BUREAU OF LAND MANAGEMENT

REPORT ON EROSION OF WILDFIRE AREAS IN ALASKA

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DEPARTMENT OF THE INTERIOR

REPORT

ON

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REPORT

ON

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Summary

On-the-ground inspections were made of three Alaska (Fairbanks District) wildfire burns by Alaska State Office, Fairbanks District, and Portland Service Center personnel during the week of June 3-7, 1968. These burns were inspected to determine (1) possible changes in future fire line construction methods to minimize resulting erosion, (2) rehabilitation measures which might be used to stabilize dozer-constructed fire lines following mop up of future fire, and (3) stabilization measures to curb accelerated erosion which has developed on 1966 C.Y. burns.

Briefly, the recommendations are as follows: (1) restrict to a minimum the use of crawler tractor dozer-constructed fire lines on north slopes and in drainage bottoms (areas where permafrost is near the ground surface); (2) where dozer-constructed fire lines are absolutely required on critical areas (north slopes, drainage bottoms, etc.), use follow up treatment to prevent water from concentrating in fire lines by blocking the lines at intervals with fire line debris; (3) to facilitate re-establishment of vegetative cover, seed all dozer-constructed fire lines on critical areas with adaptable grasses after the fire; (4) initiate a minimum level field trial for rehabilitation of existing fire line erosion using practices such as gully plugs (fire line debris, thawed soil, etc.), grass seeding, and tree seeding and/or planting; and (5) undertake (2) and (3) above through use of 1520, Fire Rehabilitation, funds (see 1631.12I4).

Purpose

During the past year Alaska personnel observed that severe erosion had resulted on some of the 1966 C.Y. wildfire burns where heavy equipment was used in controlling the fire. Damage was evident on dozer-constructed fire lines, particularly on north slopes and in drainage bottoms where permafrost is normally near the ground surface.

With the prospect of expanding the use of heavy equipment on wildfire control in the future, the Alaska State Office and the Fairbanks District Office were particularly concerned as to the magnitude of the accelerated erosion. For this reason a field evaluation to be made jointly by State Office, District Office, and Portland Service Center personnel was proposed. Such an evaluation was arranged and scheduled for the week of June 3-7, 1968. The evaluation was set up to include a field inspection of burned areas followed by a report on recommendations by the PSC participants.

Objectives

The objectives of the field inspections were established as (1) an observation of several burned areas to determine the extent and magnitude of current erosion, (2) a determination of the cause (or causes) of the accelerated erosion, (3) a recommended change in construction methods and location of dozer-constructed fire lines to minimize erosion, (4) recommended rehabilitation practices which might be employed during and immediately following fire control work to reduce erosion potential, and (5) recommended rehabilitation measures which might be used to control existing erosion if such is necessary. To meet these objectives, field observations were scheduled for both 1966 burns and aged burns (1958) where heavy equipment was used to construct lines.

Observations

Field inspections were made of three fires, Goldstream (1966), Y-34 (Chicken, 1966), and Murphy Dome (1958), where tractors were used to construct fire lines. Other fires were observed from the air but no ground observations were made.

Personnel making the helicopter field inspections were Jerry Wickstrom, Fairbanks District, Curt McVee and Sal DeLeonardis of the Alaska State Office, and Jim Hagihara and Glenn Lipscomb of the Portland Service Center. Wandell Elliot, Delta Resource Area Manager, met with the group during the Y-34 inspection.

Goldstream and Murphy Dome were inspected on June 4, while Y-34 was flown on June 5 and 6. Ground observations were made on each fire in areas where erosion appeared to be severe.

After viewing some of the eroded fire lines on the Goldstream and Y-34 burns, it is quite clear that some areas in Alaska belong in the fragile or "frail" category. Removal of the vegetation and organic accumulation in areas underlain with shallow permafrost and with deep loess soils can result in severe soil erosion. (See Photo No. 1) Melt from permafrost and thick ice lenses together with runoff from rainfall provide the eroding forces. (See Photos No. 2 and 3). Such areas are generally located on north slopes and in drainage bottoms and are characterized by spare stands of stunted black spruce. On the other hand, well drained soils generally found on south slopes, along ridge tops and on points do not appear to be a problem. Field investigation revealed very little erosion where fire lines were constructed on these areas.

The soil characteristics found on the wildfire areas are as follows:

1. The geology of the uplands is primarily composed of schists, a Precambrian formation made up of folded and strongly jointed quartz-mica and quartzite schist. Out croppings of granite, quartz diorite, and basalt occur along the ridge tops. Gold can be found in the quartz veins within the schist.

All of the sites investigated in the uplands were found to be covered by a mantle of micaceous loess that was blown in from the adjoining flood plains. This loess layer ranges from about one foot thick on the high ridges to about 200 feet thick on the lower hills. Colluvial silt that has moved from the hillsides and accumulated on the lower slopes and in the narrow upland valleys is more than 300 feet thick in places.

Permafrost underlies the alluvial fans, bottom of drainageways in the uplands and the north-facing slopes. It is absent on the moderately (12-20%) to steeply (20-30%) sloping south-facing slopes. Large ice masses are commonly found within the colluvial silt deposits.

2. The following six major soils were examined during the investigation of erosion problems. All of these soils had one common significant factor, they were susceptible to severe water erosion and gullying upon removal of the organic mat. This susceptibility to erosion by water is due to the poor mechanical and engineering properties of the soils that do not have the ability to resist detachment. Some of the major soil characteristics are shown on attachment #2.

a. The Fairbanks Soil is found on the gently sloping (7-12%) to steep (20-30%) uplands with southerly exposures. It occupies low scattered hills and long, smooth slopes. These soils are found in association with the Minto soils on the low hills and footslopes and with the Gilmore soils at the higher elevations. The dominant natural vegetation consists of white spruce and paper birch, but quaking aspen is dominant on the burned or cleared areas. Annual precipitation is about 13 inches and the frost free season averages 108 days. Elevations range from 800 to 1500 feet.

These soils are deep well drained silt loam soils underlying a mat of roots and partially decomposed forest litter. The loess mantle ranges from 30 inches to many feet in thickness over bedrock. The texture is dominantly silt loam. Runoff and susceptibility to erosion is severe upon removal of the organic layer.

b. The Minto Soil is found upon all exposures at the base of upland slopes and footslopes of ridges and hills. The lower boundaries are found in association with the Goldstream soils. On south-facing slopes they are associated with the Fairbanks soils along the upper boundary. These soils support stands of white spruce, paper birch, quaking aspen and also stands of black spruce. The annual precipitation is 13 inches with an average frost free season of 108 days. Elevations range from 700 to 1200 feet.

The Minto soils are deep poorly drained soils that are commonly underlain by large masses of ice at depths of six feet or more. Perennial permafrost is common on the north slopes and discontinuous on the south slopes. The depth to bedrock is normally more than six feet.

Upon removal of the organic layer and vegetation, this soil is susceptible to uneven settling, pitting and piping as a result of the melting of subsurface ice masses. The susceptibility to erosion is also severe upon removal of the organic layer.

These soils were found with the subsurface ice masses and permafrost in the severely gullied fire lines on the Goldstream and Y-34 Wildfire areas. Although, this soil was observed on the fire line constructed on the lower slope in the Murphy Dome area, the severe gullying had not occurred.

c. The Goldstream Soil is found on the bottoms of upland valleys, low terraces and alluvial fans. The vegetation consists of black spruce, low shrubs, mosses, and sedge tussocks that are about 12 to 18 inches high and about 12 inches in diameter. (Photo #4 depicts these tussocks). Elevations range from 600 to 1200 feet and the average frost free season is 108 days.

The Goldstream soils are poorly drained with perennially frozen sub-strata underlying a thick mat of moss, roots and partially decomposed organic matter. The depth to perennially frozen material ranges from 10 to 24 inches and contains lenses of clear ice. Under natural conditions the soil above the permafrost table is always wet. Upon removal of the organic mat, these soils thaw to greater depths increasing the susceptibility to water erosion.

These soils were observed along the severely gullied fire lines on the Y-34 fire.

d. The Saulich Soil occupies the lower parts of long north-facing slopes and is perennially frozen at depths of 10-20 inches. They are found at the base and footslopes of north-facing hills and ridges. The dominant vegetation is black spruce and scattered clumps of alder and willow. Annual precipitation is 13 inches and the average frost-free season is 108 days. The elevation ranges from 900 to 1800 feet.

The Saulich soils are moderately deep poorly drained soils underlain by bedrock at 30 inches plus. The organic mat ranges in thickness from 10-14 inches.

These soils are susceptible to severe water erosion upon removal of the organic mat. Although gullies were not observed in this soil during our investigation, they become quite susceptible to water erosion if disturbed.

E. The Gilmore Soil is found on moderately sloping (12-20%) to steep (20-30%+) uplands on south-facing slopes. They generally occupy the steeper slopes near the tops of high hills and ridges. The dominant vegetation is paper birch, white spruce, and quaking aspen. Annual precipitation is 13 inches and the average frost-free season is 100 days. The elevation ranges from 800 to 2000 feet.

The Gilmore soils are shallow, excessively drained and underlain by partially shattered schist bedrock at 10 to 20 inches. The organic layer is thin, ranging in thickness from 0 to 3 inches. Surface runoff is medium and the water erosion hazard is severe if the vegetation and organic mat are removed. Although, the erosion hazard is severe, deep gullies will not develop because of the shallow depth to bedrock.

The fire lines constructed on the Gilmore soils in the wildfire areas did not indicate serious deep gullying. However, the artificial establishment of vegetation on these fire lines will be difficult.

f. The Ester Soil is found on long steep slopes near the tops of high hills and ridges on north-facing slopes that receive little direct sunlight. They support stands of stunted black spruce, scattered alder and willows, and a thick ground cover of mosses, lichens and low shrubs. The elevation ranges from about 1000 to 1900 feet. Annual precipitation is 13 inches with a frost-free season of 90 to 100 days.

The Ester soils are shallow, poorly drained with perennially frozen subsoils at a depth of 3 to 10 inches below a thick organic mat. Shattered rock or schist bedrock is encountered at a depth of 12 to 20 inches. Most of the plant roots are found in the organic mat with a few penetrating several inches into the frozen silt loam mantle.

The water erosion hazard or susceptibility is very severe upon removal of the natural vegetation and organic layer. Although, the erosion is very severe, these soils will not develop the deep gullies found upon the fire lines along the drainageways and valley bottoms. Revegetation by artificial means may be difficult, but it was observed that natural slides have healed themselves over a period of years.

Several specific observations were made during the field inspection and these are as follows:

1. Areas with deep loess soils and containing shallow permafrost (plus ice lenses) have high erosion potential when the ground cover (vegetation plus organic accumulation) is removed.

2. Dozer constructed fire lines over permafrost areas (drainage bottoms, north slopes, etc.) appear to thaw rapidly after removal of the insulating ground cover, and new drainages or channels are created as the melt water from frost and ice lenses erode away the noncohesive loess. (Photos No. 5 and 6 show similar adjacent areas -- No. 5 contains no fire line while No. 6 contains a gullied fire line). In some areas fire line debris acted as a training dike confining water flow to the cleared line resulting in additional erosion. (Note left center of Photo No. 1).

3. Fire lines constructed by dozers on south slopes, ridges, points, and other well drained, warmer sites have very little erosion even on steep slopes. (Photo No. 7 shows a well drained soil on south slope - however, cleared line in drainage bottom has eroded to bedrock).

4. A few slumps and slides were observed particularly on Y-34. However, these slope failures were not all associated with fire lines. Some were observed in areas undisturbed by fire line construction while others were observed in unburned areas.

5. Most of the 1966 burns (excluding dozer fire lines) are well covered by grasses (calamagrostis). (See Photo No. 5).

6. The Murphy Dome (1958) fire lines appear to be well stabilized. No serious erosion was observed even along drainage bottoms and on north slopes (permafrost remains in adjacent unburned areas but has withdrawn to a greater depth on the fire lines). Good reproduction of spruce as well as all deciduous species has occurred on the fire lines. Mosses and lichens are also becoming established.

7. Debris from the eroded lines and newly formed gullies is being carried downstream and poses a damage threat. For example, on Y-34 sediment deltas were observed at the confluence of eroding drainages and lower drainages, while on Goldstream sediment appeared to be plugging railroad drainage structures as well as filling a small lake downstream. Large amounts of sediment have probably already entered downstream rivers.

8. Erosion damage on wildfire areas not disturbed by tractor clearing appeared to be minimal. Sufficient organic duff remains following the fire to provide adequate ground cover within the observed burn areas.

Conclusions

The absence of serious gully erosion on the Murphy Dome burn (1958) indicated the possibility that the heavy rains of 1967 may have accelerated erosion on the 1966 burns. While neither the Goldstream nor the Y-34 burns appear to have received the heavy rainfall which produced the Fairbanks flood, it is possible that some runoff-producing rainfall was received.

Other conclusions are:

1. Frail lands exist in Alaska where deep loess underlain with permafrost on moderate gradients is located. Such soils are extremely erosive when the ground cover is removed through disturbance such as fire line construction.

2. Fire lines constructed on frail areas produce high erosion hazards, and such lines should be kept to a minimum.

3. Fire lines constructed on gradient and continuing out over streambanks produce a hazard from headcut erosion back upslope.

4. Rehabilitation measures may be necessary to stabilize fire lines constructed on gradients in frail areas.

5. Treatment practices required to stabilize existing gully erosion are at present not fully known. Trials should be conducted to identify successful practices.

6. Revegetation trials should be undertaken to identify seeding and/or planting practices (and species) which would accelerate establishment of ground cover on fire lines constructed in frail areas.

7. Wildfire burn areas not disturbed by dozer-constructed fire lines require no artificial rehabilitation.

Recommendations

To insure that total resource loss is maintained at a minimum from both (1) wildfires, and (2) fire line erosion, the following recommendations are offered:

1. Continue use of dozer-constructed fire lines on fires where areas are accessible to heavy equipment.

2. Restrict to a minimum the construction of dozer fire lines in frail areas such as north slopes, drainage bottoms, stream banks, permafrost areas, etc.

a. Achieve through education of fire control personnel (overhead) on erosion hazards on frail areas.

b. Require fire control overhead to locate all fire lines and accompany tractor operators during construction of fire lines in frail areas.

c. Consider sacrificing additional area within constructed fire line where threat of life and/or property is not involved rather than locating fire lines in close proximity to fire and on frail areas.

3. Initiate fire rehabilitation on dozer fire lines constructed in frail areas (to be done immediately following the fire or during mop up).

a. Install rehabilitation practices while heavy equipment is still in fire area.

b. Implement rehabilitation through use of 1520, Fire Rehabilitation, funds (1631.12I4). Timing will be sensitive and critical so suggest that a request for special approval procedures be made to WO (RPM).

c. Use such practices as (1) checks or water bars on fire lines at frequent intervals using the organic debris removed from the line, (2) seeding with grasses and other plant materials adaptable and available, and (3) planting with such fast growing species as willow, aspen and alder where adaptable.

4. Maintain observations of gully erosion conditions annually at Goldstream and Y-34 (photo repeats, range lines, etc.) for a minimum of three years (1968, 1969 and 1970).

5. Consider a trial treatment of existing gullied area (1966 fire) for rehabilitation purposes.

a. Select area where treatment would be most economically feasible. (Goldstream would be preferable if cooperation and easement could be arranged with Alaska Division of Lands since State lands are involved - Otherwise, select an area in Y-34).

b. Use such practices as gully plugs (thawed soil, fire line debris) at frequent intervals, grass seeding of all disturbed area including gully plugs, and tree seeding or planting using adaptable species.

c. Use 1260 funds for financing the rehabilitation through submission of a "package."

6. Defer rehabilitation of existing gully erosion areas until results of (4) and (5) above are evaluated.

PHOTOS

OF

EROSION OF WILDFIRE AREAS IN ALASKA

Photo No. 1 - Dozer-constructed fire line on Goldstream Fire showing debris berm in left center, gully in center, and unvegetated cleared line to right.

Photo No. 2 - Deep gully (approx. 10') on Goldstream Fire showing melting ice lenses and permafrost.

Photo No. 3 - Active gully on Y-34 Fire area showing melting ice lenses and sediment laden water. Note that water is emerging from a tunnel formed in melting ice lenses.

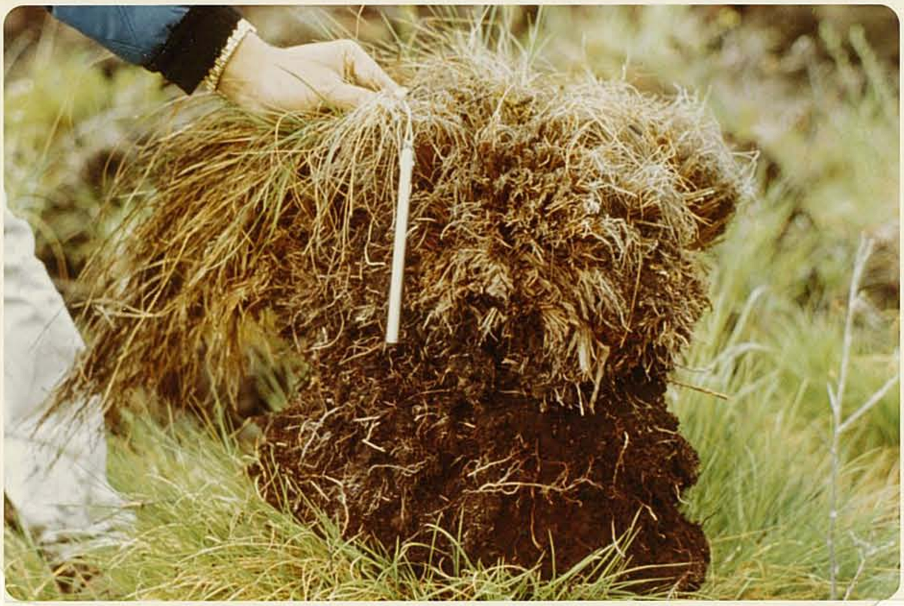

Photo No. 4 - Sedge tussock commonly found on the Goldstream soils -- Y-34 Fire area.

Photo No. 5 - Looking upstream at a small drainage in Y-34 Fire area. Note the reproduction of grasses and sedges. Photo taken at junction with drainage shown in Photo No. 6.

Photo No. 6 - Looking upstream at small drainage in Y-34 Fire area where fire line was constructed. Photo No. 5 was taken from same point but to the left up adjacent drainage.

Photo No. 7 - Shows a well drained soil on south slope -- Y-34 Fire area. Fire line constructed in drainage bottom adjacent to slope has eroded down to bedrock.

SUMMARY OF SOIL CHARACTERISTICS

Soil Series	Exposure & Slope	Location on Landscape	Elevation	Dominant Vegetation	Texture	Depth to Bedrock	Permeability in/hr	Depth to Perenn. Permafrost	Suscept. to Water Erosion	Thickness Organic Material	Ice Lenses	Frozen Ice Masses	Present Erosion	
													Disturbed	Undisturbed
Ester	N 12-30%	Steep north facing slopes	1000-1900	Stunted black spruce, scattered alder	Silt loam	12"-16"	.2-0.6	2-12"	Very severe	0-12"			Moderate	Slight to none
Saulich	N 7-12%	Lower foot-slopes of high hills & ridges	900-1800	Black spruce	Silt loam	3' plus	.2-0.6	10-30"	Severe	0-10"			Moderate	None
Fairbanks	S 12-30%	Middle & lower parts of long slopes	800-1500	White spruce paper birch Quaking Aspen on burned over areas	Silt	3' plus	.2-0.6	-	Very severe on the steep slopes	0-4"			Slight	None
Minto	All exposures 3-12%	Moderate to strongly sloping footslopes of ridges & hills	700-1200	White spruce paper birch quaking Aspen small inclusions of black spruce	Silt	6' to many feet	.2-0.6	2-12"	Very severe	0-4"	Thick	Found at depth of 6'	Severe gullying observed on Y-34 and Goldstream fires	None
Gilmore	S 7-30%	Ridge tops and tops of high hills	800-2000	White spruce paper birch quaking Aspen	Silt	10-20"	.2-0.6 to 0.2	-	Very severe	0-4"			Slight	Slight to none
Goldstream	All exposures 3-12%	Gently sloping valley bottoms, low terraces, and along upland drainageways	600-1200	~~Low shrubs,~~ mosses and spindly black spruce. Sedge tussocks about 18" high and 12" wide.	Silt loam	6' to many feet	.2-0.6	10-24"	Severe	0-7"	10-24"		Severe gullying observed on Y34 and Goldstream fires. Slight on Murphy Dome fire.	None