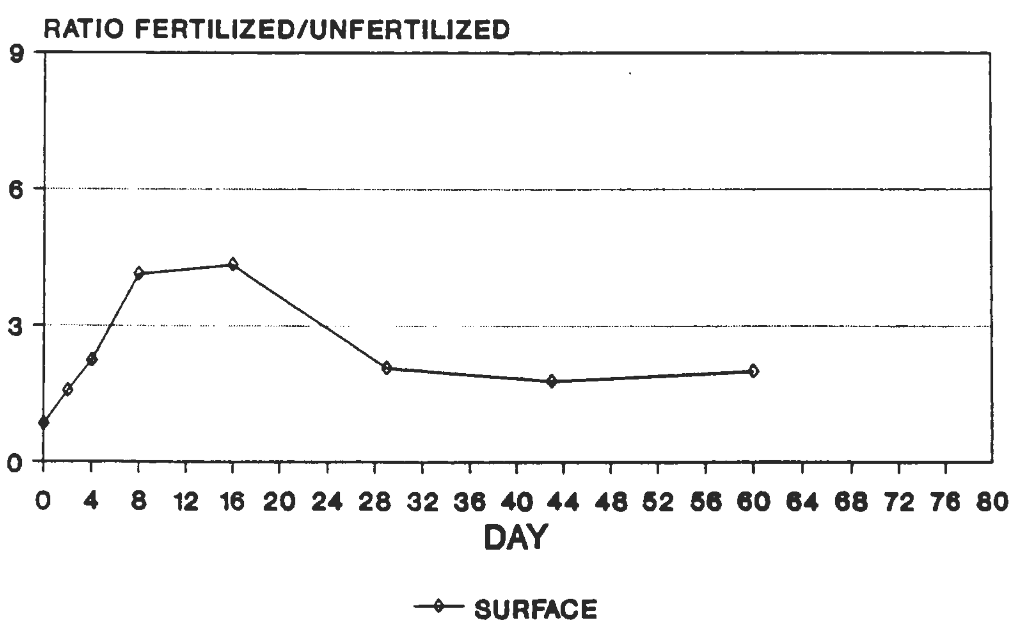
FIGURE 13
MICROBIAL MINERALIZATION ACTIVITY: KN-132B

KN132 HEXADECANE MINERALIZATION RATIO FERTILIZED / UNFERTILIZED



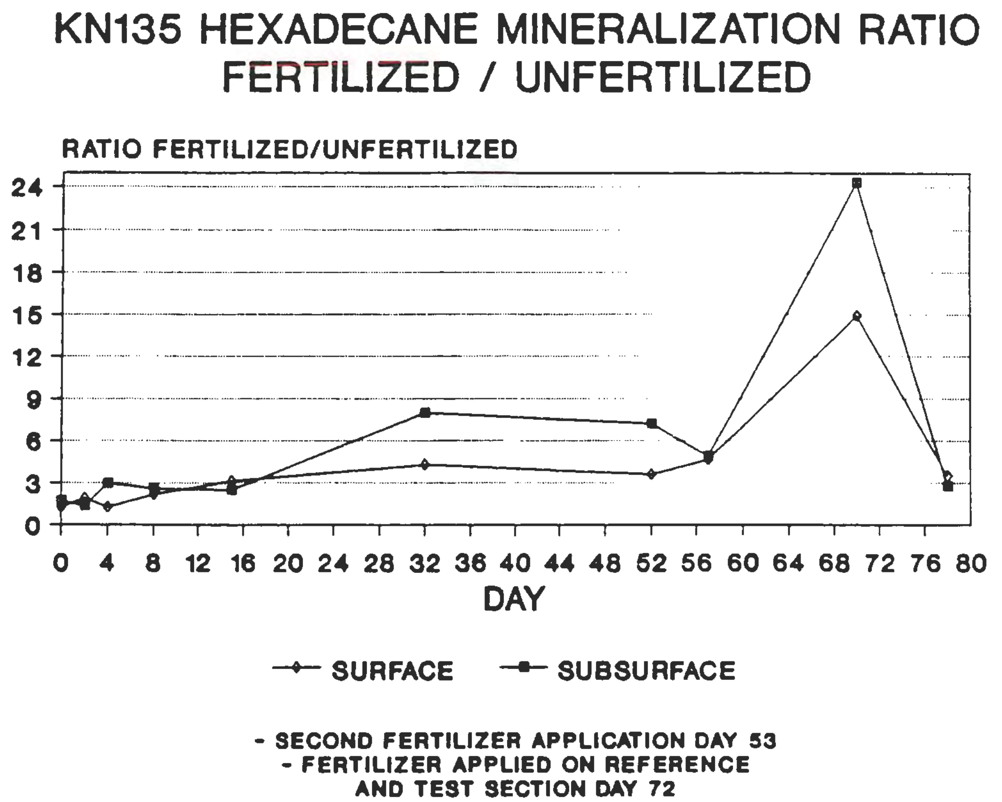
SECOND FERTILIZER APPLICATION DAY 40

KN132 PHENANTHRENE MINERALIZATION RATIO FERTILIZED / UNFERTILIZED



SECOND FERTILIZER APPLICATION DAY 40

FIGURE 14
MICROBIAL MINERALIZATION ACTIVITY; KN-135B



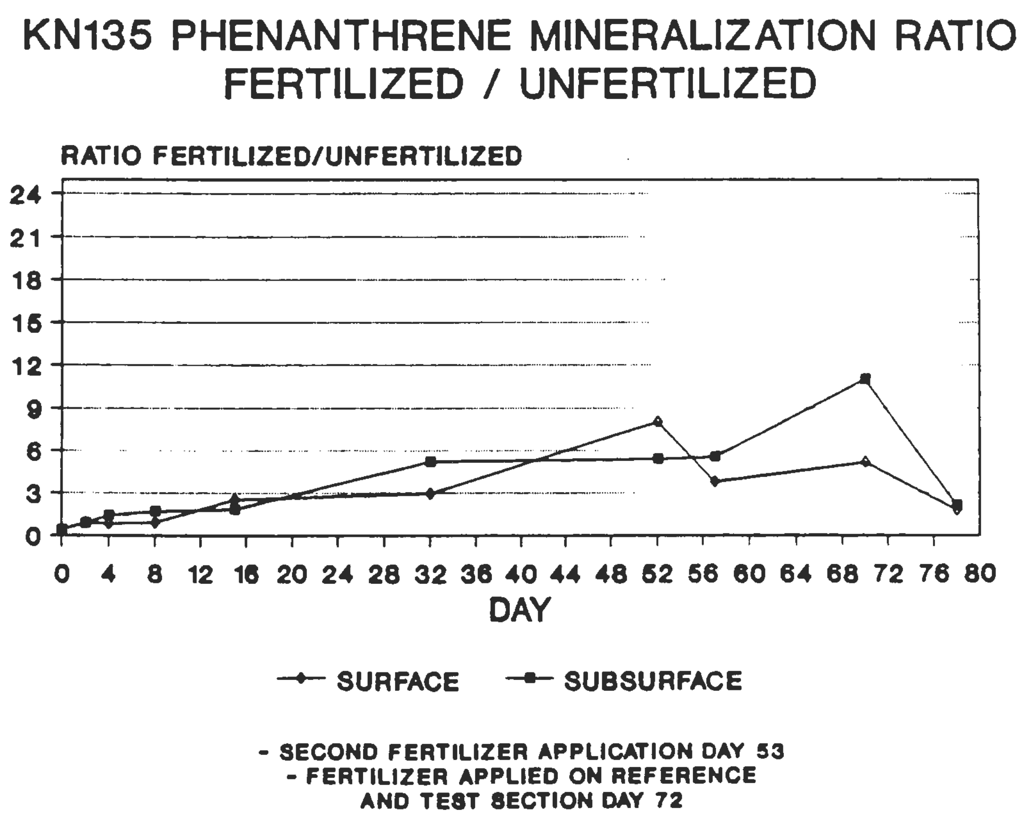
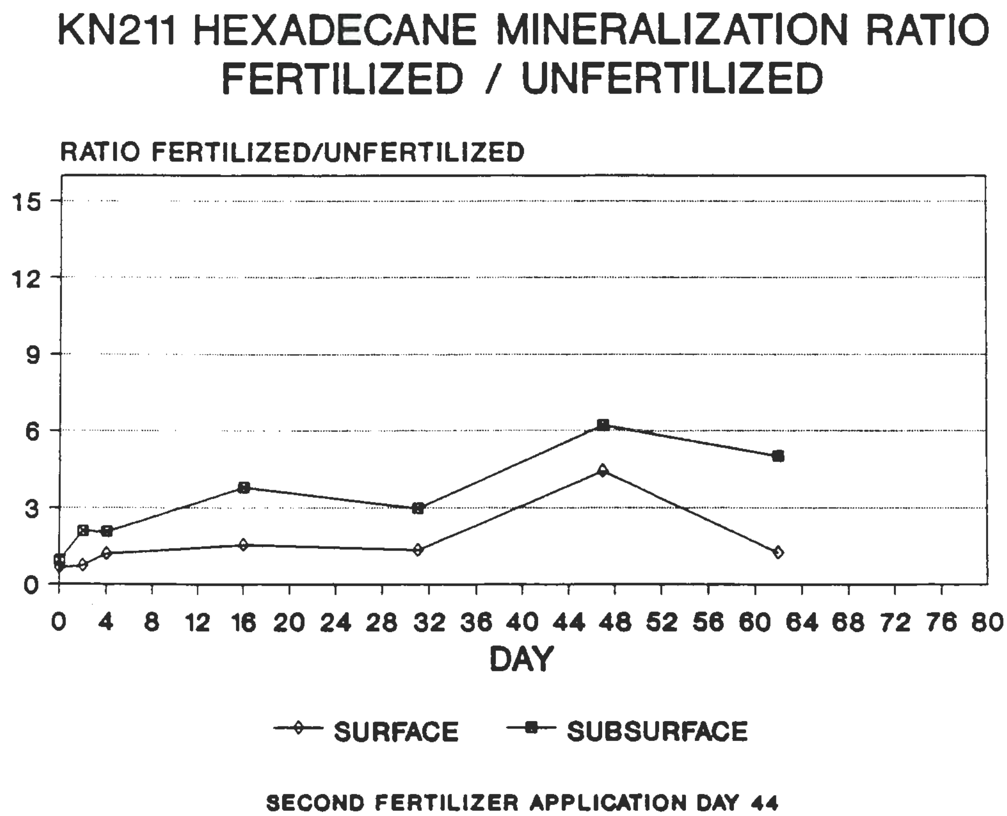


FIGURE 15
MICROBIAL MINERALIZATION ACTIVITY: KN-211E



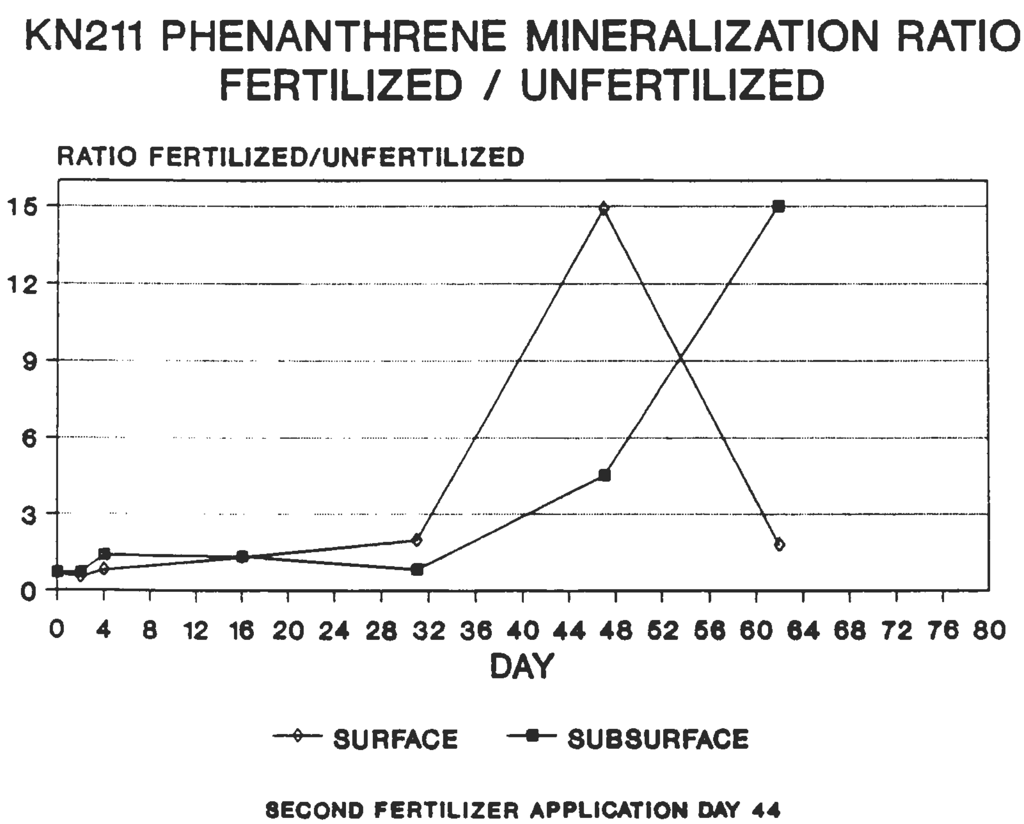
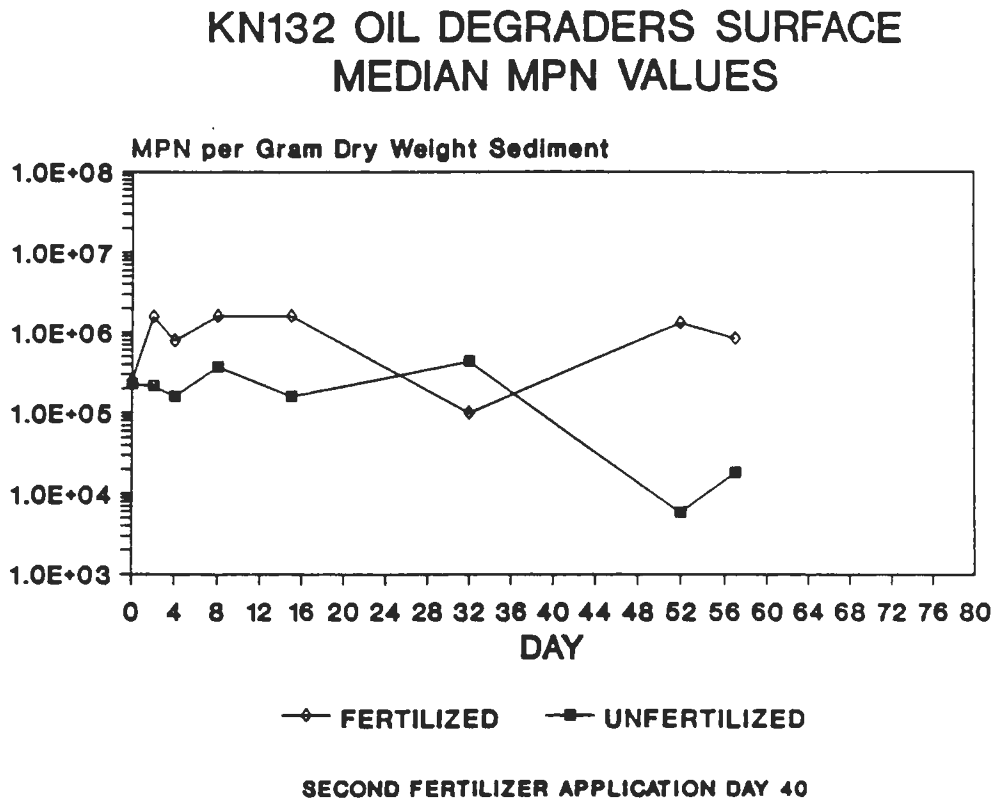


FIGURE 16
BACTERIAL POPULATIONS ON KN-132B



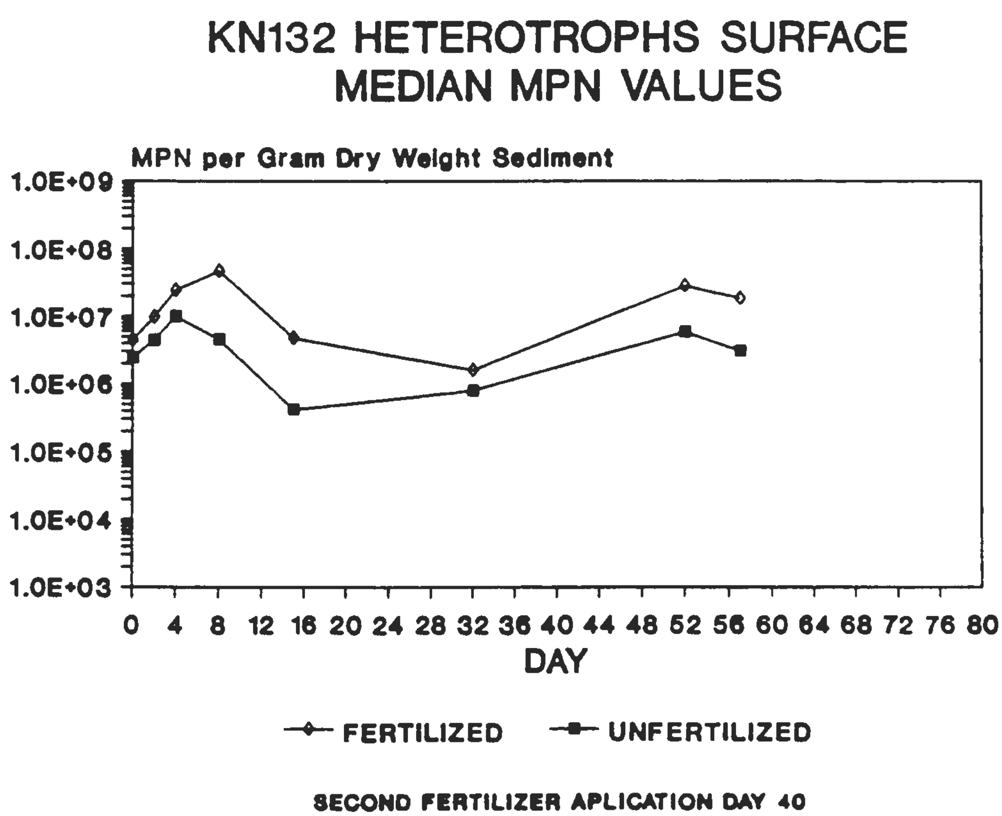
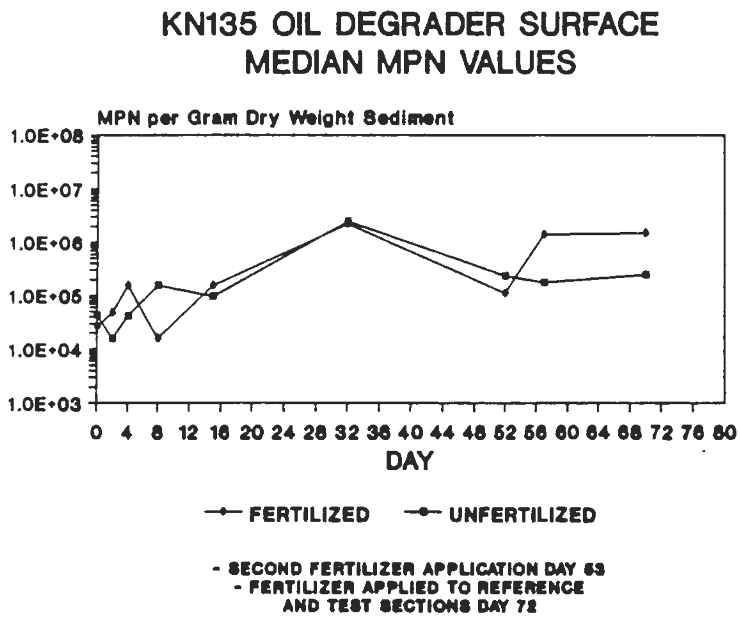
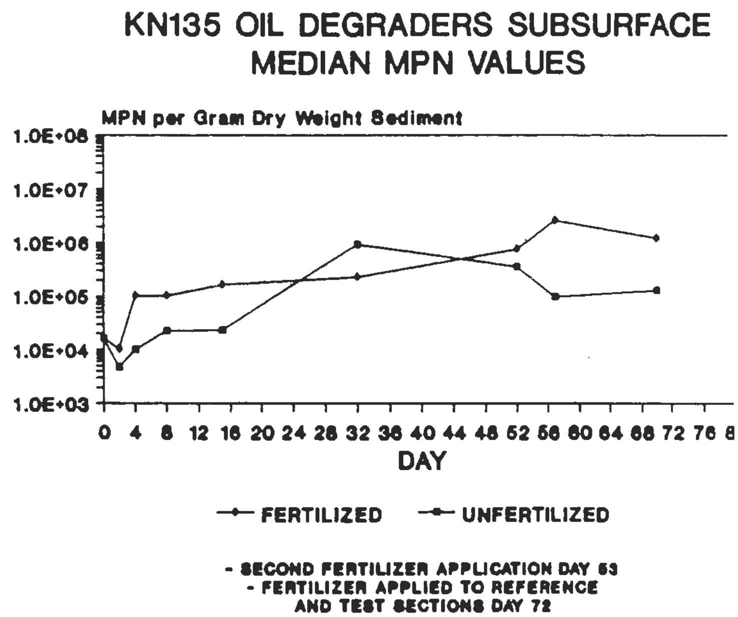
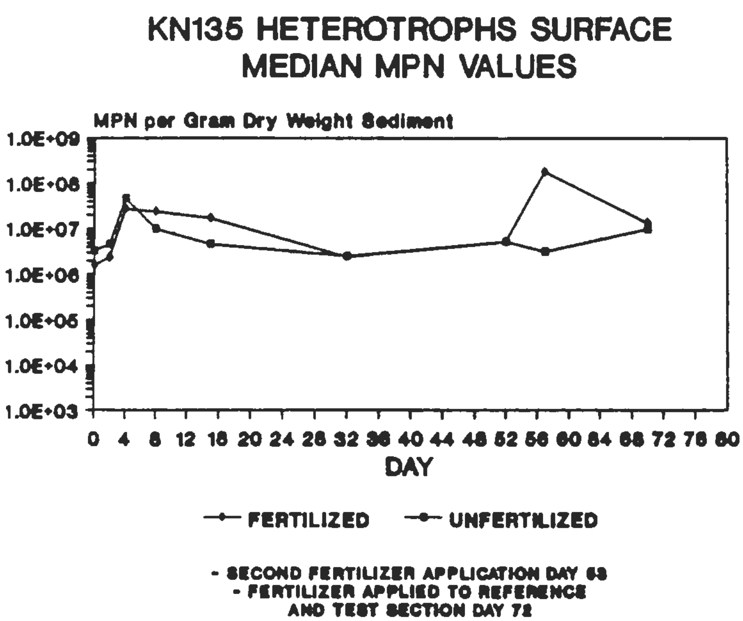


FIGURE 17
BACTERIAL POPULATIONS ON KN-135B







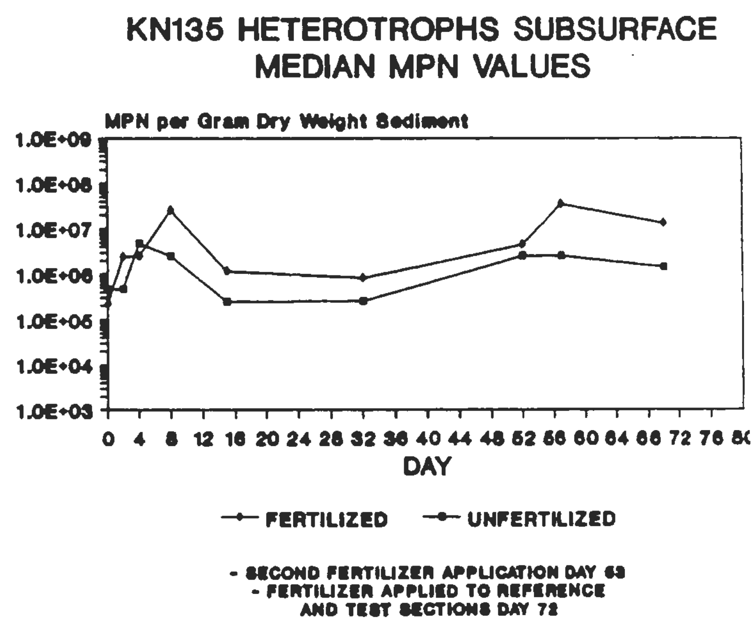
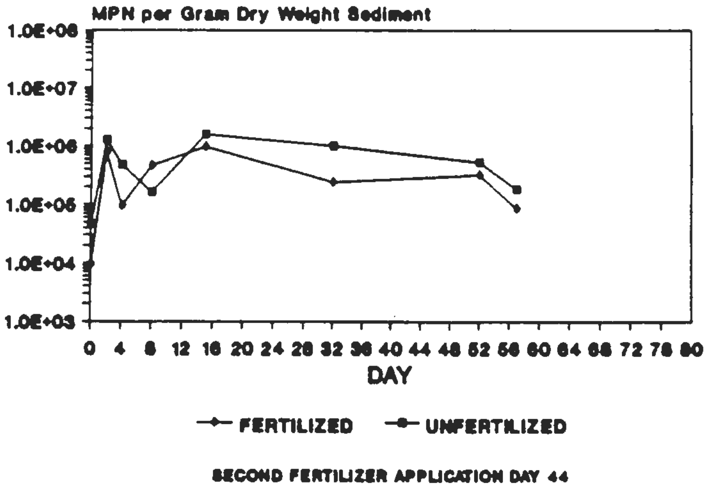
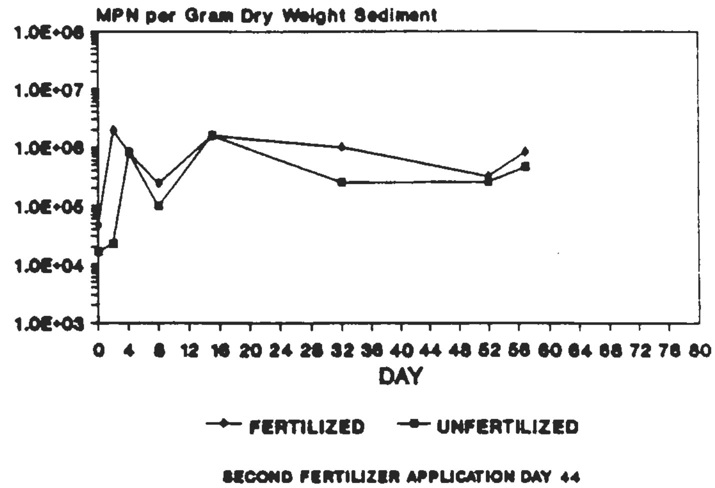


FIGURE 18
BACTERIAL POPULATIONS ON KN-211E

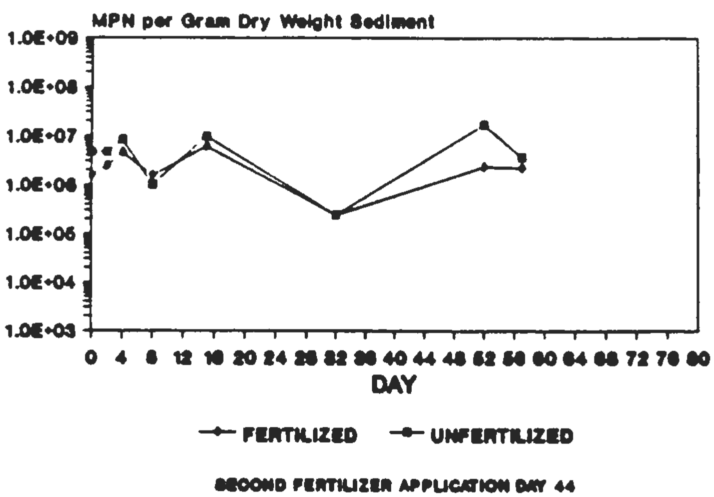
KN211 OIL DEGRADERS SURFACE MEDIAN MPN VALUES



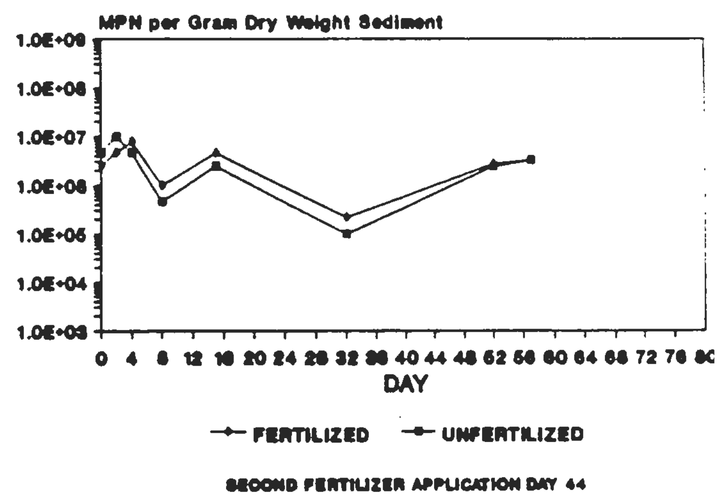
KN211 OIL DEGRADERS SUBSURFACE MEDIAN MPN VALUES



KN211 HETEROTROPHS SURFACE MEDIAN MPN VALUES



KN211 HETEROTROPHS SUBSURFACE MEDIAN MPN VALUES



OIL ANALYSES

Gravimetric Analyses

Oil was extracted from the sediments using a methylene chloride : acetone mix as outlined in Section 5 of Appendix SOP. An unexpected problem arose in subsequent analyses, however, when it was discovered that silt, probably glacial flour in the micron range, was being entrained in the solvents, and was contributing to gravimetrically determined oil weights. An additional filtration step, using a glass fiber filter with a 99.98% efficiency of filtering 0.3 um particles, was therefore introduced. Table 4 demonstrates the effect of this additional filtration for the Day 0 samples from KN-132.

TABLE 4
TOTAL EXTRACTABLE HYDROCARBON IN OILED SEDIMENTS
KN-132B, DAY 0

Sample	Unfiltered	Filtered	Ratio
As	14380	8760	1.6
As	11320	3380	3.4
As	720	400	1.8
Bs	6910	3750	1.8
Bs	3710	1920	1.9
Bs	7650	2320	3.3
Cs	2180	1490	1.5
Cs	13140	1690	7.8
Cs	1880	1350	1.4
Ds	19480	16550	1.2
Ds	23910	15980	1.5
Ds	24550	14090	1.7
Es	12080	2740	4.4
Es	5250	3840	1.4
Es	7550	4750	1.6
Fs	1210	1280	0.9
Fs	2650	2070	1.3
Fs	1660	1440	1.2
mean	8900	4880	1.8
standard deviation	7690	5260	
standard error	1810	1240	

The different samples had different amounts of filterable material; in this case an average of 45% of the unfiltered weight being sediment. Results of similar analyses on sediments from KN-135B and KN-211E are presented in Section 1 of Appendix D3. Filtration was included in the processing of all the samples discussed below.

Tables 5, 6 and 7 list the Total Extractable Hydrocarbon concentrations in individual sediment samples from KN-132B, KN-135B and KN-211E for initial sampling dates (Day 0) and for dates before (Day 29-32) and after (Day 60-70) the second fertilizer application. Neither the means nor the medians demonstrate a clear trend with time, and indeed the standard deviations are so large that they indicate that the data do not follow a normal distribution, and must be analyzed using different statistical approaches.

A preliminary analysis of the data using D'Agostino's D parameter suggests that in fact the weights of Total Extractable Hydrocarbon in the sediment sample follow a lognormal distribution. In other words, when the data are transformed by taking their logarithms, the distribution of these logarithms appears to follow a normal distribution. This allows the calculation of the confidence intervals around the mean values of Tables 5-7, as outlined in Table 8.

The variation in the measured oil loads from each portion of each site on Days 0, 32, and 60 is so great that the number of replicate measurements is too small for meaningful statistical calculations. Treating all the samples from each portion of each site as replicates, however, and ignoring the fact that they were collected at different times, allows some estimates to be made. These are also outlined in Table 8. The column labelled All Dates Combined lists the mean oil loading in the samples from each portion of each beach. The next column lists the 95% confidence interval; for KN-211E, surface-fertilized, for example, the mean is 618 mg/Kg sediment, with 95% confidence that the true value lies between 24 mg and 16 g. An alternative way of considering the confidence is presented in the final column, which is the estimated confidence that the true amount of oil in the sediment lies within a factor of 2 of the mean of the measured values; for the first row of data, there is a less than 50% confidence that the current estimate is within a factor of 2 of the actual amount of oil in the sediment.

Taken together, Tables 5-8 reveal that it is essentially impossible to estimate the amount of oil in a section of shoreline with the necessary sensitivity such that biodegradation can be quantitatively assessed in two months. As discussed in the Introduction, much effort went into finding the sites for this monitoring program, and seasoned observers from Exxon, ADEC, EPA, NOAA and Battelle Ocean Sciences all thought that the amount of oil in the sediments appeared homogeneous and similar in the two areas per site. Nevertheless, it is apparent that at least an order of magnitude more samples would have been needed in our data set to have reasonable confidence that the average of all the samples from a site was close to the true value, and at least an order of magnitude more if the oil residues at individual sampling times were to be compared with confidence.

Analysis of the Oil Composition

Before chromatographic analysis of the extracted oil, the three samples taken around each well were pooled, and passed through an alumina column to remove polar components. The samples were then analyzed by flame ionization detection gas chromatography (GCFID), which resolves the paraffinic components [Section 6 of Appendix SOP], and gas chromatography/mass spectrometry (GC/MS) with selected ion monitoring (SIM) to resolve aromatic and multi-ring compounds [Section 7 of Appendix SOP]. The latter analysis is being extended to include the detection of hopanes (Mass 191), since these are proving helpful in providing a quantitative assessment of biodegradation. The data available to date are collected in Appendix D3, Section 2.

Many processes contribute to the disappearance of oil from a shoreline, including evaporation, dissolution, physical removal while adsorbed to particles, and biodegradation. The focus of this monitoring program is to assess the contribution from biodegradation, and this can be quantified from

TABLE 5
TOTAL EXTRACTABLE HYDROCARBON IN SEDIMENTS FROM KN-132B

The data are in mg/Kg sediment dry weight
SD is the standard deviation of the mean, SE the standard error

	DAY 0 mg/Kg	DAY 29 mg/Kg	DAY 60 mg/Kg
FERTILIZED-SURFACE			
	399	1378	973
	1345	1444	1204
	1492	2269	1370
	1685	7451	1438
	1917	7946	1837
	2322	9807	2738
	3383	11203	5948
	3747	16620	9271
	8762	20026	22844
MEAN	2784	8683	5291
SD	2324	6220	6736
SE	775	2073	2245
MEDIAN	1917	7946	1837

	DAY 0 mg/Kg	DAY 29 mg/Kg	DAY 60 mg/Kg
UNFERTILIZED-SURFACE			
	1280	903	1011
	1436	956	1062
	2073	1511	1325
	2742	3919	2061
	3838	5198	3239
	4747	5230	4669
	14086	5757	11758
	15982	12384	12506
	16554	18794	13056
MEAN	6971	6072	5632
SD	6176	5594	4945
SE	2059	1865	1648
MEDIAN	3838	5198	3239

TABLE 6
TOTAL EXTRACTABLE HYDROCARBON IN SEDIMENTS FROM KN-135B

The data are in mg/Kg sediment dry weight
SD is the standard deviation of the mean, SE the standard error

	DAY 0 mg/Kg	DAY 32 mg/Kg	DAY 70 mg/Kg
FERTILIZED-SURFACE			
	1373	1171	1137
	1661	1570	1885
	1816	2680	2428
	2242	2688	2455
	2471	3097	2510
	5501	4090	5999
	8454	9542	9105
	8958	20917	10820
	20386	60799	12223
MEAN	5874	11839	5396
SD	5832	18282	4033
SE	1944	6094	1344
MEDIAN	2471	3097	2510
FERTILIZED-SUBSURFACE			
	555	940	375
	950	1069	750
	2755	1561	767
	3877	1798	1310
	4840	2125	1737
	5766	3523	2759
	7135	5538	5378
	10410	7548	5599
	10440	14611	8375
MEAN	5192	4301	3006
SD	3435	4206	2640
SE	1145	1402	880
MEDIAN	4840	2125	1737

	DAY 0 mg/Kg	DAY 32 mg/Kg	DAY 70 mg/Kg
UNFERTILIZED-SURFACE			
	1394	2944	1637
	3274	3566	2501
	3389	5426	8545
	4126	10158	9371
	4516	10583	9623
	6018	11850	15012
	7678	14570	16168
	21219	19233	16864
	27812	23753	24531
MEAN	8825	11343	11584
SD	8689	6624	6894
SE	2896	2208	2298
MEDIAN	4516	10583	9623
UNFERTILIZED-SUBSURFACE			
	1418	340	133
	2654	1012	714
	3051	1775	896
	6404	1938	1383
	8793	2157	1502
	8838	3154	1740
	9448	3306	7661
	10601	11708	15521
	29162	26456	24490
MEAN	8930	5761	6004
SD	7812	7972	8051
SE	2604	2657	2684
MEDIAN	8793	2157	1502

TABLE 7
TOTAL EXTRACTABLE HYDROCARBON IN SEDIMENTS FROM KN-211E

The data are in mg/Kg sediment dry weight
SD is the standard deviation of the mean, SE the standard error

	DAY 0 mg/Kg	DAY 31 mg/Kg	DAY 61 mg/Kg
FERTILIZED-SURFACE			
	103	210	13
	140	243	169
	201	282	367
	288	368	469
	366	591	733
	418	1154	1052
	451	9351	2049
	486	11183	2985
	631	19234	10057
MEAN	343	4735	1988
SD	165	6521	2995
SE	55	2174	998
MEDIAN	366	591	733
FERTILIZED-SUBSURFACE			
	242	228	165
	1634	303	1359
	6156	2378	3477
	19603	6442	7916
	20376	12353	10792
	22651	15879	10811
	23595	18808	17486
	23845	20546	18738
	25009	26854	23997
MEAN	15901	11532	10527
SD	9593	9141	7784
SE	3198	3047	2595
MEDIAN	20376	12353	10792

	DAY 0 mg/Kg	EST* DAY 31 mg/Kg	DAY 61 mg/Kg
UNFERTILIZED-SURFACE			
	1138	220	204
	1591	1936	228
	1745	3314	528
	3156	3418	793
	3182	4186	1013
	7316	5712	1363
	11169	6191	2064
	11765	9418	3708
	16590	20187	5835
MEAN	6406	6065	1748
SD	5266	5579	1777
SE	1755	1860	592
MEDIAN	3182	4186	1013
UNFERTILIZED-SUBSURFACE			
	5072	6366	9218
	11153	6889	9611
	14669	14388	14553
	16992	16393	14992
	18277	17963	16017
	18364	19009	16385
	21435	20143	16470
	22626	21189	16578
	23987	23239	17256
MEAN	16953	16175	14565
SD	5632	5654	2861
SE	1877	1885	954
MEDIAN	18277	17963	16017

EST* = For Day 31 dry weight of 28.67 g was presumed for each individual sample.
This value is the mean of the weights of the fertilized side (s.d of 0.60).

TABLE 8

MEANS AND CONFIDENCE INTERVALS FOR THE TOTAL EXTRACTABLE HYDROCARBON DATA

The data are in mg/Kg sediment dry weight

SAMPLE SET	DAY 0	APPROX. DAY 30	APPROX. DAY 60	ALL DATES COMBINED	95% CONF. INTERV. ALL DATA		CONF. MEAN W/IN FACTOR OF 2
KN-211E, Fert. Area, Surface	296	1246	640	618	24	16033	< 50%
KN-211E, Fert. Area, Subsurf	8780	5055	5627	6297	230	172405	< 50%
KN-211E, Unfert. Area, Surface	4303	3718	1020	2537	193	33283	< 50%
KN-211E, Unfert. Area, Subsurface	15610	14846	14228	14885	6617	33480	90%
KN-135B, Fert. Area, Surface	3873	5023	3945	4249	553	32660	50%
KN-135B, Fert. Area, Subsurf	3673	2862	1912	2719	357	20729	50%
KN-135B, Unfert. Area, Surface	5836	9223	8801	7795	1392	43669	60%
KN-135B, Unfert. Area, Subsurface	6346	2724	2128	3325	221	50066	< 50%
KN-132B, Fert. Area, Surface	2060	5980	2902	3294	394	27551	50%
KN-132B, Unfert. Area, Surface	4468	3851	3530	3931	506	30559	50%

the chemistry of the oil. Crude oil contains innumerable molecular species, which vary in their ease of biodegradation. For example, it is well known that the straight chain alkanes are more readily metabolized by microbes than their branched chain analogs, and this is the basis of the well known n-octadecane (C18) : phytane ratio. The C18 : phytane ratios of samples collected from KN-135B are presented in Table 9. All of the values are substantially lower than the values determined for Prudhoe Bay crude oil that has been artificially weathered by evaporating 30% by weight. Evaporation of crude oil following an oil spill is generally assumed to remove 30% of the initial weight, so 30% evaporated oil is used as an approximate indicator of the composition of the oil when it arrived at the shoreline. This evaporation is done at reduced pressure so that the effective temperature of evaporation is 521 F; the oil is thus called 521 oil.

As the indigenous microbes consume the more readily degradable straight chain paraffins, the C18 : phytane ratio declines. We can thus conclude that all the oil samples listed in Table 9 show evidence of substantial biodegradation. Furthermore, in general the samples collected later in the program were more biodegraded than those collected earlier.

Another measure that is sometimes used to describe the status of a weathered oil is the "Aromatic Weathering Ratio". This is a complex measure based on the aromatic molecules resolved in the GC/MS measurements reported in Appendix D3, Section 2. It is the sum of naphthalene and the alkylated naphthalenes, fluorene and the alkylated fluorenes, dibenzothiophene and the alkylated dibenzothiophenes and phenanthrene and the alkylated phenanthrenes, divided by the sum of dibenzothiophene and the alkylated dibenzothiophenes plus phenanthrene and the alkylated phenanthrenes. Like the C18 : phytane ratio, it is unitless.

While the C18 : phytane ratio is principally influenced by biodegradation, the aromatic weathering ratio is also influenced by solubility, since naphthalenes and phenanthrenes are rather soluble. They are also biodegradable, as are the dibenzothiophenes. The aromatic ratio is thus harder to interpret in terms of biodegradation, but the ratio is expected to decrease as weathering and biodegradation proceeds.

The aromatic weathering ratios of the oils collected from KN-135B during the monitoring program are presented in Table 10. Just as with the C18 : phytane ratio, there is a general trend that surface oils are more weathered than subsurface oils, but all show significant weathering. This is an important finding, because it is the aromatic compounds in the crude oil which present the greatest toxicological hazard. The range of the aromatic weathering ratio found on different samplings is too great for any conclusions to be drawn concerning the effectiveness of bioremediation, at least with the data currently to hand.

The Rate of Biodegradation

Unfortunately the ratios discussed above do not provide information that can lead to a quantitative assessment of how much oil has been degraded. Changes in the C18 : phytane ratio are dependent on the amount of oil present in a sample, for biodegradation mainly occurs at the oil-water interface. Thick layers of oil in the sediment tend to mask biodegradation in the

TABLE 9
C18:PHYTANE RATIOS OF OIL FROM KN-135B

WELL	DAY 0	8	15	32	70
As	1.05	0.64	0.92	0.32	0.29
Ass	0.93	0.76	0.83	0.48	0.34
Bs	0.34	0.36	0.78	0.54	0.42
Bss	1.23	0.80	0.89	1.09	0.49
Cs	0.55	0.49	0.34	1.35	0.42
Css	0.75	1.37	0.42	1.10	0.52
Ds	1.09	0.73	0.78	0.88	0.89
Dss	1.10	1.35	1.45	1.39	0.90
Es	1.00	0.57	0.31	0.73	0.78
Ess	1.49		1.39	1.41	1.37
Fs	0.45	0.83	0.82	0.81	0.65
Fss	1.30	1.41	1.45	1.14	1.20

Prudhoe Bay Crude	1.96
30% weathered Prudhoe Bay Crude	1.82

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

TABLE 10
AROMATIC WEATHERING RATIOS OF OIL FROM KN-135B

WELL	DAY 0	DAY 8	DAY 15	DAY 32
As	1.55	1.36		1.31
Ass	1.50	1.48		1.42
Bs	1.41	1.45		1.43
Bss	1.60	1.55		1.67
Cs	1.29	1.29		1.65
Css		1.64		1.64
Ds	1.53	1.46		1.05
Dss	1.59	1.70		1.15
Es	1.56	1.41		1.20
Ess	1.66			1.15
Fs	1.38	1.53		1.09
Fss	1.62	1.67		1.07

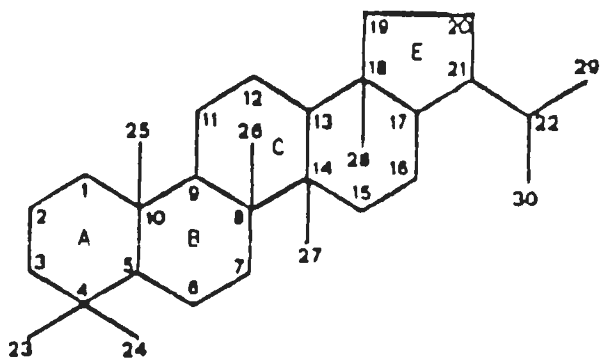
Prudhoe Bay Crude 2.76 - 2.87
30% weathered Prudhoe Bay Crude 1.77 - 1.80

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

surface layer most available to the microbes. Nevertheless, if phytane was essentially non-biodegradable, the amount of oil consumed could be determined by reference to the amount of phytane in the sample and in a reference oil. Phytane is, however, biodegraded quite readily.

What is needed is a less degradable internal marker than phytane, and there is reason to believe that hopanes fulfill this role. Hopanes are pentacyclic molecules initially in the bacteria that were the original source of the crude oil. Diagenesis of the kerogen (conversion of the oil precursor to oil) removes some of the substituents on the bacterial molecules, and the major hopane found in oil is 17α,21β-hopane; this is shown in Figure 19.

FIGURE 19
HOPANE



Hopane analyses were not a routine part of oil analyses, and the analytical laboratories at Battelle Ocean Sciences and at Exxon Research and Engineering undertook a substantial research project to develop a quantitative assay for this compound. As illustrated in Appendix D3, Section 3, the quantitative method now seems reliable. If indeed hopane is an almost completely non-degradable component in crude oil, knowing the amount of hopane in a sample allows a calculation of how much oil was originally in that sample, and thus how much has been biodegraded. As discussed above, it is generally assumed that approximately 30% of the volume of oil spilled from the tanker evaporated before the oil arrived at the shoreline. Oil that has been evaporated to lose 30% of its initial weight (521 oil) is therefore used as a standard in these calculations.

ILLUSTRATIVE CALCULATION BASED ON HOPANE
Gravimetric weight

521 oil has A mg hopane / Kg oil
Sample has a mg hopane and B Kg of oil / Kg sediment dry weight

Assuming that hopane is indeed a truly conserved species, the sample originally had a/A Kg oil / Kg sediment dry weight

Therefore the amount biodegraded = (a/A) - B Kg oil / Kg sediment

Tables 11-13 present the results of such calculations for the samples collected on Days 0 and approximately 30 for the three study sites in this program. The estimate for any one batch of samples has a large uncertainty, but averaging all of the data from all the batches provides an estimate of

3.3 ± 2.5 g oil biodegraded / Kg sediment / year at the surface
1.7 ± 1.3 g oil biodegraded / Kg sediment / year in the subsurface

Note that the amount of oil lost in any process which removes hopane, such as physical removal, will not be included in this estimate.

An alternative approach to estimating the amount of oil that has been biodegraded is to use only the chemical components of the oil. Again this relies on the assumption that hopane acts as an internal marker that is not biodegraded, but it does not rely on the independent gravimetric estimate used above; all the quantitative estimates are obtained by Gas Chromatography. This was particularly important in the July 10 Interim Report, when reliable gravimetric estimates were unavailable, but even with such data the process described here provides a partially independent estimate of the amount of oil degraded.

ILLUSTRATIVE CALCULATION BASED ON HOPANE
Individual chemical components

521 oil has A mg hopane / Kg oil, B mg C18, C mg phytane, etc.
Sample has a mg hopane / Kg sediment, b mg C18, c mg phytane, etc.

Assuming that hopane is indeed a truly conserved species, the sample originally had a/A Kg oil / Kg sediment dry weight

and (a/A)B mg C18 / Kg sediment dry weight, (a/A)C mg phytane, etc.

Therefore the amount consumed: of C18 = (a/A)B - b mg / Kg sediment
phytane = (a/A)C - c, etc.

To illustrate this procedure, the amounts of n-octadecane (C18), phytane, phenanthrene, chrysenes with two carbon substituents (C-2 chrysenes), total alkanes (C10 to C34) and total resolvable hydrocarbon (Total HC) present in the original oil, are presented in Tables 14 and 15. The amounts degraded since then are presented in Tables 16 and 17, and the percent depletions of the individual components in the actual samples are presented in Tables 18 and 19.

Tables 16 and 17 provide an alternative estimate of the overall rate of biodegradation. To get such an estimate for the total oil degraded by microbes, we can use the total hydrocarbon detectable by gas chromatography. This is 56% of 521 oil, and is useful because it integrates degradation over a broad range of chemical constituents, rather than the individual chemicals used in the ratios described above. The calculation assumes that the total

TABLE 11
ESTIMATED AMOUNTS OF OIL BIODEGRADED SINCE BEACHING, KN-132B

	DAY 0				DAY 29			
	GRAV WT	[HOPANE]	THEN WT	WT BIODEG	GRAV WT	[HOPANE]	THEN WT	WT BIODEG
AS	4999	2.92	9733	4734	6590	3.71	12367	5777
BS	2920	1.56	5200	2280	6286	2.13	7100	814
CS	3464	2.33	7767	4303	11671	4.99	16633	4962
mean	3794	2.27	7567	3772	8182	3.61	12033	3851
sd	880	0.56	1856	1070	2470	1.17	3899	2173
se	509	0.32	1073	618	1428	0.68	2254	1256
median	3464	2.33	7767	4303	6590	3.71	12367	4962
DS	15733	8.45	28167	12434	12132	5.53	18433	6301
ES	2615	2.01	6700	4085	4732	2.6	8667	3935
FS	1175	1.06	3533	2358	1246	0.63	2100	854
mean	6508	3.84	12800	6292	6037	2.92	9733	3697
sd	6550	3.28	10943	4399	4539	2.01	6711	2230
se	3786	1.90	6325	2543	2624	1.16	3879	1289
median	2615	2.01	6700	4085	4732	2.6	8667	3935

GRAV WT is the Total Extractable Hydrocarbon from Table 5, on a mg / Kg sediment dry weight basis.
[HOPANE] is the hopane concentration on a mg / Kg sediment dry weight basis Values corrected for the surrogate recovery on each sample.
THEN WT is the calculated weight of oil in the sediment at initial oiling in 1989
WT BIODEG is the weight biodegraded since beaching in 1989, obtained by subtracting GRAV WT from THEN WT

sd is the standard deviation of the mean, and se the standard error

TABLE 12
ESTIMATED AMOUNTS OF OIL BIODEGRADED SINCE BEACHING, KN-135B

	DAY 0 GRAV WT	[HOPANE]	THEN WT	WT BIODEG	DAY 32 GRAV WT	[HOPANE]	THEN WT	WT BIODEG
AS	11382	5.62	18733	7351	5244	2.56	8533	3289
BS	4218	2.23	7433	3215	7452	3.03	10100	2648
CS	1803	1.05	3500	1697	14047	4.82	16067	2020
mean	5801	2.97	9889	4088	8914	3.47	11567	2652
sd	4068	1.94	6457	2389	3740	0.97	3246	518
se	2351	1.12	3732	1381	2162	0.56	1876	300
median	4218	2.23	7433	3215	7452	3.03	10100	2648
DS	12806	6.33	21100	8294	11009	4.33	14433	3424
ES	8725	2.92	9733	1008	10984	4.77	15900	4916
FS	4574	1.96	6533	1959	8960	3.9	13000	4040
mean	8702	3.74	12456	3754	10318	4.33	14444	4127
sd	3361	1.88	6251	3234	960	0.36	1184	612
se	1943	1.08	3613	1869	555	0.21	684	354
median	8725	2.92	9733	3215	10984	4.33	14433	4040
ASS	3662	1.53	5100	1438	1487	0.75	2500	1013
BSS	6065	1.87	6233	168	7744	2.93	9767	2023
CSS	4574	1.69	5633	1059	3587	1.45	4833	1246
mean	4767	1.70	5656	889	4273	1.71	5700	1427
sd	990	0.14	463	532	2600	0.91	3029	432
se	702	0.08	268	308	1503	0.53	1751	249
median	4574	1.69	5633	1059	3587	1.45	4833	1246
DSS	5777	2.29	7633	1856	1602	0.68	2267	665
ESS	14592	4.91	16367	1775	7527	3	10000	2473
FSS	5397	1.76	5867	470	5177	2.22	7400	2223
mean	8589	2.99	9956	1367	4769	1.97	6556	1787
sd	4248	1.38	4590	635	2436	0.96	3213	800
se	2455	0.80	2653	367	1408	0.56	1857	462
median	5777	2.29	7633	1775	5177	2.22	7400	2223

GRAV WT is the Total Extractable Hydrocarbon from Table 5, on a mg / Kg sediment dry weight basis.

[HOPANE] is the hopane concentration on a mg / Kg sediment dry weight basis Values corrected for the surrogate recovery on each sample.

THEN WT is the calculated weight of oil in the sediment at initial oiling in 1989

WT BIODEG is the weight biodegraded since beaching in 1989, obtained by subtracting GRAV WT from THEN WT

sd is the standard deviation of the mean, and se the standard error

TABLE 13
ESTIMATED AMOUNTS OF OIL BIODEGRADED SINCE BEACHING, KN-211E

	DAY 0 GRAV WT	DAY 0 [HOPANE]	DAY 0 THEN WT	DAY 0 WT BIODEG	DAY 31 GRAV WT	DAY 31 [HOPANE]	DAY 31 THEN WT	DAY 31 WT BIODEG
AS	189	0.07	233	44	6339	3.02	10067	3728
BS	192	0.11	367	174	7064	2.84	9467	2403
CS	309	0.15	500	191	635	0.22	733	98
mean	230	0.11	367	137	4679	2.03	6756	2076
sd	56	0.03	109	66	2875	1.28	4265	1500
se	32	0.02	63	38	1662	0.74	2466	867
median	192	0.11	367	174	6339	2.84	9467	2403
DS	5165	2.84	9467	4302	5084	2.26	7533	2449
ES	1641	1.47	4900	3259	4151	1.61	5367	1216
FS	4468	2.51	8367	3899	9380	3.3	11000	1620
mean	3758	2.27	7578	3820	6205	2.39	7967	1762
sd	1524	0.58	1946	429	2277	0.70	2320	514
se	881	0.34	1125	248	1316	0.40	1341	297
median	4468	2.51	8367	3899	5084	2.26	7533	1620
ASS	4402	1.82	6067	1665	998	0.33	1100	102
BSS	20189	7.25	24167	3978	18321	6.37	21233	2912
CSS	12579	5.09	16967	4388	16571	5.89	19633	3062
mean	12390	4.72	15733	3344	11963	4.20	13989	2026
sd	6447	2.23	7441	1199	7787	2.74	9137	1362
se	4572	2	5277	850	4501	1.58	5282	787
median	12578	5.09	16967	3978	16571	5.89	19633	2912
DSS	9002	4.01	13367	4365	15300	4.81	16033	733
ESS	20359	6.04	20133	-226	19588	6.14	20467	879
FSS	16629	5.45	18167	1538	14786	4.47	14900	114
mean	15330	5.17	17222	1892	16558	5.14	17133	575
sd	4727	0.85	2842	1891	2153	0.72	2402	332
se	2732	0.49	1643	1093	1244	0.42	1388	192
median	16629	5.45	18167	1538	15300	4.81	16033	733

GRAV WT is the Total Extractable Hydrocarbon from Table 5, on a mg / Kg sediment dry weight basis.

[HOPANE] is the hopane concentration on a mg / Kg sediment dry weight basis Values corrected for the surrogate recovery on each sample.

THEN WT is the calculated weight of oil in the sediment at initial oiling in 1989

WT BIODEG is the weight biodegraded since beaching in 1989, obtained by subtracting GRAV WT from THEN WT

sd is the standard deviation of the mean, and se the standard error

TABLE 14
REPRESENTATIVE CHEMICAL COMPONENTS, KN-135B, DAY 0
mg/Kg dry weight sediment

	C18	phytane	phenanthrene	C-2 chrysene	total alkane	total HC	hopane
As	19.68	18.74	0.30	2.13	253.3	5512	5.62
Ass	5.26	5.63	nd	0.53	72.1	1694	1.53
Bs	1.05	3.10	nd	0.69	22.8	1615	2.23
Bss	9.76	7.96	nd	0.71	125.1	2172	11.87
Cs	0.25	0.46	0.01	0.25	6.7	496	1.05
Css	6.19	8.30	0.04	0.83	103.0	2183	1.69
Ds	22.43	20.60	nd	2.51	297.7	6493	6.33
Dss	10.12	9.24	nd	0.87	131.1	2551	2.29
Es	8.39	8.36	0.55	1.04	105.2	2374	2.92
Ess	31.92	21.36	0.17	2.06	415.1	5687	4.91
Fs	1.78	3.94	nd	0.57	34.2	1637	1.96
Fss	11.14	8.57	nd	0.64	144.4	2279	1.76

Measured as mg/Kg

	C18	phytane	phenanthrene	C-2 chrysene	total alkane	total HC	hopane
Prudhoe Bay crude oil	2530	1225	112	62	48867		
Prudhoe Bay crude oil evaporated at 521F (30% depleted)	3485	1902	297	181	43222	555599	331

Total alkanes includes C10 to C32, plus pristane and phytane. Total HC is the total hydrocarbon resolvable by Gas Chromatography. For 521 oil it is 56% of the total oil.

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

TABLE 15
REPRESENTATIVE CHEMICAL COMPONENTS, KN-135B, DAY 32
mg/Kg dry weight sediment

	C18	phytane	phenan-threne	C-2 chrysene	total alkane	total HC	hopane
As	0.57	1.81	nd	0.69	13.0	1603	2.56
Ass	0.78	1.62	nd	0.21	11.6	587	0.75
Bs	4.12	7.59	nd	1.06	51.9	2880	3.03
Bss	9.97	9.16	nd	1.21	122.4	2682	2.93
Cs	29.02	21.58	1.67	2.24	353.5	5770	4.82
Css	5.92	5.37	0.04	0.52	75.3	1521	1.45
Ds	13.16	14.88	nd	1.73	175.2	4268	4.33
Dss	4.03	2.90	nd	0.25	50.5	785	0.68
Es	11.70	16.02	0.24	1.66	151.7	4198	4.77
Ess	19.66	14.02	nd	1.21	248.4	3480	3.00
Fs	10.06	12.45	nd	1.73	129.6	3661	3.90
Fss	10.21	8.96	nd	0.94	131.9	2392	2.22

Measured as mg/Kg

	C18	phytane	phenan-threne	C-2 chrysene	total alkane	total HC	hopane
Prudhoe Bay crude oil	2530	1225	112	62	48867		
Prudhoe Bay crude oil evaporated at 521F (30% depleted)	3485	1902	297	181	43222	555599	331

Total alkanes includes C10 to C32, plus pristane and phytane. Total HC is the total hydrocarbon resolvable by Gas Chromatography. For 521 oil it is 56% of the total oil.

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

TABLE 16
REPRESENTATIVE CHEMICAL COMPONENTS, KN-135B, DAY 0
AMOUNT BIODEGRADED
mg/Kg dry weight lost since beaching
based on hopane

	C18	phytane	phenan-threne	C-2 chrysene	total alkane	total HC
As	39.49	13.55	4.74	0.94	481	3921
Ass	10.85	3.16	1.37	0.31	128	874
Bs	22.43	9.71	2.00	0.53	268	2127
Bss	9.93	2.79	1.68	0.31	119	966
Cs	10.81	5.57	0.93	0.32	130	1266
Css	11.60	1.41	1.48	0.09	118	653
Ds	44.22	15.77	5.68	0.95	529	4131
Dss	13.99	3.92	2.05	0.38	168	1292
Es	22.35	8.42	2.07	0.54	276	2527
Ess	19.78	6.85	4.24	0.62	226	2554
Fs	18.86	7.32	1.76	0.50	222	1652
Fss	7.39	1.54	1.58	0.32	85	675

Total alkanes includes C10 to C32, plus pristane and phytane. Total HC is the total hydrocarbon resolvable by Gas chromatography. For 521 oil it is 56% of the total oil.

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

TABLE 17
REPRESENTATIVE CHEMICAL COMPONENTS, KN-135B, DAY 32
AMOUNT BIODEGRADED
mg/Kg dry weight lost since beaching
based on hopane

	C18	phytane	phenan-threne	C-2 chrysene	total alkane	total HC
As	26.38	12.90	2.30	0.71	321	2694
Ass	7.12	2.69	0.67	0.20	86	672
Bs	27.78	9.82	2.72	0.60	344	2206
Bss	20.88	7.68	2.63	0.39	260	2235
Cs	21.73	6.12	2.65	0.40	276	2320
Css	9.35	2.96	1.26	0.27	114	1013
Ds	32.43	10.00	3.89	0.64	390	3000
Dss	3.13	1.01	0.61	0.12	38	356
Es	38.52	11.39	4.04	0.95	471	3029
Ess	11.93	3.22	2.69	0.43	143	1555
Fs	31.00	9.96	3.50	0.40	380	2885
Fss	13.16	3.80	1.99	0.27	158	1334

Total alkanes includes C10 to C32, plus pristane and phytane. Total HC is the total hydrocarbon resolvable by Gas chromatography. For 521 oil it is 56% of the total oil.

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

TABLE 18
REPRESENTATIVE CHEMICAL COMPONENTS, KN-135B, DAY 0
Percent depleted -v- 521 oil

	C18	phytane	phenan-threne	C-2 chrysene	total alkane	total HC
As	67	42	94	31	66	42
Ass	67	36	100	37	64	34
Bs	96	76	100	43	92	57
Bss	50	26	100	30	49	31
Cs	98	92	99	56	95	72
Css	65	15	97	10	53	23
Ds	66	43	100	27	64	39
Dss	58	30	100	30	56	34
Es	73	50	79	34	72	52
Ess	38	24	96	23	35	31
Fs	91	65	100	47	87	50
Fss	40	15	100	33	37	23

Total alkanes includes C10 to C32, plus pristane and phytane. Total HC is the total hydrocarbon resolvable by Gas chromatography. For 521 oil it is 56% of the total oil.

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

TABLE 19
REPRESENTATIVE CHEMICAL COMPONENTS, KN-135B, DAY 32
Percent depleted -v- 521 oil

	C18	phytane	phenan-threne	C-2 chrysene	total alkane	total HC
As	98	88	100	51	96	63
Ass	90	62	100	49	88	53
Bs	87	56	100	36	87	43
Bss	68	46	100	24	68	45
Cs	43	22	61	15	44	29
Css	61	36	97	34	60	42
Ds	71	40	100	27	69	41
Dss	44	26	100	32	43	31
Es	77	42	94	36	76	38
Ess	38	19	100	26	36	31
Fs	75	44	100	19	75	44
Fss	56	30	100	22	54	36

Total alkanes includes C10 to C32, plus pristane and phytane. Total HC is the total hydrocarbon resolvable by Gas chromatography. For 521 oil it is 56% of the total oil.

Well designations include s for surface and ss for subsurface. Wells A, B and C are in the fertilized portion of the beach, D, E and F in the unfertilized portion.

fraction of each oil sample that is resolvable by gas chromatography is similar to that found in 521 oil:

i.e. Total oil weight biodegraded = Total HC degraded * 100/56

Evidence that this is a reasonable assumption is presented in Appendix D3, Section 4. These calculations lead to estimates of:

4.3 ± 1.4 g oil biodegraded / Kg sediment / year at the surface
1.9 ± 1.0 g oil biodegraded / Kg sediment / year in the subsurface

These estimates are close to those described above using gravimetric estimates of oil weight. An important corollary of this finding is that although different components of the oil are being degraded at different rates (Tables 18 and 19), the fraction of the oil that is not resolvable by gas chromatography must be undergoing biodegradation at approximately the same rate as that of the resolvable species.

At this point it is worth noting that in the Interim Report of July 10, this procedure gave estimates of

2.3 ± 0.8 g oil biodegraded / Kg sediment / year at the surface
0.7 ± 0.6 g oil biodegraded / Kg sediment / year in the subsurface

The change is mainly due to increasing the estimate of hopane in the samples, which has had the effect of increasing the amount biodegraded. The increase came when the hopane concentration was corrected for surrogate recovery. This identifies a serious potential drawback with using internal markers, since relatively small errors in measuring hopane can be translated into larger errors in final estimates. Unfortunately the variance in the gravimetric data (Table 8) obviates the use of simple gravimetric estimates of biodegradation, and the internal reference procedure used here is the only avenue for obtaining quantitative estimates. Taken together, the data obtained in this monitoring program suggest that the natural rate of biodegradation of oil on the shorelines of Prince William Sound is in the range

2-5 g oil biodegraded / Kg sediment / year at the surface
0.5-2.5 g oil biodegraded / Kg sediment / year in the subsurface

A more rigorously defined estimate of the rate of degradation will be possible when all the chemistry data have been processed and reviewed. This should be available for the Final Report scheduled for delivery by January 1, 1991.

WATER QUALITY OF NEARSHORE WATER

Ammonia and Nitrate Concentrations

The trends in ammonia and nitrate concentrations following the initial fertilizer applications for each site are plotted in Figures 20 and 21 and summarized in Table 20. Baseline ammonia concentrations at KN-132B varied slightly between the fertilized and reference sites before and after fertilizer application, but there was no indication of any significant ammonia release into the nearshore waters. Baseline concentrations of nitrate ranged from 0.01 to 0.03 mg/l at this site. The maximum nitrate

FIGURE 20
AMMONIA IN NEARSHORE WATER OFF FERTILIZED SHORELINES

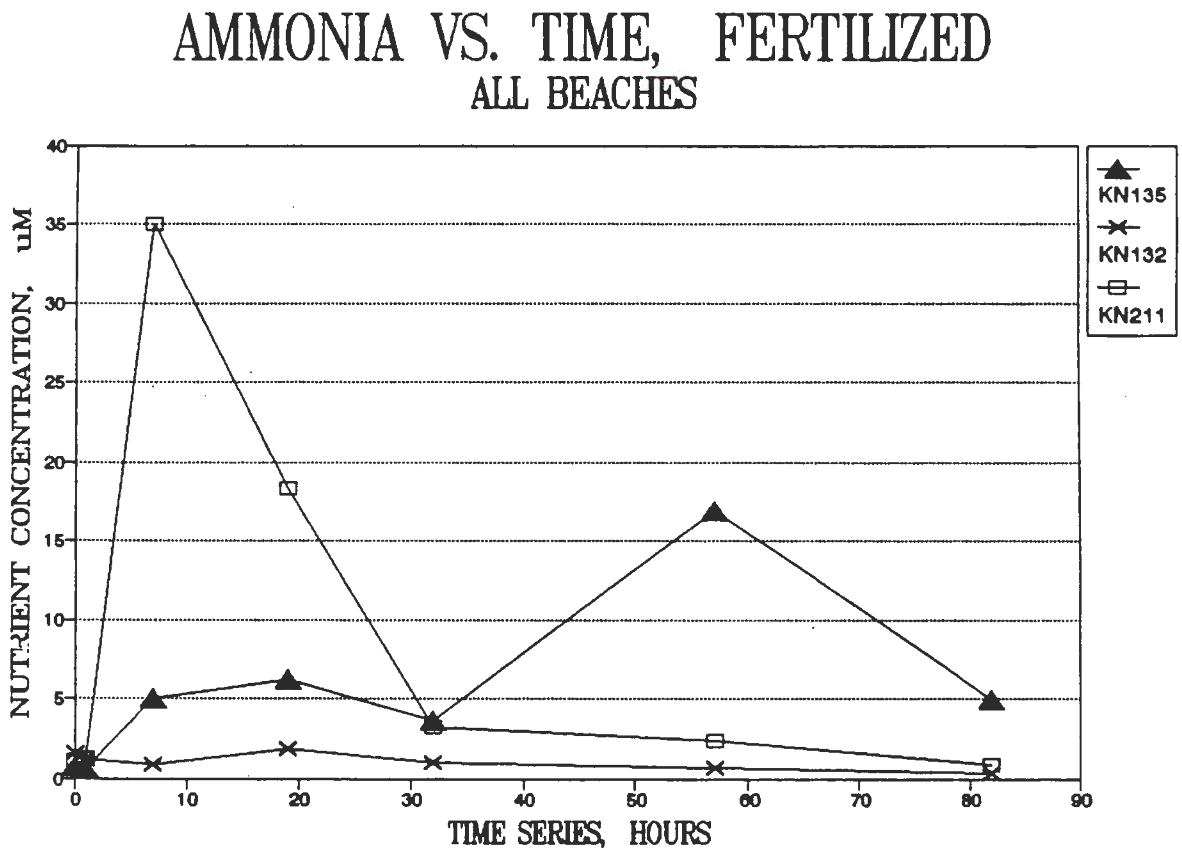


FIGURE 21
NITRATE + NITRITE IN NEARSHORE WATER OFF FERTILIZED SHORELINES

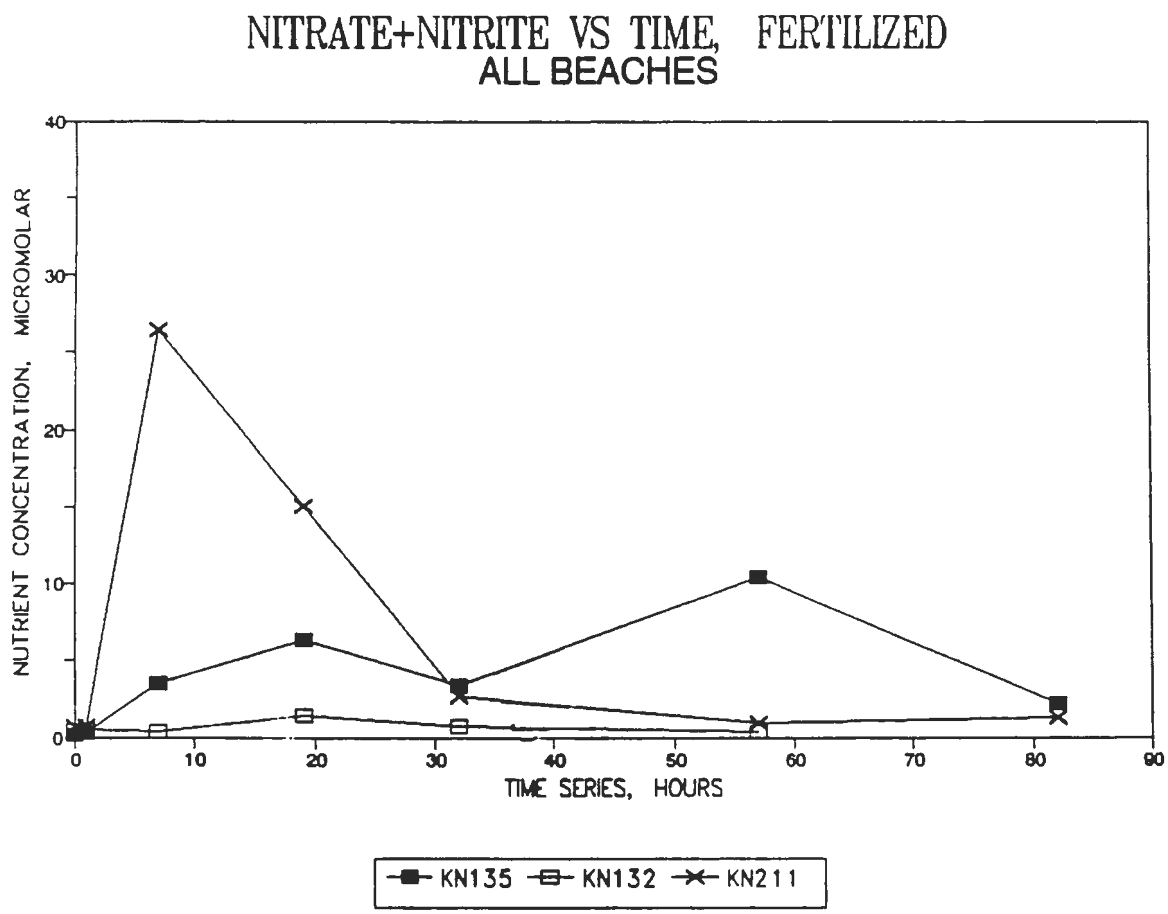


TABLE 20
SUMMARY OF AMMONIA AND NITRATE CONCENTRATIONS IN NEARSHORE WATER AFTER FIRST APPLICATION OF FERTILIZER

Times are in hours after fertilizer application.

Test Site	Maximum Concentrations (mg/l)		Time of Peak	Returned to Baseline
	Ammonia	Nitrate		
KN-135	0.29	0.65	57 hours	82 hours
KN-211	0.59	1.64	7 hours	57 hours
KN-132	0.03	0.09	19 hours	57 hours

concentration was 0.09 mg/l at 19 hr post-application, and this returned to baseline concentrations by 57 hr.

At KN-135B, both ammonia and nitrate showed the same trend, peaking at 57 hr post-application, with a trend toward baseline concentrations by 82 hr. Pre-application and reference site values for ammonia ranged from 0.01 to 0.05 mg/l. The maximum ammonia value recorded post-application was 0.29 mg/l at 57 hr; by 82 hr this had decreased to 0.08 mg/l. Background concentrations of nitrate ranged from 0.01 to 0.05 mg/l. Following fertilizer application, nitrate concentrations peaked at 0.65 mg/l with the 57-hr sample; by 82 hr this had decreased to 0.24 mg/l.

At KN-211E, baseline concentrations of ammonia and nitrate ranged from 0.01 to 0.02 mg/l and 0.01 to 0.06 mg/l, respectively. Concentrations of both nitrogen forms peaked at 7 hr post-application and returned to baseline concentrations by 57 hr post-application. The maximum ammonia concentration measured was 0.59 mg/l, whereas that for nitrate was 1.64 mg/l.

Monitoring nutrient dynamics immediately after fertilizer application was not continued for subsequent applications since there was no evidence that ammonia or nitrate concentrations were leading to adverse ecological effects, despite over-application of fertilizer at KN-132B and KN-135B. Instead, samples were collected offshore on the same schedule as other monitoring parameters after the second fertilizer application. The levels of nutrients in these samples are reported in Table 21. They show nutrient concentrations of less than 3 uM available nitrogen (<0.05 mg/l ammonia or nitrate), which are within the normal range for nearshore waters.

Toxicity Tests

A comprehensive presentation of the results of static, acute toxicity tests with each field sample is presented in Section 1 of Appendix D4; it is the final report from MEC, Inc, the contract laboratory that conducted the tests. When reviewing the results, the reader should keep in mind that there is a background mortality rate within every test population. Because juvenile test animals may die in the course of a test as the result of handling stress or natural causes, a 90% survival is the appropriate criterion for determining when toxic effects have been exhibited. For our tests, survival in all laboratory control and field reference samples was ≥90%, indicating that the test animals were in excellent condition and that the tests were conducted with appropriate care.

We have reviewed the MEC report and have summarized the pertinent test results in Table 22. Survival in all undiluted field samples collected after fertilizer application ranged from 90% to 100%, indicating no toxicity due to fertilizer application. Mysid survival in the pre-application sample collected at site KN-132B was 83%, perhaps indicating some effects of site activities and manual clean-up as field crews prepared the site for bioremediation. Nevertheless, survival in all other dilutions of this sample were ≥90%, so we characterize this mortality as not environmentally significant.

Toxicity tests conducted during the 1989 bioremediation demonstration-research program using the same worst-case sampling plan showed toxicity to oyster larvae a water sample collected 18 hr after application of Inipol

TABLE 21
NUTRIENT CONCENTRATIONS IN NEARSHORE WATER AFTER SECOND FERTILIZER APPLICATION

KN-132B - NUTRIENT DATA, FERTILIZED (uM)

DAY	NO3+NO2	NH3	PO4
43	0.40	2.75	0.10
60	0.39	0.63	0.06

KN-132B - NUTRIENT DATA, UNFERTILIZED (uM)

DAY	NO3+NO2	NH3	PO4
43	0.32	1.86	0.09
60	0.40	0.78	0.07

KN-132B - NUTRIENT DATA, REFERENCE REMOTE (uM)

DAY	NO3+NO2	NH3	PO4
43	0.21	0.82	0.04
60	0.95	0.73	0.03

KN-135B - NUTRIENT DATA, FERTILIZED (uM)

DAY	NO3+NO2	NH3	PO4
57	0.85	2.23	0.13
70	0.34	0.53	0.05

KN-135B - NUTRIENT DATA, UNFERTILIZED (uM)

DAY	NO3+NO2	NH3	PO4
57	0.05	0.30	0.01
70	0.46	0.75	0.02

KN-135B - NUTRIENT DATA, REFERENCE REMOTE (uM)

DAY	NO3+NO2	NH3	PO4
57	0.32	0.85	0.06
70	0.36	0.79	0.02

KN-211E - NUTRIENT DATA, FERTILIZED (uM)

DAY	NO3+NO2	NH3	PO4
47	1.21	2.19	0.25
61	1.19	1.15	0.15

KN-211E - NUTRIENT DATA, UNFERTILIZED (uM)

DAY	NO3+NO2	NH3	PO4
47	0.27	0.42	0.09
61	0.52	1.40	0.13

KN-211E - NUTRIENT DATA, REFERENCE REMOTE (uM)

DAY	NO3+NO2	NH3	PO4
47	0.56	2.79	0.23
61	0.26	1.04	0.16

concentration was 0.09 mg/l at 19 hr post-application, and this returned to baseline concentrations by 57 hr.

At KN-135B, both ammonia and nitrate showed the same trend, peaking at 57 hr post-application, with a trend toward baseline concentrations by 82 hr. Pre-application and reference site values for ammonia ranged from 0.01 to 0.05 mg/l. The maximum ammonia value recorded post-application was 0.29 mg/l at 57 hr; by 82 hr this had decreased to 0.08 mg/l. Background concentrations of nitrate ranged from 0.01 to 0.05 mg/l. Following fertilizer application, nitrate concentrations peaked at 0.65 mg/l with the 57-hr sample; by 82 hr this had decreased to 0.24 mg/l.

At KN-211E, baseline concentrations of ammonia and nitrate ranged from 0.01 to 0.02 mg/l and 0.01 to 0.06 mg/l, respectively. Concentrations of both nitrogen forms peaked at 7 hr post-application and returned to baseline concentrations by 57 hr post-application. The maximum ammonia concentration measured was 0.59 mg/l, whereas that for nitrate was 1.64 mg/l.

Monitoring nutrient dynamics immediately after fertilizer application was not continued for subsequent applications since there was no evidence that ammonia or nitrate concentrations were leading to adverse ecological effects, despite over-application of fertilizer at KN-132B and KN-135B. Instead, samples were collected offshore on the same schedule as other monitoring parameters after the second fertilizer application. The levels of nutrients in these samples are reported in Table 21. They show nutrient concentrations of less than 3 uM available nitrogen (<0.05 mg/l ammonia or nitrate), which are within the normal range for nearshore waters.

Toxicity Tests

A comprehensive presentation of the results of static, acute toxicity tests with each field sample is presented in Section 1 of Appendix D4; it is the final report from MEC, Inc, the contract laboratory that conducted the tests. When reviewing the results, the reader should keep in mind that there is a background mortality rate within every test population. Because juvenile test animals may die in the course of a test as the result of handling stress or natural causes, a 90% survival is the appropriate criterion for determining when toxic effects have been exhibited. For our tests, survival in all laboratory control and field reference samples was ≥90%, indicating that the test animals were in excellent condition and that the tests were conducted with appropriate care.

We have reviewed the MEC report and have summarized the pertinent test results in Table 22. Survival in all undiluted field samples collected after fertilizer application ranged from 90% to 100%, indicating no toxicity due to fertilizer application. Mysid survival in the pre-application sample collected at site KN-132B was 83%, perhaps indicating some effects of site activities and manual clean-up as field crews prepared the site for bioremediation. Nevertheless, survival in all other dilutions of this sample were ≥90%, so we characterize this mortality as not environmentally significant.

Toxicity tests conducted during the 1989 bioremediation demonstration-research program using the same worst-case sampling plan showed toxicity to oyster larvae a water sample collected 18 hr after application of Inipol

TABLE 22
RESULTS OF ACUTE TOXICITY TESTS WITH MYSIDS

Water samples were collected before and after fertilizer application. Times given for sample collection are approximate; actual times were scheduled around tidal change.

	MYSID SURVIVAL IN 96-HOUR STATIC TOXICITY TEST					
	KN-135 TEST SITE		KN-211 TEST SITE		KN-132 TEST SITE	
Collection Time	Treated	Control	Treated	Control	Treated	Control
Pre-application	100%	100%	97%	90%	83%	100%
1 hr after application	90%	--	100%	--	90%	--
7 hr after application	90%	--	97%	--	93%	--
19 hr after application	100%	97%	97%	97%	93%	100%
32 hr after application	93%	--	97%	--	97%	--
57 hr after application	100%	93%	93%	97%	97%	97%
82 hr after application	100%	--	93%	--	97%	--

EAP22 and Customblen at the Passage Cove test site. Five samples were collected and tested between 1 hr and 18 hr post-application, no subsequent samples were collected. Ammonia in nearshore waters was not monitored in conjunction with these tests so there is no point of reference for comparing this test with the 1990 test. Oyster larvae, used in 1989, and Mysids, used in 1990, have the same sensitivity when tested with Inipol and Inipol plus oil. Thus we expected similar sensitivity in the field. Differences between 1989 and 1990 toxicity test results must be attributed to site specific differences, either in the nature of fertilizer release into overlying waters or the rate of local mixing and tidal flushing along the nearshore zone. The 1989 data show that a 3-fold dilution was necessary to eliminate toxicity in the field samples. Because the samples were collected immediately above the fertilized shoreline, the results do not conflict with our assessment that any ecological effects that might occur would be localized, transient and short-term.

Toxicity tests were not continued for subsequent applications since there was no evidence of adverse ecological effects after the initial application, despite over-application of fertilizer at KN-132B and KN-135B.

Chlorophyll Monitoring

The potential that fertilizer application might stimulate an algal bloom was assessed by monitoring chlorophyll in the nearshore water. Tests to fully calibrate the fluorometer for quantifying chlorophyll are still underway, since field samples had significantly less chlorophyll than the original standards used for calibration. Nevertheless, all readings were less than 0.67 ug chlorophyll/liter. This is consistent with values reported from previous bioremediation studies in Snug Harbor and Passage Cove, where chlorophyll values ranged from 0.2 to 1 ug/l. There were no indications of fertilizer applications stimulating algal blooms in the nearshore zone at the monitoring sites (Figure 22). Chlorophyll concentrations show no consistent differences in treated versus reference comparisons and no increasing trends with time. The degree of nutrient release into nearshore waters does not stimulate an algal bloom faster than the rate of dilution and flushing driven by tidal exchange at any of the monitoring sites. These results agree with data generated during the 1989 bioremediation research/demonstration project.

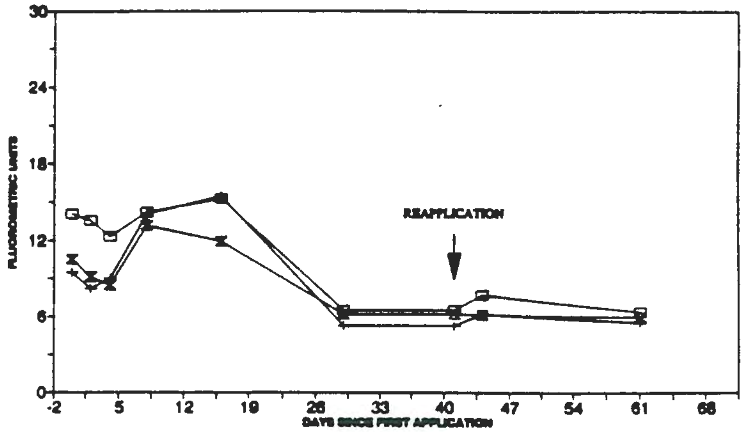
Total Petroleum Hydrocarbons

Measurements of the amounts of petroleum hydrocarbon in nearshore water are presented in Appendix D4, Table 1. Only 16 of the 174 samples of nearshore water collected in this program had detectable levels (0.2 mg/l) of Total Petroleum Hydrocarbon; none were greater than 0.41 mg/l, which was found in a sample from an untreated remote reference site.

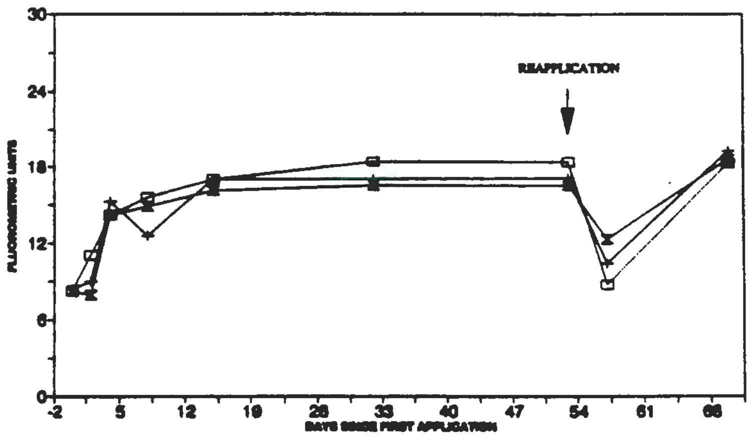
Only a single sample from KN-132B had detectable hydrocarbon; 0.24 mg/l on day 29 from near the treated area. Nine samples had detectable hydrocarbon in the first two days of monitoring at KN-135B, three of them before fertilizer application. Levels near the fertilized and unfertilized shorelines were 0.2-0.3 mg/l, while at the remote reference site the level was 0.4 mg/l. Only two subsequent samples had detectable levels of hydrocarbon, these were from the treated area on Day 15, and both were 0.23 mg/l. Only three samples had detectable levels at KN-211E, all less than 0.25 mg/l, occurring within four days of fertilizer application.

FIGURE 22
RELATIVE CHLOROPHYLL CONCENTRATIONS IN OFFSHORE WATER

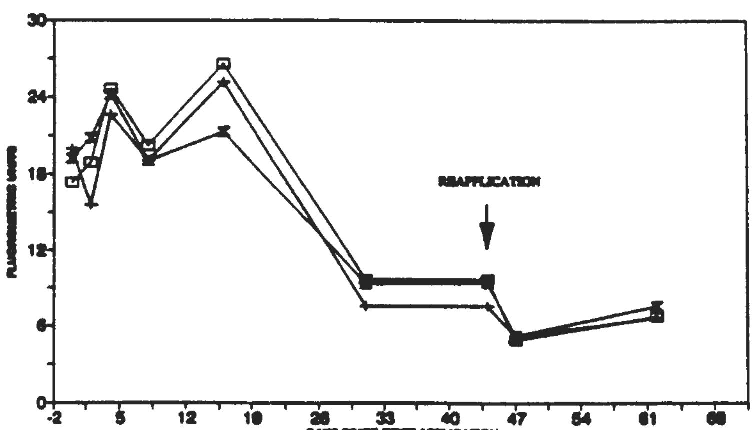
CHLOROPHYLL CONCENTRATION
KN-132



CHLOROPHYLL CONCENTRATION
KN-135



CHLOROPHYLL CONCENTRATION
KN-211



FERTILIZED — UNFERTILIZED — REMOTE REFERENCE

There is no trend in the total petroleum hydrocarbon data to suggest any correlation between fertilizer applications and release of oil from the shoreline to nearshore waters. Rather, hydrocarbon releases are most likely related to clean-up crew efforts of manual removal and site preparation for bioremediation. Hydrocarbon release will continue to be a concern as part of any clean-up activity until all the oil has been removed or degraded in place, but concentrations are likely to be at or below detection limits, and should not cause environmental problems.

BUTOXY-ETHANOL MONITORING

Butoxy-ethanol residues on the surfaces of oily cobbles are presented in Table 23. There was a five-fold difference between the initial concentrations in the two sampling areas. This could be the result of either incidental variations in the application rate within a test site or of variations in the amount of oil in the two areas of the beach, as the surface area sampled varied at the most by a factor of two. In either case, the trends through time were very similar for the upper-intertidal and mid-intertidal samples. After the first tidal flushing, the lower samples lost approximately 98% of the butoxy-ethanol, whereas the upper samples that were not covered by the high tide lost approximately 92%. Following the second tidal flushing, residues decreased to non-detectable concentrations in the lower-intertidal area and decreased another 92% in the upper-intertidal area, to approximately 0.6% of the original concentrations. During the next 24 hr, butoxy-ethanol decreased another 94%. These data agree with previous laboratory findings where 99% of the butoxy-ethanol was removed from microcosms within 24 hours.

Butoxy-ethanol poses a potential threat to wildlife if the chemical is inhaled, absorbed across the skin upon direct contact, or ingested from licking, chewing, ingesting treated substrates (i.e., rocks, sticks, gravel, etc) or as a result of cleaning or preening activities after animals have had direct contact with an Inipol-treated area. The rapid loss of butoxy-ethanol from Inipol-treated substrates supports the assertion that wildlife exposures are limited to periods immediately after application. Using the measured loss rates for butoxy-ethanol in the field, the expected 30 g of butoxy-ethanol/m^2 following Inipol application would be reduced to < 2.5 g/m^2 after one tidal exchange and to < 0.2 g/m^2 after 24 hours. At 0.2 g/m^2, butoxy-ethanol would be acutely toxic to a 1 Kg bird or mammal only if the animal absorbed all the chemical in one square meter (acute LC50 is 200 to 500 mg/Kg). As the amount of butoxy-ethanol continues to decrease with time, we feel that a 24-hr period after Inipol EAP22 application is a reasonable time to employ wildlife deterrent devices.

TABLE 23
BUTOXY-ETHANOL IN SAMPLE WIPES OF COBBLE SURFACES

Sampling Interval	ug Butoxy-ethanol/g oil taken from cobble Upper-Intertidal	Mid-Intertidal
1 hr post-application	52,000	10,000
after first tidal flooding	4,000	177
after second tidal flooding	300	ND
after fourth tidal flooding	19	ND

ND represents samples below the detection limit of 10 ug butoxy-ethanol/g oil.

SUMMARY AND CONCLUSIONS

Fertilizer Enhancements

There are several parameters that support our conclusion that bioremediation is an effective technique for removing oil from surface and subsurface sediments. First, nitrogen nutrients increased in interstitial waters to a depth of 50 cm at all sites following all fertilizer additions. The magnitude and duration of the enhancement varied from site to site; 10 to 100-fold increases in initial nutrient concentrations declined over an 8 to 15 day period to a 2-10 fold enhancement, which was then sustained for at least thirty days. The inorganic nutrients seem to come principally from the Customblen, whereas urea release from Inipol EAP22 could not be detected beyond four days after application. This is consistent with our understanding of the mechanism of Inipol EAP22, which was designed to keep nutrients associated with the oil, but this has not been measured. When detected, the urea from the Inipol EAP22 was found in interstitial water from a depth of 50 cm, indicating that this component, at least, penetrated into the shoreline sediments. In conclusion, the fertilizer applications were successful in providing substantial nitrogenous nutrients to at least 50 cm into the shoreline sediment at significantly elevated concentrations for at least 30 days.

Second, dissolved oxygen in the interstitial waters never approached limiting concentrations. A decrease of 2 to 3 mg/l dissolved oxygen in interstitial water on the fertilized sides of KN-135B and KN-132B occurred after both applications, suggesting an increased biological activity stimulated by nitrogenous nutrients. The effect diminished as nutrient concentrations decreased with time.

Third, the fertilizer treatments produced a sustained 3- to 4-fold increase in microbial activity over baseline activity in surface and subsurface sediments following the first fertilizer application at each site, even though nutrient concentrations in interstitial water varied substantially between sites. The enhanced activity was sustained for at least 30-days, demonstrating a long-term benefit from a single nutrient addition. Following the second fertilizer application, microbial activity was stimulated five to ten fold over that in the unfertilized areas. Microbial activity was enhanced throughout the oiled zone, as surface and subsurface activities responded to nutrient enrichments. There is a general trend that the fertilized portions of the sites had greater numbers of oil-degrading and heterotrophic bacteria than the unfertilized portion, except at site 211E, where there was little change. Because of the heavy and very variable degree of oiling at the sites, our sampling regime was not sensitive enough to detect statistically significant reductions in the amount of oil per Kg of sediment that might occur over the three-months of this monitoring program. Additional chemical indices have been applied with similar lack of sensitivity. Last winter's monitoring data suggest that the benefits of bioremediation will continue into the fall and winter months, and we remain optimistic that reductions in sediment oil loading will become apparent by next spring.

Ecological Effects

Nearshore waters collected at the test sites during the 4 days following fertilizer application showed no toxicity when tested with mysids, a shrimp-like crustacean selected as a surrogate for indigenous species.

Ammonia and nitrate concentrations in nearshore waters peaked between 7 and 57 hours post-application at concentrations <0.6 mg/l ammonia and <1.6 mg/l nitrate. Samples collected three or four days after the second fertilizer applications at each site followed the same trend. Short-term, transient concentrations of ammonia or nitrate of this magnitude are less than published data on acute toxicity of ammonia to most marine biota.

Samples from cobble surfaces treated with Inipol showed that more than 99% of the butoxy-ethanol had dissipated from treated shorelines within 24 hr. The time-lapse camera, taking one frame every six minutes, recorded no wildlife on Inipol EAP22 treated areas while the wildlife deterrents were present. These findings demonstrate that potential wildlife exposures are at most transient and short-term.

Our monitoring efforts demonstrated no evidence of algal blooms stimulated by nutrient release from the fertilized shorelines. Only 9% of the samples of nearshore water contained total hydrocarbon concentrations above detection limits; none exceeded 0.41 mg/l. There was no correlation with fertilizer additions.

The Rate of Biodegradation

Analyses of specific chemical components in the oil can be used to estimate the rate of oil biodegradation in sediments. First we determine the amount of a nondegradable component in a reference oil similar to that which landed on the shorelines. We have used hopane as the nondegradable component. Then we determine the amount of hopane in samples from the different sites, and use this to calculate the amount of oil present at beaching. By subtracting the amount of oil found now, we compute the amount that has been biodegraded. This approach provides estimates of approximately 3.3 g oil biodegraded/Kg sediment/year as a baseline degradation rate for surface samples, and 1.7 g oil/Kg sediment/year for subsurface (30 cm) samples.

Alternatively we compute the ratio of a degradable to a nondegradable component in the oil chemically similar to that which landed on the beach. We have used GC-detectable hydrocarbon as the biodegradable fraction, and hopane as before. Using this ratio and the amount of hopane in a sample from the beach, we compute the amount lost by biodegradation. This approach provides estimates of approximately 4.3 g oil biodegraded/Kg sediment/year as a baseline degradation rate for surface samples, and 1.9 g oil/Kg sediment/year for subsurface (30 cm) samples.

From all of these calculations, our best estimate of the baseline rate of oil degradation is

2-5 g oil biodegraded / Kg sediment / year at the surface
0.5-2.5 g oil biodegraded / Kg sediment / year in the subsurface

Although these are preliminary estimates based on data that continue to undergo reanalysis and evaluation, they agree with other data collected by the bioremediation research/demonstration program last year. We estimate that bioremediation can increase the rate at the surface by two- to three-fold with a single fertilizer application, with subsequent increases with additional nutrient additions. In the subsurface, bioremediation could increase the rate to equal the stimulated rate in surface sediments.

Although enhanced microbial activity is sustained for more than 30 days from a single fertilizer application, there is no evidence that current bioremediation strategies have saturated the capacity of the microbial community to degrade oil. Shorelines benefit from additional applications of nutrients at intervals of approximately 3 to 5 weeks. By waiting at least 3 weeks, interstitial nutrient concentrations have returned to near background levels, as has dissolved oxygen depletion, and the potential for nutrient release to offshore waters has returned to pretreatment levels. Repeated fertilizer applications over the course of the summer would probably maximize the degradation benefits of bioremediation. Rates of about 10 g/Kg/year may be attainable with a systematic fertilizer application program implemented over the course of a summer.

EXXON VALDEZ SHORELINE MONITORING PROGRAM
Summer, 1990

who?

OBJECTIVES

The primary objective of this program is to evaluate the recovery of intertidal areas impacted by the Exxon Valdez spill. Analysis of data collected by the National Oceanic and Atmospheric Administration (NOAA) and others will support decisions whose? on shoreline treatment in future spills. Comparisons will be made among shorelines treated in 1989 and 1990, untreated oiled shorelines, and unoiled controls.

The primary measures of recovery will be the quantity, composition and distribution of residual oil; the availability of oil to biological communities; and the effects of oil and shoreline treatment on biological recovery. The rates at which intertidal and selected subtidal habitats recover from oil impacts will be monitored. These data will enable comparison of oil fate and shoreline recovery, both physical and biological, on treated and untreated shorelines.

quant or qual.

The duration of monitoring will depend on the rates of recovery measured during the first season. While the program is expected to extend over a number of years, program planning for the second year and beyond must await analysis of the first season's data.

STRATEGIES

Basic Study Components

The overall program is composed of two closely related projects. The first is a continuation of the NOAA winter monitoring program to determine long-term trends in oil distribution and composition. The second project will involve monitoring the rates of recovery of selected intertidal and subtidal ecosystems with respect to the physical framework of the site, degree of oiling, and broad class of treatment.

Study Site Selection

Three types of stations will be established under this overall program: 1) oiled and untreated (set-aside sites), 2) treated sites, and 3) unoiled controls. All of the NOAA winter monitoring stations are included in this program. Stations for biological investigations have been selected to represent a combination of habitat types found in Prince William Sound (PWS).

Study sites outside PWS were included to consider impacted shorelines of widely varying potential hydrodynamic energy (PHE), both on regional and local scales.

The potential energy of an area is generally the basic factor controlling the persistence of oil on an impacted site. The Kenai Peninsula/Barren Islands represent shoreline types with the highest degree of potential energy in the affected area. A wide range of potential energy exists within each region (e.g., outer exposed beaches versus a sheltered cove along the same stretch of shoreline); however, generally speaking, even a sheltered cove on the outer Kenai Peninsula area has much more wave action than one in PWS. Study sites have been selected to show a range of energy levels within two of the three major regions (the Kodiak region is not included).

DATA COLLECTION PROGRAM : PHYSICAL PROCESSES

At each study site, the physical setting will be mapped using the zonal method described below. The biological and chemical data will be tied to this physical framework. The surveys will be done in early summer and in September. Additional surveys in early winter and early spring will depend on results of the summer monitoring effort.

Basic data measurements will include:

1. A base map of the study site constructed by either: a) a series of beach profiles run perpendicular to the beach (the zonal method); or b) a detailed survey by transit with one or two key beach profiles being established.
2. Selected beach profiles will be measured on the schedule cited above to determine morphological changes at the site through time.
3. A sediment distribution map will be made by visual estimates of the relative distribution of sediment types and direct measurements of larger particles on a grid patterns covering the entire study area. Sediment size is a critical factor in oil penetration and reworking by waves. Where necessary, enough trenches will be dug to accurately map the distribution of buried oil. NEBA?

hasn't this already been done? (Or is this an [illegible] scale?) Spec. [illegible]

4. A distribution map of oil types will be constructed and superimposed over the morphology and sediment maps.
5. Sediment samples will be collected for analysis of total petroleum hydrocarbons, with selected samples for detailed chemical characterization.
6. Detailed photographs will be used to record all of the physical attributes of the sites, including surficial and buried oil, sedimentation patterns, biological communities, and treatment methods used.
7. Videotaping of all sites will also be done.
8. Process measurements will be made at high tide in order to get a general idea of wave and tidal current patterns. Short-term changes in oil/sediment distributions and patterns in sheen production and transport will also be observed during various tidal stages and wave conditions.

DATA COLLECTION PROGRAM : BIOLOGICAL PROCESSES

The sampling effort will focus on three intertidal habitat types of particular importance in Prince William Sound: protected rock, protected sand/gravel/cobble (mixed soft), and exposed cobble. The protected sites are included because of their high biological productivity and because the low energy regime reduces the rate of natural weathering of oil. Exposed cobble beaches include some of the most heavily oiled beaches in the Sound and are areas where oil often penetrated particularly deeply into the open spaces between the coarse bed materials.

Community Studies

Intertidal Epibenthos

A stratified-random sampling design will be used to assess important assemblage and population (individual taxa) parameters. Sampling will be structured to obtain statistically reliable estimates of density or cover of macrobiota inhabiting the surface (epibiota) and, where possible, the subsurface (infauna) within important life zones. Typically, three elevations will be sampled on rocky habitats and two elevations will be sampled on cobble and mixed soft habitats.

A variety of statistical analyses will be applied to quantitatively describe the data (number of species, number of individuals, species diversity, evenness) and to evaluate the significance of the findings. Parametric and non-parametric tests will be applied as applicable to evaluate the significance of differences observed between untreated and treatment conditions for each treatment type and habitat. For untreated and treatment comparisons and for testing for significant differences between oiled and control sites, a 1- or 2-tailed, non-parametric t-test will be a primary tool. A Wilcoxin T test and/or multivariate approaches will be used for comparisons of assemblages between treatments, habitats, and over time. As time allows, cluster analysis and/or ordination procedures will be applied to the data sets to compare and contrast patterns in species composition and abundance and examine the spatial and temporal relationships among oiled, oiled and treated, and control sites.

Rocky Habitats

To minimize variability inherent on natural beaches, sampling in rocky habitats will be stratified to focus on the upper and lower portions of the Fucus zone, as well as in the typically heavily oiled supralittoral zone (at the upper limit of attached macrobiota). Each elevation to be ~~sampled will be permanently marked.~~ At each elevation, ten 0.25-m2 quadrats will be randomly located and permanently marked for non-destructive sampling.

more Re-bar on beach (this is NOT NEBA & will make future sampling difficult (holes in rocks))

Each quadrat will be photographed during each survey to document the change. Biological variables that will be measured or estimated include algal cover by taxon and abundance or cover of major epibenthic fauna (i.e., mussels, limpets, littorines, etc.). A subjective description of oiling in each quadrat will be recorded along with the percentage of the quadrat with oil cover. Each site will be sampled twice during the year.

Oiled	Oiled & Treated	Control
Herring Bay	Northwest Bay Islet	Hogg Bay
Snug Harbor	South Disk Island	Eshamy Bay
Outside Bay	W. Ingot Island	Crab Bay
		Bass Harbor

Mixed-Soft Substrates

Mixed-soft habitats will be sampled using different methods to address various components of the biota. Epibiota on surficial gravel and cobbles will be measured in a manner similar to that used in rocky habitats except that only the two lower elevations will be sampled. Ten randomly selected quadrats will be permanently marked at each elevation for sampling as described above. Fist-sized and smaller rocks will be lifted to record organisms living in the under-rock habitat. Each site will be sampled twice during the year.

Should avoid Rebar

Oiled	Oiled & Treated	Control
Herring Bay	Northwest Bay West Arm	Sheep Bay
Snug Harbor	Shelter Bay	Crab Bay
Bay of Isles	Mussel Beach	Outside Bay
	N. Elrington Island	

Boulder/Cobble

Boulder/cobble substrates will be sampled using a combination of the techniques described above for rocky and mixed-soft habitats with infauna only sampled where substrate permits.

Oiled	Oiled & Treated	Control
NE Latouche	Pt. Helen	Bass Harbor
	Sleepy Bay	

Infauna

Excavations on Mixed-soft Substrates

At the lower of the two tidal elevations on mixed-soft substrates, up to four additional 0.25-m^2 quadrats will be sampled to a depth of approximately 20 cm (or until a biologically inert substrate is reached) hand-sorted to remove large infauna. Organisms of specific concern are butter and littleneck clams (Saxidomus giganteus and Protothaca staminea) and the burrowing spoonworm Echiurus. Each site will be sampled once during the summer season.

Population Studies

Because the preponderance of oil that grounded in Prince William Sound initially came to rest in the mid to upper intertidal, it is important to examine population dynamics and reproductive success of a range of important intertidal organisms in order to determine if the hydrocarbons have interfered with the intertidal communities.

Plants - Eelgrass

Considering the amounts of hydrocarbons that may have been washed into the shallow subtidal zone by treatment, weathering, and storm activities, it is important to examine primary productivity and reproductive success of the macrophytes in that depth zone in order to determine if the hydrocarbons have interfered with either of those processes. This study is particularly significant because of the relative importance of macrophytes in carbon production in the embayments.

Each site will be sampled two times during the year. Seeds will be collected for germination studies in the laboratory. Sediments will be collected for hydorcarbon analysis.

The study will compare growth, productivity, physiological condition, and reproductive success of eelgrass (*Zostera marina*) populations in oiled and unoiled areas of Prince William Sound. Growth will be measured as changes in 1) average maximum plant length and 2) average plant biomass in specific beds. Productivity will be measured as changes in 1) bed biomass (average plant density X average plant biomass) and 2) chlorophyll concentrations in specific beds. Physiological condition will be measured by examination of chlorophyll ratios. Reproductive success will be evaluated through examination of patterns in 1) field seed germination (counting young-of-year plants), 2) flower, spadix, ovary, and seed production, and 3) laboratory seed germination. Physical and chemical measurements will include water temperature, salinity, dissolved oxygen, water transparency, concentrations of orthophosphates and nitrates in water and sediment,

Data and samples for the eelgrass studies will be collected twice from study sites at the following locations.

	Oiled	Oiled & Treated	Control
Intertidal	Herring Bay	Northwest Bay Islet	Bass Harbor Eshamy Bay

Shallow Subtidal

Snug Harbor	Shelter Bay	Crab Bay
Bay of Isles	Sleepy Bay	Bass Harbor
		Stockdale Harbor

Infaunal Core Samples

Smaller infauna in the lower intertidal zone will be sampled with five, 0.009-m2 by 15-cm deep cores. These cores will be preserved in the field for later laboratory processing to remove and identify all organisms larger than 1.0 mm. Each site will be sampled twice during the year.

Oiled	Oiled & Treated	Control
Snug Harbor	Northwest Bay West Arm	Outside Bay
Herring Bay	Shelter Bay	Sheep Bay
Bay of Isles	N. Elrington Island	Crab Bay
		Mussel Beach

Invertebrates

Clam Age and Growth

Clams will be sampled at sites listed below. Samples will be collected from from excavations of randomly placed 0.25-m^2 quadrats from within areas of suitable mixed-soft substrate. The number and condition (alive, gaping, recently dead) of all bivalves collected will be recorded in the field and key species (*Protothaca staminea)* may be retained for later length and age analysis. These data will be used to compare and contrast relationships in recruitment, size structure, and growth rates among oiled, oiled and treated, and control sites. Each site will be sampled once during the summer season.

Oiled	Oiled & Treated	Control
Snug Harbor	Northwest Bay West Arm	Outside Bay
Herring Bay	S. Disk Island	Sheep Bay
Bay of Isles	Ingot Island	Crab Bay
	Mussel Beach	N. Elrington Island

Mussel Growth and Condition

Mussels are a dominant filter-feeder in the intertidal zone and were subjected to heavy contamination in many areas of the Sound. A study of mussels is particularly significant because of the relative importance of mussels as a food resource for a broad range of vertebrate (e.g., otters, marine birds) and invertebrate predators (e.g., starfish, crabs, and drills) in the intertidal zone of Prince William Sound.

Samples of the blue mussel (Mytilus edulis) will be collected at sites listed below. Samples will be collected from randomly placed 0.0625-m^2 quadrats from within major concentrations of mussels. In the laboratory, the number and condition (alive, gaping, recently dead) will be recorded and shell length and whole wet weight will be measured. These data will be used to compare and contrast relationships in recruitment, size structure, and growth rates among oiled, oiled and treated, and control sites.

Subsamples of mussels from each site will be archived for possible histological examination to determine condition of gills, liver, kidney, digestive gland, and reproductive organs, as well as reproductive condition (maturity) and incidence of carcinomas or papillomas.

Each site will be sampled twice during year. what about Chem anal?

Oiled	Oiled & Treated	Control
NE Latouche	Mussel Beach	Bass Harbor
Snug Harbor	Northwest Bay Islet	Crab Bay
Herring Bay	Shelter Bay	Eshamy Bay
	Sleepy Bay	Outside Bay
		Hogg Bay

Littorina sitkana Growth and Condition

Littorines are a dominant grazer in the intertidal zone, were subjected to heavy contamination in many areas of the Sound, and were observed grazing on oil films. Because of their ubiquity and their intimate, long-term contact with oil (contact with the foot while moving on oiled rocks, gills with water-soluble fractions or suspended particles, and alimentary canal due to direct grazing on oiled surfaces), littorines provide one of the better opportunities to evaluate the effects of oil on intertidal organisms.

Samples of the periwinkle *Littorina sitkana* will be collected at sites listed below. Samples will be collected from randomly placed 0.0625-m^2 quadrats from within major concentrations of periwinkles. In the laboratory, the number in each sample will be recorded and shell length and whole wet weight of each individual will be measured. These data will be used to compare and contrast relationships in recruitment, size structure, and growth rates among oiled, oiled and treated, and control sites.

Subsamples of snails from each site will be archived for possible histological examination to determine condition of gills, liver, kidney, digestive gland, and reproductive organs, as well as reproductive condition (maturity) and incidence of carcinomas or papillomas.

Each site will be sampled twice during year.

Oiled	Oiled & Treated	Control
Herring Bay	NW Bay Islet	Bass Harbor
Snug Harbor	S. Disk Island	Eshamy Bay
NE Latouche	Shelter Bay	Crab Bay
		Outside Bay

Growth, Condition, and Reproduction of *Nucella* species

Drills are a dominant predator in the intertidal zone, feeding primarily on barnacles and mussels. They were subjected to heavy contamination in many areas of the Sound and prey mainly on organisms that were heavily oiled. Because their principal prey species were oiled and they have been exposed to intimate, long-term contact with oil (contact with the foot while moving on oiled rocks and gills with water-soluble fractions or suspended particles), drills provide an excellent opportunity to evaluate the effects of oil on intertidal organisms and examine bioaccumulation of hydrocarbons in the food web.

Samples of the drills *Nucella lamellosa* and *Nucella lima* will be collected at sites listed below. Samples will be collected randomly placed 0.25-m^2 quadrats from within major concentrations of drills. In the laboratory, the number per sample will be recorded and shell length and whole wet weight of each individual will be measured. These data will be used to compare and contrast relationships in recruitment, size structure, and growth rates among oiled, oiled and treated, and control sites.

Subsamples of snails from each site will be archived for possible histological examination to determine condition of gills, liver, kidney, digestive gland, and reproductive organs, as well as reproductive condition (maturity) and incidence of carcinomas or papillomas.

Each site will be sampled twice during year.

Oiled	Oiled & Treated	Control
Herring Bay	Northwest Bay West Arm	Bass Harbor
Snug Harbor	S. Disk Island	Eshamy Bay
	Shelter Bay	Crab Bay
	Northwest Bay Islet	Outside Bay

Schedule

Sampling will take place during an approximately 2 week period of favorable low tides in early July and again in early September. The exact location and number of individual study sites may be changed depending on conditions present in the field.

HYDROCARBON SAMPLING

Samples will be collected at each site to determine levels of hydrocarbon contamination in sediments and tissues. Samples will be labeled appropriately, recorded on field logs, frozen, and shipped to the specified analytical chemistry laboratory through appropriate channels.

INTERTIDAL SEDIMENTS

Intertidal sediments will be collected at each site at which mixed-soft sediments are sampled and as possible at each rocky site. At sites sampled commonly by the geological and biological program, the geological team will collect the sediments. At sites examined only for biological characteristics, sediments will be collected in accordance with the sampling strategy and techniques used by the geological team.

SUBTIDAL SEDIMENTS

Subtidal sediments will be collected at each site at which mixed-soft sediments are sampled and as possible at each rocky site. At sites sampled commonly by the geological and biological program, the geological team will collect the sediments. At sites examined only for biological characteristics, sediments will be collected in accordance with the sampling strategy and techniques used by the geological team.

INTERTIDAL TISSUE SAMPLES

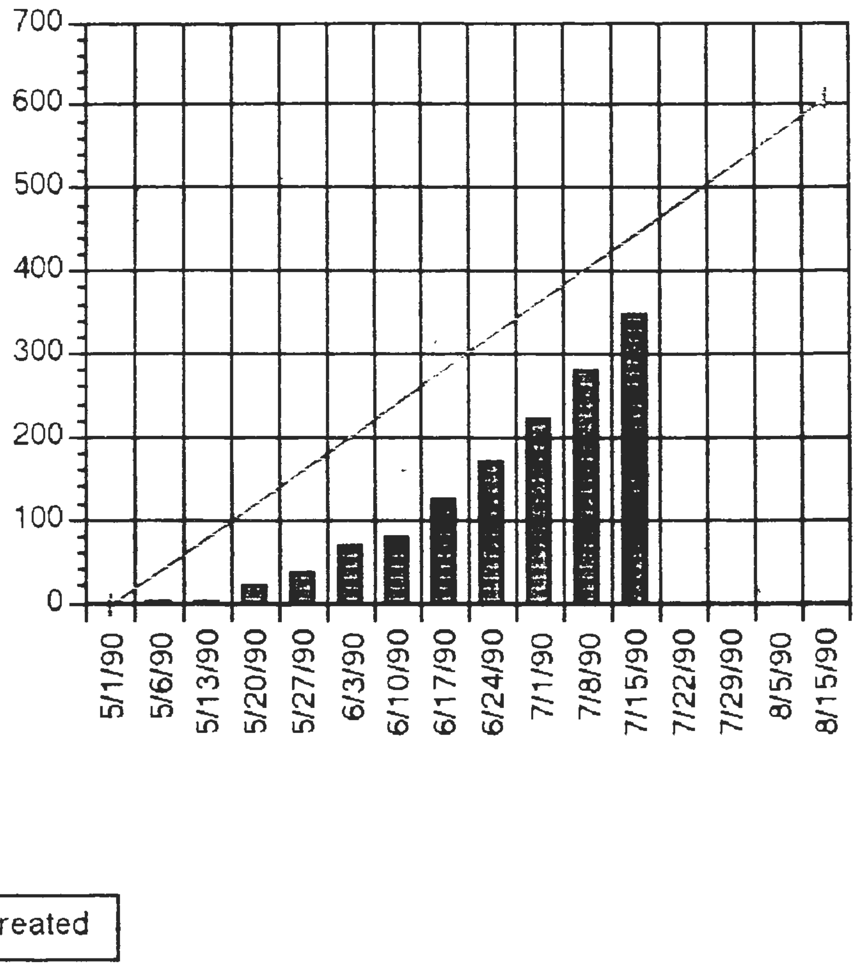
Tissue samples will be collected at each site using representative species. Target species for collections include the invertebrates species listed above (the bivalves *Mytilus edulis* and *Protothaca staminea*; the snails *Littorina sitkana*, *Nucella lamellosa* and *N. lima*), and the starfish *Pycnopodia helianthoides*.

DATA REPORT

A draft report documenting physical, chemical, and biological survey results will completed by November 30, 1990. The report will include documentation the methods used for sampling and analysis of data, documentation of the location of sample stations and sample locations within stations, and findings for each of the specific study topics.

Following review and comment on the draft report, a final report will be completed February 28, 1991. Data from field surveys will be available in an electronic form compatible with both MS-DOS or Macintosh computers.

Total Area
Subdivisions to be Treated

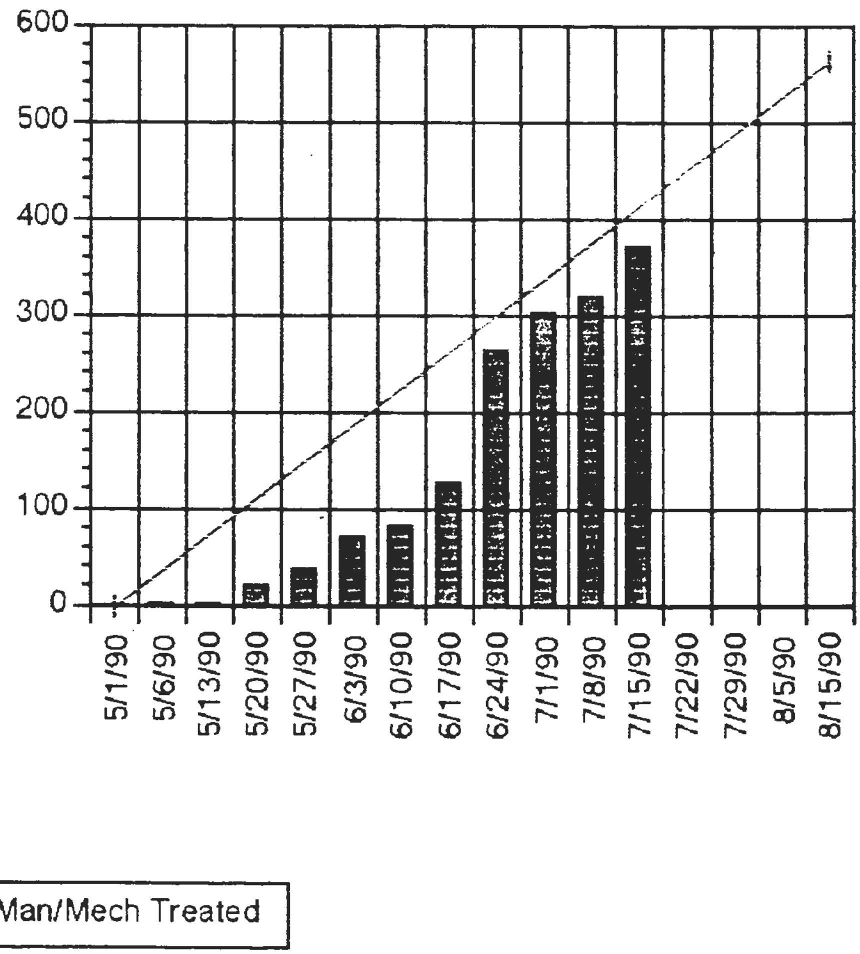


Total Subdivisions Requiring Treatment = 607

Total Subdivisions Treated as of 7/15/90 = 348

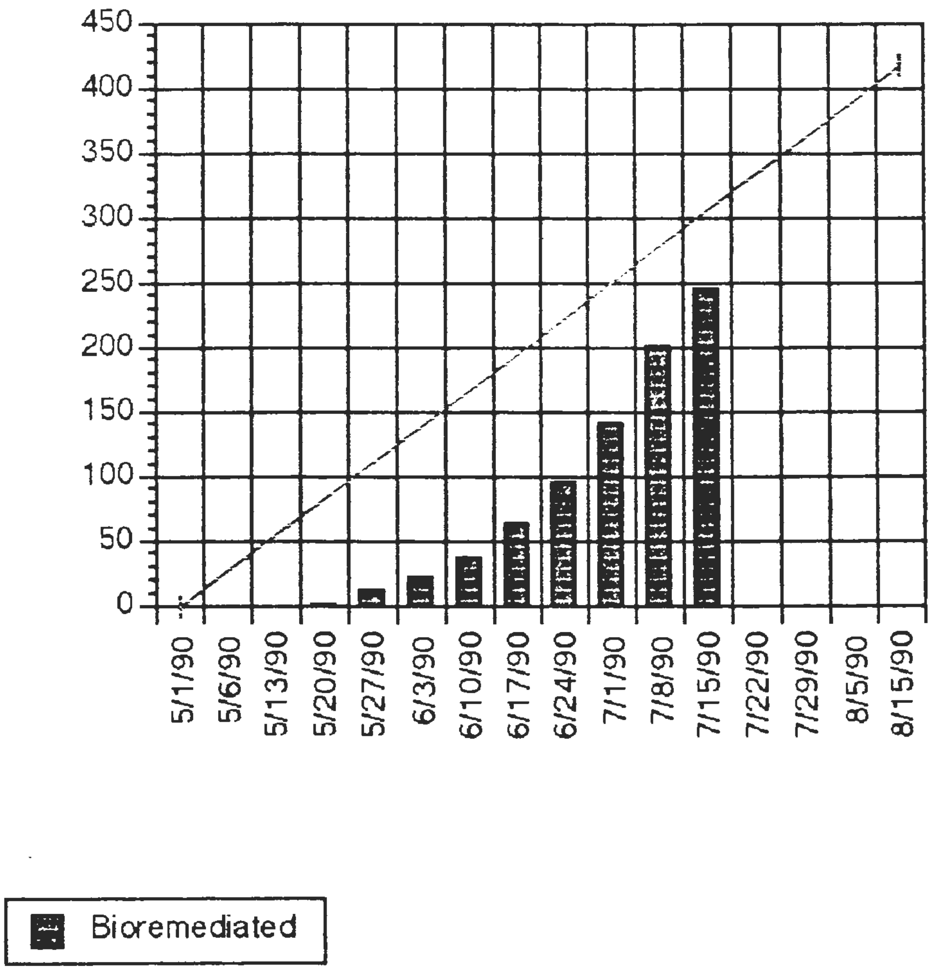
Total Area
Subdivisions to be
Manually Treated

(Includes Manual Pickup, Tarmat Removal, Spot Washing & Tilling/Raking)



Total Subdivisions Requiring Treatment = 564
Total Subdivisions Treated as of 7/15/90 = 372

Total Area Subdivisions to be Bioremediated

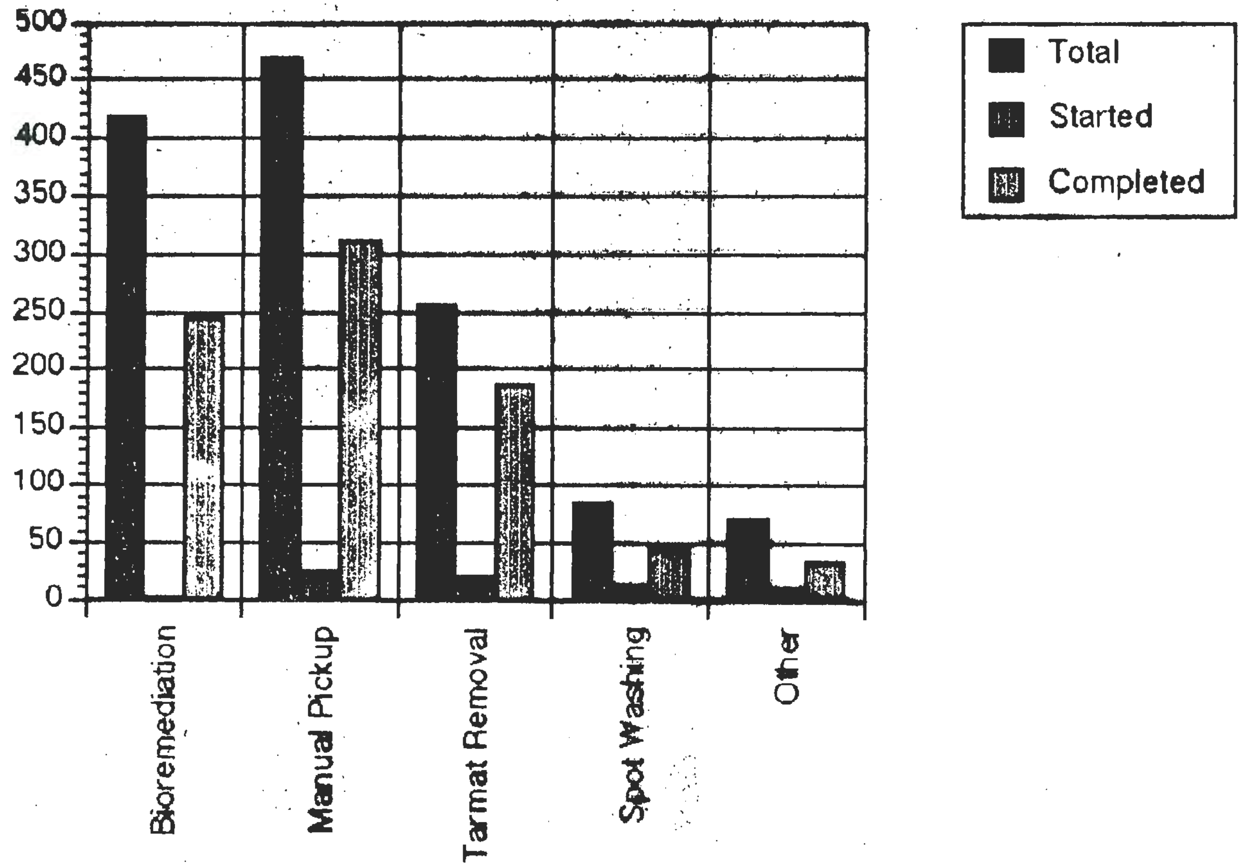


Total Subdivisions Requiring Treatment = 417
Total Subdivisions Treated as of 7/15/90 = 245

CAMEO Exxon Valdez '90

July 15, 1990

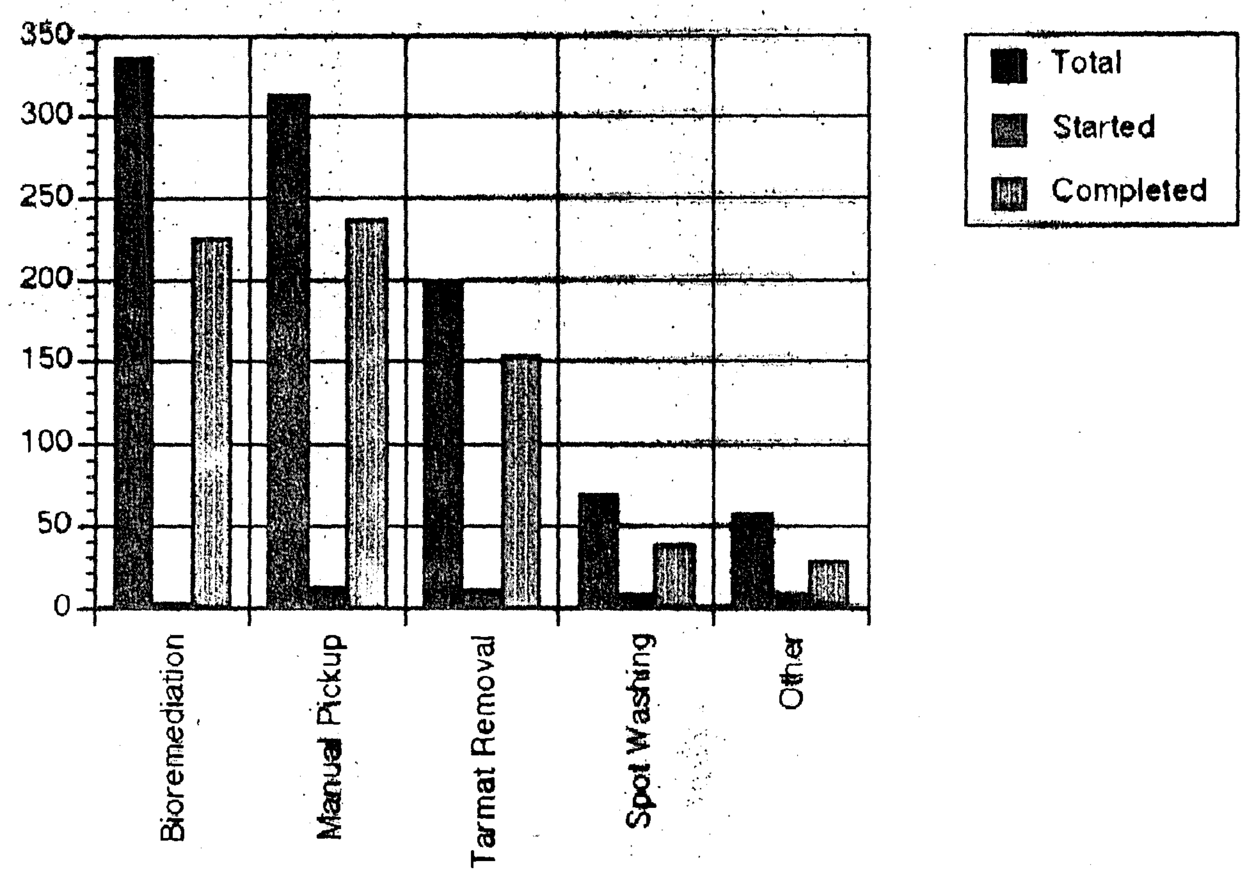
Total Area
Subdivision Treatment Types



CAMEO Exxon Valdez '90

July 15, 1990

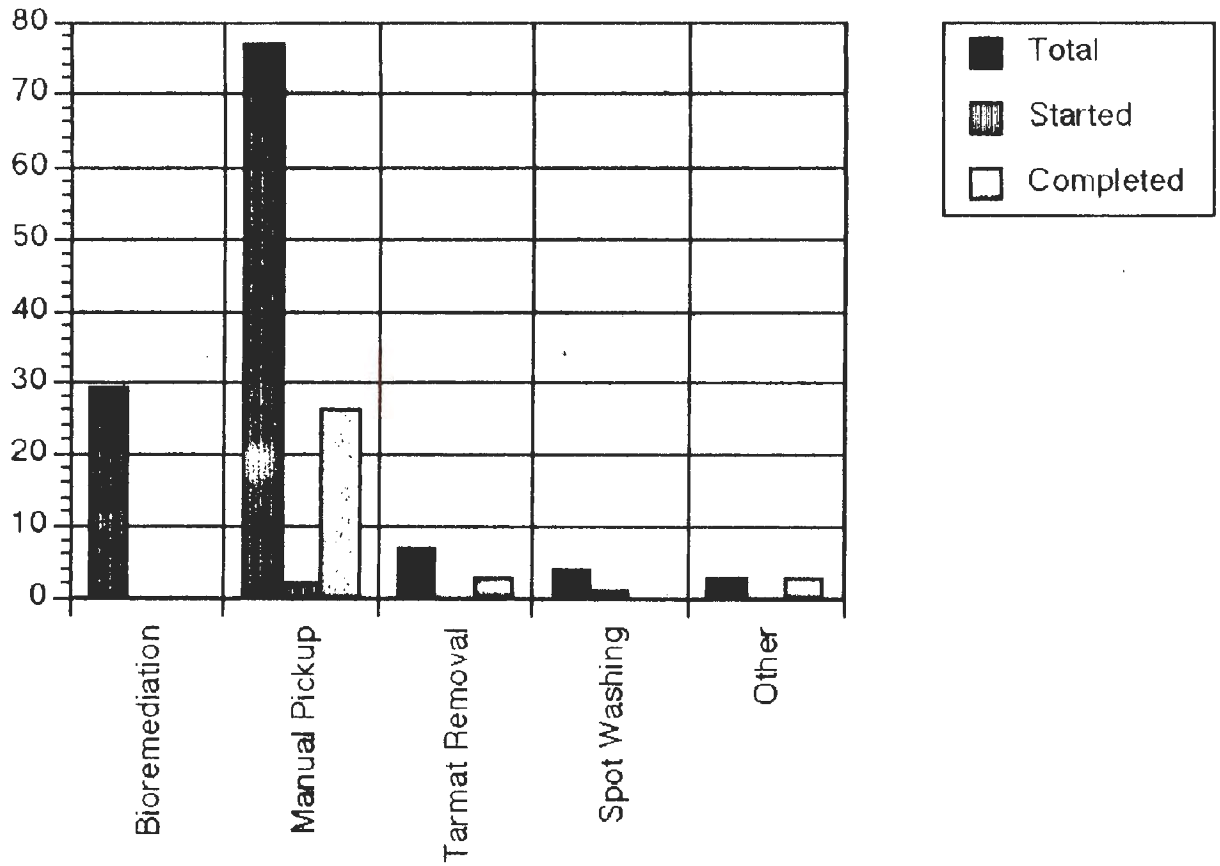
PWS
Subdivision Treatment Types



CAMEO Exxon Valdez '90

July 15, 1990

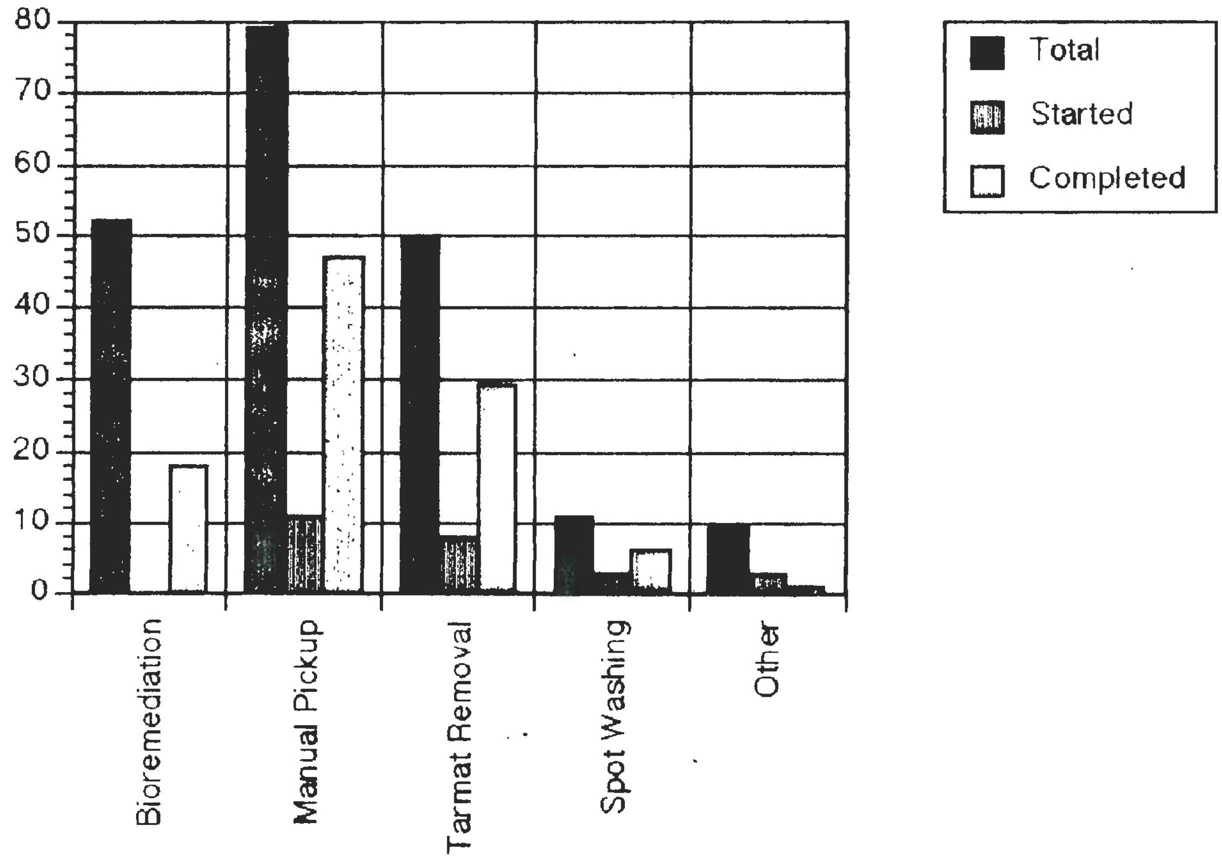
Kodiak
Subdivision Treatment Types



CAMEO Exxon Valdez '90

July 15, 1990

Kenai
Subdivision Treatment Types



Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
AE-003	Applegate Island	CACS
AG-001	Johnson Bay	CACS
BA-001	NE Bainbridge Island	CVC/CVCS/CACS
BA-004	N Bainbridge Island	CVCS
BA-005	W. Bainbridge Island	CACS/CVCS
BA-006	W. Bainbridge Island	CVCS
BA-007	W. Bainbridge Island	CVCS
BA-008	Bainbridge Passage	CVCS
BF-005	E. Blue Fjord	CVCS
BF-006	S. Blue Fjord	CVCS
BF-007	W. Blue Fjord	CVCS
BP-004	Bainbridge Passage	CVC
CH-001	E Chenega Island	CVC
CH-002	E Chenega Island	CVC
CH-003	E Chenega Island	CVC
CH-004	E Chenega Island	CVC
CH-004	E Chenega Island	CVC
CH-005	E Chenega Island	CVC
CH-006	NE Chenega Island	CVC
CH-007	NE Chenega Island	CVC
CH-008	N Chenega Island	CVC
CH-009	NE Chenega Island	CVC
CH-010	N Chenega Island	CVC
CH-011	N Chenega Island	CVC
CH-012	N Chenega Island	CVC
CH-013	N Chenega Island	CVC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
CH-014	S Chenega Island	CVC
CH-015	S Chenega Island	CVC
CH-016	S Chenega Island	CVC
CH-017	SE Chenega Island	CVC
CH-018	S Chenega Island	CVC
CH-019	S Chenega Island	CVC
CH-020	SE Chenega Island	CVC
CH-021	E Chenega Island	CVC
CH-022	S Chenega Island	CVC
CH-023	E Chenega Island	CVC
CH-900	SW Chenega Island	CVC
CP-001	Culross Pass	CACS
CR-002	Crafton Island	CACS
CR-005	Crafton Island	CACS
CU-001	Culross Island S.	CACS
DI-059	Foul Pass	CACS
DI-061	Foul Pass	CACS
DP-001	Dangerous Passage	CVC
DP-002	Dangerous Passage	CVC
EB-001	N. Eshamy	CACS
EB-006	N Eshamy Bay	CVC
EB-007	N Eshamy Bay	CVC
EB-008	S Eshamy Bay	CVC
EB-009	S Eshamy Bay	CVC
EB-010	S Eshamy Bay	CVC
EB-011	Mainland, S of Eshamy Bay	CVC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
EB-012	N Eshamy Bay	CVC
EB-013	N Eshamy Bay	CVC
EB-014	S Eshamy Bay	CVC
EB-015	S Eshamy Bay	CVC
EV-001	N Evans Island	CVC
EV-002	N Evans Island	CVC
EV-003	N Evans Island	CVC
EV-004	N Evans Island	CVC
EV-005	N Evans Island	CVC
EV-006	N Evans Island	CVC
EV-007	N Evans Island	CVC
EV-008	N Evans Island	CVC
EV-009	N Evans Island	CVC
EV-010	N Evans Island	CVC
EV-012	NE Evans Island	CVC
EV-013	NE Evans Island	CVC
EV-014	NE Evans Island	CVC
EV-015	NE Evans Island	CVC
EV-016	NE Evans Island	CVC
EV-017	NE Evans Island	CVC
EV-018	Shelter Bay, Evans Island	CVC
EV-019	Shelter Bay, Evans Island	CVC
EV-020	Shelter Bay, Evans Island	CVC
EV-021	Shelter Bay, Evans Island	CVC
EV-022	Shelter Bay, Evans Island	CVC
EV-023	Shelter Bay, Evans Island	CVC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
EV-024	Shelter Bay, Evans Island	CVC
EV-025	Shelter Bay, Evans Island	CVC
EV-026	Shelter Bay, Evans Island	CVC
EV-027	Shelter Bay, Evans Island	CVC
EV-028	Shelter Bay, Evans Island	CVC
EV-036	NE Evans Island	CVC
EV-037	NE Evans Island	CVC
EV-038	NE Evans Island	CVC
EV-039	NE Evans Island	CVC
EV-040	NE Evans Island	CVC
EV-050	Sawmill Bay, Evans Island	CVCS
EV-051	Sawmill Bay, Evans Island	CVCS
EV-056	Sawmill Bay, Evans Island	CVC
EV-057	Sawmill Bay, Evans Island	CVC
EV-060	NW Evans Island	CVC
EV-068	SW Evans Island	CVCS
EV-070	W Evans Island	CVC/CVCS
EV-071	W Evans Island	CVCS
EV-072	Shelter Bay, Evans Island	CVC
EV-500	Sawmill Bay, Evans Island	CVC
EV-900	NE Evans Island	CVC
EW-001	Ewan Bay	CVC
EW-900	S. Dangerous Passage	CVC
FL-001	Fleming Island	CVC
FL-002	Fleming Island	CVC
FL-003	Fleming Island	CVC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
FL-004	Fleming Island	CVC
FL-008	Fleming Island	CVC
GA-001	Gage island	CVC
GB-001	N Granite Bay	CVC
GB-002	S Granite Bay	CVC
GR-001A	Green Island	CACS
GR-009	Green Island	CACS
GR-013	Green Island	CACS
GR-103	Green Island	CACS
IN-021	Ingot Island	CACS
IN-031	Foul Pass	CACS
KN-004	Bay of Isles, Knight Island	CACS
KN-005	Bay of Isles, Knight Island	CAC
KN-007	Bay of Isles, Knight Island	CAC
KN-008	Bay of Isles, Knight Island	CAC
KN-009	Bay of Isles, Knight Island	CAC
KN-010	Bay of Isles, Knight Island	CACS
KN-011	Bay of Isles, Knight Island	CAC
KN-012	Bay of Isles, Knight Island	CAC
KN-013	Bay of Isles, Knight Island	CAC
KN-014	Bay of Isles, Knight Island	CAC
KN-015	Bay of Isles, Knight Island	CAC
KN-016	Bay of Isles, Knight Island	CAC
KN-017	Bay of Isles, Knight Island	CAC
KN-022	Islands in Bay of Isles	CAC
KN-023	Islands in Bay of Isles	CAC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
KN-024	S. Bay of Island, Knight Island	CAC
KN-026	Knight Island	CAC
KN-103	Lower Passage, Knight Island	CACS
KN-104	Louis Bay, Knight Island	CACS
KN-106	Mummy Bay, Knight Island	CACS
KN-110	Lower Passage, Knight Island	CACS
KN-134	SW Bay of Isles, Knight Island	CAC
KN-135	SW Bay of Isles, Knight Island	CAC
KN-136	SE Bay of Isles, Knight Island	CAC
KN-200	W Bay of Isles, Knight Island	CAC
KN-201	W Bay of Isles, Knight Island	CAC
KN-202	W Bay of Isles, Knight Island	CAC
KN-203	W Bay of Isles, Knight Island	CAC
KN-204	W Bay of Isles, Knight Island	CAC
KN-205	W Bay of Isles, Knight Island	CAC
KN-206	S Bay of Isles, Knight Island	CAC
KN-207	Bay of Isles, Knight Island	CAC
KN-208	W. Bay of Isles	CAC
KN-209	N. Bay of Isles	CAC
KN-212	E. Central Knight Island	CAC
KN-213	E. Central Knight Island	CAC
KN-214	E. Central Knight Island	CAC
KN-404	SE Knight Island	CVCS
KN-405	S. Knight Island	CVC/CACS/CVCS
KN-406	SE Knight Island	CVC/CVCS
KN-410	Hogan Bay, Knight Island	CVC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
KN-411	Hogan Bay, Knight Island	CVC
KN-412	Hogan Bay, Knight Island	CVC
KN-413	Hogan Bay, Knight Island	CVC
KN-505	N. Knight Island	CAC
KN-575	Drier Bay, Knight Island	CAC/CACS
KN-577	Copper Bay, Knight Island	CAC
KN-578	Lower Passage	CACS
KN-579	Copper Bay, Knight Island	CAC
KN-598	Long Channel, Knight Island	CACS
KN-601	Mummy Bay	CACS
KN-603	Mummy Bay	CACS
KN-604	S. Knight Island	CVC
KN-605	Mummy Bay, Knight Island	CVC
KN-606	S. Knight Island	CVC
KN-607	S. Knight Island	CVC
KN-608	S. Knight Island	CVC/CACS
KN-700	Marsha Bay, Knight Island	CAC
KN-701	Marsha Bay, Knight Island	CAC
KN-702	Marsha Bay, Knight Island	CAC
KN-704	Marsha Bay, Knight Island	CAC/CACS
KN-705	E. Central Knight Island	CAC
LA-015	NE Latouche Island	CVC
LA-016	Sleepy Bay, Latouche Island	CVC
LA-017	Sleepy Bay, Latouche Island	CVC
LA-018	Sleepy Bay, Latouche Island	CVC
LA-019	Sleepy Bay, Latouche Island	CVC

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
LA-020	Sleepy Bay, Latouche Island	CVC
LA-021	NW Latouche Island	CVC
LA-022	NW Latouche Island	CVC
LA-025	SE Latouche Island	CAC
LA-026	SE Latouche Island	CAC
LA-027	SE Latouche Island	CAC
LA-028	NE Latouche Island	CAC
LA-029	NE Latouche Island	CAC
LA-030	NE Latouche Island	CAC
LA-031	NE Latouche Island	CAC/CVC
LA-035	NW Latouche Island	CAC/CVC
LA-036	NW Latouche Island	CAC
LA-037	SW Latouche Island	CAC
LA-038	SW Latouche Island	CAC
LA-039	SW Latouche Island	CAC
LA-040	SW Latouche Island	CAC
LA-041	SW Latouche Island	CACS/CAC
LA-042	SE Latouche Passage	CACS/CAC
LA-043	W Latouche Island	CAC
MA-001	N. of Main Bay	CACS
MA-004	N. of Main Bay	CACS
MA-005	W. of Main Bay	CACS
MA-015	Main Bay	CACS
MU-001	Mummy Island	CACS
NJ-001	Shipyard Bay	CACS
No Segment	Long Bay 1	CACS

Exxon Valdez Oil Spill

Alaska Shoreline Segmments

7/27/90

Prince William Sound

Segment ID	Location	Land Owr/Mgr
NY-001	Islands W. of Knight Island	CACS
PA-001	N Paddy Bay	CVC
PL-001	Pleiades Island	CVC
PN-001	Point Nowell	CVC
PN-002	Point Nowell	CVC
PN-003	Point Nowell	CVC
PN-004	Point Nowell	CVC
PN-005	Point Nowell	CVC
PR-001	SE Perry Island	CACS
SL-001	Squirrel Island	CACS

Completed Subdivisions 7/29/90

Prince William Sound Completed Subdivisions									
Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
AE001A	A	6/9/90	X	6/9/90	6/9/90	X	5/17/90	5/17/90	NFS
AE002A	A	6/9/90	X	6/9/90	6/9/90	X	6/6/90	6/6/90	NFS
AE004A	A	6/15/90	X	6/14/90	6/15/90	X	6/1/90	6/4/90	NFS
AE004B	A	6/15/90	X	6/9/90	6/15/90	X	6/2/90	6/3/90	NFS
AE005A	A	6/17/90	X	6/15/90	6/17/90	X	5/17/90	5/23/90	NFS
AE005B	A	7/8/90	X	7/8/90	7/8/90	X	6/3/90	6/3/90	NFS
AE005C	A	6/15/90	X	6/15/90	6/15/90	X	6/5/90	6/6/90	NFS
AE007A	A	5/23/90				X	5/23/90	5/23/90	NFS
AG001A	D	7/15/90	X	7/15/90	7/15/90				NFS
AG009A	D	7/14/90	X	7/14/90	7/14/90	X	5/13/90	5/13/90	NFS
AG009B	D	5/13/90				X	5/13/90	5/13/90	NFS
BA001B	A	6/22/90				X	6/22/90	6/22/90	NFS
BA001C	A	6/22/90	X	6/22/90	6/22/90	X	6/22/90	6/22/90	NFS
BA001E	A	6/23/90				X	6/23/90	6/23/90	NFS
BA007A	A	5/29/90				X	5/29/90	5/29/90	NFS
BA008A	A	6/23/90				X	6/23/90	6/23/90	NFS
BL012A	B	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	NFS
CH001A	A	7/3/90	X	7/3/90	7/3/90	X	6/16/90	6/16/90	CVC
CH002A	A	7/3/90	X	7/3/90	7/3/90	X	6/14/90	6/14/90	CVC
CH002B	A	7/3/90	X	7/3/90	7/3/90	X	6/15/90	6/17/90	CVC
CH003A	A	7/3/90	X	7/3/90	7/3/90				CVC
CH008A	A	7/3/90	X	7/3/90	7/3/90	X	6/17/90	6/17/90	CVC
CH009A	A	7/4/90				X	7/4/90	7/4/90	CVC
CH009B	A	7/19/90	X	7/19/90	7/19/90	X	7/19/90	7/19/90	CVC
CH010A	A	7/19/90	X	7/19/90	7/19/90	X	7/19/90	7/19/90	CVC
CH010B	A	7/3/90	X	7/3/90	7/3/90	X	6/19/90	6/19/90	CVC
CH010C	A	7/19/90				X	7/19/90	7/19/90	CVC
CH011A	A	7/20/90	X	7/19/90	7/19/90	X	7/19/90	7/20/90	CVC
CH012A	A	7/20/90	X	7/20/90	7/20/90	X	6/21/90	7/20/90	CVC
CH013A	A	7/20/90	X	7/20/90	7/20/90	X	7/20/90	7/20/90	CVC
CH015A	A	6/20/90				X	6/20/90	6/20/90	CVC
CH016A	A	7/3/90	X	7/3/90	7/3/90	X	6/20/90	6/20/90	CVC
CH020A	A	7/3/90	X	7/3/90	7/3/90	X	6/20/90	6/20/90	CVC
CP001A	A	6/9/90				X	6/6/90	6/9/90	NFS
CR001A	A	6/5/90	X	6/5/90	6/5/90				NFS
CR002C	A	6/6/90	X	6/6/90	6/6/90	X	6/5/90	6/5/90	NFS
CR005A	A	6/6/90	X	6/6/90	6/6/90	X	5/28/90	5/28/90	NFS
CR005B	A	6/6/90	X	6/6/90	6/6/90	X	5/28/90	5/28/90	NFS
CR005E	A	5/27/90				X	5/27/90	5/27/90	NFS
CU001A	A	6/13/90	X	6/9/90	6/13/90	X	5/18/90	5/23/90	NFS
CU003A	A	6/9/90	X	6/9/90	6/9/90	X	5/29/90	5/29/90	NFS
CU007A	A	7/8/90	X	7/8/90	7/8/90	X	6/22/90	6/22/90	NFS
CU010A	A	7/14/90				X	7/12/90	7/14/90	NFS
CU011A	A	6/8/90	X	6/8/90	6/8/90	X	5/29/90	6/5/90	NFS
CU013A	A	6/7/90	X	6/7/90	6/7/90	X	6/2/90	6/3/90	NFS
CU017A	A	7/7/90	X	7/7/90	7/7/90	X	6/21/90	6/21/90	NFS
DA001A	C	7/18/90	X	7/18/90	7/18/90	X	5/13/90	7/17/90	NFS
DI059A	B	5/27/90	X	5/27/90	5/27/90	X	5/12/90	5/12/90	NFS
DI062A	B	5/27/90	X	5/27/90	5/27/90	X	5/12/90	5/13/90	NFS

DI063A	B	7/9/90	X	7/9/90	7/9/90	X	6/11/90	6/11/90	NFS
DI064A	B	5/29/90	X	5/29/90	5/29/90	X	5/29/90	5/29/90	NFS
DI064B	B	7/10/90	X	7/9/90	7/10/90	X	5/29/90	5/29/90	NFS
DI065A	B	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	NFS
DI066A	B	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	NFS
DI067A	B	5/10/90				X	5/9/90	5/10/90	NFS
DI068A	B	5/12/90				X	5/12/90	5/12/90	NFS
DI069A	B	5/27/90	X	5/27/90	5/27/90	X	5/13/90	5/14/90	NFS
EB004A	A	5/25/90				X	5/25/90	5/25/90	NFS
EB006A	A	5/2/90				X	5/2/90	5/2/90	NFS
EB008A	A	5/26/90				X	5/26/90	5/26/90	CVC
EB010A	A	6/10/90	X	6/6/90	6/6/90	X	6/6/90	6/10/90	CVC
EB011A	A	6/3/90	X	6/3/90	6/3/90	X	6/3/90	6/3/90	CVC
EB013A	A	6/1/90				X	5/31/90	6/1/90	CVC
EB015A	A	5/31/90				X	5/31/90	5/31/90	CVC
EL010A	B	7/9/90	X	7/5/90	7/9/90	X	5/5/90	5/5/90	NFS
EL011A	B	7/5/90	X	7/5/90	7/5/90	X	5/13/90	5/14/90	NFS
EL013A	B	7/14/90	X	7/13/90	7/14/90	X	7/13/90	7/14/90	CVC
EL013B	B	7/20/90	X	7/20/90	7/20/90	X	7/13/90	7/13/90	CVC
EL015A	B	5/25/90				X	5/24/90	5/25/90	NFS
EL052A	B	6/28/90	X	6/28/90	6/28/90	X	5/25/90	5/25/90	NFS
EL052B	B	6/28/90	X	6/28/90	6/28/90	X	5/22/90	5/22/90	NFS
EL053A	B	7/19/90	X	7/19/90	7/19/90	X	7/19/90	7/19/90	NFS
EL053B	B	7/12/90	X	7/12/90	7/12/90	X	7/12/90	7/12/90	NFS
EL054A	B	6/27/90	X	6/27/90	6/27/90	X	5/25/90	5/25/90	NFS
EL055A	B	6/24/90	X	6/24/90	6/24/90	X	6/8/90	6/8/90	NFS
EL055B	B	6/24/90	X	6/24/90	6/24/90	X	5/22/90	5/22/90	NFS
EL055C	B	6/24/90	X	6/24/90	6/24/90	X	6/8/90	6/8/90	NFS
EL056A	B	6/27/90	X	6/27/90	6/27/90				NFS
EL056B	B	7/14/90	X	7/14/90	7/14/90	X	7/14/90	7/14/90	NFS
EL056C	B	6/26/90	X	6/26/90	6/26/90	X	5/20/90	5/20/90	NFS
EL056D	B	6/27/90	X	6/27/90	6/27/90	X	5/20/90	5/20/90	NFS
EL057A	B	6/26/90	X	6/26/90	6/26/90	X	5/19/90	5/19/90	NFS
EL058A	B	6/27/90	X	6/27/90	6/27/90	X	5/19/90	5/19/90	NFS
EL058B	B	6/27/90	X	6/27/90	6/27/90	X	5/19/90	5/19/90	NFS
EL058C	B	6/27/90	X	6/27/90	6/27/90	X	5/20/90	5/20/90	NFS
EL058D	B	7/19/90	X	7/19/90	7/19/90	X	7/12/90	7/13/90	NFS
EL102A	B	7/14/90				X	7/14/90	7/14/90	NFS
EL102B	B	7/14/90	X	7/14/90	7/14/90	X	7/14/90	7/14/90	NFS
EL104C	B	6/18/90	X	6/18/90	6/18/90				NFS
EL106B	B	7/12/90	X	7/12/90	7/12/90	X	6/25/90	6/28/90	NFS
EL106C	B	7/5/90	X	7/5/90	7/5/90				NFS
EL107A	B	7/12/90	X	7/12/90	7/12/90	X	6/23/90	6/25/90	NFS
EL107B	B	7/11/90	X	7/11/90	7/11/90	X	6/25/90	6/25/90	NFS
EL107C	B	7/11/90	X	7/11/90	7/11/90	X	5/23/90	5/23/90	NFS
EL108A	B	4/29/90				X	4/28/90	4/29/90	NFS
EL108C	B	7/11/90	X	7/11/90	7/11/90	X	6/26/90	6/26/90	NFS
EL109A	B	7/11/90	X	7/11/90	7/11/90	X	5/23/90	5/24/90	NFS
EL110A	B	7/5/90	X	7/5/90	7/5/90	X	5/23/90	5/23/90	NFS
EN046A	B	7/12/90	X	7/12/90	7/12/90	X	6/26/90	6/26/90	NFS
EN046B	B	6/26/90				X	6/26/90	6/26/90	NFS

ER001A	C	5/30/90				X	5/30/90	5/30/90	DNR
ER002B	C	6/22/90	X	6/22/90	6/22/90	X	6/2/90	6/2/90	NFS
ER005A	C	6/21/90				X	6/21/90	6/21/90	NFS
ER006A	C	6/21/90				X	6/21/90	6/21/90	NFS
ER007A	C	6/14/90	X	6/14/90	6/14/90	X	6/2/90	6/4/90	DNR
ER008A	C	6/14/90	X	6/14/90	6/14/90	X	5/30/90	5/31/90	NFS
ER009A	C	7/18/90	X	6/15/90	7/18/90	X	5/31/90	5/31/90	NFS
ER010A	C	6/16/90	X	6/15/90	6/16/90	X	5/30/90	5/30/90	NFS
ER011A	C	6/15/90	X	6/15/90	6/15/90	X	5/30/90	6/1/90	NFS
ER012B	C	6/15/90	X	6/15/90	6/15/90	X	6/3/90	6/3/90	NFS
ER018A	C	6/19/90	X	6/19/90	6/19/90				NFS
ER020A	C	6/22/90	X	6/22/90	6/22/90				DNR
EV001A	C	6/27/90				X	6/27/90	6/27/90	CVC
EV002A	C	7/5/90	X	7/5/90	7/5/90	X	6/27/90	6/27/90	CVC
EV003A	C	6/21/90	X	6/19/90	6/21/90	X	6/10/90	6/10/90	CVC
EV005A	C	6/21/90	X	6/19/90	6/21/90	X	6/7/90	6/7/90	CVC
EV005B	C	6/21/90	X	6/19/90	6/21/90	X	6/9/90	6/9/90	CVC
EV005C	C	6/7/90				X	6/7/90	6/7/90	CVC
EV008B	C	6/2/90				X	6/2/90	6/2/90	CVC
EV009A	C	6/2/90				X	6/2/90	6/2/90	CVC
EV010A	C	6/3/90				X	6/2/90	6/3/90	CVC
EV010B	C	6/16/90				X	6/16/90	6/16/90	CVC
EV012A	C	7/1/90	X	6/6/90	7/1/90	X	5/2/90	6/23/90	CVC
EV014A	C	6/23/90	X	6/23/90	6/23/90	X	6/23/90	6/23/90	CVC
EV015A	C	6/6/90	X	6/6/90	6/6/90	X	6/3/90	6/3/90	CVC
EV017A	C	5/15/90				X	5/15/90	5/15/90	CVC
EV018A	C	6/8/90	X	6/6/90	6/8/90				CVC
EV020A	C	7/5/90	X	7/4/90	7/5/90	X	6/28/90	6/28/90	CVC
EV021A	C	6/8/90	X	6/8/90	6/8/90	X	5/11/90	5/14/90	CVC
EV023A	C	5/10/90				X	5/9/90	5/10/90	CVC
EV024A	C	6/9/90	X	6/8/90	6/8/90	X	6/6/90	6/9/90	CVC
EV025A	C	5/17/90				X	5/15/90	5/17/90	CVC
EV026A	C	6/10/90	X	6/9/90	6/10/90	X	6/2/90	6/2/90	CVC
EV027A	C	5/16/90				X	5/16/90	5/16/90	CVC
EV028A	C	7/3/90	X	7/3/90	7/3/90	X	6/2/90	6/2/90	CVC
EV037A	C	7/19/90	X	7/4/90	7/19/90	X	6/15/90	7/19/90	CVC
EV039A	C	7/17/90	X	7/4/90	7/17/90	X	6/9/90	7/17/90	CVC
EV050B	C	6/13/90	X	6/9/90	6/13/90	X	6/5/90	6/5/90	NFS
EV050C	C	6/13/90	X	6/9/90	6/13/90				NFS
EV051A	C	6/13/90	X	6/9/90	6/13/90	X	6/5/90	6/5/90	NFS
EV052A	C	7/3/90	X	7/3/90	7/3/90	X	6/17/90	6/17/90	NFS
EV053B	C	7/3/90	X	7/3/90	7/3/90	X	6/18/90	6/18/90	NFS
EV053D	C	6/5/90				X	6/5/90	6/5/90	NFS
EV054A	C	6/13/90	X	6/13/90	6/13/90	X	6/4/90	6/4/90	NFS
EV060A	C	7/3/90	X	7/3/90	7/3/90	X	6/29/90	6/30/90	CVC
EV060B	C	7/3/90	X	7/3/90	7/3/90	X	6/30/90	6/30/90	CVC
EV070D	C	6/10/90	X	6/10/90	6/10/90	X	6/2/90	6/2/90	NFS
EV070E	C	6/28/90				X	6/27/90	6/28/90	NFS
EV070F	C	6/12/90	X	6/12/90	6/12/90				NFS
EV070G	C	6/11/90	X	6/11/90	6/11/90	X	6/10/90	6/11/90	NFS
EV070H	C	6/18/90				X	6/18/90	6/18/90	NFS

EV072A	C	6/29/90	X	6/29/90	6/29/90	X	6/28/90	6/29/90	CVC
FA002A	A	5/28/90				X	5/27/90	5/28/90	NFS
FL001A	C	6/11/90	X	6/11/90	6/11/90	X	5/2/90	5/2/90	CVC
FL002A	C	6/11/90	X	6/11/90	6/11/90	X	5/17/90	5/17/90	CVC
FL004A	C	6/30/90	X	6/29/90	6/30/90	X	6/19/90	6/21/90	CVC
FL004B	C	6/29/90	X	6/29/90	6/29/90	X	6/19/90	6/19/90	CVC
FL005B	C	6/30/90	X	6/30/90	6/30/90				CVC
GR001AA	E	7/15/90	X	7/13/90	7/15/90	X	6/28/90	6/29/90	NFS
GR001BA	E	7/15/90	X	7/15/90	7/15/90	X	6/28/90	6/29/90	NFS
GR007A	E	6/28/90	X	6/27/90	6/28/90	X	6/27/90	6/27/90	NFS
GR008A	E	6/27/90	X	6/25/90	6/27/90	X	6/25/90	6/25/90	NFS
GR009A	E	6/29/90	X	6/25/90	6/29/90	X	6/25/90	6/25/90	NFS
GR010A	E	6/29/90	X	6/27/90	6/29/90	X	6/27/90	6/27/90	NFS
GR015A	E	7/15/90	X	7/15/90	7/15/90				NFS
GR103A	E	6/24/90	X	6/24/90	6/24/90	X	6/24/90	6/24/90	NFS
GR103B	E	6/28/90	X	6/26/90	6/28/90	X	6/26/90	6/26/90	NFS
GR103C	E	6/27/90	X	6/25/90	6/27/90	X	6/25/90	6/26/90	NFS
GR104A	E	6/28/90	X	6/28/90	6/28/90				NFS
GR300A	E	6/27/90				X	6/27/90	6/27/90	NFS
GR301B	E	6/28/90				X	6/28/90	6/28/90	NFS
GR302A	E	6/28/90	X	6/27/90	6/28/90	X	6/27/90	6/27/90	NFS
IN020A	B	7/8/90	X	7/7/90	7/8/90	X	6/29/90	6/29/90	NFS
IN022A	B	5/31/90	X	5/31/90	5/31/90	X	5/6/90	5/7/90	PG
IN022B	B	7/7/90	X	7/7/90	7/7/90	X	6/10/90	6/11/90	NFS
IN023A	B	7/7/90	X	7/7/90	7/7/90	X	6/10/90	6/10/90	NFS
IN024B	B	7/8/90	X	7/8/90	7/8/90	X	6/10/90	6/10/90	NFS
IN024C	B	6/10/90				X	6/10/90	6/10/90	NFS
IN028A	B	7/8/90	X	7/8/90	7/8/90				NFS
IN029A	B	7/10/90	X	7/10/90	7/10/90	X	6/30/90	6/30/90	NFS
IN030A	B	7/8/90	X	7/8/90	7/8/90				NFS
IN031A	B	5/8/90				X	5/6/90	5/8/90	NFS
IN031B	B	5/29/90	X	5/29/90	5/29/90	X	5/6/90	5/8/90	NFS
IN032A	B	7/10/90	X	7/9/90	7/10/90	X	6/9/90	6/9/90	NFS
IN033B	B	7/20/90	X	7/20/90	7/20/90	X	7/20/90	7/20/90	NFS
KN0004A	E	6/21/90	X	6/21/90	6/21/90	X	5/29/90	5/29/90	CAC
KN0005B	E	6/22/90	X	6/22/90	6/22/90	X	5/23/90	5/27/90	CAC
KN0006A	E	5/30/90				X	5/30/90	5/30/90	NFS
KN0007A	E	6/21/90	X	6/21/90	6/21/90	X	6/8/90	6/8/90	CAC
KN0008A	E	5/31/90				X	5/30/90	5/31/90	CAC
KN0009A	E	6/23/90	X	6/22/90	6/23/90	X	6/6/90	6/9/90	CAC
KN0011A	E	6/21/90	X	6/21/90	6/21/90	X	6/5/90	6/5/90	CAC
KN0012A	E	6/21/90	X	6/21/90	6/21/90	X	6/3/90	6/4/90	CAC
KN0013A	E	6/21/90	X	6/21/90	6/21/90	X	6/3/90	6/4/90	CAC
KN0014A	E	6/21/90	X	6/21/90	6/21/90	X	6/1/90	6/1/90	CAC
KN0016A	E	7/21/90	X	7/21/90	7/21/90	X	5/9/90	7/21/90	NFS
KN0019A	E	6/22/90	X	6/22/90	6/22/90	X	6/4/90	6/4/90	NFS
KN0023A	E	6/22/90	X	6/22/90	6/22/90	X	6/9/90	6/9/90	CAC
KN0024A	E	7/22/90	X	7/22/90	7/22/90	X	7/22/90	7/22/90	CAC
KN0101A	B	7/5/90	X	7/5/90	7/5/90				NFS
KN0102A	B	5/22/90	X	5/22/90	5/22/90	X	5/5/90	5/7/90	NFS
KN0103A	B	7/12/90				X	5/11/90	7/12/90	NFS

KN0104A	B	7/13/90	X	7/13/90	7/13/90	X	5/4/90	7/11/90	NFS
KN0104B	B	7/10/90				X	7/10/90	7/10/90	NFS
KN0105A	B	5/11/90				X	5/11/90	5/11/90	NFS
KN0105B	B	5/26/90	X	5/26/90	5/26/90	X	5/11/90	5/11/90	NFS
KN0106A	B	5/26/90	X	5/26/90	5/26/90	X	5/16/90	5/16/90	NFS
KN0106B	B	5/16/90				X	5/16/90	5/16/90	NFS
KN0106D	B	5/16/90				X	5/16/90	5/16/90	NFS
KN0107A	B	7/5/90	X	7/5/90	7/5/90				NFS
KN0107B	B	7/13/90	X	7/13/90	7/13/90	X	7/12/90	7/13/90	NFS
KN0109A	D	7/28/90	X	5/25/90	7/28/90	X	5/25/90	5/25/90	NFS
KN0110A	D	7/8/90	X	7/5/90	7/8/90	X	7/5/90	7/5/90	NFS
KN0111A	D	7/19/90	X	7/17/90	7/19/90	X	7/15/90	7/18/90	NFS
KN0112A	D	7/2/90	X	7/2/90	7/2/90				NFS
KN0112B	D	7/2/90	X	7/2/90	7/2/90				NFS
KN0113B	D	7/19/90	X	7/19/90	7/19/90				NFS
KN0114A	D	7/2/90	X	7/1/90	7/2/90	X	5/3/90	5/3/90	NFS
KN0115A	D	7/17/90	X	7/17/90	7/17/90	X	7/17/90	7/17/90	NFS
KN0116A	D	5/23/90	X	5/23/90	5/23/90	X	5/3/90	5/3/90	NFS
KN0117A	D	5/23/90	X	5/23/90	5/23/90	X	5/2/90	5/2/90	NFS
KN0118A	D	6/1/90	X	6/1/90	6/1/90				NFS
KN0119A	D	6/1/90	X	6/1/90	6/1/90	X	5/2/90	5/2/90	NFS
KN0121A	D	7/1/90	X	7/1/90	7/1/90	X	5/31/90	5/31/90	NFS
KN0123B	D	5/31/90	X	5/24/90	5/24/90	X	5/31/90	5/31/90	NFS
KN0124A	D	5/20/90	X	5/19/90	5/20/90				NFS
KN0125A	D	6/30/90	X	6/30/90	6/30/90	X	5/31/90	5/31/90	NFS
KN0126A	D	6/30/90	X	6/30/90	6/30/90	X	5/30/90	5/30/90	NFS
KN0127A	D	5/30/90				X	5/30/90	5/30/90	NFS
KN0127B	D	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	NFS
KN0127C	D	6/30/90	X	6/30/90	6/30/90	X	5/29/90	5/29/90	NFS
KN0128A	D	6/30/90	X	6/30/90	6/30/90	X	5/9/90	5/9/90	NFS
KN0129A	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0129B	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0131A	D	6/1/90	X	6/1/90	6/1/90	X	5/9/90	5/9/90	NFS
KN0132A	D	5/29/90				X	5/29/90	5/29/90	NFS
KN0132B	D	7/12/90	X	6/2/90	7/12/90	X	5/26/90	5/29/90	NFS
KN0132C	D	6/19/90	X	6/19/90	6/19/90	X	5/29/90	5/29/90	NFS
KN0132D	D	6/30/90	X	6/30/90	6/30/90	X	5/29/90	5/29/90	NFS
KN0133A	D	6/30/90	X	6/30/90	6/30/90	X	5/10/90	5/13/90	NFS
KN0134A	E	6/23/90	X	6/23/90	6/23/90	X	5/23/90	5/26/90	NFS
KN0135A	E	6/23/90	X	6/23/90	6/23/90	X	5/18/90	5/21/90	CAC
KN0135B	E	5/21/90	X	5/21/90	5/21/90	X	5/15/90	5/18/90	CAC
KN0141A	D	7/1/90	X	7/1/90	7/1/90	X	5/3/90	5/3/90	NFS
KN0141B	D	5/3/90				X	5/3/90	5/3/90	NFS
KN0145A	D	5/25/90	X	5/25/90	5/25/90				NFS
KN0200A	E	6/20/90	X	6/20/90	6/20/90	X	5/14/90	5/14/90	CAC
KN0201A	E	6/21/90	X	6/20/90	6/21/90	X	5/31/90	6/1/90	CAC
KN0202A	E	6/1/90				X	5/31/90	6/1/90	CAC
KN0204A	E	6/1/90				X	6/1/90	6/1/90	CAC
KN0205B	E	6/4/90	X	6/1/90	6/4/90	X	6/1/90	6/4/90	CAC
KN0206A	E	6/22/90	X	6/22/90	6/22/90	X	6/4/90	6/6/90	CAC
KN0207B	E	7/22/90	X	7/22/90	7/22/90				CAC

KN0208A	E	7/22/90	X	7/22/90	7/22/90	X	7/22/90	7/22/90	NFS
KN0209B	B	7/12/90	X	7/12/90	7/12/90	X	6/26/90	6/26/90	NFS
KN0211E	E	7/13/90	X	5/30/90	7/13/90	X	5/30/90	7/9/90	NFS
KN0212A	E	7/22/90	X	7/22/90	7/22/90	X	5/15/90	5/15/90	CAC
KN0213B	E	7/6/90	X	7/6/90	7/6/90	X	7/6/90	7/6/90	CAC
KN0300A	D	7/11/90	X	7/11/90	7/11/90	X	5/2/90	5/2/90	NFS
KN0400A	E	7/24/90	X	7/24/90	7/24/90	X	5/9/90	5/9/90	NFS
KN0401A	E	7/26/90	X	7/26/90	7/26/90	X	7/26/90	7/26/90	NFS
KN0402A	E	7/14/90				X	7/14/90	7/14/90	NFS
KN0403A	E	7/25/90	X	7/24/90	7/25/90	X	5/11/90	7/25/90	NFS
KN0403B	E	7/14/90				X	7/14/90	7/14/90	NFS
KN0405A	E	7/25/90	X	7/25/90	7/25/90	X	7/17/90	7/20/90	CVC
KN0410A	E	7/20/90				X	7/20/90	7/20/90	CVC
KN0411A	E	7/20/90				X	7/20/90	7/20/90	CVC
KN0412A	E	7/25/90	X	7/25/90	7/25/90				CVC
KN0413A	E	5/13/90				X	5/13/90	5/13/90	CVC
KN0500A	D	7/7/90	X	7/7/90	7/7/90	X	7/7/90	7/7/90	NFS
KN0500B	D	7/20/90	X	7/5/90	7/20/90	X	7/5/90	7/20/90	NFS
KN0501A	D	7/13/90	X	7/12/90	7/13/90	X	7/10/90	7/10/90	NFS
KN0502A	D	7/13/90	X	7/12/90	7/13/90	X	7/10/90	7/11/90	NFS
KN0503A	D	7/12/90	X	7/11/90	7/12/90	X	7/11/90	7/11/90	NFS
KN0505A	D	7/13/90	X	7/13/90	7/13/90	X	7/11/90	7/12/90	NFS
KN0508A	D	7/13/90	X	7/11/90	7/13/90	X	5/6/90	5/6/90	NFS
KN0509A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0510A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0552A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0574A	D	5/13/90				X	5/13/90	5/13/90	NFS
KN0576B	D	7/16/90	X	7/16/90	7/16/90				NFS
KN0578A	D	7/16/90	X	7/16/90	7/16/90				NFS
KN0608A	D	7/20/90				X	7/20/90	7/20/90	CVC
KN0700A	E	7/24/90				X	7/24/90	7/24/90	CAC
KN0701A	E	5/25/90				X	5/25/90	5/25/90	CAC
KN0701B	E	7/28/90	X	7/28/90	7/28/90	X	5/26/90	7/28/90	CAC
KN0701C	E	5/26/90				X	5/26/90	5/26/90	CAC
KN0702A	E	7/28/90	X	7/26/90	7/28/90	X	7/24/90	7/26/90	CAC
KN0702B	E	7/28/90	X	7/24/90	7/28/90	X	7/25/90	7/26/90	CAC
KN0703A	E	7/27/90	X	7/27/90	7/27/90	X	7/24/90	7/26/90	CAC
KN0704A	E	7/26/90				X	7/26/90	7/26/90	CAC
KN5002A	D	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NFS
KN5002B	D	7/10/90	X	7/10/90	7/10/90	X	5/9/90	5/9/90	NFS
KN5012A	D	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NFS
LA015B	C	7/3/90	X	7/3/90	7/3/90	X	6/28/90	7/3/90	CVC
LA015D	C	6/14/90				X	6/12/90	6/14/90	CVC
LA016A	C	7/6/90	X	7/5/90	7/6/90	X	6/12/90	6/12/90	CVC
LA017A	C	7/6/90	X	7/6/90	7/6/90	X	6/16/90	6/17/90	CVC
LA020B	C	7/17/90	X	7/17/90	7/17/90	X	5/23/90	5/24/90	CVC
LA021A	C	7/6/90	X	7/6/90	7/6/90	X	6/13/90	6/13/90	CVC
LA021B	C	6/17/90	X	6/17/90	6/17/90				CVC
LA023A	C	5/25/90				X	5/25/90	5/25/90	CVC
LA024A	C	6/1/90				X	6/1/90	6/1/90	CVC
LA033A	C	7/17/90	X	7/17/90	7/17/90	X	5/9/90	5/12/90	NFS

LA038A	C	6/17/90	X	6/17/90	6/17/90	X	5/12/90	5/12/90	CAC
LA039A	C	5/23/90				X	5/23/90	5/23/90	CAC
LN001A	A	7/21/90	X	7/21/90	7/21/90	X	6/7/90	6/7/90	NFS
LN002A	A	6/28/90	X	6/28/90	6/28/90	X	6/23/90	6/23/90	NFS
LN004A	A	6/8/90				X	6/7/90	6/8/90	NFS
LN005A	A	6/28/90	X	6/28/90	6/28/90	X	6/8/90	6/8/90	NFS
LN006A	B	6/28/90	X	6/28/90	6/28/90	X	6/7/90	6/8/90	NFS
LN007A	A	6/28/90	X	6/28/90	6/28/90	X	6/7/90	6/7/90	NFS
LN008A	A	6/28/90	X	6/28/90	6/28/90	X	6/7/90	6/7/90	NFS
MA001A	A	7/20/90				X	7/20/90	7/20/90	DNR
MA002A	A	6/7/90	X	6/7/90	6/7/90	X	6/7/90	6/7/90	DNR
MA003A	A	5/3/90				X	5/3/90	5/3/90	DNR
MA004A	A	6/4/90	X	6/4/90	6/4/90	X	5/2/90	5/2/90	NFS
MA006A	A	5/29/90				X	5/29/90	5/29/90	PG
MA009A	A	6/7/90	X	6/7/90	6/7/90	X	5/24/90	5/24/90	NFS
MA010A	A	6/4/90	X	6/4/90	6/4/90	X	6/1/90	6/2/90	NFS
MN001A	E	7/23/90				X	7/23/90	7/23/90	NFS
MN002A	E	7/21/90	X	7/21/90	7/21/90	X	7/21/90	7/21/90	NFS
MN003A	E	7/24/90				X	7/24/90	7/24/90	NFS
MN006A	E	7/24/90				X	7/24/90	7/24/90	NFS
MN007B	E	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	NFS
MN500B	E	7/22/90	X	7/22/90	7/22/90	X	7/22/90	7/22/90	NFS
MU001A	D	6/29/90	X	6/29/90	6/29/90	X	6/24/90	6/24/90	NFS
MU001B	D	6/29/90	X	6/29/90	6/29/90	X	6/24/90	6/24/90	NFS
MU001C	D	6/29/90	X	6/29/90	6/29/90	X	6/26/90	6/29/90	NFS
MU002A	D	6/27/90				X	6/26/90	6/27/90	NFS
MU002B	D	6/29/90	X	6/29/90	6/29/90	X	6/27/90	6/29/90	NFS
MU003A	D	6/29/90	X	6/29/90	6/29/90	X	6/27/90	6/27/90	NFS
MU900A	D	5/13/90				X	5/13/90	5/13/90	NFS
NA005A	B	7/9/90				X	7/9/90	7/9/90	DNR
NA006A	B	7/9/90				X	7/9/90	7/9/90	NFS
NA006B	B	7/9/90				X	7/9/90	7/9/90	NFS
NA006C	B	7/12/90	X	7/9/90	7/12/90	X	7/9/90	7/11/90	NFS
NA021B	B	7/8/90				X	7/8/90	7/8/90	NFS
NA023A	B	7/8/90				X	7/8/90	7/8/90	DNR
NA024A	B	7/8/90				X	7/8/90	7/8/90	NFS
NA024F	B	7/10/90	X	7/8/90	7/10/90	X	7/8/90	7/9/90	NFS
NA025A	B	7/8/90				X	7/8/90	7/8/90	DNR
NA026B	B	7/8/90				X	7/8/90	7/8/90	NFS
NA027A	B	7/9/90				X	7/9/90	7/9/90	DNR
NJ001A	A	5/4/90				X	5/3/90	5/4/90	DNR
NJ002A	A	7/20/90				X	7/20/90	7/20/90	PWS
PN004A	A	7/19/90	X	7/19/90	7/19/90	X	5/3/90	5/3/90	CVC
PN005A	A	7/19/90				X	7/19/90	7/19/90	CVC
PR002A	A	7/25/90	X	7/6/90	7/6/90	X	6/9/90	7/25/90	NFS
PR003A	A	7/6/90	X	7/6/90	7/6/90	X	6/6/90	6/6/90	NFS
PR003B	A	7/6/90	X	7/6/90	7/6/90	X	6/6/90	6/8/90	NFS
PR003C	A	6/8/90				X	6/8/90	6/8/90	NFS
PR003D	A	7/6/90	X	7/6/90	7/6/90				NFS
PR005A	A	7/21/90	X	7/21/90	7/21/90	X	7/11/90	7/11/90	NFS
PR005B	A	6/8/90	X	6/8/90	6/8/90	X	6/8/90	6/8/90	NFS

PR005C	A	7/6/90	X	7/6/90	7/6/90				NFS
PR006A	A	7/11/90				X	7/11/90	7/11/90	NFS
PR007A	A	7/6/90	X	7/6/90	7/6/90	X	6/9/90	6/9/90	NFS
PR008A	A	7/6/90	X	7/6/90	7/6/90				NFS
PR008B	A	7/6/90	X	7/6/90	7/6/90	X	6/11/90	6/12/90	NFS
PR008C	A	7/6/90	X	7/6/90	7/6/90	X	6/11/90	6/12/90	NFS
PR012A	A	7/11/90				X	7/11/90	7/11/90	NFS
PR013A	A	7/7/90	X	7/7/90	7/7/90	X	6/13/90	6/13/90	NFS
PR016A	A	7/21/90	X	7/21/90	7/21/90	X	7/13/90	7/15/90	NFS
SL001B	D	7/14/90	X	7/14/90	7/14/90				NFS
SL001C	D	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	NFS
SL001D	D	7/15/90	X	7/15/90	7/15/90				NFS
SL001E	D	7/14/90	X	7/14/90	7/14/90				NFS
SM005B	E	7/18/90	X	7/16/90	7/18/90	X	7/16/90	7/18/90	NFS
SM006A	E	7/19/90	X	7/19/90	7/19/90	X	7/19/90	7/19/90	NFS
SM006B	E	7/19/90	X	7/18/90	7/19/90	X	7/18/90	7/19/90	NFS
SP043A	B	5/31/90	X	5/31/90	5/31/90	X	5/13/90	5/13/90	NFS
SQ002A	D	7/16/90	X	7/16/90	7/16/90	X	7/16/90	7/16/90	NFS
SQ005A	D	7/15/90	X	7/15/90	7/15/90				NFS
Kenai Completed Subdivisions									
BM005A	F	7/11/90				X	7/10/90	7/11/90	NPS
BM006A	F	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NPS
CB002A	F	7/19/90				X	7/18/90	7/19/90	EB
CB003A	F	5/20/90				X	5/16/90	5/20/90	GVC
CB003C	F	7/19/90				X	6/19/90	7/19/90	GVC
CB004A	F	6/25/90	X	6/25/90	6/25/90	X	5/20/90	5/23/90	ER
CB004B	F	6/25/90	X	6/25/90	6/25/90	X	5/24/90	5/24/90	EB
CB004C	F	6/25/90	X	6/25/90	6/25/90	X	6/17/90	6/17/90	EB
CB004D	F	6/25/90	X	6/25/90	6/25/90	X	6/17/90	6/17/90	EB
EI001A	F	7/1/90				X	7/1/90	7/1/90	DNR
NK001A	F	7/4/90				X	4/28/90	7/4/90	DNR
NK002A	F	7/4/90	X	7/3/90	7/4/90	X	7/3/90	7/4/90	DNR
NK004B	F	7/5/90				X	7/5/90	7/5/90	DNR
NK004C	F	5/13/90				X	5/12/90	5/13/90	DNR
PD001A	F	7/21/90	X	7/21/90	7/21/90	X	6/23/90	6/30/90	DNR
PD001B	F	6/29/90				X	6/29/90	6/29/90	DNR
PD002A	F	5/3/90				X	5/3/90	5/3/90	DNR
PD003A	F	5/5/90				X	5/5/90	5/5/90	DNR
PD004A	F	7/17/90	X	7/12/90	7/12/90	X	6/22/90	7/17/90	DNR
PD004B	F	7/14/90				X	7/14/90	7/14/90	DNR
PD005A	F	7/21/90				X	7/17/90	7/21/90	DNR
PD008A	F	6/20/90				X	6/20/90	6/20/90	DNR
PD010A	F	6/21/90	X	6/21/90	6/21/90	X	6/20/90	6/21/90	DNR
PY002A	F	7/26/90		7/21/90	7/21/90	X	7/13/90	7/26/90	FWS
PY006A	F	5/8/90				X	5/8/90	5/8/90	FWS
PY007B	F	5/8/90				X	5/7/90	5/8/90	FWS
PY008B	F	7/28/90	X	7/28/90	7/28/90	X	5/6/90	7/28/90	FWS
PY008C	F	7/20/90	X	7/15/90	7/20/90	X	7/15/90	7/20/90	FWS
PY008E	F	7/28/90	X	7/28/90	7/28/90	X	7/28/90	7/28/90	FWS
PY008F	F	7/28/90				X	7/28/90	7/28/90	FWS

PY011B	F	7/22/90	X	7/22/90	7/22/90	X	5/10/90	5/10/90	FWS
PY012B	F	7/22/90	X	7/22/90	7/22/90	X	5/14/90	5/14/90	FWS
PY015B	F	7/22/90	X	7/22/90	7/22/90	X	5/9/90	5/9/90	FWS
PY015D	F	5/14/90				X	5/14/90	5/14/90	FWS
RB001A	F	7/25/90	X	7/25/90	7/25/90	X	7/25/90	7/25/90	DNR
RB003A	F	7/25/90				X	7/25/90	7/25/90	PG
RB004A	F	7/25/90				X	7/25/90	7/25/90	PG
RB005A	F	6/27/90	X	6/27/90	6/27/90	X	6/26/90	6/27/90	PG
RB005B	F	6/27/90				X	6/26/90	6/27/90	PG
TB002A	F	7/15/90	X	7/14/90	7/15/90	X	7/14/90	7/15/90	DNR
TB004A	F	6/26/90	X	6/26/90	6/26/90	X	6/9/90	6/17/90	DNR
TB005A	F	7/15/90				X	7/15/90	7/15/90	DNR
TB005B	F	7/15/90	X	7/15/90	7/15/90	X	7/15/90	7/15/90	DNR
US005A	F	6/3/90				X	6/3/90	6/3/90	FWS
WB001A	F	6/19/90				X	5/16/90	6/19/90	PG
WB001B	F	5/18/90				X	5/16/90	5/18/90	PG
WB002A	F	6/23/90	X	6/23/90	6/23/90	X	6/2/90	6/3/90	PG/EB
WB002B	F	6/24/90	X	6/23/90	6/24/90	X	5/30/90	6/3/90	PG/EB
WB002C	F	6/24/90	X	6/23/90	6/24/90	X	5/24/90	5/30/90	PG/EB
WB002D	F	6/24/90	X	6/23/90	6/24/90	X	5/19/90	5/22/90	PG/EB
WB002F	F	5/18/90				X	5/16/90	5/18/90	PG/EB
WB003A	F	6/8/90				X	6/8/90	6/8/90	PG
WB003B	F	7/22/90				X	6/19/90	7/22/90	PG
WB003E	F	6/8/90				X	6/8/90	6/8/90	PG
WB006A	F	6/24/90	X	6/24/90	6/24/90	X	5/15/90	5/15/90	PG
WB007A	F	6/24/90	X	6/24/90	6/24/90	X	5/15/90	5/15/90	PG
WB008A	F	5/26/90				X	5/26/90	5/26/90	PG
WB009A	F	7/28/90	X	6/24/90	7/28/90	X	6/5/90	6/7/90	PG
YG002A	F	7/12/90	X	7/5/90	7/12/90	X	7/5/90	7/12/90	NPS
YP004A	F	7/11/90	X	7/11/90	7/11/90	X	7/11/90	7/11/90	DNR
Kodiak Completed Subdivisions									
K0101-SI011A	G	7/21/90	X	7/21/90	7/21/90	X	7/21/90	7/21/90	DNR
K0101-SI012B	G	7/2/90				X	6/29/90	7/2/90	DNR
K0101-SI012C	G	7/18/90				X	7/17/90	7/18/90	DNR
K0101-SI012F	G	7/18/90				X	7/17/90	7/18/90	DNR
K0101-SI012G	G	7/18/90				X	7/17/90	7/18/90	DNR
K0101-SI013A	G	7/3/90				X	7/3/90	7/3/90	DNR
K0102-SI014A	G	7/21/90				X	7/21/90	7/21/90	DNR
K0102-SI015B	G	7/18/90				X	7/18/90	7/18/90	DNR
K0103-SS002B	G	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	DNR
K0104-NB001B	G	7/22/90				X	7/22/90	7/22/90	DNR
K0104-NB001C	G	7/23/90				X	7/23/90	7/23/90	DNR
K0104-NB001D	G	7/23/90	X	7/23/90	7/23/90	X	7/23/90	7/23/90	DNR
K0110-SI003A	G	7/25/90	X	7/25/90	7/25/90	X	7/24/90	7/25/90	DNR
K0110-SI005A	G	7/20/90				X	7/20/90	7/20/90	DNR
K0110-SI100A	G	7/25/90				X	7/19/90	7/25/90	DNR
K0111-PI003A	G	7/20/90	X	7/20/90	7/20/90	X	7/13/90	7/13/90	DNR
K0119-SE002A	G	7/19/90				X	7/19/90	7/19/90	FWS
K0204-FB011A	G	6/8/90				X	6/8/90	6/8/90	FWS
K0204-FB013B	G	6/8/90				X	6/7/90	6/8/90	FWS

K0302-IB004A	G	6/5/90				X	6/5/90	6/5/90	FWS
K0302-IB005A	G	6/5/90				X	6/5/90	6/5/90	FWS
K0619-SB006A	G	6/17/90				X	6/17/90	6/17/90	FWS
K0634-SL001A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL002A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL003A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL007A	G	6/17/90				X	6/17/90	6/17/90	DNR
K0634-SL015A	G	7/10/90				X	7/10/90	7/10/90	KIK
K0634-SL017A	G	6/30/90				X	6/30/90	6/30/90	KIK
K0908-CD001A	G	7/16/90				X	7/16/90	7/16/90	NPS
K0910-CD010A	G	7/20/90				X	7/20/90	7/20/90	NPS
K0910-CD011A	G	7/20/90				X	7/20/90	7/20/90	NPS
K0910-CD012A	G	7/21/90				X	7/21/90	7/21/90	NPS
K0910-CD013A	G	7/21/90				X	7/21/90	7/21/90	NPS
K0910-CD016A	G	6/8/90				X	6/8/90	6/8/90	NPS
K0917-CC001A	G	7/11/90				X	7/5/90	7/11/90	NPS
K0919-HB001A	G	6/14/90				X	6/12/90	6/14/90	NPS
K0919-HB100A	G	6/26/90				X	6/25/90	6/26/90	NPS
K0921-KU003A	G	7/22/90	X	7/22/90	7/22/90	X	7/20/90	7/20/90	NPS
K0921-KU004A	G	7/22/90	X	7/22/90	7/22/90	X	7/21/90	7/22/90	NPS
K0924-KU001A	G	6/20/90				X	6/19/90	6/20/90	NPS
K0934-KB001A	G	7/25/90				X	7/25/90	7/25/90	NPS
K0935-KA002A	G	7/4/90				X	6/25/90	7/4/90	NPS
K0935-KA003A	G	6/27/90				X	6/27/90	6/27/90	NPS
K1002-AS007A	G	7/15/90				X	7/15/90	7/15/90	FWS
K1002-AS008A	G	7/15/90				X	7/15/90	7/15/90	FWS
K1002-AS008B	G	7/19/90	X	7/15/90	7/19/90	X	7/15/90	7/19/90	FWS
K1005-AS002B	G	7/19/90				X	7/5/90	7/19/90	FWS
K1005-AS004A	G	7/14/90				X	7/14/90	7/14/90	FWS
K1005-AS004B	G	7/14/90				X	7/14/90	7/14/90	FWS
K1007-PB001A	G	6/24/90				X	6/22/90	6/24/90	FWS
K1007-PB019B	G	7/25/90				X	7/25/90	7/25/90	FWS

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
AE001A	A	6/9/90	X	6/9/90	6/9/90	X	5/17/90	5/17/90	NFS
AE002A	A	6/9/90	X	6/9/90	6/9/90	X	6/6/90	6/6/90	NFS
AE004A	A	6/15/90	X	6/14/90	6/15/90	X	6/1/90	6/4/90	NFS
AE004B	A	6/15/90	X	6/9/90	6/15/90	X	6/2/90	6/3/90	NFS
AE005A	A	6/17/90	X	6/15/90	6/17/90	X	5/17/90	5/23/90	NFS
AE005B	A	7/8/90	X	7/8/90	7/8/90	X	6/3/90	6/3/90	NFS
AE005C	A	6/15/90	X	6/15/90	6/15/90	X	6/5/90	6/6/90	NFS
AE007A	A	5/23/90				X	5/23/90	5/23/90	NFS
AG009A	D	7/14/90	X	7/14/90	7/14/90	X	5/13/90	5/13/90	NFS
AG009B	D	5/13/90				X	5/13/90	5/13/90	NFS
BA001B	A	6/22/90				X	6/22/90	6/22/90	NFS
BA001E	A	6/23/90				X	6/23/90	6/23/90	NFS
BA002A	A	5/7/90				X	5/5/90	5/7/90	NFS
BA007A	A	5/29/90				X	5/29/90	5/29/90	NFS
BA008A	A	6/23/90				X	6/23/90	6/23/90	NFS
BM005A	F	7/11/90				X	7/10/90	7/11/90	NPS
BM006A	F	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NPS
CB003A	F	5/20/90				X	5/16/90	5/20/90	GVC
CB004A	F	6/25/90	X	6/25/90	6/25/90	X	5/20/90	5/23/90	ER
CB004B	F	6/25/90	X	6/25/90	6/25/90	X	5/24/90	5/24/90	EB
CB004C	F	6/25/90	X	6/25/90	6/25/90	X	6/17/90	6/17/90	EB
CB004D	F	6/25/90	X	6/25/90	6/25/90	X	6/17/90	6/17/90	EB
CH002A	A	7/3/90	X	7/3/90	7/3/90	X	6/14/90	6/14/90	CVC
CH002B	A	7/3/90	X	7/3/90	7/3/90	X	6/15/90	6/17/90	CVC
CH003A	A	7/3/90	X	7/3/90	7/3/90				CVC
CH009A	A	7/4/90				X	7/4/90	7/4/90	CVC
CH010B	A	7/3/90	X	7/3/90	7/3/90	X	6/19/90	6/19/90	CVC
CH015A	A	6/20/90				X	6/20/90	6/20/90	CVC
CH016A	A	7/3/90	X	7/3/90	7/3/90	X	6/20/90	6/20/90	CVC
CH020A	A	7/3/90	X	7/3/90	7/3/90	X	6/20/90	6/20/90	CVC
CP001A	A	6/9/90				X	6/6/90	6/9/90	NFS
CR001A	A	6/5/90	X	6/5/90	6/5/90				NFS
CR002C	A	6/6/90	X	6/6/90	6/6/90	X	6/5/90	6/5/90	NFS
CR005A	A	6/6/90	X	6/6/90	6/6/90	X	5/28/90	5/28/90	NFS
CR005B	A	6/6/90	X	6/6/90	6/6/90	X	5/28/90	5/28/90	NFS
CR005E	A	5/27/90				X	5/27/90	5/27/90	NFS
CU001A	A	6/13/90	X	6/9/90	6/13/90	X	5/18/90	5/23/90	NFS
CU003A	A	6/9/90	X	6/9/90	6/9/90	X	5/29/90	5/29/90	NFS
CU007A	A	7/8/90	X	7/8/90	7/8/90	X	6/22/90	6/22/90	NFS
CU010A	A	7/14/90				X	7/12/90	7/14/90	NFS
CU011A	A	6/8/90	X	6/8/90	6/8/90	X	5/29/90	6/5/90	NFS
CU013A	A	6/7/90	X	6/7/90	6/7/90	X	6/2/90	6/3/90	NFS
CU017A	A	7/7/90	X	7/7/90	7/7/90	X	6/21/90	6/21/90	NFS
DI059A	B	5/27/90	X	5/27/90	5/27/90	X	5/12/90	5/12/90	NFS
DI062A	B	5/27/90	X	5/27/90	5/27/90	X	5/12/90	5/13/90	NFS
DI063A	B	7/9/90	X	7/9/90	7/9/90	X	6/11/90	6/11/90	NFS
DI064A	B	5/29/90	X	5/29/90	5/29/90	X	5/29/90	5/29/90	NFS
DI064B	B	7/10/90	X	7/9/90	7/10/90	X	5/29/90	5/29/90	NFS
DI067A	B	5/10/90				X	5/9/90	5/10/90	NFS
DI068A	B	5/12/90				X	5/12/90	5/12/90	NFS
DI069A	B	5/27/90	X	5/27/90	5/27/90	X	5/13/90	5/14/90	NFS
EB006A	A	5/2/90				X	5/2/90	5/2/90	NFS
EB008A	A	5/26/90				X	5/26/90	5/26/90	CVC

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
EB013A	A	6/1/90				X	5/31/90	6/1/90	CVC
EB015A	A	5/31/90				X	5/31/90	5/31/90	CVC
EI001A	F	7/1/90				X	7/1/90	7/1/90	DNR
EL010A	B	7/9/90	X	7/5/90	7/9/90	X	5/5/90	5/5/90	NFS
EL011A	B	7/5/90	X	7/5/90	7/5/90	X	5/13/90	5/14/90	NFS
EL013A	B	7/14/90	X	7/13/90	7/14/90	X	7/13/90	7/14/90	CVC
EL015A	B	5/25/90				X	5/24/90	5/25/90	NFS
EL052A	B	6/28/90	X	6/28/90	6/28/90	X	5/25/90	5/25/90	NFS
EL052B	B	6/28/90	X	6/28/90	6/28/90	X	5/22/90	5/22/90	NFS
EL053B	B	7/12/90	X	7/12/90	7/12/90	X	7/12/90	7/12/90	NFS
EL054A	B	6/27/90	X	6/27/90	6/27/90	X	5/25/90	5/25/90	NFS
EL055A	B	6/24/90	X	6/24/90	6/24/90	X	6/8/90	6/8/90	NFS
EL055B	B	6/24/90	X	6/24/90	6/24/90	X	5/22/90	5/22/90	NFS
EL055C	B	6/24/90	X	6/24/90	6/24/90	X	6/8/90	6/8/90	NFS
EL056B	B	7/14/90	X	7/14/90	7/14/90	X	7/14/90	7/14/90	NFS
EL056C	B	6/26/90	X	6/26/90	6/26/90	X	5/20/90	5/20/90	NFS
EL056D	B	6/27/90	X	6/27/90	6/27/90	X	5/20/90	5/20/90	NFS
EL057A	B	6/26/90	X	6/26/90	6/26/90	X	5/19/90	5/19/90	NFS
EL058A	B	6/27/90	X	6/27/90	6/27/90	X	5/19/90	5/19/90	NFS
EL058B	B	6/27/90	X	6/27/90	6/27/90	X	5/19/90	5/19/90	NFS
EL058C	B	6/27/90	X	6/27/90	6/27/90	X	5/20/90	5/20/90	NFS
EL102A	B	7/14/90				X	7/14/90	7/14/90	NFS
EL102B	B	7/14/90	X	7/14/90	7/14/90	X	7/14/90	7/14/90	NFS
EL104C	B	6/18/90	X	6/18/90	6/18/90				NFS
EL106B	B	7/12/90	X	7/12/90	7/12/90	X	6/25/90	6/28/90	NFS
EL106C	B	7/5/90	X	7/5/90	7/5/90				NFS
EL107A	B	7/12/90	X	7/12/90	7/12/90	X	6/23/90	6/25/90	NFS
EL107B	B	7/11/90	X	7/11/90	7/11/90	X	6/25/90	6/25/90	NFS
EL107C	B	7/11/90	X	7/11/90	7/11/90	X	5/23/90	5/23/90	NFS
EL108A	B	4/29/90				X	4/28/90	4/29/90	NFS
EL108C	B	6/26/90		7/11/90	7/11/90	X	6/26/90	6/26/90	NFS
EL109A	B	7/11/90	X	7/11/90	7/11/90	X	5/23/90	5/24/90	NFS
EL110A	B	7/5/90	X	7/5/90	7/5/90	X	5/23/90	5/23/90	NFS
EN046A	B	7/12/90	X	7/12/90	7/12/90	X	6/26/90	6/26/90	NFS
EN046B	B	6/26/90				X	6/26/90	6/26/90	NFS
ER001A	C	5/30/90				X	5/30/90	5/30/90	DNR
ER002B	C	6/22/90	X	6/22/90	6/22/90	X	6/2/90	6/2/90	NFS
ER004B	C	6/22/90	X	6/22/90	6/22/90				NFS
ER007A	C	6/14/90	X	6/14/90	6/14/90	X	6/2/90	6/4/90	DNR
ER008A	C	6/14/90	X	6/14/90	6/14/90	X	5/30/90	5/31/90	NFS
ER009A	C	6/16/90	X	6/15/90	6/16/90	X	5/31/90	5/31/90	NFS
ER010A	C	6/16/90	X	6/15/90	6/16/90	X	5/30/90	5/30/90	NFS
ER011A	C	6/15/90	X	6/15/90	6/15/90	X	5/30/90	6/1/90	NFS
ER012B	C	6/15/90	X	6/15/90	6/15/90	X	6/3/90	6/3/90	NFS
ER018A	C	6/19/90	X	6/19/90	6/19/90				NFS
ER020A	C	6/22/90	X	6/22/90	6/22/90				DNR
EV002A	C	7/5/90	X	7/5/90	7/5/90	X	6/27/90	6/27/90	CVC
EV003A	C	6/21/90	X	6/19/90	6/21/90	X	6/10/90	6/10/90	CVC
EV005A	C	6/21/90	X	6/19/90	6/21/90	X	6/7/90	6/7/90	CVC
EV005B	C	6/21/90	X	6/19/90	6/21/90	X	6/9/90	6/9/90	CVC
EV005C	C	6/7/90				X	6/7/90	6/7/90	CVC
EV008B	C	6/2/90				X	6/2/90	6/2/90	CVC
EV009A	C	6/2/90				X	6/2/90	6/2/90	CVC

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
EV010A	C	6/3/90				X	6/2/90	6/3/90	CVC
EV010B	C	6/16/90				X	6/16/90	6/16/90	CVC
EV012A	C	7/1/90	X	6/6/90	7/1/90	X	5/2/90	6/23/90	CVC
EV014A	C	6/23/90	X	6/23/90	6/23/90	X	6/23/90	6/23/90	CVC
EV015A	C	6/6/90	X	6/6/90	6/6/90	X	6/3/90	6/3/90	CVC
EV017A	C	5/15/90				X	5/15/90	5/15/90	CVC
EV018A	C	6/8/90	X	6/6/90	6/8/90				CVC
EV020A	C	7/5/90	X	7/4/90	7/5/90	X	6/28/90	6/28/90	CVC
EV021A	C	6/8/90	X	6/8/90	6/8/90	X	5/11/90	5/14/90	CVC
EV023A	C	5/10/90				X	5/9/90	5/10/90	CVC
EV024A	C	6/9/90	X	6/8/90	6/8/90	X	6/6/90	6/9/90	CVC
EV025A	C	5/17/90				X	5/15/90	5/17/90	CVC
EV026A	C	6/10/90	X	6/9/90	6/10/90	X	6/2/90	6/2/90	CVC
EV027A	C	5/16/90				X	5/16/90	5/16/90	CVC
EV028A	C	7/3/90	X	7/3/90	7/3/90	X	6/2/90	6/2/90	CVC
EV037A	C	7/5/90	X	7/4/90	7/5/90	X	6/15/90	6/17/90	CVC
EV039A	C	7/4/90	X	7/4/90	7/4/90	X	6/9/90	6/15/90	CVC
EV050B	C	6/13/90	X	6/9/90	6/13/90	X	6/5/90	6/5/90	NFS
EV050C	C	6/13/90	X	6/9/90	6/13/90				NFS
EV051A	C	6/13/90	X	6/9/90	6/13/90	X	6/5/90	6/5/90	NFS
EV052A	C	7/3/90	X	7/3/90	7/3/90	X	6/17/90	6/17/90	NFS
EV053B	C	7/3/90	X	7/3/90	7/3/90	X	6/18/90	6/18/90	NFS
EV053D	C	6/5/90				X	6/5/90	6/5/90	NFS
EV054A	C	6/13/90	X	6/13/90	6/13/90	X	6/4/90	6/4/90	NFS
EV060A	C	7/3/90	X	7/3/90	7/3/90	X	6/29/90	6/30/90	CVC
EV060B	C	7/3/90	X	7/3/90	7/3/90	X	6/30/90	6/30/90	CVC
EV070D	C	6/10/90	X	6/10/90	6/10/90	X	6/2/90	6/2/90	NFS
EV070E	C	6/28/90				X	6/27/90	6/28/90	NFS
EV070F	C	6/12/90	X	6/12/90	6/12/90				NFS
EV070G	C	6/11/90	X	6/11/90	6/11/90	X	6/10/90	6/11/90	NFS
EV070H	C	6/18/90				X	6/18/90	6/18/90	NFS
FA002A	A	5/28/90				X	5/27/90	5/28/90	NFS
FL001A	C	6/11/90	X	6/11/90	6/11/90	X	5/2/90	5/2/90	CVC
FL002A	C	6/11/90	X	6/11/90	6/11/90	X	5/17/90	5/17/90	CVC
FL004A	C	6/30/90	X	6/29/90	6/30/90	X	6/19/90	6/21/90	CVC
FL004B	C	6/29/90	X	6/29/90	6/29/90	X	6/19/90	6/19/90	CVC
FL005B	C	6/30/90	X	6/30/90	6/30/90				CVC
GR007A	E	6/28/90	X	6/27/90	6/28/90	X	6/27/90	6/27/90	NFS
GR008A	E	6/27/90	X	6/25/90	6/27/90	X	6/25/90	6/25/90	NFS
GR009A	E	6/29/90	X	6/25/90	6/29/90	X	6/25/90	6/25/90	NFS
GR010A	E	6/29/90	X	6/27/90	6/29/90	X	6/27/90	6/27/90	NFS
GR103A	E	6/24/90	X	6/24/90	6/24/90	X	6/24/90	6/24/90	NFS
GR103B	E	6/28/90	X	6/26/90	6/28/90	X	6/26/90	6/26/90	NFS
GR103C	E	6/27/90	X	6/25/90	6/27/90	X	6/25/90	6/26/90	NFS
GR104A	E	6/28/90	X	6/28/90	6/28/90				NFS
GR300A	E	6/27/90				X	6/27/90	6/27/90	NFS
GR301B	E	6/28/90				X	6/28/90	6/28/90	NFS
GR302A	E	6/28/90	X	6/27/90	6/28/90	X	6/27/90	6/27/90	NFS
IN020A	B	7/8/90	X	7/7/90	7/8/90	X	6/29/90	6/29/90	NFS
IN022A	B	5/31/90	X	5/31/90	5/31/90	X	5/6/90	5/7/90	PG
IN022B	B	7/7/90	X	7/7/90	7/7/90	X	6/10/90	6/11/90	NFS
IN023A	B	7/7/90	X	7/7/90	7/7/90	X	6/10/90	6/10/90	NFS
IN024B	B	7/8/90	X	7/8/90	7/8/90	X	6/10/90	6/10/90	NFS

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
IN024C	B	6/10/90				X	6/10/90	6/10/90	NFS
IN028A	B	7/8/90	X	7/8/90	7/8/90				NFS
IN029A	B	6/30/90		7/10/90	7/10/90	X	6/30/90	6/30/90	NFS
IN030A	B	7/8/90	X	7/8/90	7/8/90				NFS
IN031A	B	5/8/90				X	5/6/90	5/8/90	NFS
IN031B	B	5/29/90	X	5/29/90	5/29/90	X	5/6/90	5/8/90	NFS
IN032A	B	7/10/90	X	7/9/90	7/10/90	X	6/9/90	6/9/90	NFS
K0204-FB011A	G	6/8/90				X	6/8/90	6/8/90	FWS
K0204-FB013B	G	6/8/90				X	6/7/90	6/8/90	FWS
K0302-IB004A	G	6/5/90				X	6/5/90	6/5/90	FWS
K0302-IB005A	G	6/5/90				X	6/5/90	6/5/90	FWS
K0619-SB006A	G	6/17/90				X	6/17/90	6/17/90	FWS
K0634-SL001A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL002A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL003A	G	6/30/90				X	6/30/90	6/30/90	FWS
K0634-SL007A	G	6/17/90				X	6/17/90	6/17/90	DNR
K0634-SL008A	G	6/30/90				X	6/30/90	6/30/90	DNR
K0634-SL015A	G	7/10/90				X	7/10/90	7/10/90	KIK
K0634-SL017A	G	6/30/90				X	6/30/90	6/30/90	KIK
K0917-CC001A	G	7/11/90				X	7/5/90	7/11/90	NPS
K0919-HB001A	G	6/14/90				X	6/12/90	6/14/90	NPS
K0919-HB100A	G	6/26/90				X	6/25/90	6/26/90	NPS
K0924-KU001A	G	6/20/90				X	6/19/90	6/20/90	NPS
K0935-KA002A	G	7/4/90				X	6/25/90	7/4/90	NPS
K0935-KA003A	G	6/27/90				X	6/27/90	6/27/90	NPS
K1005-AS004B	G	7/14/90				X	7/14/90	7/14/90	FWS
K1007-PB001A	G	6/24/90				X	6/22/90	6/24/90	FWS
KN0004A	E	6/21/90	X	6/21/90	6/21/90	X	5/29/90	5/29/90	CAC
KN0005B	E	6/22/90	X	6/22/90	6/22/90	X	5/23/90	5/27/90	CAC
KN0006A	E	5/30/90				X	5/30/90	5/30/90	NFS
KN0007A	E	6/21/90	X	6/21/90	6/21/90	X	6/8/90	6/8/90	CAC
KN0008A	E	5/31/90				X	5/30/90	5/31/90	CAC
KN0009A	E	6/23/90	X	6/22/90	6/23/90	X	6/6/90	6/9/90	CAC
KN0011A	E	6/21/90	X	6/21/90	6/21/90	X	6/5/90	6/5/90	CAC
KN0012A	E	6/21/90	X	6/21/90	6/21/90	X	6/3/90	6/4/90	CAC
KN0013A	E	6/21/90	X	6/21/90	6/21/90	X	6/3/90	6/4/90	CAC
KN0014A	E	6/21/90	X	6/21/90	6/21/90	X	6/1/90	6/1/90	CAC
KN0019A	E	6/22/90	X	6/22/90	6/22/90	X	6/4/90	6/4/90	NFS
KN0023A	E	6/22/90	X	6/22/90	6/22/90	X	6/9/90	6/9/90	CAC
KN0101A	B	7/5/90	X	7/5/90	7/5/90				NFS
KN0102A	B	5/22/90	X	5/22/90	5/22/90	X	5/5/90	5/7/90	NFS
KN0103A	B	7/12/90				X	5/11/90	7/12/90	NFS
KN0104A	B	7/13/90	X	7/13/90	7/13/90	X	5/4/90	7/11/90	NFS
KN0104B	B	7/10/90				X	7/10/90	7/10/90	NFS
KN0105B	B	5/26/90	X	5/26/90	5/26/90	X	5/11/90	5/11/90	NFS
KN0106A	B	5/26/90	X	5/26/90	5/26/90	X	5/16/90	5/16/90	NFS
KN0106B	B	5/16/90				X	5/16/90	5/16/90	NFS
KN0106D	B	5/16/90				X	5/16/90	5/16/90	NFS
KN0107A	B	7/5/90	X	7/5/90	7/5/90				NFS
KN0107B	B	7/13/90	X	7/13/90	7/13/90	X	7/12/90	7/13/90	NFS
KN0109A	D	5/25/90	X	5/25/90	5/25/90	X	5/25/90	5/25/90	NFS
KN0110A	D	7/8/90	X	7/5/90	7/8/90	X	7/5/90	7/5/90	NFS
KN0112A	D	7/2/90	X	7/2/90	7/2/90				NFS

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
KN0112B	D	7/2/90	X	7/2/90	7/2/90				NFS
KN0114A	D	7/2/90	X	7/1/90	7/2/90	X	5/3/90	5/3/90	NFS
KN0116A	D	5/23/90	X	5/23/90	5/23/90	X	5/3/90	5/3/90	NFS
KN0117A	D	5/23/90	X	5/23/90	5/23/90	X	5/2/90	5/2/90	NFS
KN0118A	D	6/1/90	X	6/1/90	6/1/90				NFS
KN0119A	D	6/1/90	X	6/1/90	6/1/90	X	5/2/90	5/2/90	NFS
KN0121A	D	7/1/90	X	7/1/90	7/1/90	X	5/31/90	5/31/90	NFS
KN0123B	D	5/31/90	X	5/24/90	5/24/90	X	5/31/90	5/31/90	NFS
KN0125A	D	6/30/90	X	6/30/90	6/30/90	X	5/31/90	5/31/90	NFS
KN0126A	D	6/30/90	X	6/30/90	6/30/90	X	5/30/90	5/30/90	NFS
KN0127A	D	5/30/90				X	5/30/90	5/30/90	NFS
KN0127C	D	6/30/90	X	6/30/90	6/30/90	X	5/29/90	5/29/90	NFS
KN0128A	D	6/30/90	X	6/30/90	6/30/90	X	5/9/90	5/9/90	NFS
KN0129A	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0129B	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0131A	D	6/1/90	X	6/1/90	6/1/90	X	5/9/90	5/9/90	NFS
KN0132A	D	5/29/90				X	5/29/90	5/29/90	NFS
KN0132B	D	7/12/90	X	6/2/90	7/12/90	X	5/26/90	5/29/90	NFS
KN0132C	D	6/19/90	X	6/19/90	6/19/90	X	5/29/90	5/29/90	NFS
KN0132D	D	6/30/90	X	6/30/90	6/30/90	X	5/29/90	5/29/90	NFS
KN0133A	D	6/30/90	X	6/30/90	6/30/90	X	5/10/90	5/13/90	NFS
KN0134A	E	6/23/90	X	6/23/90	6/23/90	X	5/23/90	5/26/90	NFS
KN0135A	E	6/23/90	X	6/23/90	6/23/90	X	5/18/90	5/21/90	CAC
KN0135B	E	5/21/90	X	5/21/90	5/21/90	X	5/15/90	5/18/90	CAC
KN0136A	E	7/4/90	X	7/4/90	7/4/90	X	6/9/90	6/24/90	CAC
KN0141A	D	7/1/90	X	7/1/90	7/1/90	X	5/3/90	5/3/90	NFS
KN0141B	D	5/3/90				X	5/3/90	5/3/90	NFS
KN0145A	D	5/25/90	X	5/25/90	5/25/90				NFS
KN0200A	E	6/20/90	X	6/20/90	6/20/90	X	5/14/90	5/14/90	CAC
KN0201A	E	6/21/90	X	6/20/90	6/21/90	X	5/31/90	6/1/90	CAC
KN0202A	E	6/1/90				X	5/31/90	6/1/90	CAC
KN0204A	E	6/1/90				X	6/1/90	6/1/90	CAC
KN0205B	E	6/4/90	X	6/1/90	6/4/90	X	6/1/90	6/4/90	CAC
KN0206A	E	6/22/90	X	6/22/90	6/22/90	X	6/4/90	6/6/90	CAC
KN0209B	B	7/12/90	X	7/12/90	7/12/90	X	6/26/90	6/26/90	NFS
KN0300A	D	7/11/90	X	7/11/90	7/11/90	X	5/2/90	5/2/90	NFS
KN0413A	E	5/13/90				X	5/13/90	5/13/90	CVC
KN0501A	D	7/10/90		7/12/90	7/13/90	X	7/10/90	7/10/90	NFS
KN0502A	D	7/13/90	X	7/12/90	7/13/90	X	7/10/90	7/11/90	NFS
KN0503A	D	7/12/90	X	7/11/90	7/12/90	X	7/11/90	7/11/90	NFS
KN0505A	D	7/13/90	X	7/13/90	7/13/90	X	7/11/90	7/12/90	NFS
KN0508A	D	7/13/90	X	7/11/90	7/13/90	X	5/6/90	5/6/90	NFS
KN0509A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0510A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0552A	D	7/12/90				X	7/12/90	7/12/90	NFS
KN0574A	D	5/13/90				X	5/13/90	5/13/90	NFS
KN0701A	E	5/25/90				X	5/25/90	5/25/90	CAC
KN0701C	E	5/26/90				X	5/26/90	5/26/90	CAC
KN5002A	D	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NFS
KN5002B	D	7/10/90	X	7/10/90	7/10/90	X	5/9/90	5/9/90	NFS
KN5012A	D	7/10/90	X	7/10/90	7/10/90	X	7/10/90	7/10/90	NFS
LA015D	C	6/14/90				X	6/12/90	6/14/90	CVC
LA016A	C	7/6/90	X	7/5/90	7/6/90	X	6/12/90	6/12/90	CVC

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
LA017A	C	7/6/90	X	7/6/90	7/6/90	X	6/16/90	6/17/90	CVC
LA021A	C	7/6/90	X	7/6/90	7/6/90	X	6/13/90	6/13/90	CVC
LA021B	C	6/17/90	X	6/17/90	6/17/90	X	6/13/90	6/13/90	CVC
LA023A	C	5/25/90				X	5/25/90	5/25/90	CVC
LA024A	C	6/1/90				X	6/1/90	6/1/90	CVC
LA038A	C	6/17/90	X	6/17/90	6/17/90	X	5/12/90	5/12/90	CAC
LA039A	C	5/23/90				X	5/23/90	5/23/90	CAC
LN002A	A	6/28/90	X	6/28/90	6/28/90	X	6/23/90	6/23/90	NFS
LN004A	A	6/8/90				X	6/7/90	6/8/90	NFS
LN005A	A	6/28/90	X	6/28/90	6/28/90	X	6/8/90	6/8/90	NFS
LN006A	B	6/28/90	X	6/28/90	6/28/90	X	6/7/90	6/8/90	NFS
LN007A	A	6/28/90	X	6/28/90	6/28/90	X	6/7/90	6/7/90	NFS
LN008A	A	6/28/90	X	6/28/90	6/28/90	X	6/7/90	6/7/90	NFS
MA002A	A	6/7/90	X	6/7/90	6/7/90	X	6/7/90	6/7/90	DNR
MA003A	A	5/3/90				X	5/3/90	5/3/90	DNR
MA004A	A	6/4/90	X	6/4/90	6/4/90	X	5/2/90	5/2/90	NFS
MA006A	A	5/29/90				X	5/29/90	5/29/90	PG
MA009A	A	6/7/90	X	6/7/90	6/7/90	X	5/24/90	5/24/90	NFS
MA010A	A	6/4/90	X	6/4/90	6/4/90	X	6/1/90	6/2/90	NFS
MU001A	D	6/29/90	X	6/29/90	6/29/90	X	6/24/90	6/24/90	NFS
MU001B	D	6/29/90	X	6/29/90	6/29/90	X	6/24/90	6/24/90	NFS
MU001C	D	6/29/90	X	6/29/90	6/29/90	X	6/26/90	6/29/90	NFS
MU002A	D	6/27/90				X	6/26/90	6/27/90	NFS
MU003A	D	6/29/90	X	6/29/90	6/29/90	X	6/27/90	6/27/90	NFS
MU900A	D	5/13/90				X	5/13/90	5/13/90	NFS
NA005A	B	7/9/90				X	7/9/90	7/9/90	DNR
NA006A	B	7/9/90				X	7/9/90	7/9/90	NFS
NA006B	B	7/9/90				X	7/9/90	7/9/90	NFS
NA006C	B	7/11/90		7/9/90	7/12/90	X	7/9/90	7/11/90	NFS
NA021B	B	7/8/90	X	7/8/90	7/8/90	X	7/8/90	7/8/90	NFS
NA023A	B	7/8/90	X	7/8/90	7/8/90	X	7/8/90	7/8/90	DNR
NA024A	B	7/8/90				X	7/8/90	7/8/90	NFS
NA024F	B	7/10/90	X	7/8/90	7/10/90	X	7/8/90	7/9/90	NFS
NA025A	B	7/8/90				X	7/8/90	7/8/90	DNR
NA026B	B	7/8/90	X	7/8/90	7/8/90	X	7/8/90	7/8/90	NFS
NA027A	B	7/9/90				X	7/9/90	7/9/90	DNR
NJ001A	A	5/4/90				X	5/3/90	5/4/90	DNR
NK002A	F	7/4/90	X	7/3/90	7/4/90	X	7/3/90	7/4/90	DNR
NK004C	F	5/13/90				X	5/12/90	5/13/90	DNR
PD002A	F	5/3/90				X	5/3/90	5/3/90	DNR
PD003A	F	5/5/90				X	5/5/90	5/5/90	DNR
PD004B	F	7/14/90				X	7/14/90	7/14/90	DNR
PD008A	F	6/20/90				X	6/20/90	6/20/90	DNR
PR002A	A	7/6/90	X	7/6/90	7/6/90	X	6/9/90	6/11/90	NFS
PR003A	A	7/6/90	X	7/6/90	7/6/90	X	6/6/90	6/6/90	NFS
PR003B	A	7/6/90	X	7/6/90	7/6/90	X	6/6/90	6/8/90	NFS
PR003C	A	6/8/90				X	6/8/90	6/8/90	NFS
PR004A	A	7/6/90	X	7/6/90	7/6/90				NFS
PR005B	A	6/8/90	X	6/8/90	6/8/90	X	6/8/90	6/8/90	NFS
PR005C	A	7/6/90	X	7/6/90	7/6/90				NFS
PR006A	A	7/11/90				X	7/11/90	7/11/90	NFS
PR007A	A	7/6/90	X	7/6/90	7/6/90	X	6/9/90	6/9/90	NFS
PR008A	A	7/6/90	X	7/6/90	7/6/90				NFS

Total Area Completed Subdivisions as of 7/15/90

Subdivision ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
PR008B	A	7/6/90	X	7/6/90	7/6/90	X	6/11/90	6/12/90	NFS
PR008C	A	7/6/90	X	7/6/90	7/6/90	X	6/11/90	6/12/90	NFS
PR013A	A	7/7/90	X	7/7/90	7/7/90	X	6/13/90	6/13/90	NFS
PY001A	F	7/13/90				X	7/13/90	7/13/90	FWS
PY005A	F	7/13/90				X	7/13/90	7/13/90	FWS
PY006A	F	5/8/90				X	5/8/90	5/8/90	FWS
PY007B	F	5/8/90				X	5/7/90	5/8/90	FWS
PY012B	F	5/14/90				X	5/14/90	5/14/90	FWS
PY015D	F	5/14/90				X	5/14/90	5/14/90	FWS
RB005A	F	6/27/90	X	6/27/90	6/27/90	X	6/26/90	6/27/90	PG
RB005B	F	6/27/90				X	6/26/90	6/27/90	PG
SL001B	D	7/14/90	X	7/14/90	7/14/90				NFS
SL001E	D	7/14/90	X	7/14/90	7/14/90				NFS
SP043A	B	5/31/90	X	5/31/90	5/31/90	X	5/13/90	5/13/90	NFS
TB004A	F	6/26/90	X	6/26/90	6/26/90	X	6/9/90	6/17/90	DNR
US005A	F	6/3/90				X	6/3/90	6/3/90	FWS
WB001B	F	5/18/90				X	5/16/90	5/18/90	PG
WB002A	F	6/23/90	X	6/23/90	6/23/90	X	6/2/90	6/3/90	PG/EB
WB002B	F	6/24/90	X	6/23/90	6/24/90	X	5/30/90	6/3/90	PG/EB
WB002C	F	6/24/90	X	6/23/90	6/24/90	X	5/24/90	5/30/90	PG/EB
WB002D	F	6/24/90	X	6/23/90	6/24/90	X	5/19/90	5/22/90	PG/EB
WB002E	F	5/30/90				X	5/18/90	5/30/90	PG/EB
WB002F	F	5/18/90				X	5/16/90	5/18/90	PG/EB
WB003E	F	6/8/90				X	6/8/90	6/8/90	PG
WB006A	F	6/24/90	X	6/24/90	6/24/90	X	5/15/90	5/15/90	PG
WB007A	F	6/24/90	X	6/24/90	6/24/90	X	5/15/90	5/15/90	PG
WB008A	F	5/26/90				X	5/26/90	5/26/90	PG
WB009A	F	6/24/90	X	6/24/90	6/24/90	X	6/5/90	6/7/90	PG
YG002A	F	7/12/90	X	7/5/90	7/12/90	X	7/5/90	7/12/90	NPS
YP004A	F	7/11/90	X	7/11/90	7/11/90	X	7/11/90	7/11/90	DNR

Total Area Completed Streams as of 7/15/90

Subdivision ID	Stream ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
BA002	226-40-16451	A	6/23/90	X	6/22/90	6/23/90	X	6/22/90	6/23/90	NFS
BP004	226-20-16388	F	7/2/90				X	7/1/90	7/2/90	CVC
BP004	226-20-16392	F	7/3/90				X	7/2/90	7/3/90	CVC
BP004	226-20-16395	F	7/4/90				X	7/3/90	7/4/90	CVC
BP004	226-20-16397	F	7/7/90	X	7/7/90	7/7/90	X	7/4/90	7/7/90	CVC
CB003	242-20-10190	F	6/14/90				X	6/14/90	6/14/90	GVC
CH001	226-20-16280	A	6/16/90				X	6/16/90	6/16/90	CVC
CH002	226-20-16180	A	7/3/90	X	7/3/90	7/3/90	X	6/16/90	6/16/90	CVC
CH009	226-20-16182	A	7/4/90	X	7/4/90	7/4/90	X	7/4/90	7/4/90	CVC
CH014	226-20-16255	A	6/20/90				X	6/20/90	6/20/90	CVC
CH0900	226-20-16200	A	7/3/90				X	7/3/90	7/3/90	CVC
CU001	224-20-12995	A	5/23/90				X	5/18/90	5/23/90	NFS
CU013	224-20-13030	A	6/3/90				X	6/3/90	6/3/90	CVC
CU014	224-20-13034	A	6/21/90				X	6/21/90	6/21/90	CVC
CU014	224-20-13036	A	6/21/90				X	6/21/90	6/21/90	CVC
EI001	242-10-10270	F	7/1/90				X	7/1/90	7/1/90	DNR
EL015	226-10-16906	B	6/30/90				X	6/30/90	6/30/90	CVC
EL052	226-10-16902	B	6/28/90	X	6/28/90	6/28/90				NFS
ER005	226-50-16432	C	6/21/90				X	6/21/90	6/21/90	NFS
ER006	226-50-16430	C	6/20/90				X	6/20/90	6/20/90	NFS
ER007	226-50-16428	C	6/20/90				X	6/20/90	6/20/90	NFS
EV003	226-40-16590	C	6/10/90				X	6/10/90	6/10/90	CVC
EV012	EV012-UNCAT	C	6/23/90	X	6/22/90	6/23/90	X	6/22/90	6/23/90	CVC
EV014	226-40-16640	C	6/23/90				X	6/23/90	6/23/90	CVC
EV017	226-40-16620	C	6/19/90				X	6/19/90	6/19/90	CVC
EV017	226-40-16630	C	6/19/90				X	6/19/90	6/19/90	CVC
EV025	226-40-16613	C	7/1/90	X	7/1/90	7/1/90	X	6/9/90	6/9/90	CVC
EV027	226-40-16610	C	7/8/90				X	7/8/90	7/8/90	CVC
EV070	226-40-16509	C	6/12/90	X	6/12/90	6/12/90	X	6/12/90	6/12/90	NFS
EV071	226-40-16484	C	7/5/90	X	7/5/90	7/5/90	X	6/21/90	6/21/90	NFS
GR007	GR007-UNCAT	E	6/27/90				X	6/27/90	6/27/90	NFS
GR103	227-20-17880	E	6/26/90				X	6/24/90	6/26/90	NFS
IN031	226-10-16916	B	7/5/90				X	7/5/90	7/5/90	NFS
K0101-SI014	251-82-10090	G	7/3/90				X	7/3/90	7/3/90	DNR
K0112-SS009	251-50-10045	G	7/2/90				X	7/2/90	7/2/90	FWS
K0302-IB005	252-31-10020	G	6/5/90				X	6/5/90	6/5/90	FWS
K0911-CD020	262-10-10040	G	7/8/90				X	7/3/90	7/8/90	NPS
K0911-CD020	262-10-10080	G	6/28/90				X	6/28/90	6/28/90	NPS
K0911-CD020	262-10-10092	G	6/28/90				X	6/28/90	6/28/90	NPS
K0919-HB001	262-20-10040	G	6/14/90				X	6/12/90	6/14/90	NPS
K1002-AB002	262-65-655	G	7/8/90				X	7/7/90	7/8/90	FWS
K1007-PB001	262-70-10025	G	6/24/90				X	6/23/90	6/24/90	FWS
K1007-PB016	262-70-10010	G	7/10/90				X	7/10/90	7/10/90	FWS
KN0103	226-10-16922	B	7/7/90	X	7/7/90	7/7/90	X	7/7/90	7/7/90	NFS
KN0106	226-10-16890	B	6/30/90				X	6/30/90	6/30/90	NFS
KN0129	226-10-16975	D	5/30/90				X	5/30/90	5/30/90	NFS
KN0129	KN0129-UNCAT	D	6/19/90	X	6/19/90	6/19/90	X	5/30/90	5/30/90	NFS
KN0132	226-10-16982	D	6/19/90	X	6/19/90	6/19/90	X	5/26/90	5/29/90	NFS
KN0134	226-30-16865	E	6/23/90	X	6/23/90	6/23/90	X	6/23/90	6/23/90	NFS
KN0201	226-30-16872	E	6/1/90				X	6/1/90	6/1/90	CAC
KN0205	226-30-16860	E	6/3/90				X	6/1/90	6/3/90	CAC
KN0213	226-30-16853	E	7/6/90	X	7/1/90	7/6/90	X	7/1/90	7/6/90	CAC
KN0401	226-30-16820	E	6/30/90				X	6/30/90	6/30/90	NFS

Total Area Completed Streams as of 7/15/90

Subdivision ID Stream ID	Sector	Completed	Bio	Bio Start	Bio End	Man	Man Start	Man End	Land Owner
KN0500 226-10-16992	D	7/7/90	X	7/5/90	7/7/90	X	7/5/90	7/7/90	NFS
KN0500 226-10-16996	D	7/7/90	X	7/7/90	7/7/90	X	7/5/90	7/7/90	NFS
KN0701 226-30-16840	E	7/1/90	X	6/30/90	7/1/90	X	6/30/90	6/30/90	CAC
LA015 226-40-16782	C	7/8/90	X	7/3/90	7/8/90	X	7/3/90	7/8/90	CVC
LA018 226-40-16780	C	7/4/90	X	7/3/90	7/4/90	X	6/15/90	7/4/90	CVC
LA021 226-40-16774	C	6/17/90	X	6/17/90	6/17/90	X	6/13/90	6/14/90	CVC
NK001 232-21-10230	F	7/4/90	X	7/3/90	7/4/90	X	7/3/90	7/4/90	DNR
PD002 242-42-10450	F	6/23/90				X	6/21/90	6/23/90	DNR
PD003 242-42-10460	F	6/23/90				X	6/21/90	6/23/90	DNR
TB002 232-10-10340	F	7/1/90				X	7/1/90	7/1/90	DNR
TB003 232-10-10342	F	7/1/90				X	6/20/90	7/1/90	DNR
WB001 242-32-10155	F	6/19/90				X	6/19/90	6/19/90	PG
WB003 242-32-10160	F	6/19/90				X	6/19/90	6/19/90	PG
WH003 226-40-16322	A	7/8/90	X	7/8/90	7/8/90	X	7/8/90	7/8/90	CAC