BASE FROM U.S. GEOLOGICAL SURVEY
7½-MINUTE QUADRANGLE.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1965 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

GEOLOGIC HAZARDS MAP OF THE GRAY RESERVOIR QUADRANGLE

BY

WALTER R. JUNGE

1978

CGS OF-78-12
PLATE 1 OF 7
EXPLANATION OF MAP IS PLATE 7

BASE FROM U.S. GEOLOGICAL SURVEY
7½-MINUTE QUADRANGLE

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1965 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

GEOLOGIC HAZARDS MAP OF THE BOWIE QUADRANGLE

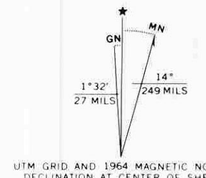
BY

WALTER R. JUNGE

1978

CGS OF-78-12
PLATE 2 OF 7
EXPLANATION OF MAP IS PLATE 7

Base from U.S. Geological Survey
7½-minute quadrangle.



UTM grid and 1964 magnetic north
declination at center of sheet

SCALE 1:24 000

1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

GEOLOGIC HAZARDS MAP OF THE SOMERSET QUADRANGLE

BY

WALTER R. JUNGE

1978

CGS OF-78-12
PLATE 3 OF 7
EXPLANATION OF MAP IS PLATE 7

Base from U.S. Geological Survey
7½-minute quadrangle.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1978 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

GEOLOGIC HAZARDS MAP OF THE PAONIA RESERVOIR QUADRANGLE

BY

WALTER R. JUNGE

1978

CGS OF-78-12
PLATE 4 OF 7
EXPLANATION OF MAP IS PLATE 7

Base from U.S. Geological Survey
7½-minute quadrangle.

UTM grid and 1965 magnetic north
declination at center of sheet

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET

GEOLOGIC HAZARDS MAP OF THE HOTCHKISS QUADRANGLE

BY

WALTER R. JUNGE

1978

CGS OF-78-12
PLATE 5 OF 7
EXPLANATION OF MAP IS PLATE 7

BASE FROM U.S. GEOLOGICAL SURVEY
7½-MINUTE QUADRANGLE.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1965 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

GEOLOGIC HAZARDS MAP OF THE PAONIA QUADRANGLE

BY

WALTER R. JUNGE

1978

CGS OF-78-12
PLATE 6 OF 7
EXPLANATION OF MAP IS PLATE 7

OPEN-FILE REPORT
78-12
Plate 7 of 7

GEOLOGIC HAZARDS
HOTCHKISS-PAONIA RESERVOIR AREA
DELTA AND GUNNISON COUNTIES, COLORADO

by WALTER R. JUNGE
1978

Colorado Geological Survey
Department of Natural Resources
State of Colorado
John W. Rold, Director

GENERAL DESCRIPTION

The valley along the North Fork Gunnison River from Hotchkiss to Paonia Reservoir is likely to experience in the near future a rapid population growth caused by increased coal mining. To aid planning for this anticipated growth, geologic conditions in the area were studied and mapped in accordance with House Bill 1041 (C.R.S. 1973, 24-65.1-101, et seq.) to determine areas of geologic hazard that could cause an economic loss or affect the safety of the citizens of Colorado. The mapped units used in this study conform to the terms and definitions given in Colorado House Bill 1041 and in the Colorado Geological Survey's "Guidelines and Criteria for Identification and Mineral Resource Areas" (Rogers and others, 1974). As defined in House Bill 1041, a geologic hazard means "a geologic phenonmenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property." These geologic hazards, which are normal dynamic processes, may be intensified or lessened by human activity. Regardless of the intensity, the hazards should be recognized and considered prior to any land-use changes.

SUGGESTIONS TO MAP USERS

Potentially hazardous geologic conditions are mapped at 1:24,000 in six contiguous 7.5-minute quadrangles, including Hotchkiss, Gray Reservoir, Bowie, Paonia, Somerset, and Paonia Reservoir. These maps show only the most severe geologic hazard in a specific area. Additional geologic conditions, which may affect a certain land use, may be present locally.

The accompanying Explanation of Map Units and the Geologic Hazards Assessment for Common Land Uses should be consulted when using these maps. The Explanation of Map Units is a description of the process that affects a certain area and the Geologic Hazards Assessment for Common Land Uses is an estimation of the degree of hazard for a specific land use and description of conditions affecting the hazards. The degree of hazard will vary depending on the particular land use. Landslides, for example, may be a serious constraint to high-density residential development, whereas recreational areas may be only slightly affected. The geologic hazard maps and accompanying descriptions and explanations are not intended as a detailed analysis of a particular site or land use, and should not be used in place of detailed field investigations of specific areas. We recommend that these maps serve as a basis for further, detailed investigations such that the safety and feasibility of specific projects can be adequately evaluated.

EXPLANATION OF MAP UNITS

ls$_1$ ls$_2$ ls$_3$ Landslide Area: an area formed by and susceptible to the moderate to rapid downward and outward movement of rock and/or soil where there is a surface of rupture or zone of weakness that separates the landslide mass from more stable underlying material. These landslide areas include earthflows, translational slides, rotational slides, and debris slides. Man-caused disturbance of the landslide areas could initiate additional instability and mass movement of part or all of the slide mass. This mass movement could damage or destroy structures and could affect adjacent downslope areas. Relative age of the landslide areas is indicated by subscripts (1 is the youngest).

mf Mudflow Area: an area subject to the rapid downslope movement of wet, viscous masses of fine-grained material following mobilization of the material by intense rainfall or snowmelt runoff. Mobilization usually includes the erosion and transport of poorly consolidated surficial materials that have accumulated in a drainage basin and its channels. Mudflows are a potential danger for most development activities.

da Debris Avalanche Area: an elongate chute-like area susceptible to the very rapid sliding and flow of unsorted mixtures of soil and rock material down relatively steep slopes. Debris avalanche areas form during periods of intense rainfall and may cover gentle slopes below the steep source areas. Debris avalanches are very hazardous for many land uses.

rf Rockfall Area: an area subject to rapid, intermittent, nearly unpredictable rolling sliding, or free-falling of detached bedrock of any size from a cliff or very steep slope. Rockfall areas most commonly occur on sparsely vegetated slopes with jointed bedrock cliffs. Rockfalls may adversely affect residential or commercial development.

df$_1$ df$_2$ Debris Flow Area: a triangular-shaped area resulting from the accumulation of water-transported rock, soil, and vegetation debris usually at the confluence of a tributary stream with a larger drainage. Debris movement and accumulation generally is associated with rapid flows that are caused by intense rainfall. Relative age of the debris flows are indicated by subscripts (1 is the youngest). The youngest debris flow areas (Qdf$_1$) usually are very hazardous locations for the works of man.

sfc$_1$ sfc$_2$ sfc$_3$ Slope Failure Complex Area: an area formed by various types of mass-wasting processes such as landslides, mudflows, rockfalls, and soil creep. These areas generally are unstable and the advisability of their development should be determined only after detailed geotechnical studies. The age of movement within these areas usually varies; however, the general age of this unit is indicated by subscripts (1 is the youngest).

us Unstable Slope: a slope were mass movement may have occurred and where recent movement is not apparent or is uncertain. These slopes generally are characterized by landslide or soil-creep physiography and may be susceptible to landslide, earthflow, mudflow, or accelerated-creep processes, especially if disturbed. Construction on these slopes should be carefully evaluated prior to any development.

pus Potentially Unstable Slope: a slope which currently is in equilibrium and where past or present mass movement of the soil or rock is not apparent. Physical attributes, such as composition of surficial and bedrock materials or slope inclination and aspect, are similar to nearby areas that have failed. Accordingly, these slopes may be susceptible to mass-movement failures if they are disturbed.

pfp Physiographic Flood Plain Area: a flat, relatively smooth area adjacent to and formed by a river in its present regimen. The flood plain may be covered by water during flood stages and is susceptible to the adverse affects of erosion and sedimentation; e.g., undercutting, slumping, scour, and infilling. Any construction within the flood plain could raise the level of flood waters and should be very carefully evaluated to determine if flood waters will adversely affect the construction site or adjacent areas. Flash flood areas have not been shown on the map; however, all major drainages in the area are prone to water and debris flooding as well as attendant erosion and sedimentation.

sf Sheet-Flow Flooding and Erosion Area: an area subject to the overland flow of runoff that spreads as a relatively thin, continuous, uniform sheet of water over a relatively large, nearly planar area. Sheet flows cause erosion and deposition of fine-grained materials and commonly occur on terraces, alluvial fans, and in valley-fill areas. Proper construction techniques usually can minimize or abate any potentially adverse affects.

ph Potential Hydrocompaction Area: an area which may be subject to the downward displacement of the ground surface by collapse of certain low-density, weak soils after wetting. Excessive wetting from irrigation, broken water lines, surface ponding, or drainage diversions can cause hydrocompaction. A soils foundation investigation should be made to determine the severity of this hazard and ascertain construction design parameters.

es Expansive (Swelling) Soil or Rock Area: an area containing clays that expand significantly upon wetting and shrink upon drying. The Mancos Shale and surficial deposits derived from it are especially prone to such changes in volume. Expansive soil or rock may cause structural damage to buildings, roads, and pipelines and should be evaluated by a soils and foundation engineering investigation.

MAP SYMBOLS

Map unit contact

Debris avalanche (Qda): may correspond with snow avalanche track in mountainous areas.

Recent landslide scarp: hachures point in the direction of landslide movement.

Potential Mine Subsidence Area: an area susceptible to ground-surface displacement caused by collapse of underground mining voids. The maps show only those areas undermined before 1978. Subsidence effects could extend outward from these areas in the future from increased coal mining. Construction should be undertaken only after a geotechnical investigation determines the possible extent of mining and the potential for future ground movement.

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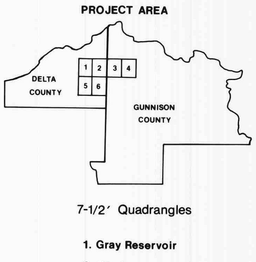
INDEX MAP

COLORADO

PROJECT AREA



7-1/2′ Quadrangles

1. Gray Reservoir
2. Bowie
3. Somerset
4. Paonia Reservoir
5. Hotchkiss
6. Paonia

Drafting by: Susan Soukup

GEOLOGIC HAZARDS ASSESSMENT FOR COMMON LAND USES

Land-Use Activity

Geologic Hazard

	Residential Development: High Density	Residential Development: Low Density	Commercial / Industrial Development	Roads	Utilities	On-Lot Effluent Disposal	Agriculture / Ranching	Open Space / Recreation
Landslide (ls), Slope Failure Complex (sfc)	4 ABCH HAZARD MITIGATION TYPICALLY IS PROHIBITIVELY EXPENSIVE	4 ABCH FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION MEASURES	4 ABCH USUALLY REQUIRES ELABORATE AND EXPENSIVE MITIGATION MEASURES	4 ABCH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; HIGH MAINTENANCE COSTS	3 ABCH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; VERY HIGH MAINTENANCE COSTS	4 AC USUALLY NOT FEASIBLE; EFFLUENT (WATER) MAY REACTIVATE LANDSLIDE	1 CD USUALLY MINOR PROBLEMS EXCEPT FOR BUILDINGS AND IRRIGATION DITCHES	2 AD COMMONLY FEASIBLE; BUILDING SITES SHOULD BE CAREFULLY SELECTED
Unstable Slope (us)	4 ABCH HAZARD MITIGATION USUALLY IS NECESSARY AND MAY BE PROHIBITIVELY EXPENSIVE	4 ABCH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	4 ABCH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	4 ABCH HAZARD MITIGATION MAY BE NECESSARY AND EXPENSIVE; HIGH MAINTENANCE COSTS	3 ABCH MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	4 AC NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; LANDSLIDES MAY BE REACTIVATED	1 CD USUALLY MINOR PROBLEMS EXCEPT WHERE DITCH LEAKAGE CAUSES MASS-WASTING	2 AD COMMONLY FEASIBLE; MAINTENANCE COSTS LIKELY
Potentially Unstable Slope (pus)	3 BCEH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; MITIGATION MAY BE EXPENSIVE	3 BCEH MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	3 BCEH USUALLY FEASIBLE WITH CAREFUL PLANNING AND DESIGN	3 ABCEH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	2 BCEH HAZARD CAN BE MINIMIZED WITH CAREFUL PLANNING AND DESIGN	3 AC MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	1 CDE USUALLY MINOR PROBLEMS EXCEPT IN AREAS OF INTENSE CULTIVATION OR STEEP SLOPES	1 DE TYPICALLY NO DIFFICULTIES
Rockfall (rf), Debris Avalanche (da)	4 ABD FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	4 ABD HAZARD MITIGATION IS NECESSARY AND MAY BE PROHIBITIVELY EXPENSIVE	2 ABD HAZARD MITIGATION IS NECESSARY AND MAY BE EXPENSIVE	4 AB HAZARD MITIGATION IS NECESSARY; MAINTENANCE COST USUALLY VERY HIGH	3 AB USUALLY FEASIBLE; HIGH MAINTENANCE COSTS	1 USUALLY FEW OR MINOR PROBLEMS	1 USUALLY FEW OR MINOR PROBLEMS; BUILDING SITES SHOULD BE CAREFULLY SELECTED	3 AD COMMONLY FEASIBLE; BUILDING SITES SHOULD BE CAREFULLY SELECTED
Mudflow (mf), Debris Fan (df)	4 CDEFH FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	4 CDEFH FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	3 CDEFH NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; MITIGATION MAY BE EXPENSIVE	4 CDFH FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	3 CEFH MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	1 USUALLY FEW OR MINOR PROBLEMS	2 CEF USUALLY FEW OR MINOR PROBLEMS; BUILDING SITES SHOULD BE CAREFULLY SELECTED	3 CDEF MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN; HIGH PERIODIC MAINTENANCE COSTS
Physiographic Flood Plain (pfp)	4 FH SEVERE HAZARD AREA; HYDROLOGIC FLOOD PLAIN DETERMINATION NECESSARY	4 FH SEVERE HAZARD AREA; HYDROLOGIC FLOOD PLAIN DETERMINATION NECESSARY	4 FH SEVERE HAZARD AREA; HYDROLOGIC FLOOD PLAIN DETERMINATION NECESSARY	3 FH HAZARD MITIGATION DIFFICULT AND EXPENSIVE; DAMAGE-PRONE AREA	3 F HAZARD MITIGATION DIFFICULT AND EXPENSIVE; DAMAGE-PRONE AREA	4 C COMMONLY NOT FEASIBLE; SEVERE POLLUTION OF NEAR-SURFACE GROUND-WATER	2 F COMMONLY FEASIBLE; HIGH, PERIODIC MAINTENANCE COSTS	3 F COMMONLY FEASIBLE; HIGH, PERIODIC MAINTENANCE COSTS
Sheet Flow (sf)	3 DFH HAZARD MITIGATION NOT DIFFICULT; MAINTENANCE COSTS MINIMAL; DRAINAGE STUDY NECESSARY	3 DFH HAZARD MITIGATION NOT DIFFICULT; MAINTENANCE COSTS MINIMAL; DRAINAGE STUDY NECESSARY	3 DFH HAZARD MITIGATION NOT DIFFICULT; MAINTENANCE COSTS MINIMAL; DRAINAGE STUDY NECESSARY	2 DFH COMMONLY FEASIBLE; PERIODIC MAINTENANCE COSTS; DRAINAGE STUDY NECESSARY	2 DF COMMONLY FEASIBLE; MAINTENANCE COSTS MINIMAL; LOCAL HIGH GROUND-WATER LEVELS	4 C NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	1 F TYPICALLY NO DIFFICULTIES	1 F TYPICALLY NO DIFFICULTIES
Expansive Soil (es), Potential Hydrocompaction (ph)	3 CH FEASIBLE WITH SPECIAL CONSTRUCTION TECHNIQUES; SOIL AND FOUNDATION STUDIES NECESSARY	3 CH FEASIBLE WITH SPECIAL CONSTRUCTION TECHNIQUES; SOIL AND FOUNDATION STUDIES NECESSARY	3 CH FEASIBLE WITH SPECIAL CONSTRUCTION TECHNIQUES; SOIL AND FOUNDATION STUDIES NECESSARY	2 CH USUALLY FEASIBLE WITH CAREFUL PLANNING AND DESIGN; SOIL AND FOUNDATION STUDIES NECESSARY	2 C COMMONLY FEASIBLE	3 C MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	1 TYPICALLY NO DIFFICULTIES	1 TYPICALLY NO DIFFICULTIES
Potential Mine Subsidence (pms)	4 G MAY NOT BE FEASIBLE; SUBSIDENCE RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	4 G MAY NOT BE FEASIBLE; SUBSIDENCE RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	4 G MAY NOT BE FEASIBLE; SUBSIDENCE RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	3 G SUBSIDENCE RELATED DAMAGE MAY CAUSE VERY HIGH MAINTENANCE COSTS	4 G MAY NOT BE FEASIBLE; SUBSIDENCE RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	2 G COMMONLY FEASIBLE; SUBSIDENCE MAY DISRUPT DISPOSAL SYSTEM	2 G COMMONLY FEASIBLE; SUBSIDENCE MAY DISRUPT SURFACE DRAINAGE	1 G COMMONLY FEASIBLE

Explanation of Chart Symbols

Key

Degree of Hazard

4 HIGH: DETAILED GEOTECHNICAL STUDIES NECESSARY TO DETERMINE IF AREA IS COMPATIBLE WITH PROPOSED LAND USE
3 MODERATE: DETAILED GEOTECHNICAL STUDIES NECESSARY DURING PLANNING STAGES
2 LOW: GEOTECHNICAL STUDIES MAY BE NECESSARY DURING PLANNING STAGES
1 VERY LOW: GEOTECHNICAL STUDIES COMMONLY NOT NECESSARY

Conditions Affecting Hazard

A HAZARD ESPECIALLY SEVERE ON STEEP SLOPES
B OVERSTEEPENING OR CUTTING OF SLOPES CAN INCREASE HAZARD
C ARTIFICIAL OR NATURAL INCREASE IN GROUND MOISTURE CAN INCREASE HAZARD
D REMOVAL OF NATURAL VEGETATION CAN INCREASE HAZARD
E HAZARD MAY DECREASE AS SLOPE DECREASES
F HAZARD RELATED DIRECTLY TO METEOROLOGICAL EVENTS
G HAZARD RELATED TO COAL EXTRACTION
H DISTURBANCE OF NATURAL DRAINAGE SYSTEM CAN INCREASE HAZARD