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GEOLOGICAL HAZARDS STUDY
PROPOSED USAFA EUL DEVELOPMENT
NORTHGATE BOULEVARD WEST OF INTERSTATE 25
UNITED STATES AIR FORCE ACADEMY
EL PASO COUNTY, COLORADO

PROJECT NO. 18-2-219

AUGUST 31, 2018

PREPARED FOR:

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a Geological Hazards Study for the proposed United States Air Force Academy Enhanced Use Lease Project (USAFA EUL) development to be located to the north and south of Northgate Boulevard, west of Interstate 25 in El Paso County, Colorado. The project site is shown on Figure 1. The purpose of the study was to evaluate the geologic conditions and their potential impact on the project. The study was conducted in accordance with our proposal for engineering geology services to Blue and Silver Development Partners, LLC, dated August 21, 2018.

A reconnaissance of the project site was conducted on August 27, 2018 to obtain information on the geologic conditions. Aerial photographs and published regional geologic, engineering geology, and mineral extraction maps were also reviewed. This report summarizes the data obtained during this study and presents our conclusions, recommendations, and other geologic considerations based on the proposed construction and geologic conditions observed.

PROPOSED DEVELOPMENT

We understand the proposed construction will include development of approximately 57 acres of mostly vacant land, to include roughly 11 acres of visitor center, 12 acres of hotel, 6 acres of commercial retail, 9 acres of office development, and 19 acres for future development. Associated asphalt-paved drive lanes and parking lots will loop throughout the property. Site grading is anticipated to be substantial, with cuts and fills up to around 20 feet. There is currently a small parking area on the north side of Northgate Boulevard at the trailhead of the Santa Fe Regional Trail. The trailhead is proposed to be relocated to the southeastern corner of the proposed development. Northgate Boulevard, which bisects the property, and the entrance gate to the United States Air Force Academy within this area is not included in the subject property. We understand that the geological hazards study is required for the submittal for annexation of the property to The City of Colorado Springs and for additional entitlement processing.

If development plans change significantly from those described, we should be notified to re-evaluate the recommendations presented in this report.

SITE CONDITIONS

The proposed USAFA EUL development consists of about 57 acres located in parts of the NESW, SESW, and SWSE portions of Section 1, T12S, R67W and parts of the NENW, NWNE, SENW, and SWNE portions of Section 12, T12S, R67W. The project site is currently vacant. Northgate Boulevard bisects the southern portion of the property. This road and the entrance gate to the USAFA are not included in the subject property. A gravel surfaced road runs along the eastern edge of the subject site, just outside the property line. The site is bordered to the west by Monument Creek and to the south by Smith Creek. The Aardvark Auxiliary Airfield is to the north of the subject site.

The terrain in the north part of the site, in the future development area, is valley bottom with variable slopes ranging from around 15 to 25 percent, generally down to the southwest. Vegetation consists of native grass and weeds, scattered brush, patches of water plants and thistles, and scattered mature conifers in the upper elevations. There are multiple moderately sized drainages trending generally to the southwest toward Monument Creek in this area. Multiple areas of possible minor seasonal water seepage were observed in these drainages indicated by cat-tails and water plants. No flowing or standing water was observed at the time of our site visit. No signs of ground bulging, cracking, or other indicators of slope movement were observed in this area.

The terrain in the area south of the future development area and in the area of the proposed visitor center and indoor skydiving facility is valley bottom with slopes around 5 to 10 percent generally down to the southwest. Vegetation consists of native grass and weeds, scattered brush, scattered small conifers, and small cacti. A few shallow natural drainages are scattered throughout this area. No signs of water seepage, ground bulging, cracking, or other indicators of slope movement were observed in this area.

The terrain in the area of the proposed retail development and existing parking area consists of a relatively flat, man-placed fill area. There is a fill slope down to the west along the western edge of the proposed retail development. Vegetation in this area consists of native grass and weeds with sparse conifers along the fill slope. The existing fill should be evaluated for suitability for support of foundations during the geotechnical study portion of the development.

The terrain in the area of the two proposed hotels and central parking area is valley bottom with slopes around 5 to 10 percent down to the west. Vegetation consists of native grass and weeds, scattered brush, scattered cactus, and patches of thick, moderately mature scrub oak in the natural drainages. Water plants were observed to be growing along the natural drainage. Water was flowing in the bottom of the drainage at the time of observation. Indications of possible seasonal perched groundwater were observed near the natural drainage. No signs of ground bulging, cracking or other indicators of slope movement were observed.

The terrain in the area of the proposed office development is valley bottom with slopes around 5 to 10 percent down to the southwest. Vegetation consists of thick native grass and weeds with very scattered scrub oak and very scattered yucca plants. Signs of possible minor seasonal seepage were observed in this area below the natural drainage to the east. No signs of slope instability were observed in this area.

The terrain in the area of the proposed trailhead and trailhead parking development consists of variable slopes from about 5 to 20 percent. There is a small natural drainage near the center of the proposed parking area. Vegetation consists of native grass and weeds, cactus, and scattered scrub oak. No signs of water seepage, ground bulging, cracking, or other indicators of slope movement were observed in this area.

GEOLOGIC SETTING

The main geologic features in the project area are shown on Figure 4. This map is based on the published regional map by Madole and Thorson (2003).

The project site is predominately underlain by Paleocene-age Facies Unit 3 of the Dawson Formation (TKda3). Facies Unit 3 of the Dawson Formation consists of thickly bedded and cross-bedded white, tan, and light-grey arkosic and pebbly-arkosic sandstone with interbedded light-green to dark grey micaceous and feldspathic clayey sandstones and sandy claystones. Facies Unit 3 of the Dawson Formation is around 200 to 400 feet thick with bedding generally dipping around 5 degrees to the north (Madole and Thorson, 2002).

Surficial deposits at the project site predominately consist of middle Pleistocene-age alluvial slope deposits (Qas2). These alluvial slope deposits are thin beds of pale-brown to brown poorly

sorted sand and sandy pebble gravel that were deposited by sheetwash and streams. The estimated thickness of these deposits ranges from around 5 to 40 feet. Holocene- and late Pleistocene-age terrace alluvium (Qt1) can be found in the extreme southern end of the project site. This material consists of around 5 to 35 feet of pale-brown and brown to greyish-brown beds of sand, silty sand, sandy silt, clayey silt, and gravel (Madole and Thorson, 2002).

There is a large amount of man placed, artificial fill (af) in the area of the USAFA gate along Northgate Boulevard and in the area of the existing trailhead parking area.

GEOLOGIC SITE ASSESSMENT

The project site geology should not present major constraints or unusually high risks to the proposed development. There are, however, several conditions of a geologic nature that should be considered. Geologic conditions that should be considered, their potential risks, and mitigations to reduce the potential risks are discussed below. The site could experience moderate levels of earthquake related ground shaking. Foundation bearing conditions at building sites and pavement section areas should be evaluated by site-specific geotechnical engineering studies.

POTENTIAL FLOODING

According to the “Flood Insurance Rate Map”, map number 08041C0290F by the Federal Emergency Management Agency (FEMA, 1997); the site is in Zone D (unshaded – areas in which flood hazards are undetermined). The edges of the development area are around 30 to 40 feet higher in elevation than Monument Creek and around 10 to 15 feet higher in elevation than Smith Creek. No signs of high water from either of these creeks was observed within the proposed development area, however, designating the 100-year flood plain at the project site is beyond the scope of this study. The project civil engineer should evaluate the site hydrology and any potential for impact by stream flooding.

HEADWARD ERODING GULLIES

The progression of the headward eroding features on this site are anticipated to continue if not mitigated by site grading, landscaping or other means. If site development concentrates surface

water flow over these features, accelerated erosion of the gullies should be expected and the project civil engineer should evaluate possible methods to mitigate potential for erosion.

SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE

Indications of possible seasonally shallow groundwater were observed in the proposed future development area, the proposed hotel areas, and the proposed office areas. These areas should be evaluated for seepage during the spring runoff. If seepage is encountered, it may need to be collected and diverted away from structures and roadways.

PRE-EXISTING MAN-PLACED FILL

The area of proposed commercial retail development and the area in between proposed hotel development and proposed retail development contains pre-existing man-placed fill. The suitability of the pre-existing man-placed fill for foundation support and any other grading and construction uses should be evaluated during the geotechnical study portion of the development.

EXPANSIVE/COLLAPSIBLE SOILS AND BEDROCK

The Dawson Formation commonly contains layers of expansive claystone. Swell/consolidation characteristics of the soil and bedrock are expected to vary across the subject site. The surficial alluvial slope deposits are not anticipated to exhibit swell potential. Shallow foundations supported by expansive soil or bedrock, or collapsible soils may experience movement causing structural distress. Analysis of the swell/consolidation potential of the site soils and bedrock should be evaluated in the geotechnical evaluation for the proposed development.

SUBSURFACE MINING

The Colorado Geological Survey does not show any mining features on or in the vicinity of the subject site.

SEISMICITY

The Rampart Range Fault, a high-angle generally north-south trending reverse fault, is mapped approximately 3.5 miles west of the site. According to Widmann, Kirkham, and Rogers (1998),

there is evidence that the Rampart Range Fault may have moved between 600,000 and 30,000 years ago.

For *firm rock sites* with shear wave velocities of 2,500 fps in the upper 100 feet, the U. S. Geological Survey 2014 National Seismic Hazard Maps indicates that a peak ground acceleration of 0.03g has a 10% exceedance probability for a 50-year exposure time and a peak ground acceleration of 0.10g has a 2% exceedance probability for a 50-year exposure time at the project site (Peterson and Others, 2014). This corresponds to a statistical recurrence time of about 500 years and 2,500 years, respectively. It is our opinion that the seismic soil profile at the project site should be considered as Class D, *stiff soil sites*, as described in the 2015 International Building Code unless site specific shear wave velocity studies show otherwise.

RADIOACTIVE GASES

According to the Environmental Protection Agency (EPA) and the El Paso County Department of Health, elevated levels of radon gas (4 pCi/L or more) have been found in buildings in El Paso County. Radon is a radioactive gas that forms from the natural breakdown of uranium in soil, rock, and water. Radon tends to accumulate in poorly ventilated areas below ground level; however, radon may accumulate inside any above or below-grade construction. According to the EPA, radon levels in buildings can be reduced by several methods, including pressurization of the building using a heating, ventilation and air-conditioning system, sealing of cracks in foundation walls and floor slabs which may allow entry of radon, and using active soil depressurization (ASD) systems.

SLOPES GREATER THAN 30 PERCENT

Some of the edges of the larger drainages in the northern portion of the development area exceed 30 percent. These slopes appear to be stable and no signs of recent movement were observed. Signs of seasonal seepage were observed scattered throughout the area. The steep slope and seepage areas should be evaluated for possible mitigation methods as part of the site specific geotechnical studies for the proposed development.

POTENTIAL MINERAL RESOURCES

According to the "El Paso County- Aggregate Resource Evaluation Maps, El Paso County – Master Plan for Mineral Extraction" (1996), the site is designated as 'Military Base' and no aggregate resources are indicated. The United States Department of Agriculture Natural Resource Conservation Service (NRCS) Web Soil Survey shows the site overlain with the Kettle-Rock outcrop complex, the Pring coarse sandy loam, and the Tomah-Crowfoot complex. The NRCS classifies the Kettle-Rock outcrop complex as Fair suitability as a gravel source, Fair suitability as a sand source, and Fair suitability as a roadfill source. The NRCS classifies the Pring coarse sandy loam as Poor suitability as a gravel source, Fair suitability as a sand source, and Good suitability as a roadfill source. The NRCS classifies the Tomah-Crowfoot complex as Poor suitability as a gravel source, Fair suitability as a sand source, and Good suitability as a roadfill source. The Pring sandy loam and the Tomah-Crowfoot complex soils will likely be acceptable for use as fill material required for site grading and construction but should be evaluated for suitability during the geotechnical study portion of the development. Evaluation of commercial feasibility of gravel, sand, or roadfill mining on the subject site is beyond the scope of this study.

DEVELOPMENT CONSIDERATIONS

Presented below is a discussion of geologic and geotechnical engineering related development considerations, including identified geologic hazards.

POTENTIAL FLOODING

We recommend that the drainage gullies located adjacent to or upslope of proposed building areas and roadways be infilled or re-graded, and revegetated to prohibit flooding.

HEADWARD ERODING GULLIES

The incised drainage gullies on the site should be protected from further accelerated headward erosion. It may be feasible for accelerated erosion to be mitigated by infilling or re-grading the slopes to 3:1 (horizontal to vertical) or flatter, and revegetating the new slopes. It appears that

the proposed development areas are located near the tops of these features and grading and filling in these areas is proposed, which should result in mitigation of the accelerated erosion.

SLOPES GREATER THAN 30 PERCENT

Based on our review of the current site conditions, the information provided, and our experience in the area, the proposed building sites are feasible from a geotechnical viewpoint. The steep slopes around the edges of the larger drainages in the northern part of the site appear stable and should not be adversely affected by the proposed development if the site grading recommendations bellow are followed.

SITE GRADING

Embankment fills outside of building and movement sensitive structures should be compacted to at least 95% of the maximum standard Proctor density near optimum moisture content. Prior to fill placement, the subgrade should be carefully prepared by removing all vegetation and topsoil, scarifying to a minimum depth of 6 inches and compacting to at least 95% of the maximum standard Proctor density. The fill should be benched into the portions of the hillside exceeding 20% grade.

Permanent unretained cut and fill slopes should be graded at 2 horizontal to 1 vertical or flatter and protected against erosion by revegetation or other means. The risk of slope instability will be increased if seepage is encountered in cuts and flatter slopes may be necessary. Seepage conditions should be evaluated at the time of construction. If seepage is encountered in permanent cuts, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. Kumar & Associates should review site grading plans for the project prior to construction.

LIMITATIONS

This study has been conducted in accordance with generally accepted geological and geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and preliminary recommendations submitted in this

report are based upon our field observations, aerial photograph interpretations, published regional geology information, the proposed type of construction, and our experience in the area. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted.

This report has been prepared for the exclusive use by our client for planning and preliminary design purposes. We are not responsible for technical interpretations by others of our information. Significant design changes may require additional analysis or modifications to the recommendations presented herein.

Respectfully Submitted,

H-P KUMAR

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Reviewed by:

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RLD/kac

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REFERENCES

City of Colorado Springs, 1997, Uniform Building Code.

El Paso County (1996), "El Paso County-Aggregate Resource Evaluation Map 1, 2, and 3", El Paso County-Master Plan for Mineral Extraction.

Federal Emergency Management Agency (FEMA), March 17, 1997, Flood Insurance Rate Map (FIRM): Map No. 08041C0290F.

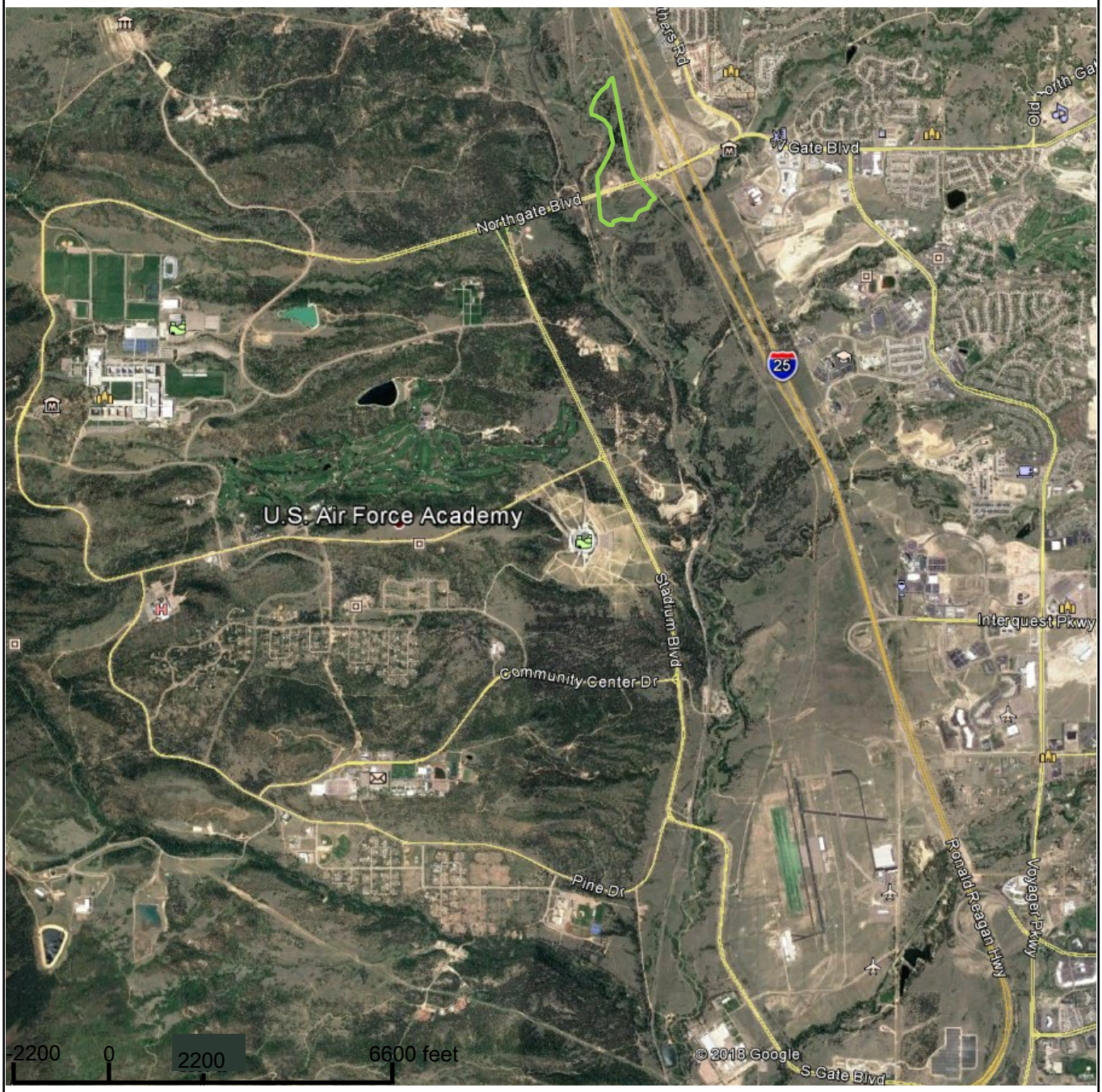
Kirkham, R. M. and Rogers, W. P., 1985, *Colorado Earthquake Data and Interpretations 1867 to 1985*: Colorado Geological Survey Bulletin 46.

Madole, R. F., and Thorson, J. P., 2004, *Geologic Map of the Monument Quadrangle, El Paso County, Colorado*: Colorado Geological Survey Open File Report OF02-4.

Peterson, M. D. and Others, 2014, *Documentation for the 2014 Update of the National Seismic Hazard Maps*: U. S. Geological Survey Open-File Report 2014–1091.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. Accessed [8/31/2018].

Widmann B. L. and Others, 1998, *Preliminary Quaternary Fault and Fold Map and Data Base of Colorado*: Colorado Geological Survey Open-File Report 98-8.



Project Site Location

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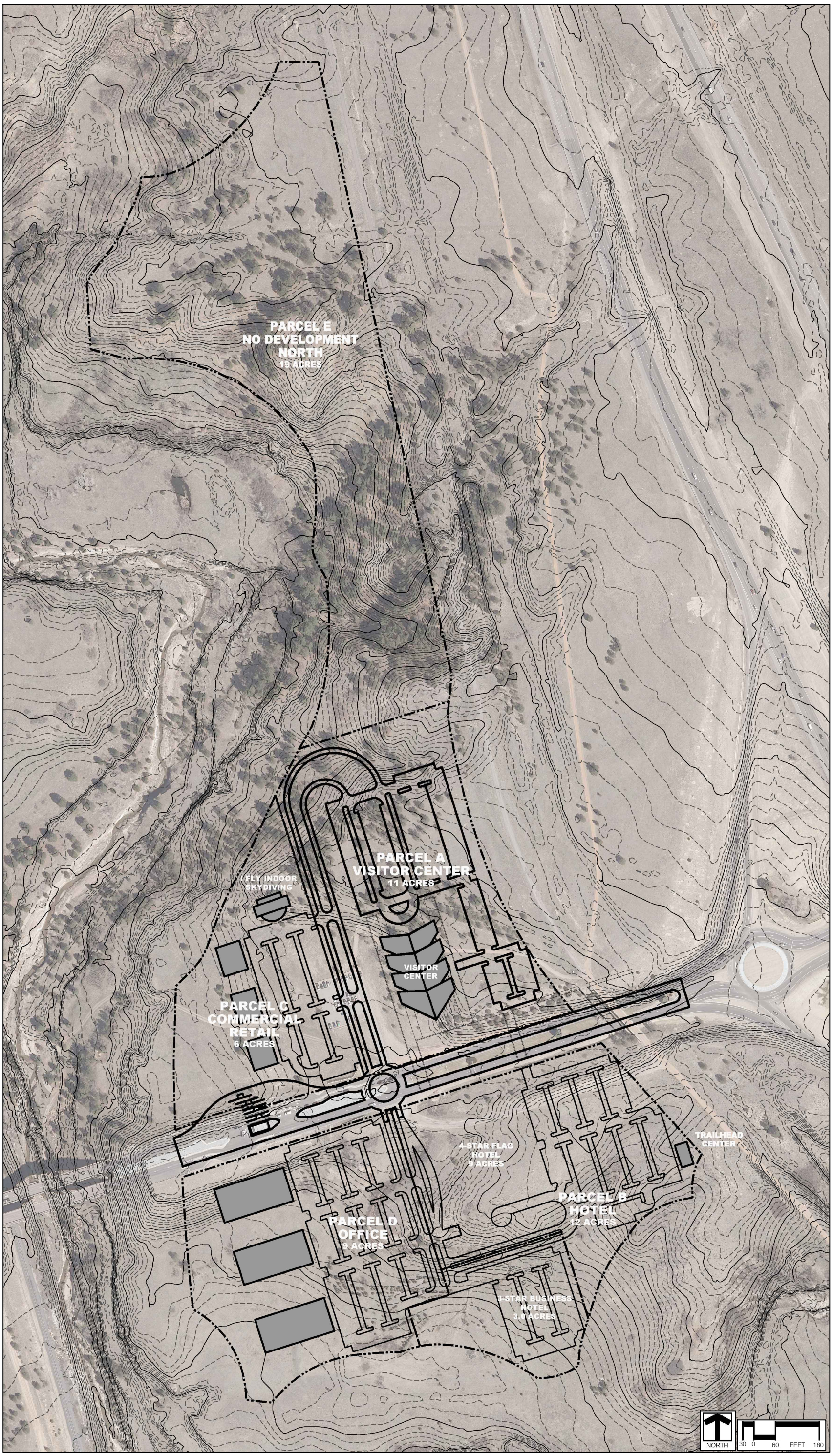
16-7-619	H-P KUMAR	Project Site Location	**Figure 1**



18-2-219	H-P KUMAR Geotechnical Engineering | Engineering Geology Materials Testing | Environmental	PROPOSED DEVELOPMENT AND EXISTING TOPOGRAPHY	Figure 2

18-2-219	Kumar & Associates		Regional Geology Map	Figure 3

28 - Ellicott Loamy Coarse Sand

42 - Kettle-Rock Outcrop Complex

71 - Pring Coarse Sandy Loam

93 - Tomah-Crowfoot Complex

101 - Ustic Torrifluvents, Loamy

18-2-219	H-P KUMAR	NRCS Soil Survey Map	**Figure 4**