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Appendix 6: A15 Pit – Geology and Hydrology Report

GEOLOGY AND HYDROLOGY

ENCANA OIL AND GAS (USA), INC.
NP WF A15 596 FACILITY
GARFIELD COUNTY, COLORADO

PREPARED FOR:
ENCANA OIL AND GAS (USA), INC.
143 DIAMOND AVENUE
PARACHUTE, COLORADO 81635

PREPARED BY:
OLSSON ASSOCIATES
4690 TABLE MOUNTAIN DRIVE
GOLDEN, CO 80403
PH: (303) 237-2072

AUGUST 2014

OLSSON ASSOCIATES
PROJECT NO. 014-0455

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1.0 SITE GEOLOGY

The proposed location of the Encana Oil and Gas USA, Inc. (Encana) North Parachute – West Fork (NP WF) A15 596 facility (Site) is in the NE ¼ NE ¼ Section 5, Township 5 South, Range 96 West, of the 6th Principal Meridian, coordinates 39.621792 North latitude and -108.148903 West longitude, Garfield County, Colorado. Encana is converting an existing produced water pit (COGCC Facility No. 428147) to a water handling facility which meets the Colorado Oil and Gas Conservation Commission (COGCC) definition of a Centralized E&P Waste Management Facility intended for handling of produced water. Produced water is an exploration and production (E&P) waste, and it will be stored and treated from multiple wells operated by Encana throughout the area. A site topographic map is presented as T-1, and a geologic map of the site area is presented as G-1.

1.1 Topography

The Site lies at an approximate elevation between 6,400 feet and 6,440 feet. The topography of the West Fork of Parachute Creek is characterized by deep canyons, with steep slopes interrupted by ledges, and surrounded by high ridges (Hail, 1982). The Davis Point Ridge is located to the east of the West Fork of Parachute Creek, and the Roan Plateau is located to the north.

1.2 Structural Geology

The Site is located within the Piceance Basin, a broad, roughly elliptically-shaped, structural depression in the earth's crust resulting from tectonic adjustments associated with the uplift of the Colorado Plateau and the Colorado Rocky Mountains during the late Cretaceous and early Tertiary geologic periods. The Piceance Basin is bound to the northwest by the Uinta Uplift and Sand Wash Basin, to the east by the White River Uplift, to the southeast by the Sawatch Range Uplift, to the south by the Uncompahgre-San Luis highland, and to the west by the Douglas Creek Arch (Grout and Verbeek, 1992) (Czyzewski, 1999). The Piceance Basin is also a depositional basin which accumulated thick sequences of sediments shed from uplifted areas.

The structure of the central Roan Plateau area is fairly simple and structural trends are characteristic of those throughout most of the Piceance Basin. The site lies to the northeast of the Crystal Creek anticlinal fold, a low amplitude northwest-trending fold system. The anticline is somewhat asymmetrical and dips more steeply on its southwestern flank of about 200 feet per mile, and dips more gently on the northeast flank of about 65 feet per mile. The Crystal Creek anticline plunges to the northwest.

The sedimentary rocks gently dip toward the center of the basin. The dip angle is typically between 2º to 5º north-northeast. The low dip angles gave rise to the gently sloping structural terraces supported by sandstones in the Wasatch Formation in the area south of the West Fork of Parachute Creek closer to the town of Parachute.

There are no major faults mapped in the central Roan Plateau area. Three narrow grabens are present along a northwest trending fracture zone in an area to the north of the NP WF A15 596 site. These down-dropped blocks are between one and 2.5 miles long and range from 200 feet to 1,200 feet wide. Maximum stratigraphic displacement along these faults does not exceed 120 feet, and most displacement is considerably less. Small northwest-striking faults are located between the graben in the central part of Township 4 South, Range 97 West, and the graben in the southwestern part of Township 4 South, Range 96 West that suggests the grabens lie along a fracture zone that extends for a total distance of about 9 miles (Hail, 1992).

1.3 Bedrock Geology

Bedrock consists of the Parachute Creek member of the Tertiary Green River Formation. The Parachute Creek Member consists of light-gray to light-brown marlstone much of which is "oil shale." The unit also contains lesser silty marlstone and marly siltstone, some sandstone, numerous very thin beds of tuff throughout the member, and some fissile shale and dolomitic claystone in the lower part. The thickness of the Parachute Creek Member ranges from about 950 feet to 1,200 feet (Hail, 1982). The Mahogany ledge is a rich oil-shale zone within the Parachute Creek Member. The thickness of the Mahogany ledge is 100 feet to 130 feet.

The Douglas Creek Member, Garden Gulch Member and the Anvil Points Member of the Green River Formation lie stratigraphically below the Parachute Creek Member, and overlie the Tertiary age Wasatch Formation. The Douglas Creek Member consists of a silty dolomitic shale and claystone, shale, and lesser siltstone, sandstone, oil shale, and limestone. The Garden Gulch Member consists of grayish-brown silty dolomitic claystone and shale, shaley marlstone, and marlstone. The Anvil Points Member consists of kerogen-rich fissile shale, with lesser but conspicuous brown-weathering fine- to medium grained sandstone beds. The Wasatch Formation consists of varicolored red and grayish-yellow claystone, and channel-sandstone beds. These units crop out further down in the Parachute Creek valley but are not exposed in the vicinity of the NP WF A15 596 site.

The Tertiary Uinta Formation lies stratigraphically above the Parachute Creek Member. The Uinta Formation crops out on the tops of ridges while the Parachute Creek Member forms the slopes, ledges, and benches of the canyon walls. The Uinta Formation consists of siltstone and medium-grained sandstone, with subordinate marlstone and oil shale.

1.4 Surficial Geology

According to published geologic information from the USGS, surficial deposits within the area of the site consist of Quaternary age talus and slope wash deposits (symbol Qt) and alluvial fan deposits (Qf). The talus and slope wash are gravity and sheet wash deposits that are present on or at the base of steep cliffs, and the alluvial fan sediments are flash-flood deposits located at the mouths of steep drainages. Both the talus/slope wash and alluvial fan deposits are derived from the overlying Green River Formation and the Uinta Formation (Hail, 1982).

1.5 Geologic Hazards

Olsson Associates visited the site on August 4, 2014 to assess the geologic setting of the Encana NP WF A15 596 facility. The site was observed to be located northwest of the town of Parachute at an elevation of approximately 6,400 feet. The site is surrounded by steep canyon walls of the West Fork of Parachute Creek.

Steep slopes and rockfall are potential geologic hazards in this area. There were no landslide deposits mapped on the Circle Dot Gulch Preliminary Geologic Map (Hail, 1982). Alluvial fan deposits are present at the mouths of steep side canyons which indicate the potential for flash floods in these areas are a hazard.

No faults have been identified or mapped in the immediate area of the NP WF A15 596 site. There are some small grabens located to the north and northwest. During the period from 1962 and 2007 one earthquake a magnitude of 5 to 5.5 on the Richter scale is shown to the south of the town of Parachute in Garfield County with is shown on the 2007 Colorado Earthquake Hazards Map prepared by the Colorado Geologic Survey (Morgan, 2007). Another earthquake with similar magnitude is shown to the north in Rio Blanco County. According to USGS Bulletin 1787-R, Geology of the Central Roan Plateau Area Northwestern Colorado, there are no major faults in the central Roan Plateau (Hail, 1992).

1.6 Soils

A soils map is presented as S-1. The soil types in the vicinity of the site consist of the Rock outcrop-Torriorthents complex (unit #61) which occupies 15 to 90 percent slopes at elevations between 5,800 feet to 8,500 feet above mean sea level. This map unit is found on south facing slopes of mountains, hills, ridges, and canyon sides in extremely rough and eroded areas. Vegetation is sparse and the unit is about 65 percent rock outcrop and 30 percent Torriorthents soils. The Rock outcrop consists of barren escarpments, ridge caps, and rocky points of sandstone, shale, limestone, or siltstone. Escarpments are commonly three to 100 feet high and 25 feet to 2,500 feet long. The Torriorthents commonly are very shallow and lie directly over bedrock. These soils are well drained, and formed in residuum and colluvium derived from sandstone, shale, or siltstone (Harman and Murray, 1985).

Runoff is very rapid in areas of this unit, and the hazard of water erosion is very severe. The main limitations for development of mineral resources in this area are the slope and the depth to rock outcrop.

The Nihill channery loam (unit #47) is found on the north facing slope across the valley from the NP WF A15 596 site. This soil occupies 6 to 25 percent slopes at elevations from 5,000 feet to 6,500 feet above mean sea level. The Nihill channery loam is a deep, well-drained, moderately sloping to hilly soil that formed on valley sides and alluvial fans. This soil formed in alluvium derived from Green River shale and sandstone. Permeability is moderately rapid, and available water capacity is low. Surface runoff is slow, and the erosion hazard is severe (Alstatt, 2003).

1.7 Climate

Garfield County Colorado is warm to hot in most valleys and much cooler in the mountains during the summer. Winter in Garfield County is cold in the mountains, but it may be colder in the valleys than the lower parts of the adjacent mountains because of the cold air sinking and draining down through the valleys. Precipitation falls in the mountainous areas year round, and snowpack accumulates in the winter and early spring. Precipitation is heaviest in the valleys in the spring and summer occurring as rain showers or thunderstorms (Harman and Murray, 1985).

Mean annual precipitation is between 10 to 15 inches. Flash-floods may occur as a result of thunderstorms moving through the area in the early summer months or due to rapid snowmelt and runoff from higher elevations. The mean annual air temperature is between 39 and 46 degrees Fahrenheit, and the average frost-free period is between 80 and 105 days (Harman and Murray, 1985) (Alstatt, 2003).

2.0 SITE HYDROLOGY

The following sections present the site hydrology. The hydrology map, H-1, shows the surface water in the area.

2.1 Surface Water Hydrology

The surface water hydrology in the vicinity of the site is controlled by the West Fork of Parachute Creek. The West Fork of Parachute Creek is located approximately 250 feet to the west-southwest of the Site. The confluence of the West Fork of Parachute Creek and the Middle Fork of Parachute Creek is approximately 3.5 miles to the southeast of the NP WF A15 596 site, or approximately 10 miles northwest of the town of Parachute.

2.2 Groundwater Hydrology

The Uinta – Animas aquifer is composed of lower Tertiary age rocks in the Piceance Basin of northwestern Colorado and consists of the Uinta Formation and the Parachute Creek Member of the Green River Formation (Robson and Banta, 1995). As discussed in the geology section, the Uinta Formation covers the upland areas and is at the surface over most the Parachute Creek Basin. The Parachute Creek member is the most important for groundwater resources of the five members of the Green River Formation. Much of the intergranlar space in these rocks has been filled by sodium and calcium bicarbonate cements, but fractures are numerous resulting in greater permeability than underlying members of the Green River Formation. This makes the Parachute Creek member the most important hydrogeologic unit in the basin (Czyzewski, 1999).

The Parachute Creek member has been divided into three zones which are based on lithology, hydrology, and geophysical log characteristics. These include, in ascending order 1) the stratigraphically lower high resistivity zone, which is found only in the north-central part of the basin and ranges in thickness from 200 feet to 900 feet, 2) the Mahogany zone which consists of 100 feet to 200 feet of kerogen-rich marlstone, and 3) the upper low resistivity or “leached” zone.

The high resistivity zone consists of oil shale and saline mineral deposits and is relatively impermeable. The low resistivity zone is the most porous and the best aquifer of the three zones within the Parachute Creek member and is overlain by the Mahogany zone, which is a confining unit, separating the upper low resistivity zone consisting of the upper Parachute Creek member and Uinta formation from the lower Parachute Creek member. The Garden Gulch, Douglas Creek, and Anvil Points members of the Green River Formation consist primarily of relatively impermeable marlstone, shale, and sandstone, and also act as confining layers that restrict the movement of groundwater to the underlying Wasatch Formation (Czyewski, 1999).

The two major bedrock aquifer systems that exist within the Piceance Basin are locally referred to as the upper and lower aquifers. The upper aquifer occurs in the upper part of the Parachute Creek member and the Uinta Formation and consists of lean oil shales and marlstone above the Mahogany zone and sandstones in the overlying Uinta Formation. The Mahogany Zone crops out in walls of the canyon. The Uinta Formation is saturated only below stream level (Czyewski, 1999).

Recharge and discharge to the Uinta-Animas aquifer occurs in the higher elevation areas along the margins of each basin. Groundwater is discharged mainly to streams, springs, and by transpiration from vegetation growing along stream valleys. The Uinta-Animas aquifer in the Piceance Basin receives about 24,000 acre-feet per year of recharge, primarily in the upland areas near the margins of the aquifer. Discharge is approximately equal to recharge and primarily occurs in the valleys of Piceance Creek and other tributaries to the White River or in the Valley of the Colorado River and its tributaries, such as Parachute Creek (Robson and Banta, 1995).

Well yields in the upper aquifer can be up to 300 gallons per minute (gpm), however, 100 gpm is common. Water wells completed in the lower aquifer yield as much as 1,000 gpm, but 200 gpm to 400 gpm are more typical.

Alluvial aquifers are found along the lower sections of the major streams and tributaries. In many places the alluvium may be as much as 40 feet thick and is generally saturated below stream levels. Water well yields of up to 1,500 gpm from the alluvial aquifer have been reported. Water quality in the alluvial aquifers is generally good, and is of sodium bicarbonate type water (Czyewski, 1999).

Groundwater in the Uinta-Animas aquifer in the Piceance Basin is typically sodium bicarbonate type water of fair to good quality. Dissolved solids concentrations in the upper aquifer generally range from about 500 milligrams per liter (mg/L) to more than 1,000 mg/L. Concentrations in the lower aquifer exceed 10,000 mg/L in the central part of the basin where extensive fracturing of the saline zone that underlies the aquifer has enable upward movement of brine (Robson and Banta, 1995).

2.3 Groundwater Wells within a One Mile Radius of the Site

There are only two water well permit numbers associated with multiple monitoring wells located within a one mile radius of the site. Both well sets are monitoring wells owned by Encana. These wells are approximately located as follows:

- Colorado Division of Water Resources Permit # 044233-MH
  SW ¼ SE ¼ Section 10, T5S, R96W (39.624083N; -108.15310232W)
  Estimated depth: 30 feet below ground surface (bgs)

- Colorado Division of Water Resources Permit #051369-MH
  NE ¼ NE ¼ Section 15 T5S, R96W (39.620463N; -108.148414W)
  Estimated depth: 100 feet bgs.

The first well is located to the northwest of the site, in Section 10, and the second well is located to the south of the NP WF A15 596 site. The static water levels are not provided for either of the monitoring wells. There are two other permits for monitoring wells to the south of the site located in the SE ¼ NW ¼ Section 23, T5S, R96W that have a listed total depth of 34 feet bgs, but the wells were reportedly dry at the time of installation.

There are no permitted water supply wells in the immediate vicinity of the site. There are permitted monitoring wells owned by Exxon located to the east further than a mile from the site. These wells are completed in the Uinta and upper Parachute Creek member to total depths ranging from 615 feet to 1,020 feet below top of casing. The static water levels in these wells are listed at 469 feet and 695.10 feet below top of casing. These wells are used to measure groundwater elevations and sampled to assess water quality in conjunction with the reclamation of Exxon's Colony Shale Oil Project mining site on Davis Point.

2.4 Flood Plain Designation

The site is not located within a mapped flood plain. The flood plain map, FP-1, shows the area along the Colorado River and in the vicinity of the town of Parachute. The site is however at risk from flash-floods that could occur if significant rainfall or rapid snowmelt in the upland areas to the northwest and east of the site result in heavy runoff to the West Fork of Parachute Creek.

3.0 SOURCE WATER SUPPLIES, QUALITY, AND USES

The following sections present a discussion of source water supplies, the quality of water based on readily available data, and the identified uses of water in the area of the Site. The 2014 Water Quality Report for the Town of Parachute presented as Attachment C.

3.1 Public Water Supply COGCC Rule 317B

The Site lies at higher elevation and approximately 13 miles northwest of the town of Parachute. There are no water supply wells in the immediate vicinity of the site, and the permitted water wells in the vicinity of the site are used for monitoring groundwater levels and water quality. The West Fork of Parachute Creek is not covered under the COGCC Rule 317B since the Public Water System Surface Water Supply Area Map shows the area for Parachute as being located along the Colorado River east-northeast of town.

3.2 Colorado River Partnership Source Water Protection Plan

Source water protection for the Colorado River Partnership serves five community water systems including the town of New Castle, Talbott Enterprises, the town of Silt, the City of Rifle, and the Town of Parachute. The source water protection plan was developed voluntarily as a tool for the five participating communities to help ensure clean and high quality drinking water for current residents and future generations (Hill and Eiler, 2013).

The drinking water supply protection areas are located within the Colorado River basin to the south of the site. The Colorado River flow is primarily driven by snowmelt with highest flows during spring and early summer runoff. Low flows occur during the fall and early winter when the river flow is fed by groundwater (Hill and Eiler, 2013).

The population of the town of Parachute has fluctuated dramatically in recent years as a result of the variability of natural gas activity in the region. Parachute's drinking water supply operation is unique in that it is the only drinking water system in the partnership that relies on groundwater not associated with the Colorado River alluvium. A portion of the town's water comes from the Revelle Springs located on the southeast of town. According to the January 2013 Source Water Protection Plan for the Colorado River Partnership, the geologic source of these springs is currently unknown (Hill and Elier, 2013).

The Colorado River also supplies a portion of the Town's public water supply, particularly in the summer when water demand is greater. The Colorado River intake is located in the river bed beneath a bridge that crosses between Parachute and Battlement Mesa. Both the river intake and the springs are expected to be up gradient of the confluence with the main branch of Parachute Creek and the Colorado River.

The town of Parachute has an ordinance regulating industrial and other activities to protect the drinking water supplies. The town of Parachute's jurisdiction extends five miles upstream of drinking water intakes on the Revelle Springs and the Colorado River, as well as all waterworks used by the Town. Activities that are permitted, rather than prohibited, are considered using various factors regarding the potential for adverse impact to the town's water resources.

The COGCC has water quality data for a creek sample location in proximity to the site (COGCC sample site ID#707543) for which water quality data was available. The total dissolved solids (TDS) results for samples collected from 2004 to 2006 ranged from 310 mg/L to 420 mg/L. There is water quality data for other creek sampling sites located at the confluence of Light Gulch and the West Fork of Parachute Creek and springs located to the northwest of the site at higher elevation. The available sample results show similar ranges of TDS for the creek samples, and higher TDS, ranging from 460 mg/L to 590 mg/L for the samples collected from springs, which would be indicative of groundwater conditions.

3.3 Water Usage

The surface water in the West Fork of Parachute Creek is used for wildlife and livestock watering. The permitted water wells in the area belong to Encana and are used for groundwater monitoring. There are reportedly a total of four groundwater monitoring wells that were installed at the NP WF A15 596 location. The monitoring wells are reportedly dry in State records, but may contain water during the spring months.

4.0 POTENTIAL IMPACTS TO WATER RESOURCES

Potential sensitive receptors include groundwater and surface water resources within the West Fork of Parachute Creek located to the south and southwest of the Site, and water supplies located down gradient of the Site. Groundwater monitoring wells are present in the vicinity of the Site to assess groundwater conditions.

The Site is located at an elevation of approximately 6,400 feet near a point where the canyon for the West Fork of Parachute Creek broadens. The site is bound by steep canyon walls. There is a low mound of excavated soil and rock on the east side of the facility. If a rock fall or flash-flood occurs there is the potential that produced water from the site could impact surface water in the West Fork of Parachute Creek.

8.0 REFERENCES

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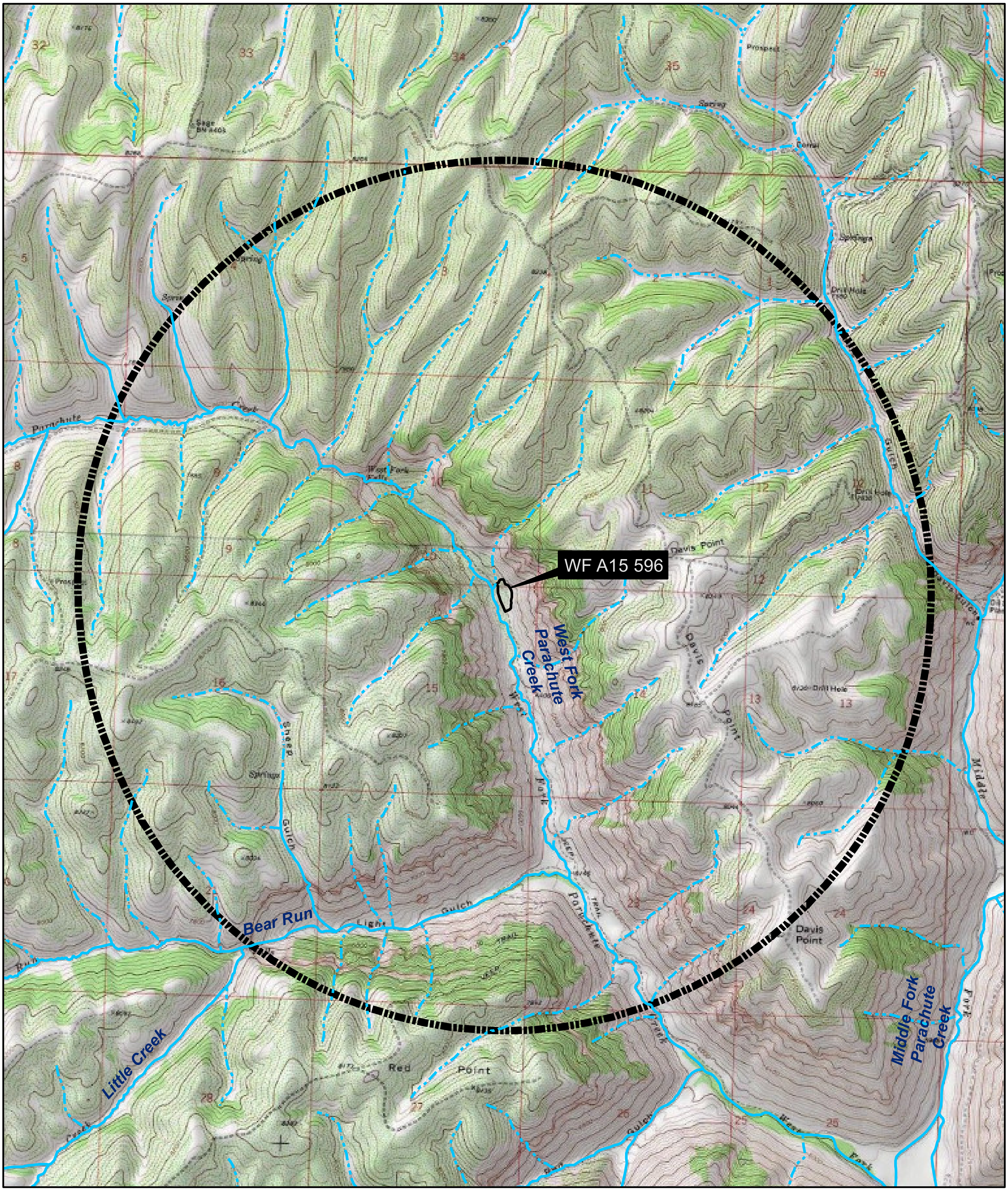
USGS National Hydrologic Dataset
http://nhd.usgs.gov/

Colorado Division of Water Resources database
http://water.state.co.us/Home/Pages/default.aspx

United States Department of Agriculture (USDA) – Natural Resource Conservation Service.
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/home

Colorado Oil and Gas Conservation Commission (COGCC)
http://cogcc.state.co.us/

FIGURES



Legend

- Perennial Stream
- Intermittent Stream
- WF A15 596
- 2 Mile Buffer

Surface Water Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

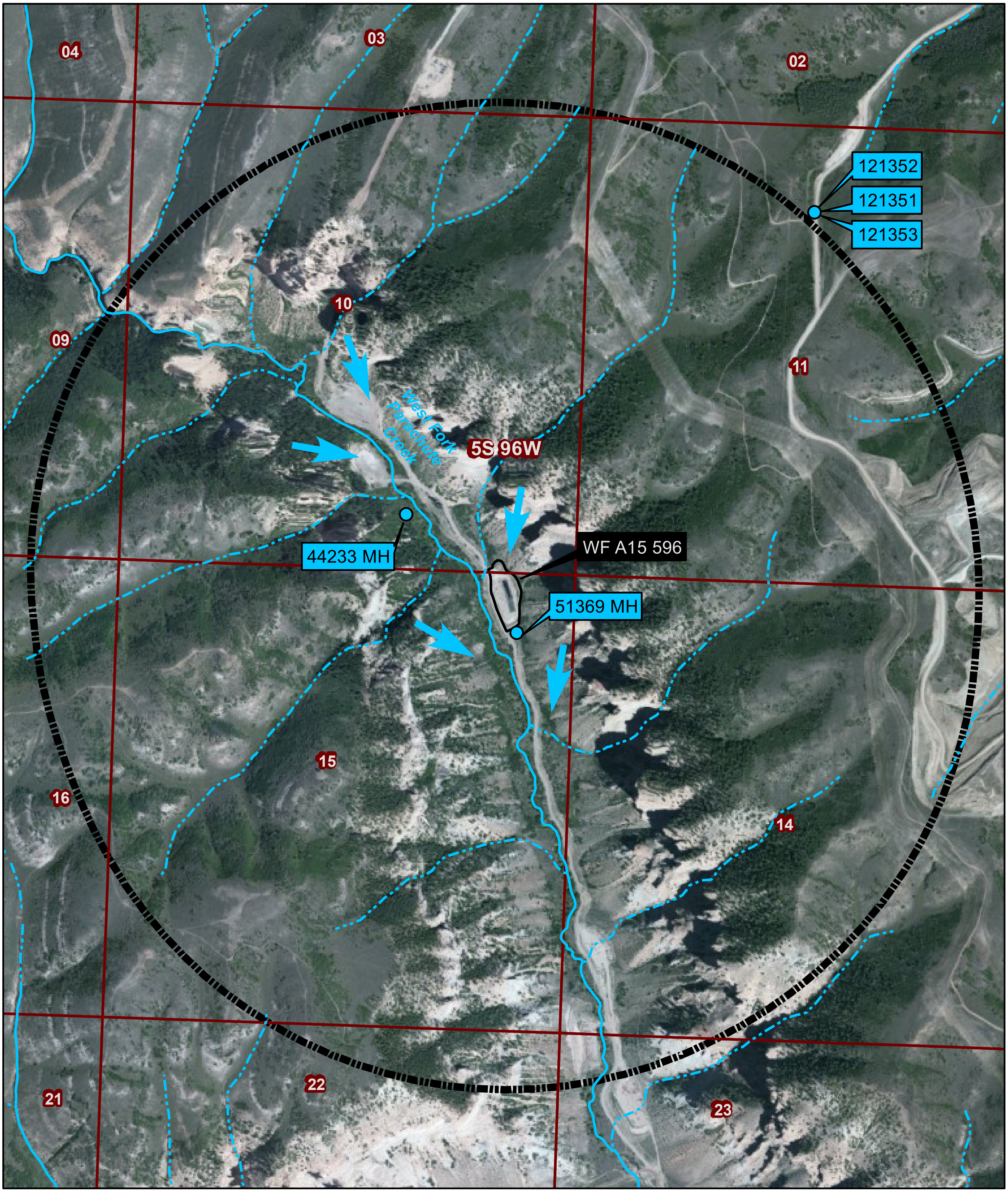
0 0.5 1 Miles

N

Figure SW-1

encana

F:\Projects\014-0455\GIS\MXD\SW-1 Surface Water Map.mxd



Legend

Groundwater Flow Direction

CDWR Water Well Application

Perennial Stream

Intermittent Stream

WF A15 596

1 Mile Buffer

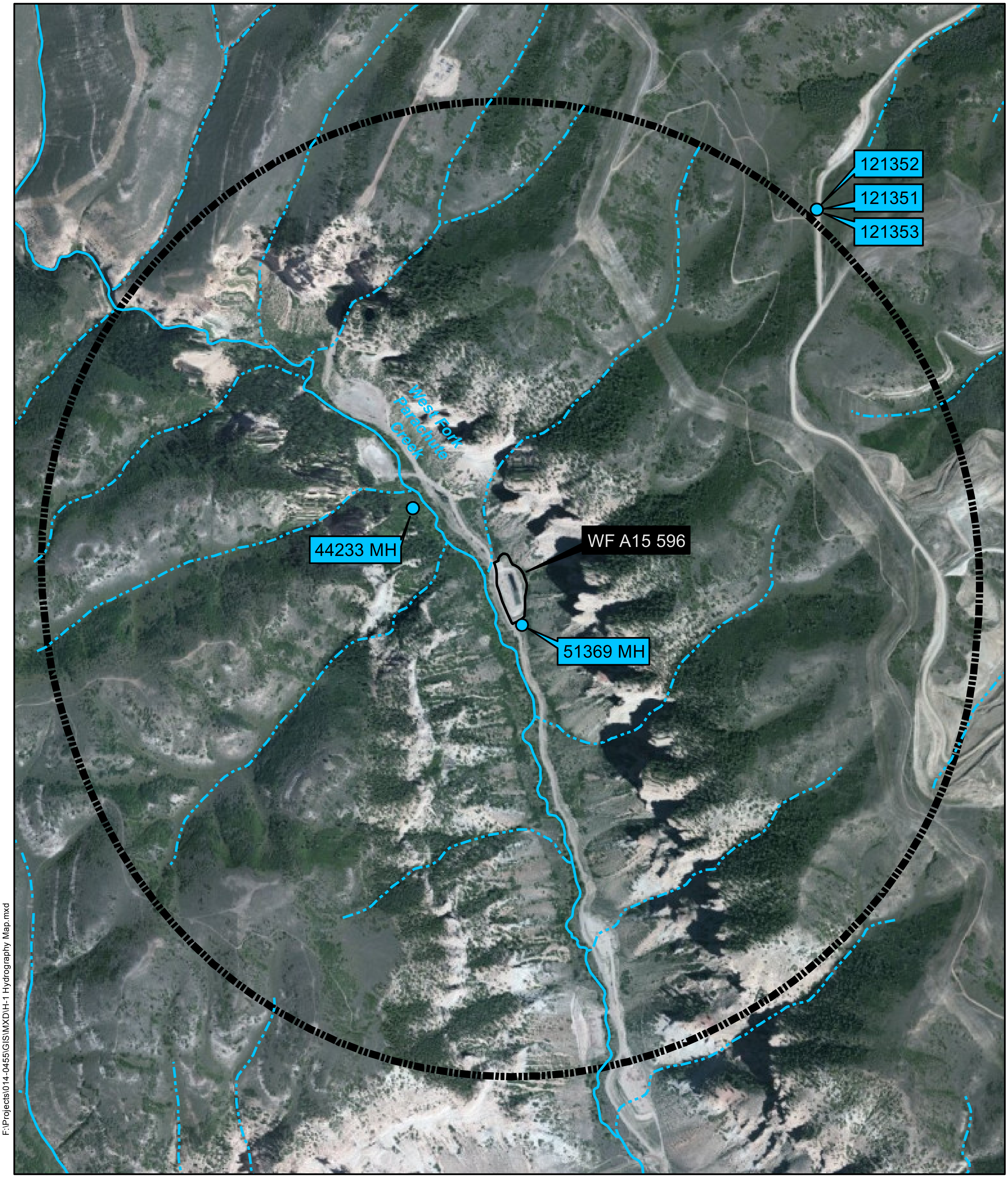
Groundwater Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

0 0.25 0.5 Miles

N

Figure GW-1

encana



Legend

- CDWR Water Well Application
- Perennial Stream
- Intermittent Stream
- WF A15 596
- 1 Mile Buffer

Hydrography Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

0 0.25 0.5 Miles

N

Figure H-1

encana natural gas

F:\Projects\014-0455\GIS\MXD\S-1 Soils Map.mxd

Legend

WF A15 596

NRCS Soils

Nihill channery loam, 6 to 25 percent slopes

Rock outcrop-Torriorthents complex, very steep

Soils Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

0 100 200 Feet

N

Figure S-1

encana

Legend

WF A15 596

Surficial Geology

- Tgl Green River Formation, Lower part
- Tgp Green River Formation, Parachute Creek Member
- Tu Uinta Formation

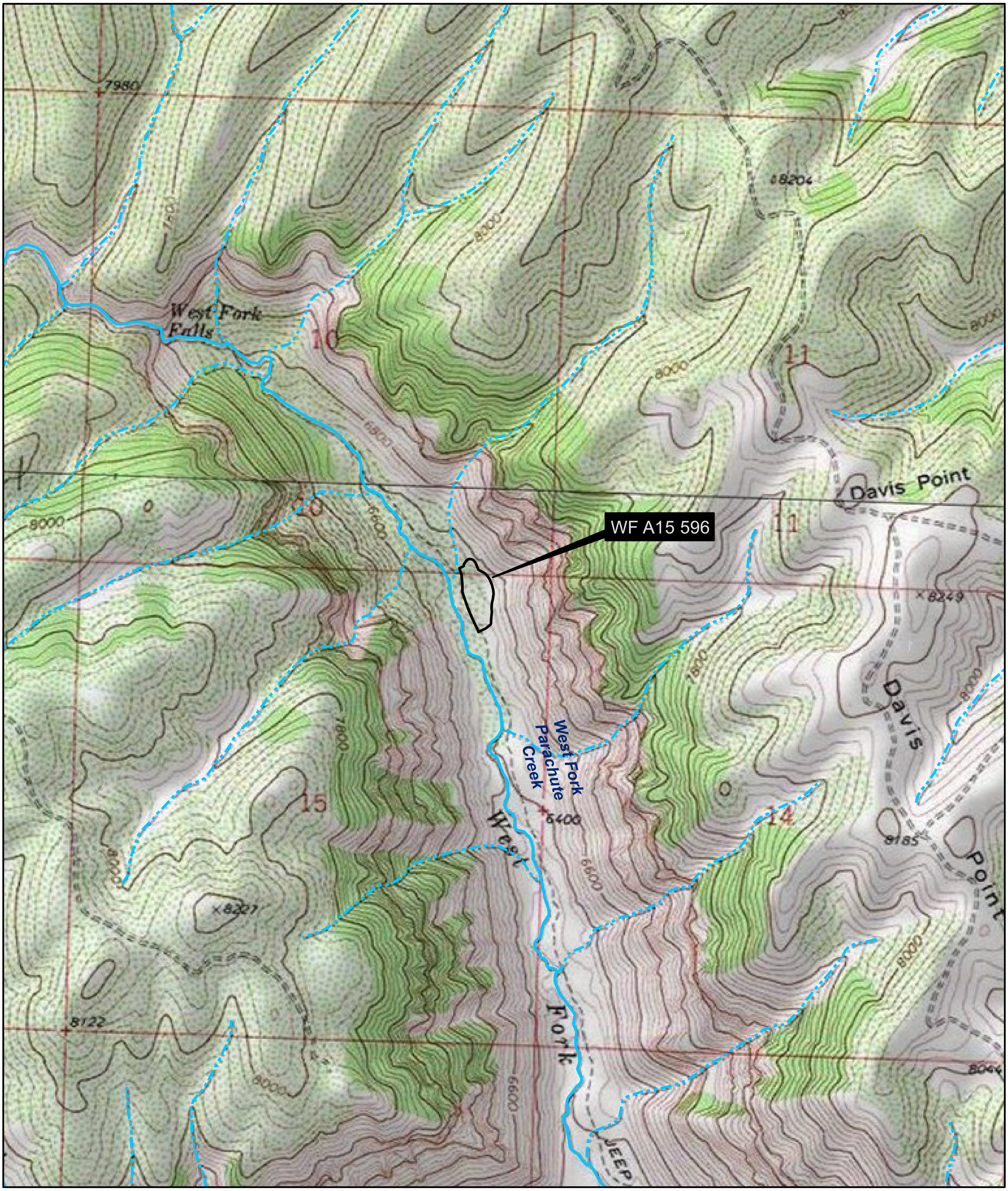
Surficial Geology Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

0 0.25 0.5 Miles

N

Figure G-1

encana



F:\Projects\014-0455\GIS\MXD\T-1 Topographic Site Map.mxd

Legend

Perennial Stream

Intermittent Stream

WF A15 596

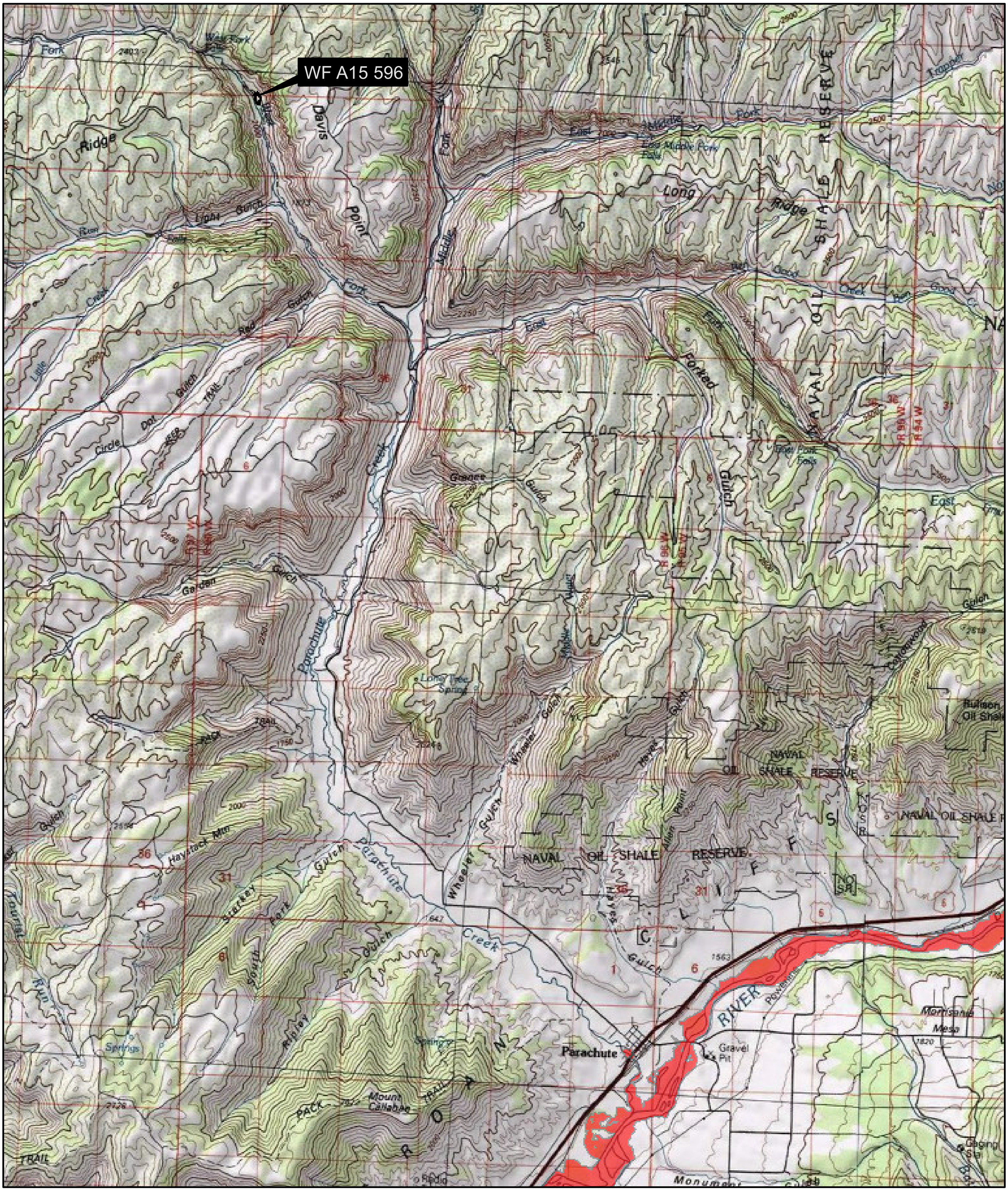
0 0.5 1 Miles

N

Topographic Site Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

Figure T-1

encana



F:\Projects\014-0455\GIS\MXD\FP-1 Flood Plain Map.mxd

Legend

WF A15 596

100/500 Year Flood Plain

Flood Plain Map
WF A15 596 Pit
Garfield County, CO
Encana Oil & Gas (USA), Inc.

0 1 2 Miles

N

Figure FP-1

encana

ATTACHMENT A

CUSTOM SOIL RESOURCE REPORT

United States Department of Agriculture

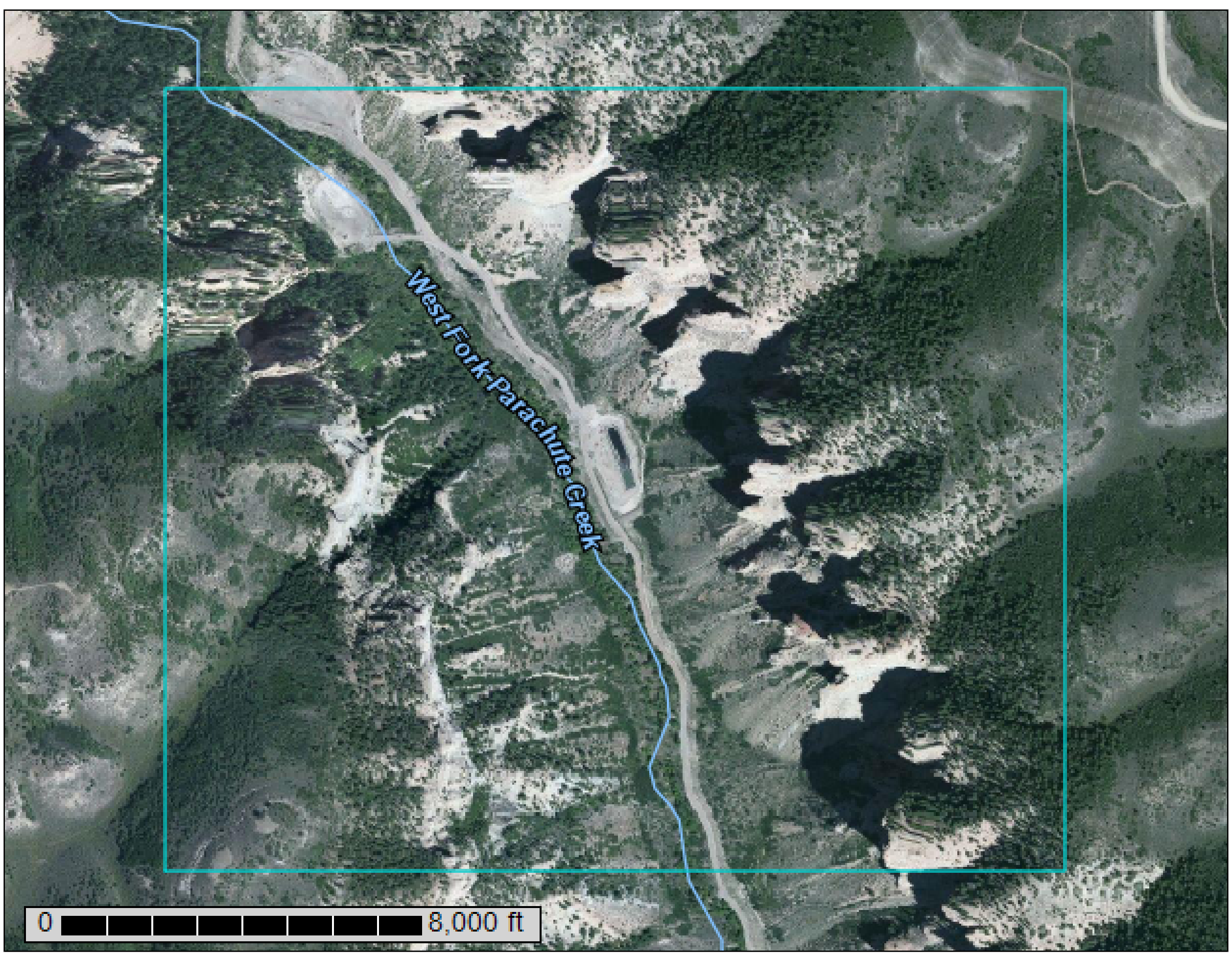
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Rifle Area, Colorado, Parts of Garfield and Mesa Counties

Encana A15 location



August 7, 2014

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

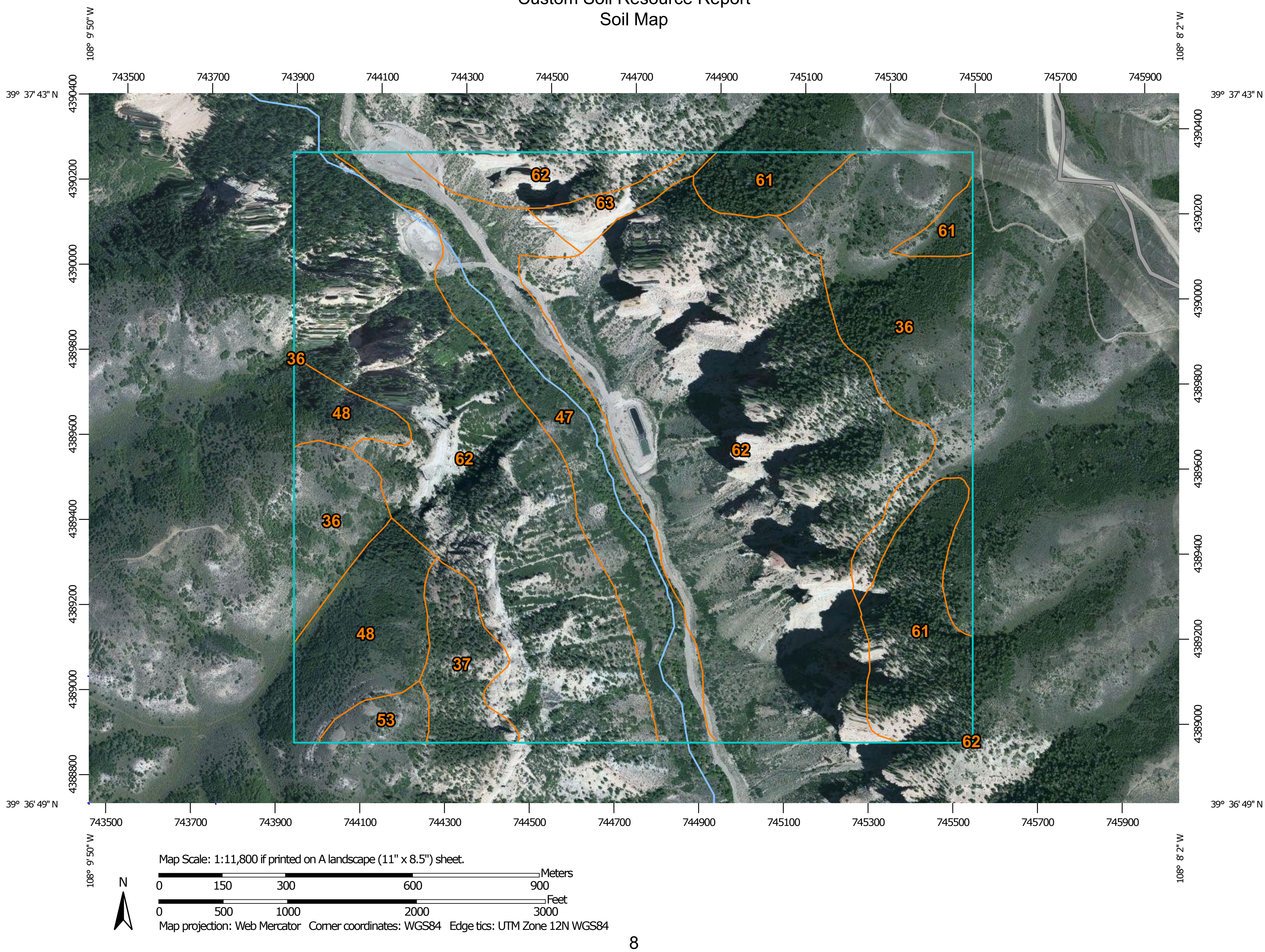
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:11,800 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Rifle Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 7, Dec 23, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 22, 2010—Sep 2, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Rifle Area, Colorado, Parts of Garfield and Mesa Counties (CO683)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
36	Irigul channery loam, 9 to 50 percent slopes	75.3	13.7%
37	Irigul channery loam, 50 to 75 percent slopes	15.7	2.8%
47	Nihill channery loam, 6 to 25 percent slopes	58.4	10.6%
48	Northwater loam, 15 to 65 percent slopes	34.8	6.3%
53	Parachute-Rhone loams, 5 to 30 percent slopes	6.0	1.1%
61	Rhone loam, 30 to 70 percent slopes	43.6	7.9%
62	Rock outcrop-Torriorthents complex, very steep	310.7	56.3%
63	Silas loam, 3 to 12 percent slopes	7.1	1.3%
Totals for Area of Interest		**551.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Rifle Area, Colorado, Parts of Garfield and Mesa Counties

36—Irigul channery loam, 9 to 50 percent slopes

Map Unit Setting

National map unit symbol: jny2
Elevation: 7,800 to 8,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Irigul and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Irigul

Setting

Landform: Ridges, mountainsides
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Marl and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 6 inches: channery loam
H2 - 6 to 17 inches: extremely channery sandy clay loam
H3 - 17 to 21 inches: unweathered bedrock

Properties and qualities

Slope: 9 to 50 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Loamy slopes (R048AY303CO)

37—Irigul channery loam, 50 to 75 percent slopes

Map Unit Setting

National map unit symbol: jny3
Elevation: 7,800 to 8,700 feet

Farmland classification: Not prime farmland

Map Unit Composition

Irigul and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Irigul

Setting

Landform: Mountainsides, ridges
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Marl and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 6 inches: channery loam
H2 - 6 to 17 inches: extremely channery sandy clay loam
H3 - 17 to 21 inches: unweathered bedrock

Properties and qualities

Slope: 50 to 75 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D

47—Nihill channery loam, 6 to 25 percent slopes

Map Unit Setting

National map unit symbol: jnyg
Elevation: 5,000 to 6,500 feet
Farmland classification: Not prime farmland

Map Unit Composition

Nihill and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nihill

Setting

Landform: Valley sides, alluvial fans

Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Alluvium derived from sandstone and shale

Typical profile

H1 - 0 to 11 inches: channery loam
H2 - 11 to 18 inches: very channery loam
H3 - 18 to 60 inches: stratified extremely channery sandy loam to extremely channery loam

Properties and qualities

Slope: 6 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Rolling loam (R048AY298CO)

48—Northwater loam, 15 to 65 percent slopes

Map Unit Setting

National map unit symbol: jnyh
Elevation: 7,600 to 8,400 feet
Farmland classification: Not prime farmland

Map Unit Composition

Northwater and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Northwater

Setting

Landform: Mountainsides
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from sedimentary rock

Typical profile

H1 - 0 to 25 inches: loam

H2 - 25 to 50 inches: very channery clay loam
H3 - 50 to 54 inches: unweathered bedrock

Properties and qualities

Slope: 15 to 65 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C

53—Parachute-Rhone loams, 5 to 30 percent slopes

Map Unit Setting

National map unit symbol: jnyp
Elevation: 7,600 to 8,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Parachute and similar soils: 55 percent
Rhone and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Parachute

Setting

Landform: Mountainsides, ridges
Landform position (three-dimensional): Mountainflank, mountaintop
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Marl and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 5 inches: loam
H2 - 5 to 18 inches: loam
H3 - 18 to 29 inches: extremely channery loam
H4 - 29 to 33 inches: unweathered bedrock

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Mountain loam (R048AY228CO)

Description of Rhone

Setting

Landform: Ridges, mountainsides
Landform position (three-dimensional): Mountaintop, mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Marl and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 28 inches: sandy clay loam
H3 - 28 to 52 inches: very channery sandy clay loam
H4 - 52 to 56 inches: unweathered bedrock

Properties and qualities

Slope: 5 to 20 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Mountain loam (R048AY228CO)

61—Rhone loam, 30 to 70 percent slopes

Map Unit Setting

National map unit symbol: jnyz
Elevation: 7,600 to 8,600 feet

Farmland classification: Not prime farmland

Map Unit Composition

Rhone and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rhone

Setting

Landform: Mountainsides, ridges
Landform position (three-dimensional): Mountainflank, mountaintop
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Marl and/or residuum weathered from sandstone

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 28 inches: sandy clay loam
H3 - 28 to 52 inches: very channery sandy clay loam
H4 - 52 to 56 inches: unweathered bedrock

Properties and qualities

Slope: 30 to 70 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: Brushy loam (R048AY238CO)

62—Rock outcrop-Torriorthents complex, very steep

Map Unit Setting

National map unit symbol: jnz0
Elevation: 5,800 to 8,500 feet
Mean annual precipitation: 10 to 15 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 80 to 105 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 65 percent
Torriorthents and similar soils: 30 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Setting

Landform: Hillslopes, plateaus, escarpments
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Free face
Down-slope shape: Convex, concave
Across-slope shape: Convex, concave
Parent material: Very stony colluvium derived from calcareous shale

Typical profile

H1 - 0 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 50 to 80 percent
Depth to restrictive feature: 0 inches to paralithic bedrock
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Description of Torriorthents

Setting

Landform: Plateaus, hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Free face
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium derived from calcareous shale

Typical profile

H1 - 0 to 4 inches: variable
H2 - 4 to 30 inches: fine sandy loam
H3 - 30 to 34 inches: unweathered bedrock

Properties and qualities

Slope: 50 to 80 percent
Depth to restrictive feature: 4 to 30 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8e
Hydrologic Soil Group: D

63—Silas loam, 3 to 12 percent slopes

Map Unit Setting

National map unit symbol: jnz1
Elevation: 7,600 to 8,300 feet
Farmland classification: Not prime farmland

Map Unit Composition

Silas and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Silas

Setting

Landform: Valley floors
Landform position (three-dimensional): Lower third of mountainflank
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Marl and/or alluvium derived from sandstone

Typical profile

H1 - 0 to 14 inches: loam
H2 - 14 to 60 inches: loam

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Mountain swale (R048AY245CO)

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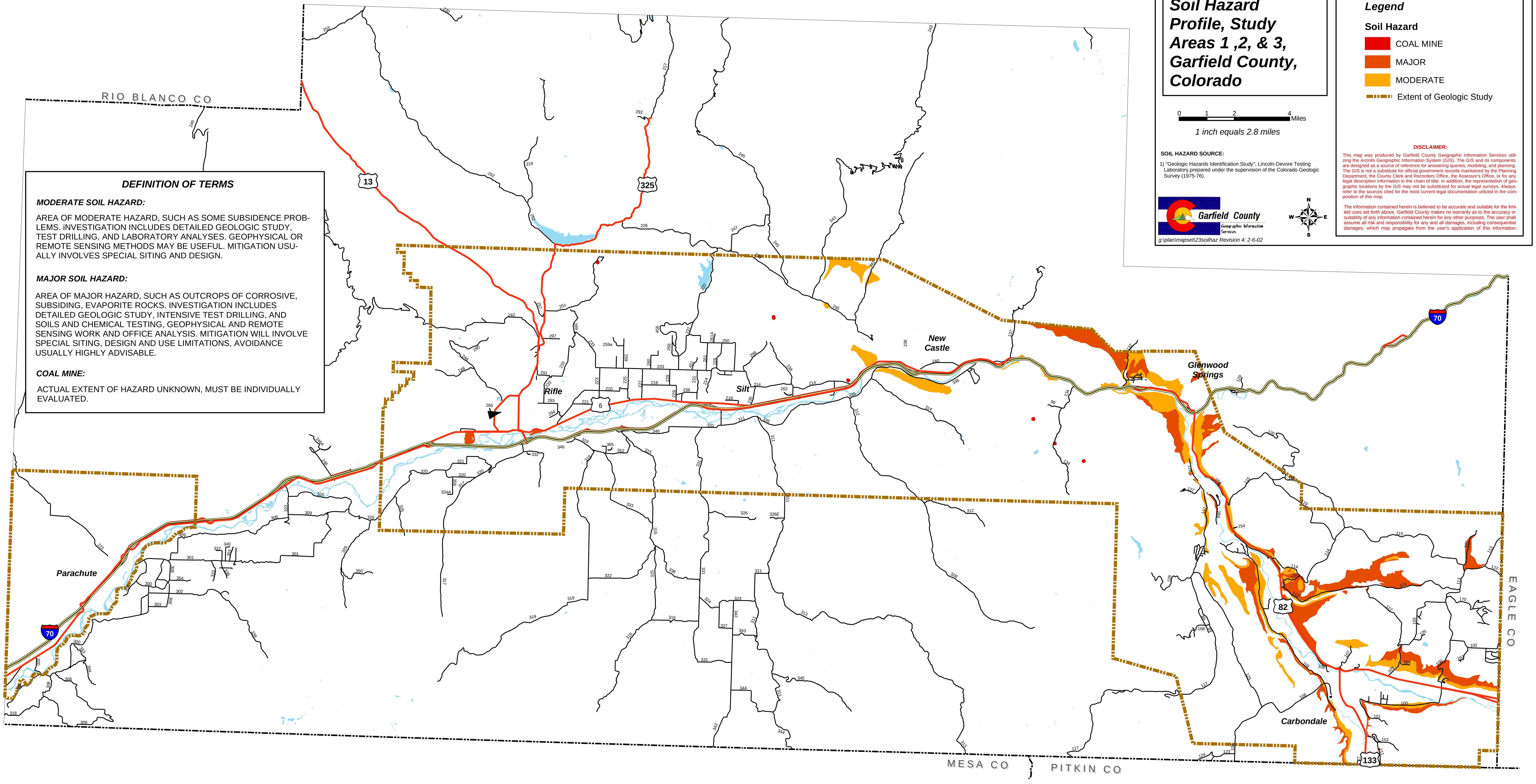
ATTACHMENT B

GARFIELD COUNTY

GEOLOGIC HAZARD MAPS

Soil Hazard Profile, Study Areas 1 ,2, & 3, Garfield County, Colorado



DEFINITION OF TERMS

MODERATE SOIL HAZARD:

AREA OF MODERATE HAZARD, SUCH AS SOME SUBSIDENCE PROBLEMS. INVESTIGATION INCLUDES DETAILED GEOLOGIC STUDY, TEST DRILLING, AND LABORATORY ANALYSES. GEOPHYSICAL OR REMOTE SENSING METHODS MAY BE USEFUL. MITIGATION USUALLY INVOLVES SPECIAL SITING AND DESIGN.

MAJOR SOIL HAZARD:

AREA OF MAJOR HAZARD, SUCH AS OUTCROPS OF CORROSIVE, SUBSIDING, EVAPORITE ROCKS. INVESTIGATION INCLUDES DETAILED GEOLOGIC STUDY, INTENSIVE TEST DRILLING, AND SOILS AND CHEMICAL TESTING, GEOPHYSICAL AND REMOTE SENSING WORK AND OFFICE ANALYSIS. MITIGATION WILL INVOLVE SPECIAL SITING, DESIGN AND USE LIMITATIONS, AVOIDANCE USUALLY HIGHLY ADVISABLE.

COAL MINE:

ACTUAL EXTENT OF HAZARD UNKNOWN, MUST BE INDIVIDUALLY EVALUATED.

Legend

Soil Hazard

- COAL MINE
- MAJOR
- MODERATE
- Extent of Geologic Study

SOIL HAZARD SOURCE:

1) "Geologic Hazards Identification Study", Lincoln-Devore Testing Laboratory,prepared under the supervision of the Colorado Geologic Survey (1975-76).

Garfield County Geographic Information Services

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Slope Hazard Study Areas 1, 2, & 3, Garfield County, Colorado

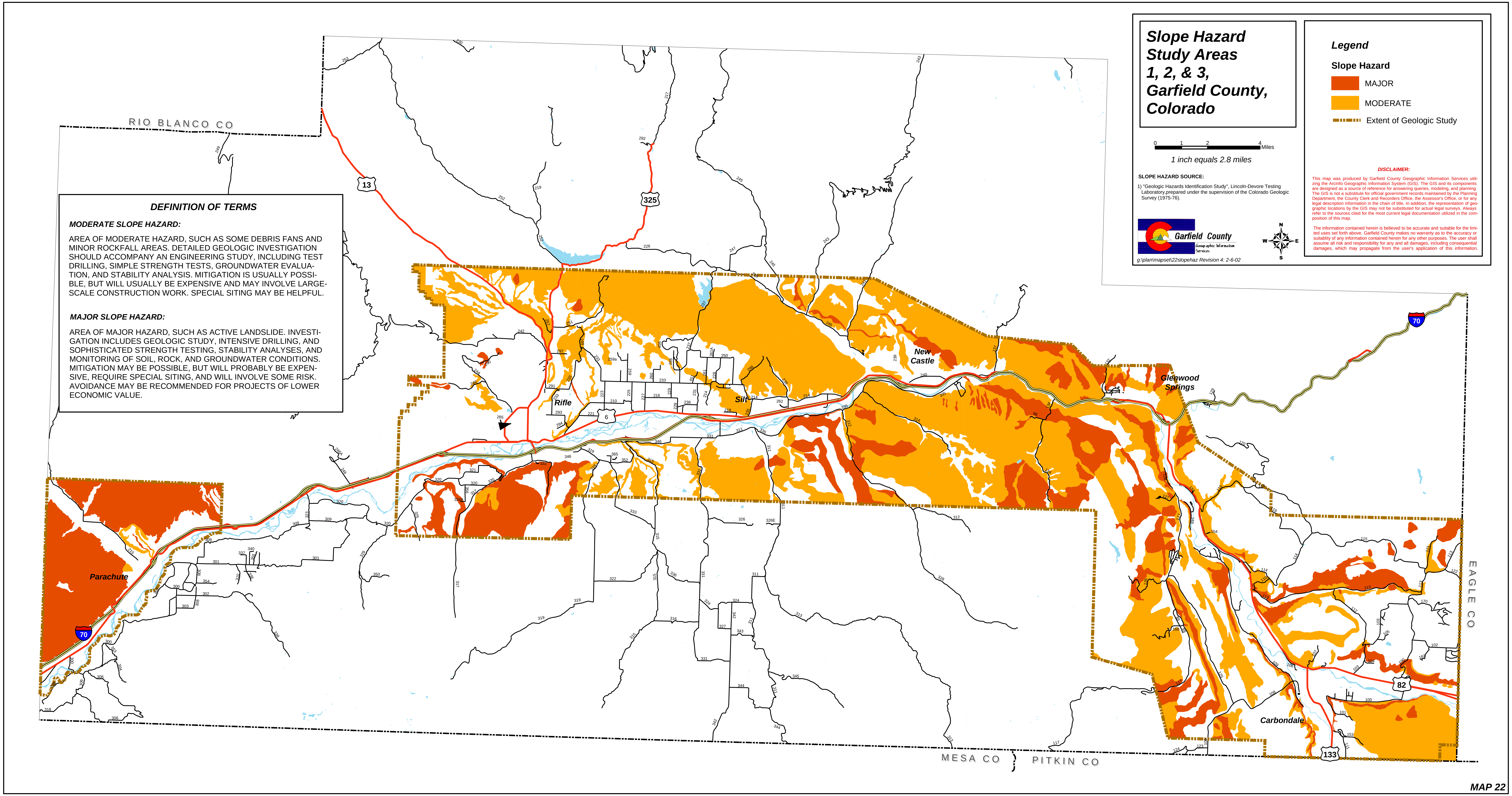
DEFINITION OF TERMS

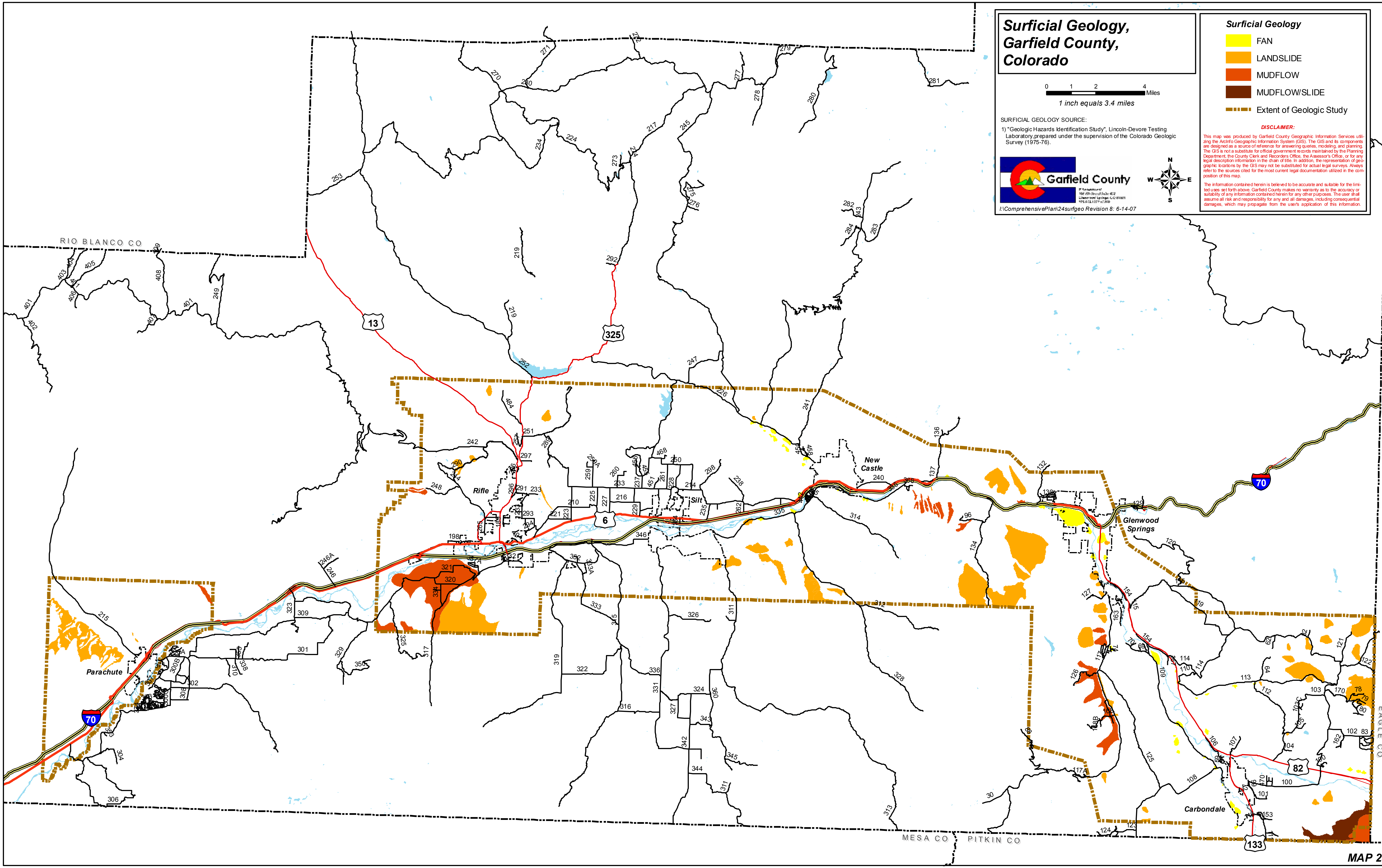
MODERATE SLOPE HAZARD:

AREA OF MODERATE HAZARD, SUCH AS SOME DEBRIS FANS AND MINOR ROCKFALL AREAS. DETAILED GEOLOGIC INVESTIGATION SHOULD ACCOMPANY AN ENGINEERING STUDY, INCLUDING TEST DRILLING, SIMPLE STRENGTH TESTS, GROUNDWATER EVALUATION, AND STABILITY ANALYSIS. MITIGATION IS USUALLY POSSIBLE, BUT WILL USUALLY BE EXPENSIVE AND MAY INVOLVE LARGE-SCALE CONSTRUCTION WORK. SPECIAL SITING MAY BE HELPFUL.

MAJOR SLOPE HAZARD:

AREA OF MAJOR HAZARD, SUCH AS ACTIVE LANDSLIDE. INVESTIGATION INCLUDES GEOLOGIC STUDY, INTENSIVE DRILLING, AND SOPHISTICATED STRENGTH TESTING, STABILITY ANALYSES, AND MONITORING OF SOIL, ROCK, AND GROUNDWATER CONDITIONS. MITIGATION MAY BE POSSIBLE, BUT WILL PROBABLY BE EXPENSIVE, REQUIRE SPECIAL SITING, AND WILL INVOLVE SOME RISK. AVOIDANCE MAY BE RECOMMENDED FOR PROJECTS OF LOWER ECONOMIC VALUE.




Surficial Geology, Garfield County, Colorado
0 1 2 4 Miles
1 inch equals 3.4 miles
SURFICIAL GEOLOGY SOURCE:
1) "Geologic Hazards Identification Study", Lincoln-Devore Testing Laboratory,prepared under the supervision of the Colorado Geologic Survey (1975-76).
Garfield County
N S E W
I:\ComprehensivePlan\24surfgeo Revision 8: 6-14-07
Surficial Geology
FAN
LANDSLIDE
MUDFLOW
MUDFLOW/SLIDE
Extent of Geologic Study
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RIO BLANCO CO
MESA CO
PITKIN CO
EAGLE CO
Rifle
Silt
New Castle
Glenwood Springs
Parachute
Carbondale
13
325
6
70
82
133
MAP 24