Appendix 5-8

Subsidence Monitoring Plan

FOREST PLAN FOR STUDYING THE EFFECTS OF UNDERGROUND COAL MINING ON SURFACE AND SUBSURFACE RESOURCES

Manti-LaSal National Forest

Public Law 86-517
86th Congress, H. R. 10572
June 12, 1960

AN ACT

74 STAT. 215.

To authorize and direct that the national forests be managed under principles of multiple use and to produce a sustained yield of products and services, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. The purposes of this Act are declared to be supplemental to, but not in derogation of, the purposes for which the national forests were established as set forth in the Act of June 4, 1897 (16 U.S.C. 475). Nothing herein shall be construed as affecting the jurisdiction or responsibilities of the several States with respect to wildlife and fish on the national forests. Nothing herein shall be construed so as to affect the use or administration of the mineral resources of national forest lands or to affect the use or administration of Federal lands not within national forests.

National forests, management.

30 Stat. 34.

SEC. 2. The Secretary of Agriculture is authorized and directed to develop and administer the renewable surface resources of the national forests for multiple use and sustained yield of the several products and services obtained therefrom. In the administration of the national forests due consideration shall be given to the relative values of the various resources in particular areas. The establishment and maintenance of areas of wilderness are consistent with the purposes and provisions of this Act.

Multiple use; sustained yield.

SEC. 3. In the effectuation of this Act the Secretary of Agriculture is authorized to cooperate with interested State and local governmental agencies and others in the development and management of the national forests.

SEC. 4. As used in this Act, the following terms shall have the following meanings:

Definitions.

(a) "Multiple use" means: The management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

(b) "Sustained yield of the several products and services" means the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land.

Approved June 12, 1960.

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7. Photographic Targets

I. INTRODUCTION

Minerals are one of the abundant resources of the Manti-LaSal National Forest. The extraction of these minerals is endorsed by the Forest Land Management Plans, except where this action is incompatible with planned surface uses. The Forest, by regulation and law, is committed to multiple use management of all National Forest resources, and must assure that adverse impacts to surface and subsurface resources are minimized whenever any resource is utilized--including minerals and mineral resources.

Data describing the effects of coal mining and mining-related activities is scarce. Current resource protection, mitigation, and reclamation measures are based on this limited data. A resource monitoring program is needed to assess impacts to resources, to evaluate the effectiveness of protection, mitigation, and reclamation measures, and to provide a basis for making--as needed--new protection, mitigation, and reclamation stipulations for mineral leases, and mining and reclamation plans.

Since 1973, the Manti-LaSal National Forest has recommended that a program be established to quantify impacts to surface resources due to underground mining. Certain stipulations have appeared in all Environmental Assessment Reports and Impact Statements dealing with coal programs which are prepared by or had concurrence of the Forest Service.

Two stipulations have been developed that relate to the mining activity. Stipulation number one requires that baseline data be obtained prior to any disturbance, and stipulation number two requires that a monitoring program be initiated during mining operations. They are as follows:

Stipulation 1 - Prior to mining, the lessee shall perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. The study will be established in consultation with and concurrence by the surface managing agency, and shall be

adequate to locate ~~and~~ quantify and demonstrate the interrelationships of the geology, topography, all surface hydrology, vegetation, and wildlife. The baseline data will be established so that future programs of observation can be ~~made~~ incorporated at regular intervals for comparison.

Stipulation 2 - The lessee shall establish a monitoring system to locate, measure and quantify the progressive and final affects of underground mining activities on the land surface, the underground and surface hydrology, and on the vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time. The monitoring shall be an extension of baseline data at representative locations and will be conducted in a manner approved by the surface managing agency in consultation with the State and Federal regulatory agencies.

In managing wildlands, information is needed to address all Forest Service resource systems, forest and rangeland, water, wildlife and fish, outdoor recreation and wilderness, etc. To make an assessment of the potential effects of alternative land uses such as underground mining on surface resource systems, requires basic information on their resources and their relationship to each other. Local management and planning decisions require mapped and pinpointed information, whereas State, regional and national level decisions may be based on statistical information obtained from much broader samples. This plan requires a high degree of resolution, consequently large scale (low altitude) aerial photographs and large scale maps will be required to facilitate the process.

II. OBJECTIVES

Objectives of the program will include:

A. Establishing baseline surface terrain resource and hydrologic data prior to mining, and for existing mines.

B. Implementing programs of observation at regular intervals, which would generate data for comparison with baseline.

C. Defining impacts of coal mining upon wildlife, range, vegetation, timber, water, topography, geology, other minerals, recreation, and visual resources; all of which are encompassed in the multiple use direction of the Forest Service.

D. Coordinating resource uses and management planning with coal mining, minimize adverse impacts to surface resources on Forest lands.

E. Predicting change(s) in the hydrologic cycle that may occur as a result of coal mining so that provisions for relocation of water sources or development of alternative water sources can be made available to facilitate the multiple uses of the Forest.

F. Careful inventorying and monitoring of resources at each mine prior to, during, and after the conclusion of undermining will help establish and predict the area's response to coal extraction, and expedite technology to minimize the resultant effects.

III. RESOURCE CONSIDERATIONS

The objective of resource monitoring is to quantify and display the progression and final effects of undermining upon surface resources of National Forest lands.

The surface and subsurface resources to be considered have been categorized into four resource groups. They are:

A. Recreation and Visual Resources.
B. Vegetation (which includes Range, Wildlife Habitat, and Timber).
C. Geology and Hydrology.
D. Other.

The basic data requirements with which these resources will be inventoried and monitored is included with each resource group.

A. Recreation and Visual Resources

Potential effects of mining on recreation and visual resources shall be evaluated - including an inventory to establish a comparison baseline - prior to any mining activity. The recreational uses and scenic values of the area will determine the nature and extent of monitoring requirements.

It is expected that monitoring of Recreation Resources would include defining of changes in areas use by recreationists, i.e., fishing, hunting, camping, hiking, etc., as may be affected by mining activities (i.e., coal hauling, mining).

For Visual Resources, a monitoring program would most generally be visual inspections on a programmed frequency. This would include a photographic record and map at a scale compatible for registration

with other data map record layers as well as a written record. It would address such items as the visual change in mine facilities, roads, streams, slopes and escarpments (i.e., rockfalls), slope failures, excessively eroded areas, etc.

B. Vegetation

The effect of undermining upon vegetation is still largely unknown. Range analyses, timber surveys, and wildlife habitat studies will be conducted in areas expected to be affected by mining. The intensity and frequency of these investigations will be determined on a site-by-site basis. Data will be summarized annually, and used to define change.

This monitoring program would rely upon existing data, supplemented where necessary with data from other sources and from field inventories obtained prior to mining. These data would form the base upon which the monitoring program data would be compared for definition of change.

In situations where mining effects become substantial, the mining company would be required to participate in formulation and implementation of mitigation measures.

C. Geology and Hydrology

The geologic structure and stratigraphic nature of an area has a major determining effect upon the ground water regimen, upon the mining, conservation of the resource, mode of subsidence, and surface features such as topography, soils, and slope stability.

Without adequate geologic data--both from surface exposures and drilling and mining--resource conservation planning cannot be done. Also, any impacts to surface resources cannot be identified or mitigated without a knowledge of the geology.

To fulfill the requirements of this monitoring plan, the following is required to establish baseline data.

1. A geologic map at the same scale as other data map layers showing lease location, faults, folds, joint systems, geologic formations, seeps, springs, and other data which are essential for proper identification of the existing geologic and hydrologic conditions. The map would be updated as new information becomes available.

2. A narrative description of each of the above items, giving sufficient detail for evaluation. Existing seeps and springs on the lease area and adjacent areas, which would be affected by undermining, will be inventoried. In most cases, estimates of quantity would be adequate. However, representative springs (springs having current use for wildlife, range, or for municipal use) which are important for the management of the surface resource will be sampled and tested for quality, and flows determined.

The responsibility for these data would be that of the mining company. The Forest Service and the U.S. Geological Survey would, however, cooperate in the designation of hydrologic monitoring requirements for each site, and would provide those data which may have been obtained from previous studies.

D. <u>Other</u>

Surface structures, such as power transmission lines, pipelines, oil and gas wells, roads, dams and reservoirs, and other physical improvements could be affected by mining. Mine planning must consider these features, and data must be obtained prior to mining that will identify possible impacts. Those structures that are identified which might be damaged should be photographed before and after mining, together with the documented inspections which establish their condition prior to, during, and after mining.

The mining company would have responsibility for this information. There are, however, considerable data available on these structures which could be made available by the Forest Service, U.S. Geological Survey, State, and County.

IV. FOREST SERVICE REQUIREMENTS

The following responsibilities, procedures, resource inventories, and study programs are those which the Manti-LaSal National Forest will require for leasing of Forest lands for coal mining, exploration, or for coal mine plan approval. These are, in part, requirements of laws and regulations of the Department of the Interior and, in part, requirements of the Forest Service. Those required by the Department of the Interior are not referenced and may not be included in their entirety or have the same specific requirements. It is not intended that this program plan supersede in whole or in part requirements of the Department of the Interior. The programs are intended to generate the data we have determined essential for responsible multiple resource management. The operator would be responsible for those parts where data are needed to determine the effects of mining upon surface resources.

All programs to monitor the effect of mining on surface and subsurface resources will be applicable to existing leases (in all stages of development) and future leases. Accumulation of data pertinent to coal mining studies will occur at all stages of lease development.

A. Tract Leasing

Prior to leasing of any land on the Manti-LaSal National Forest for coal mining, the preparation of a site specific Environmental Assessment (EA) will be required. This assessment is the process by which the Manti-LaSal National Forest will determine a tract's suitability for leasing and is the approval document for coal land leasing. The Forest Service will be responsible for its preparation. The Technical Examination required to obtain the essential data for the EA will be performed by the Forest Service in cooperation with the U.S. Geological Survey and Office of Surface Mining. Data would be obtained by the Forest Service, U.S. Geological Survey, Bureau of Land Management, State, and other agencies as needed.

The Technical Examination will include an inventory and description of surface resources and uses; and will include the requirements given in items 1 through 9 below. These requirements, however, are not intended to be of a detail as to establish baseline data for the requirements of resource monitoring as specified in item C. for mine plan approval. They will, however, include sufficient detailed data to make an assessment of the compatibility of a coal lease tract with other resource elements, uses, determining the tract's leasability, an evaluation of probable impacts of mining the tract upon the environment, and for developing of lease stipulations.

The requirements for the Environmental Assessment will include the following information:

1. A description and assessment of the existing environment, including wildlife, vegetation, hydrology, soils, topography, geology, mineral occurrence, recreation, visual quality, historical, archeological, surface structures, and other resources as may be appropriate, will be required. This report also would include an assessment with regard to areas which may not be available for leasing, i.e., wilderness, withdrawals, threatened and endangered species, special uses, oil and gas fields, pipelines, reservoirs, and other surface features as may affect human safety.

2. A preliminary geologic map of an acceptable scale that will include faults, folds, joint systems, geologic formations, and significant surface geologic features, such as landslides and unstable slopes, is required.

3. A topographic map. This would properly serve as the base map for 2 and 4. Currently, existing color resource photography would supplement the topographic map for making the inventory and assessments.

4. A preliminary inventory of known ponds, reservoirs, springs, seeps, and significant wet areas will be recorded on a map. Flows will be estimated.

5. a. A preliminary assessment of the surface hydrology that will include climate, precipitation, flooding, and descriptions of the stream(s) and drainage systems.

   b. A preliminary assessment of the ground water geohydrology. This would include item 4 above, with a description as necessary. In addition, it will include an appraisal of the importance of each item listed and described to Forest management and will furnish estimated flow quantities and, where appropriate, the water quality. This would also include a description of the water source (i.e., seeps, springs, wells, etc.) in relation to topography, geologic conditions, vegetation, and other resources as may be appropriate.

6. Existing transportation and utility corridors, and possible future corridors, should be located and recorded on maps. Each should be accompanied by a detailed description.

7. Existing roads, existing mine portals, possible mine sites, oil and gas wells, and the opportunity for relocation of these features should be discussed jointly with the Forest Service and Geological Survey so that any major restrictions to these activities will be brought to light early in the process.

8. An evaluation of the tract for feasibility of mining, in-place tonnage, and expected recoverability will be addressed in a report to the Forest Service by the Geological Survey. A conceptual mine plan, complete with a transportation plan, will accompany this data.

9. Any drilling prior to leasing ~~done~~ by the U.S. Geological Survey should be required to follow exploration regulations (Part B, below).

B. Exploration

Exploration of a coal mining tract is normally performed by the lessee after the lease is obtained. Some exploration for evaluation prior to leasing may be done by the Geological Survey as required by 30 CFR 211. Exploration is performed to evaluate the value of the coal seam(s) and the geologic structure; and the lithology of the rock formations for mine planning.

Exploration is most often performed by drilling of holes from the ground surface to the coal seam(s). However, not all lessees will explore by drilling, nor is it required. New exploration methods are being developed. Presently, drilling is the method used.

When exploration is done by drilling, the following should be required of the operator:

1. A comprehensive plan of operations as required by 30 CFR 211. This plan should include:

   a. A map showing the locations of the proposed activity (drill hole locations) and the proposed access.

   b. A detailed description of drilling plans and procedures. This should include:

      (1) Drill hole locations, T., R., S.
      (2) Expected depths of drill holes.
      (3) Proposed access routes, including a description of the requirements for upgrading, reconstruction, or construction of the access roads.
      (4) The time frame for the drilling program.
      (5) Surface resource protection considerations.

   c. A reclamation plan.

2. A log from each drill hole showing the ground waters encountered. Data will be compiled and submitted by the company, giving depths and lithologies where water is encountered. An attempt will be made to quantify amounts of water in the aquifers. Each actual drill hole location will be accurately plotted on the base map or appropriate overlay.

These data, combined with the surface geologic and hydrologic data, will aid to define the ground water system. This will be used to develop the hydrologic monitoring system required by regulation, as well as to aid in identifying possible impacts to surface water sources from undermining.

Selected holes may be required to be left open for periodic water level measurements and groundwater sampling. These drill holes and intervals of monitoring will be designated by Geological Survey upon the review of the operating plan. Coordination between the Forest Service, Geological Survey, and the operator is required to determine a need for, and establishment of, hole locations and reclamation.

C. Mine Plan Approval

All mining plans for underground coal mines should include, as part of the mining plan, a study and monitoring program to determine what, if any, effects mining will have upon other resource elements and land uses. This plan or study program will necessarily include two phases; (1) establishment of baseline data for existing resource and land use elements from which any change due to mining can be measured (see stipulation #1), and (2) establishment of study programs to monitor these resource and land use elements for measurement of any change that has occurred because of the mining (see stipulation #2).

1. Baseline Data Collection

The Forest Service will require of the operator the following specific data:

a. Water - The location and identification, including a detailed description, of water sources. This should include the topography, geology, use, flow, quality, and other data as may be necessary to define each water source. Water sources which will be inventoried include seeps, springs, wet areas, natural ponds, lakes, reservoirs, stock ponds, streams, and water wells, on and within the area of influence of the leasehold. This would include a literature search, compilation of existing data, and a field search, investigation, and description of each.

To aid in the location and identification of these water sources, color infrared aerial photography (CIR) of the proposed mine area and area of influence may be required. The main purpose for the color infrared photography is to aid in: (1) the location identification and description of all water source points, and (2) the detection and monitoring of dead or dying (stressed) vegetation due to subsurface mining activities.

Water sources, surface cracks, property corners, and other points that are not used or tied to basic project control may be photo-identified in the field by direct or precise methods. A description of the procedures using these two methods can be found in the Appendix (VIII A).

It is expected that the infrared photography will not be required for all mine plans. The need for this photography is to be determined by the Forest Service in consultation with and concurrence of the U.S. Geological Survey and the Office of Surface Mining (OSM) on a site-by-site basis.

Each water source shall be located and plotted on the base map or appropriate overlay, giving elevation, coordinates, flow (gpm), and date flow was measured. The method used to measure the flow must be described, i.e., weir, flow meter, estimated, etc. See a. above. Measurements ideally should be quarterly for a minimum of two years and preferably longer prior to any significant mining.

It is recognized that some water sources cannot be measured at these frequencies because of heavy snow cover, intermittent flows, or difficulty of access to the area.

It is not a requirement that the targets or ground panels required for the subsidence monitoring photography appear or be visible on the CIR photography. The same scale of photography, (or degree of resolution) may not be required for detecting or interpreting images as may be required for accurate terrain measurements. However, there are several advantages in maintaining the ground panels for visibility on the CIR photography and flying all photography at the same altitude or scale. Cross correlation for interpretive comparisons and the transfer of points and data from one set to the other are but a few of these advantages.

If required, the CIR photography will be obtained with an acceptable 9" x 9" format mapping camera with an 8½" or 6" focal length and single-lens-between-the-lens-shutter system. ~~See Appendix VIII for detailed camera specifications.~~ Film will be Kodak Aerochrome Infrared 2443 (or equivalent) and will be exposed with the proper filter and camera setting as to provide the best possible image resolution and print quality. The flight dates of the CIR photography will be scheduled by individual project to obtain the optimum results for water and vegetative detection and analysis. The nominal or mean scale of this photography will not exceed 1:6000.

b. Geology - A geologic map on which will be shown the rock formations, faults, folds, joint systems, dip and strikes, landslides, and other significant geologic features is required of the operator.

c. Manmade Features - The location of surface and subsurface features that might incur damage by subsidence is required. This would include power transmission lines, property or land corners, pipelines (water, oil and gas, etc.), oil and gas wells, roads, dams, reservoirs, buildings, and other features as may be present. Documented descriptions, along with appropriate photographs, are required. The location of existing major highways and proposed highways should be identified. Unless otherwise specified, this information will be shown on the original topographic and/or planimetric base.

d. Monumentation - A network of monuments is to be established, both over the mine or proposed mine workings and in adjacent areas not expected to be disturbed (reference monuments) by the mining operations (subsidence). Each mine or proposed mine area will require an individual control survey and targeting plan to complement the topography, access, mine layout, aerial photography coverage, and other constraints. The monuments will be constructed as survey control points for the subsidence, hydrologic, vegetative, and other monitoring study programs. The monuments will be located on a coordinate system that is the same for the mine survey and surface survey, so that surface points and the subsurface mine works can be superimposed. It is recommended that the State plane coordinate system be used as primary control for all surveys. Reference the Appendix for target or ground panel configuration and dimensions.

e. Surface Terrain - Initial, low altitude color or black and white aerial photography of the proposed mine area will be flown at a scale such that elevations to within one foot vertically and horizontally (±0.5) can be attained by photogrammetric methods. This photography will be used for constructing the initial baseline surface map upon which potential subsequent surface subsidence will be measured and recorded. It will also provide the master base to assist in documenting changes to vegetation, topography, geology, surface structures, recreational, and land uses on the surface over undermined areas. All other map data layers will be registered to this base which will be constructed at a scale of 1" = 10A'.

See attached map specifications for symbols, etc. This map will contain the following:

(1) Plotted horizontal positions of all control survey monuments and elevations.

(2) Plane coordinate grid 5000' intervals.

(3) Contours. Interval to be specified on a project by project basis.

(4) Aerial photo centers.

(5) Paneled section and quarter corners.

(6) Planimetry and cultural features.

(7) Legend.

(8) Water sources - streams, springs, marshes, wet areas, reservoirs and lakes.

(9) Transportation system including all existing travelways, roads, trails, railroads, etc.

(10) Grid ticks showing the horizontal position including coordinates and vertical elevation of all terrain surface points, read photogrammetrically.

f. Vegetation - Vegetative and wildlife inventories are to be conducted in areas subject to potential impacts. The inventories will consist of on-the-ground transects. Data will be presented in the form of a map overlay which will register to the master base. In most cases, the photography will be used for delineation of vegetative types and from which this data will be photogrammetrically transferred to its respective overlay.

The following vegetative analysis studies will be established for areas which may be affected or disturbed and will be measured as:

(1) Permanent photo points and photo studies.
(2) Changes in plant species composition and vegetative trends.
(3) Changes in ground cover density (changes in vegetative and litter cover).
(4) Changes in total forage production.
(5) Quantification by acre of all riparian vegetation.

g. Visual Observation - Visual observation of surface effects. Every monitoring plan will include an on-the-ground observation to document the existing (premining) condition of the ground surface, at the proposed portal, access, and over the proposed mine area (plus angle of draw).

h. Precipitation Gages - Installation of precipitation gages at the mine site. A qualified hydrologist will supervise the site selection and the installation of the gages.

i. Seismic Events - Natural seismic events. All such events that may occur over mine areas shall be documented. It would include a documentation of each event, its magnitude, intensity, epicenter location, date of occurrence, any resulting underground or surface disturbance, and its probable intensity at the mine site.

2. Study Programs for Resource Monitoring

The Forest Service will require of the operator the following specific monitoring plans:

a. Subsidence Monitoring - Color aerial photography will be required initially for baseline data collection. Subsequent flights will be annual and will cover the area mined and the area to be mined in the next 18 months (plus the angle of draw) on the entire lease area, as may be appropriate. A 30-percent overlap of flight lines and a 65-percent overlap of photographs will be required. The photography will be flown at a scale that will produce elevations accurate to within one foot (±0.5). Unless otherwise approved, the nominal or mean scale will be 1:4800 for an 8½" focal length camera and 1:6600 for a 6" focal length camera. The criteria being that vertical photogrammetric measurements should be obtainable to 1/10,000 of the flying height. Both scales and respective focal lengths theoretically equal .33 feet. The vertical margin should allow for some residual reading errors.

Aerial photography will be evaluated each year for determining the location and magnitude of subsidence. It will be supplemented by surveys for subsidence evaluation.

The aerial photography will not only serve for subsidence monitoring, but will aid in interpreting and documenting changes to vegetation, topography, geology, hydrology, recreational uses, wildlife use, range use, and surface structures. Prints of the color aerial photography will be furnished to the Forest Service by the operator of the initial flight and of each annual flight as requested. "Pugged" diapositives of the baseline flights will also be furnished, along with control coordinates as requested.

Monuments established for the initial flight will be properly paneled each year prior to each annual flight. For required dimensions and suggested materials, see Figure _.

Visual Observation of Surface Effects. An on-the-ground visual inspection will be made each year of the condition of the ground surface above all underground mine workings (plus angle of draw). This survey should attempt to locate, photo-identify and document the presence of tension cracks, fissures, structural offsets, and obvious subsidence damage to buildings, roads, powerlines, pipelines, railroads, dams, reservoirs, or other features. The hydrologic monitoring program will assess changes in spring flows, streams, groundwater levels, etc. Photographs, as well as written documentation, will be required.

An annual field inspection of all unstable areas will be made for evidence of renewed movement. Unstable areas would include landslides, escarpments, etc. These will be documented with photographs, written descriptions, and maps.

A continued documentation of seismic events will be maintained throughout the mine life. These data are available from State and Federal agencies.

b. Hydrologic Monitoring - The monitoring for water quality and quantity will be of representative sources selected from the baseline inventory. Time intervals and methods of monitoring will be determined on a site specific basis. Representative sources and specifics of the requirements for monitoring will be determined by coordination of the operator, Forest Service, and Geological Survey. Requirements for sampling, measuring of flows, and testing are defined by the Geological Survey

guidelines. Those water sources not designated for detailed monitoring within the affected area where subsidence might reasonably be expected to occur will be visually evaluated annually.

Frequent recording and quantification (where possible) of water encountered in the mining operations will be required. Sufficient measurements of major seeps of flows within the mine should be made to determine any trends in flow and quality. Location of the flow should be documented and a description should be made of the geologic structure where such waters are produced. This would include such features as faults, joints, sandstone beds, wet coal, etc.

Mine water discharge must be sampled and analyzed as required by EPA and State regulations. In addition, mine water discharge will be measured for volume, and the moisture content of the coal will be measured.

Infrared aerial photography as required will be repeated once every five years, or more frequently if needed. This will be for the mine area, plus the area to be mined in the next five years. Prints of the initial flight will be furnished upon request.

The precipitation gages required by l.h. will be monitored daily. Data will be furnished the Geological Survey and Forest Servic[illegible]thly.

c. Vegetative and Wildlife Monitoring - The plots (on-ground transects) established for the baseline inventory will be permanently identified on the ground. They will be reevaluated at 3- to 5-year intervals throughout the mine's life. Shorter intervals may be required at some sites. The data

will be presented in the form of a map having a scale of 1:4800. It would be expected that the aerial photography would be used for this study and would serve as the base map.

d. Visual and Recreation Monitoring - Monitoring of visual resources will include a visual inspection at least annually and more frequently if required. This inspection will include a photographic and map record, as well as written. It will document the visual changes in an area from installation of mine facilities, roads, and traffic of these facilities. It would address such items as portal areas, roads, conveyor lines, streams, slopes, escarpments (i.e., rockfalls), slope failures, excessively eroded areas, etc.

Monitoring of recreation resources will include defining of changes in an area's use by recreationists as is affected by the installation of a coal mine. This would include fishing, hunting, camping, hiking, etc. Of particular importance to this monitoring program would be the affect of the increased truck traffic on the roads.

V. LEASE READJUSTMENT

Rentals, royalties, and other conditions of the lease are subject to readjustment at the end of the primary term of 20 years, and at the end of each following 10-year period. The Bureau of Land Management and the U.S. Geological Survey, in cooperation with the Forest Service, are required to prepare an Environmental Assessment Report/Technical Examination. Stipulations may be added which bring the lease into conformance with surface management planning or other legal requirements. Monitoring programs, because they are part of the mine plans, will be implemented or modified as needs are identified, and will generally not be part of the lease readjustment process.

VI. RECLAMATION/MITIGATION

At this point in time, it is difficult to suggest any mitigation of impacts or reclamation of areas that are impacted by undermining, since we can only assume those impacts and their effect. Mitigating measures will be contingent upon the findings of the program. As data is collected, methods of mitigation and reclamation will be formulated. This will be done in cooperation with the OSM and other agencies as required.

Since significant subsidence is expected to occur after final mining, the Forest Service will require continuance of pertinent programs until such time that it is determined the program is no longer needed. This time period will be a result of data evaluation and information from not only the specific mine involved, but as a result of data from several sources. The time period will be established by the Forest Service, Geological Survey, Office of Surface Mining, and Bureau of Land Management.

VII. LAND MANAGEMENT POLICY

All data accumulated by these monitoring programs will be used to mitigate impacts to resource elements of the National Forest lands and to update the Forest's land management plans, and to provide source information for processing new leases and/or new mining proposals and operations. The programs will be congruous with all present and future management plans. Changes in resource values and emphases will also have bearing on the intensity of these programs. Flexibility of these programs and their implementation is important in the management of the Forest. The Forest Service will, therefore, recommend modification of the monitoring programs as necessary.

This monitoring plan will be evaluated and updated as frequently as needed by the Forest Service, in cooperation with the Geological Survey and Office of Surface Mining, in response to the data generated and to changes in management policies and direction.

A problem to monitoring is access to surface areas, particularly on private land.

DIRECT AND PRECISE METHODS FOR PHOTO IDENTIFICATION

If size prohibits the direct identification, a small diameter image point readily identifiable on the photography is used for a compass bearing and distance tie to the water source. Small pinholes in the photo emulsion surface are used to identify the image point selected (reference Figure 1).

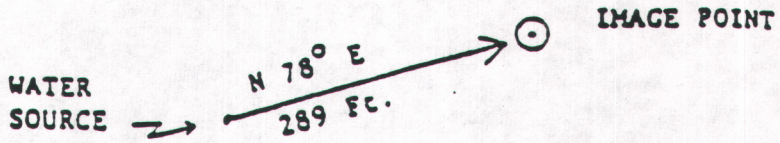


Figure 1 -

Figure 1. Compass bearing and distance. Note that the bearing is from the property corner to the image point. If horizontal distance exceeds 400 feet, the precise identification procedure should be used (reference Figure 2).

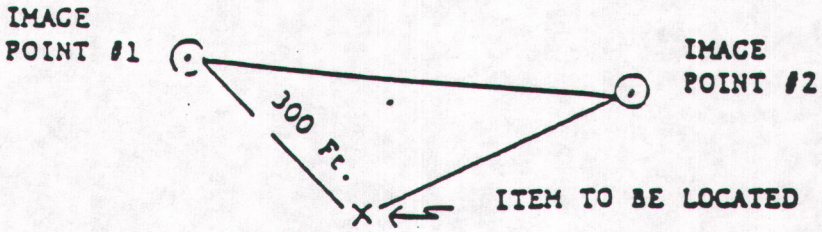


Figure 2 - Precise Identification Tie

In Figure 2, both image points must be pinpricked on the photograph. Horizontal and vertical angles are observed from X to image points 1 and 2. Horizontal and vertical angles are observed from image point #1 to X and image point #2. Horizontal distance is measured between image point 1 and X. Regardless of the method used, a sketch (and description of image points and item being located) on the back of the photograph are essential. Both methods of identification provide for accurate photogrammetric transfer to a base map. If water sources or other items required to be plotted on a base map are tied horizontally to the photo control network their positions may be scaled on the base map from coordinate values. In the event color infrared photography is not required or available, the photo-identification will apply to existing project photography.

B.

PHOTOGRAMMETRIC MAP COMPILATION

DESCRIPTION

1. This work shall consist of compiling a topographic map and/or "reading" a series of points from aerial photographs in accordance with these specifications, including labor, equipment, materials, and incidentals necessary to complete the work. The initial area to be mapped shall be the area to be mined in the next 18 months (plus angle of draw) on the entire lease area as appropriate.

MATERIALS

2. Base sheets for both the original base manuscripts and the overlays shall be polyester base film between 0.004 inch and 0.007 inch in thickness. Paper prints of the final drafted map sheets shall be 16 pounds or heavier stock paper.

REQUIREMENTS

3. MANUSCRIPT MAP REQUIREMENTS. Manuscripts shall be compiled as follows:

   a. Coordinate Grid Ticks. The plotted positions of each plane coordinate grid tick shall not vary by more than 0.01 inch from the true grid position. Grid ticks shall be plotted at 5 inch intervals. A north arrow indicating grid north shall be shown on each sheet.

   b. Scale and Contour Interval. The scale and contour interval shall be 1" = 100' and 2' or as specified by individual project.

   c. Match Lines. Match lines and reference numbers shall be provided so that each map may be accurately joined to those which are adjacent.

d. Sheet Layout. Each sheet shall be numbered in the border area in each of the four corners. The numbers shall be approximately 0.5 inch high and shall be encircled. A label which includes Forest name, project name, date and scale shall be placed in the margin at the lower right hand corner of each sheet.

e. Control Points. All control points shall be plotted and labeled including: horizontal and vertical control points, pass points, tie points, and construction survey control points when required. The principle point of each photo shall also be plotted and labeled.

f. Planimetric Features. All planimetric features visible and identifiable on the aerial photos shall be shown. Planimetric feature symbols shall conform to Figure ~~195-1~~ 3. Planimetric features not shown on Figure ~~195-1~~ 3 shall be drawn to scale and labeled.

g. Topographic Features. All contours shown shall be compiled using a stereo plotting instrument. Every fifth contour shall be a heavier weight line. The elevation of every fifth contour shall be shown in tiers approximately 10 inches apart.

Where contours spacing is more than 2 inches apart at final scale, spot elevations shall be shown in a 1-inch grid pattern. Spot elevations shall also be shown at peaks, depressions, saddles, on centerline at each end of a bridge, on centerline at road intersections, and at locations where interpolation from contours will not give true elevations.

Where contour spacing is less than 10 per inch, the intermediate contours may be dropped and every fifth contour, with heavier line weights, shall be left.

4. FINAL MAP REQUIREMENTS. Except for sheet layout the final map sheets shall meet the manuscript map requirements. In addition, the final map sheets shall meet the following requirements.

a. Sheet Size and Layout. Sheets shall be the size specified in Special Project Specifications. Each sheet shall have a border and title block in the lower right hand corner.

A title block and bar scale shall be shown on each final map sheet. The title blocks shall include the following statements:

(1) Date of photography, scale of aerial photography and scale at which map was compiled.

(2) Statement of datum basis of map grid and elevation.

A small scale, correctly oriented, map sheet index shall be shown on each map sheet. The index shall show all sheets and their numbers. The sheet upon which the index is located shall be crosshatched.

b. Drafting. Final map sheets shall be either scribed, or drafted with ink, at the final map scale. The drafting method chosen shall be used for all sheets.

Map details shall be clear, sharp, and legible after reproduction. Lettering shall not be done freehand.

5. MAP ACCURACY

a. Topography. At least 90 percent of all elevations determined from contours shall be within 0.5 contour interval of true elevation, and all elevations so determined shall be within 1.0 contour interval of true elevation except as follows:

(1) Where the ground is obscured by brush or tree cover, contours shall be plotted from the stereoscopic model, making use of spot elevations measured photogrammetrically in places where the ground is visible. In these areas, at least 90 percent of the elevations determined from contours shall be within 1.0 contour interval of true elevation. All elevations so determined shall be within 2 contour intervals of true elevation. Contours within these areas shall be shown as dashed lines.

(2) In densely wooded areas where spot elevations cannot be determined, contours shall not be drawn. They shall be outlined and labeled "ground not visible" or "GVN".

b. Spot Elevations. At least 90 percent of all spot elevations shall be within 0.25 contour interval of true elevation. All spot elevations shall be within 0.50 contour interval of true elevation.

c. Planimetric Features. At least 90 percent of all well-defined planimetric features such as structures, paved roads, intersections, etc., shall be within 0.025 inch of their true position. All shall be within 0.050 inch of their true position.

d. Coordinate Grid Ticks. The plotted position of all coordinate grid ticks shall not vary by more than 0.01 inch from their true grid position.

e. Horizontal Control. The plotted position of all horizontal control points shall not vary by more than 0.01 inch from their calculated position.

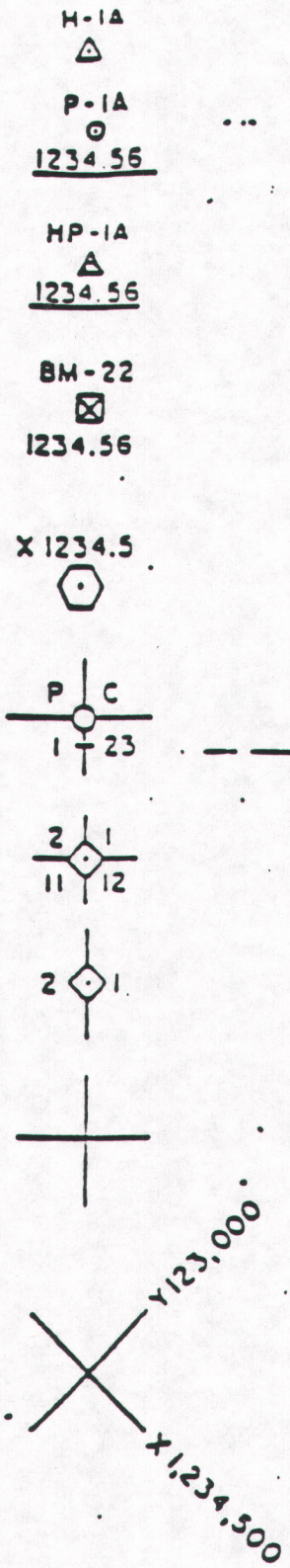
Acceptance or rejection of the map or portions thereof will be the responsibility of the lessee and based on whatever means they feel necessary to perform (generally field survey methods).

6. MAP ACCURACY TESTS. The Forest Service may elect to evaluate map accuracy and precision based on a sample of test points. The test points will be randomly selected models and representative of the feature being tested.

The position and elevation of test points will be determined by the Forest Service using photogrammetric or ground survey methods of equal or better precision than those used for map production. Discrepancies will be calculated between the test values and map values. Statistical methods of hypothesis testing will be used to determine if the mean and standard error of the sample of discrepancies indicate that map accuracy requirements have been met.

The values listed on Table 195-1 will be used to determine if the mean and standard error may be reduced by assuming a horizontal displacement not to exceed 0.025 inch. Tests for accuracy will apply only to the models in which tests were performed.

All required materials or suitable duplicate thereof will provided to the Forest Service as requested to insure and assist in the successful implementation and continuation of this program.



HORIZONTAL CONTROL POINT (LABEL)

VERTICAL CONTROL POINT - FIELD (LABEL)

HORIZONTAL & VERTICAL CONTROL POINT - FIELD

BENCH MARK

SPOT ELEVATION
PHOTOGRAMMETRICALLY CONTROLLED POINT

AERIAL PHOTO CENTER

SECTION CORNER

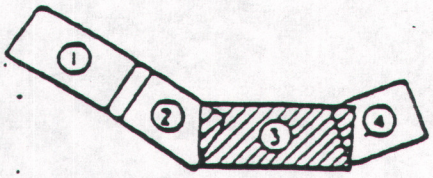
QUARTER CORNER

GRID TICK (1 INCH LONG)

COORDINATE VAULES - LABEL AROUND
PERIMIETER OF SHEET

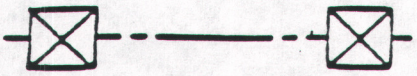
SHEET NUMBERS - ON EACH CORNER OF MANUSCRIPT SHEETS. ADJACENT MATCH SHEET NUMBER SAME. NO CIRCLE.

Figure ~~195-1~~ 3 -- Photogrammetric Map Symbols



SHEET LAYOUT DIAGRAM, FINAL SHEETS. ORIENT TO SHEET BEING DRAFTED, CROSS HATCH SHEET ON DIAGRAM.

UTILITY POLES.

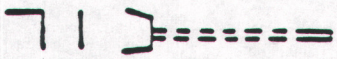


TRANSMISSION LINES & TOWERS

MANHOLE 3/32 INCH CIRCLE w/3 DOTS

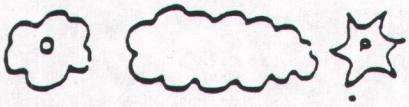
DRAINAGE INLET SMALL SQUARE w/3 LINES

FIRE HYDRANT

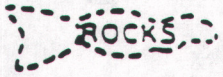


HEADWALL, HOWL w/PIPE, LABEL ONLY TO CLARIFY

MARSH OR SWAMP



INDIVIDUAL AND GROUPED TREES, BRUSH GROUND COVER
P - PINE O - OAK



ROCKS (LABEL)

TANK (LABEL)

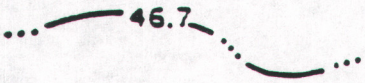
FIRE HYDRANT - FH
FLAGPOLE - LABEL - FP
PULLBOX - PB
WELL - WELL
ETC. LABEL TO CLARIFY
ALL 1/16 INCH CIRCLE

Figure ~~195-1~~ 3 -- Photogrammetric Map Symbols

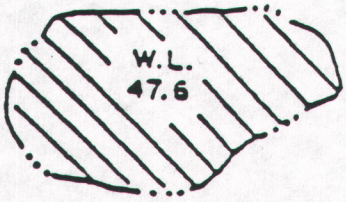
RAILROADS - 50 SCALE OR LARGER
100 SCALE OR SMALLER

FREEWAY SIGNS

SIGNS

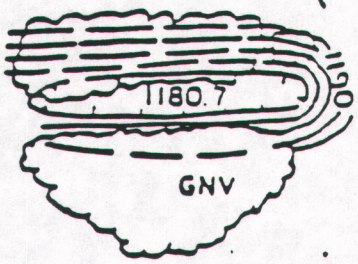


SMALL STREAM

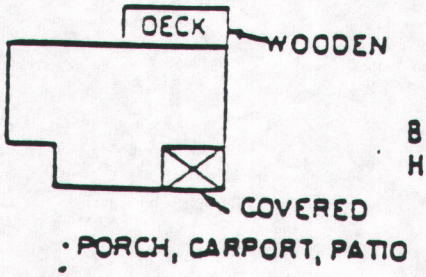


LARGE BODIES OF WATER. WATER LEVEL AS SHOWN. CROSS HATCH APPROX. 0.25 INCH IN AROUND EDGE

SMALL BODIES OF WATER CROSS HATCH AS SHOWN.

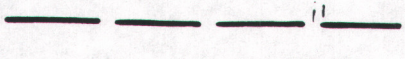


CONTOURS SOLID LINES IN OPEN AREAS. 1.0 INCH DAS LINES UNDER TREES AND BRUSH WHERE GROUND IS OBSCURED, BUT WITH OPEN SPOTS. WHERE GROUND IS N VISIBLE AND THERE ARE NO OPEN SPOTS, DO NOT DRAW CONTOURS. LABEL GNV. USE TICK MARKS AND SPOT ELEVATIONS TO INDICATE DEPRESSIONS.



BUILDING. LABEL ONLY TO CLARIFY. SHOW MOBILE HOMES THE SAME. DO NOT SHOW TRAVEL TRAILERS.

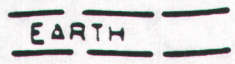
EDGE OF CONCRETE OR ASPHALT TRAVELED WAY. 0.5 IN DASH.



EDGE OF SHOULDERS TURNOUTS, PARKING AREAS 0.5 INC DASH.

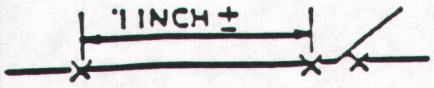
ASPHALT DIKE (LABEL)

Figure ~~195-1~~ 3 -- Photogrammetric Map Symbols

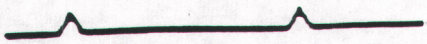


EDGE OF AGGREGATE OR EARTH TRAVELED WAY. 0.25 INCH DASH LABEL TO CLARIFY.

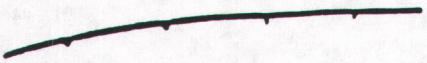
TRAIL OR WHEEL TRACKS. 0.25 INCH DASH. LABEL TO CLARIFY.



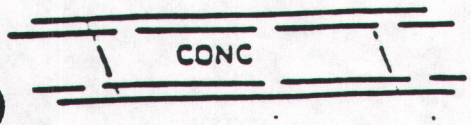
FENCE & GATE.



RETAINING WALL. "V" TOWARD HIGH SIDE



GUARD RAIL POSTS - PLOT AT SCALE



BRIDGE SHOW RAIL AND ENDS OF BRIDGE.

MISCELLANEOUS PLANIMETRY LABEL TO CLARIFY.

NOTES: 1. All maps 1:1200 and larger shall be drafted with two line weights.

SCRIBE	INK
a. Fine=0.010 inch	#00 Rapidograph or equal
b. Heavy=0.016 inch	# 2 Rapidograph or equal

For maps smaller than 1:1200 use:

a. Fine=0.006 inch	#000 Rapidograph or equal
b. Heavey=0.013 inch	#0 Rapidograph or equal

2. Map lettering shall be size 100 Leroy caps or equal. Except for proper names which shall be 120 Leroy caps or equal with fine pen.

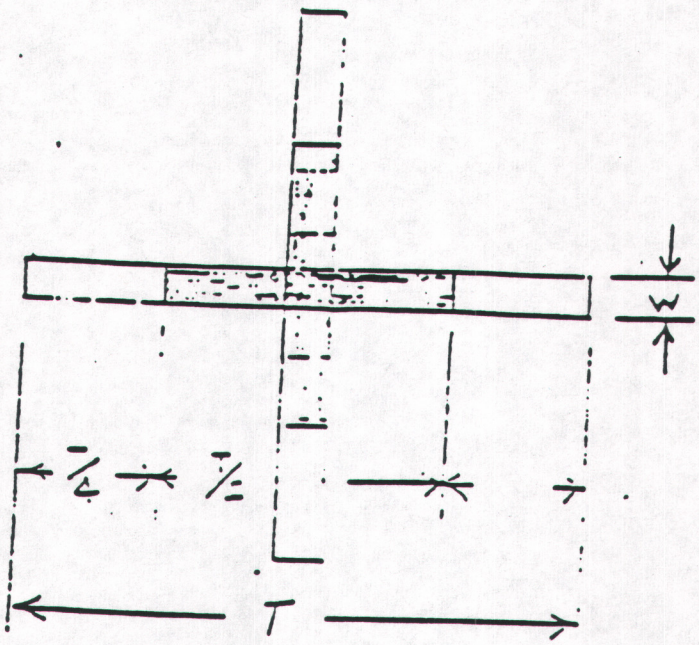
Figure ~~1951~~ 3 -- Photogrammetric Map Symbols

PHOTOGRAPHIC TARGETS (GROUND PANELS)

The precision required in large scale mapping projects using photogrammetrics methods, requires an exact correlation between the photography coverage and a significant number of selected points or monuments on the ground for which X, Y, and Z coordinates are accurately measured and established by ground survey methods. These points are usually station markers in the ground in solid rock or on a permanent concrete-type structure where the points, once measured, will be well preserved for recovery and use whenever needed. Placement of a target centered on the monument or station marker so it will appear as a well-defined concentric image on the aerial photographs is essential (see Figure 3). These targets should also be placed on all supplemental control points required for orientation of the aerial photographs in photogrammetric instruments for forming stereoscopic models to scale and elevation for accomplishing the required measuring and mapping. Targets should also be placed on pertinent survey monuments on the boundaries of all affected properties including Township and Range, Section and quarter corners. Predetermined points on which photogrammetric measurements will be made to establish surface bareline information may also require targeting, however, these will not require permanent monumentation. In this case, capped rebar in the center of each target will be adequate. Property corners not used as basic control may be targeted with only 3 legs of equal spacing using the same dimensions as shown in Figure 3.

Care should be taken where possible to place control and targets in open areas where they will not be obscured by ground cover and/or shadows. In some cases, this may not be possible and clearing will be required. Figure 5 illustrates the approximate clearing criteria. Experience has shown that the darker center of the target provides better contact for "readability".

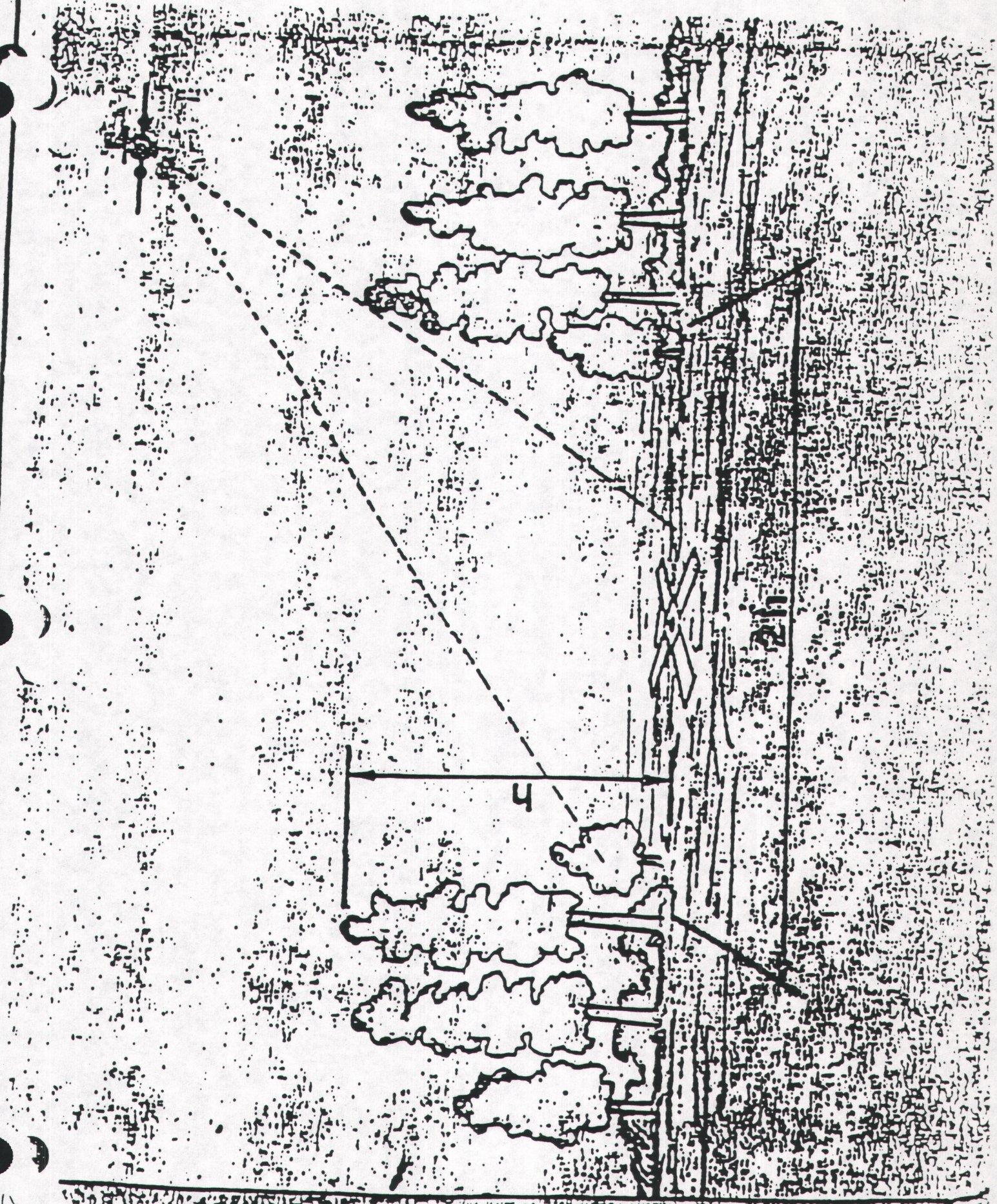
FIGURE 3 - Recommended target configurations and dimensions for placement on station markers. Recommended material is Griffolyn Type 65 black and white matte finish or equivalent.



T = total length (in feet) = 1/40 photo scale expressed in feet to inches. Example: 1:4800 photo scale equals 1" = 400' ÷ 50 = 10'.

W = width of leg in inches = 1/60 photo scale expressed in feet to inches. Example: 1:4800 = 1" = 400' ÷ 60 = 6.7.

Note: Allowances should be made in width and length for "hem" or double thickness if spikes are used to hold down target. Additional width and length should also be used if rocks are necessary to hold down target or if targets are placed on steep sideslopes.



MASTER VUGRAPH OF
FOR
X 11 SIDE VERTICAL

United States Department of Agriculture

Forest Service

R-4

7140 Geometronics

Date: 7-19-85

Subject: Aerial Photography and Photogrammetry Project, Genwal - Crandall Canyon Mine (yr Ltr)

To: Forest Supervisor, Manti-LaSal NF

☐ Enclosed is a project request form showing the details of your project for Forest verification, [redacted] a copy of Flight/control plan map, and cost est. worksheet.

☐ Additional information necessary as indicated on enclosed form.

☒ Submit Form 6500-46 identifying each project, management codes, and costs.

☐ Submit prints of resource photograph for navigation and control planning:

Resource Project	Strip No.	Roll No.	Exposure No.

Estimated cost for this project $1450.00 (including C; C; IR 2 sets prints ea.)

Return requested information by _____.

If you have questions, please call Lynn Wiese. His telephone number is 586-5213 or commercial (801) 625-5213.

ROBERT H. BYE
Geometronics Engineer

Enclosure

cc: WIESE
A. Reed

MANTI-LASAL N.F.
JUL 22 1985

cc: Gerald Gates

CRANDALL CANYON

Subsidence and Hydrologic Monitoring

1985 Photography Cost Estimate

Aircraft and Pilot (Color and Color IR)

Ferrying Time	Hrs. @		$
Photo Time	Hrs. @		$
		Subtotal	$ 315.00

Photo Crew (2 Members for Color and Color IR)

Salary	Hrs. @		$
Overtime	Hr. Lunch @		$ NA
		Subtotal	

Transportation (pilot, crew, and equipment between the airport and official station)

	Day @	$

Photography

Color*	Label, shipping & mailing 24 @ 1.50 ea	$ 36.00
	24 Exposures @ 5.50 / ea	$ 137.50
	24 Prints @ 3.00 / ea	$ 72.00
	24 Film Positives @ 10 / ea	$ 240.00
	1 set Color Subtotal	$ 485.50
Color Infrared*	24 Exposures @ 7.00 ea	$ 168.00
	24 Prints @ 3.00 / ea	$ 72.00
	1 set CIR Subtotal	$ 240.00

Per Diem (2 days, 2 people, $50/day/person) Prorated amt. $ (25.00)

Actual Total	$ 1065.50
Rounded Total	$ 1450.00

with 2 sets C & C

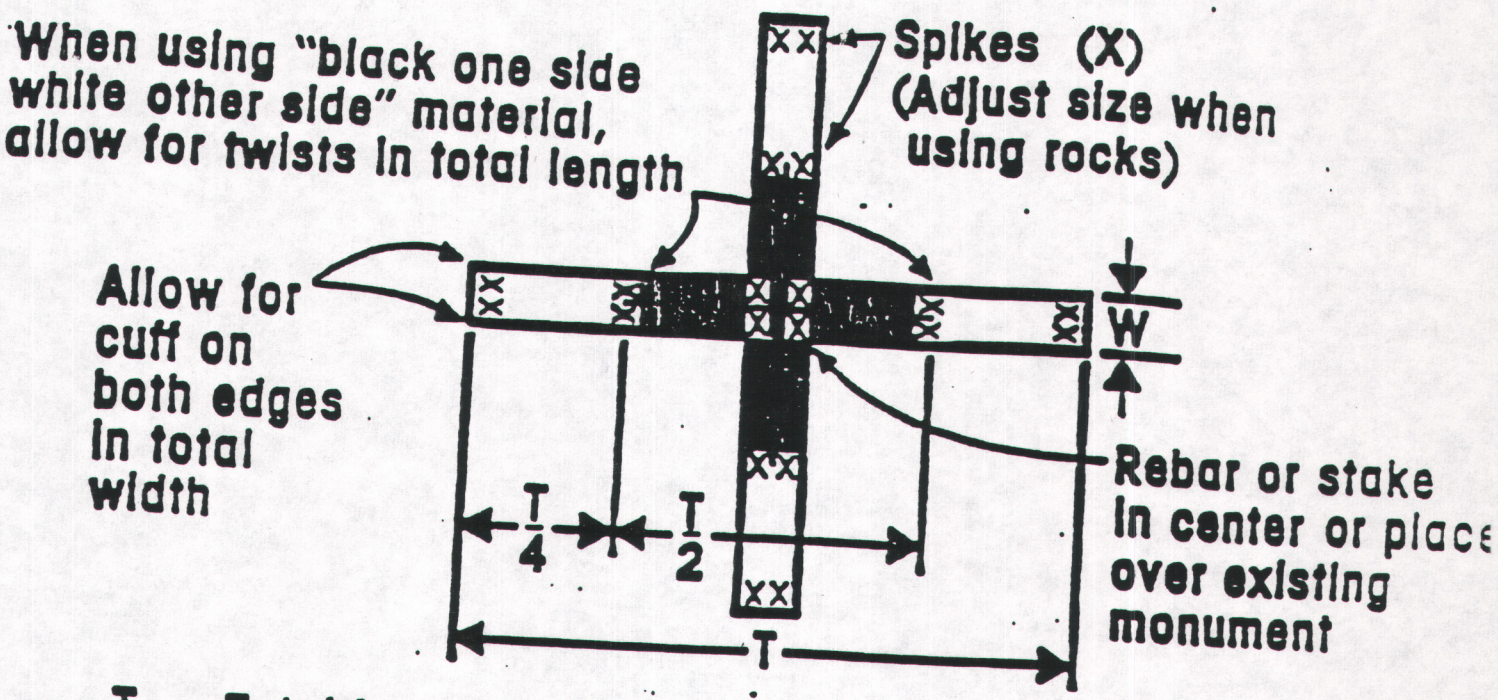
*Includes film processing, B/W inspection prints, and one set of color prints (additional prints $3.00 each).

3 strips Color yes Color IR yes

2 strips required Prior

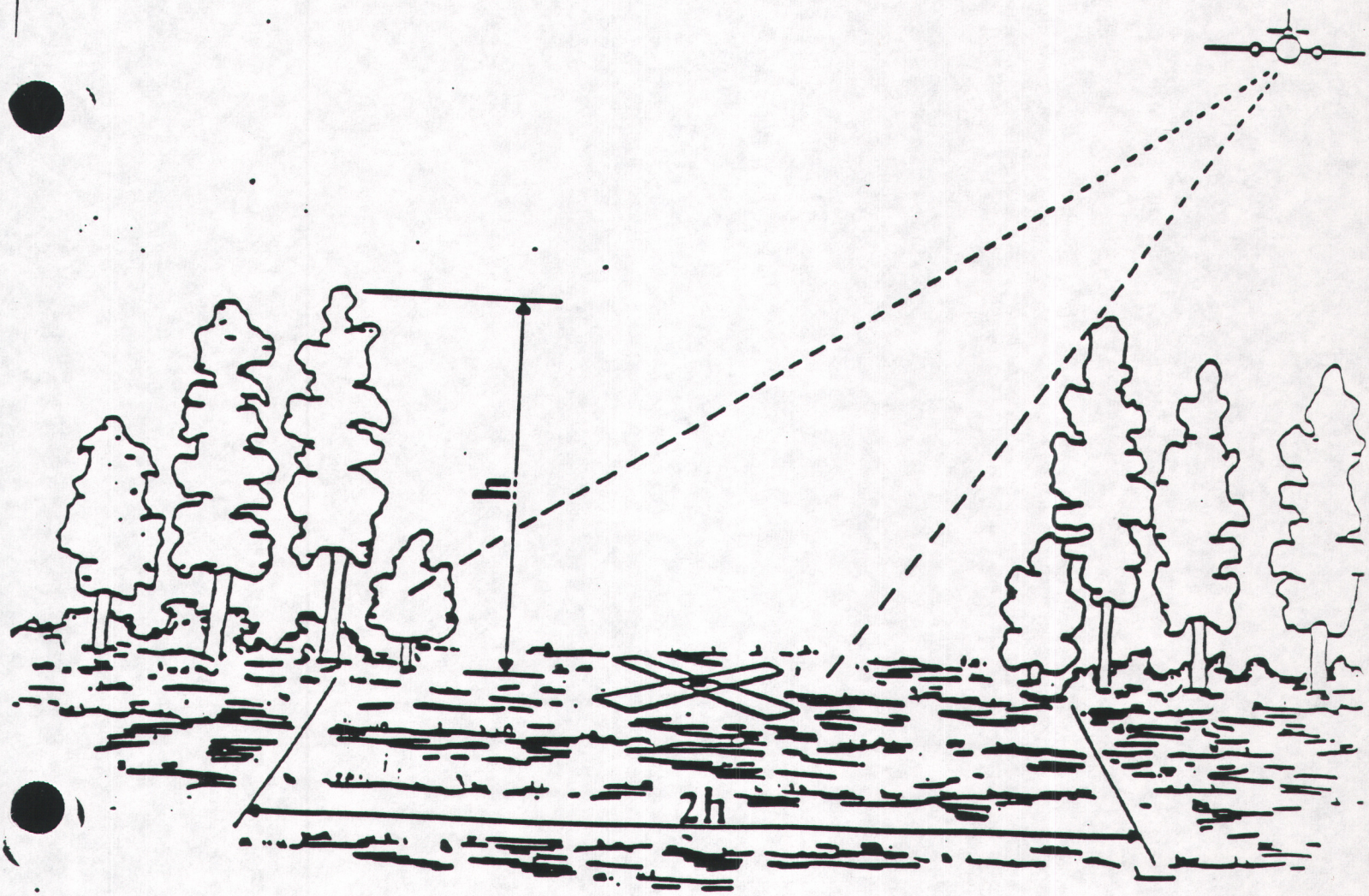
GROUND TARGETS FOR CONTROL SURVEYS

RECOMMENDED DIMENSIONS



T = Total Length (in feet)
= 1/50 Photo Scale (ft to 1 in)
ie. 1:6000 PSR = 1" = 500' ÷ 50 = 10'-12'

W = Width of Leg (in inches)
= 1/60 Photo Scale (ft to 1 in)
ie. 1:6000 = 1" = 500' ÷ 60 = 8.3"-12"

- Terrain, cover and reflectance characteristics of surface material affect pt. reading accuracy of targeted control station
- Record of location (photo I.D./image pt. tie)
- Maintenance
- Roll stock, pre-cut and/or prefabricated material and targets available from commercial sources

GROUND TARGET PLACEMENT GUIDE