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GEOLOGIC HAZARDS STUDY
PROPOSED CORVALLIS AT FOUNTAIN
MIXED USE DEVELOPMENT
SOUTH OF FONTAINE BOULEVARD
WEST OF MARKSHEFFEL ROAD
FOUNTAIN, COLORADO

PROJECT NO. 20-2-163.A

SEPTEMBER 1, 2020

PREPARED FOR:

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a Geologic Hazards Study for the proposed Corvallis at Fountain Mixed Use development to be located to the south of Fontaine Boulevard and west of Marksheffel Road in Fountain, 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 Matrix Design Group, Inc., dated May 29, 2020, Proposal No. C20-189.

A reconnaissance of the project site was conducted on June 10 and 11, 2020 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 275 acres of mostly vacant land, to include roughly 37 acres of commercial development, 141 acres of single-family residential development, 22 acres of multi-family residential development, 9 acres of school site, 18 acres of collector roadways, and 48 acres of open space. Associated asphalt-paved drive lanes and parking lots will loop throughout the property. Site grading is anticipated to be moderate, with cuts and fills up to around 10 feet. We understand that the geological hazards study is required for the submittal for annexation of the property to The City of Fountain.

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 Corvallis development consists of about 275 acres located in parts of the NWNE, NENE, SWNE, and SENE portions of Section 21, T15S, R65W and parts of the NWNW,

SWNW, NENW, SENW, and SWNE portions of Section 22, T15S, R65W. The project site is currently vacant. The property is bordered on the north by Fontaine Blvd., the east by Marksheffel Rd. and the south by The Glen at Widefield Subdivision.

The proposed subdivision is located within an undeveloped area of the northeastern portion of Fountain, Colorado. The topography includes gently rolling hills and valleys. The overall slope trends down to the south. Medium to high density residential lots border the south and east sides of the site, and low density lots border the west. An acreage lot is located near the approximate center of the north side of the site and is outside of the proposed subdivision. Two unnamed intermittent streams flow south through the site, and an irrigation canal intersects the site several times. There are several abandoned irrigation ditches that have been filled in in the northeast part of the site. Vegetation is mainly composed of grasses, with shrubs and some small trees, with larger cottonwood trees near the streams and canal. Bedrock was exposed along the banks of the rivers in some locations.

GEOLOGIC SETTING

The main geologic features in the project area are shown on Figure 2. This map is based on the published regional map by White, Lindsey, et al.) (2017) and on our field mapping performed on June 10 and 11, 2020.

The project site is predominately underlain by Upper Cretaceous-age Pierre Shale. The Pierre Shale is characterized by an abundance of marine invertebrate fossils and expansive clay minerals. Following the nomenclature of Scott and Cobban (1986) that was used by Madole and Thorson (2003) in the adjacent Elsmere quadrangle, the Pierre Shale has been divided by White, Lindsey, et al. (2017) into informal zones. In this area, the Pierre Shale is mapped by White, Lindsey, et al. (2017) as the cone-in-cone zone designated by C.S. Lavington (1933). This designation was given by Lavington because of the concentric cone-in-cone structures that frequently occur within the tabular concretionary masses within this stratum.

The cone-in-cone zone of Lavington of the Pierre Shale (Kpc) consists of dark gray to olive gray non-calcareous shale to silty shale with thinly interbedded bentonite layers. The cone-in-cone zone of Lavington of the Pierre Shale is about 2,300 feet thick (White, Lindsey, et al.), 2017).

Surficial deposits at the project site predominately consist of Holocene-age valley fill deposits (Qav). These deposits are generally composed of light brown well graded sandy silty clay with gravel located in broad drainage swales and are up to 20 feet thick. The valley fill deposits could contain expansive clay.

The southeastern corner of the site contains an alluvial (glaciofluvial) deposit that occurred during the third of five aggradation and downcutting episodes, most likely occurring during interglacial periods of the Holocene and lower Middle Pleistocene Epochs. The lower Holocene-age Alluvium three (Qa3) consists of gray clayey to silty sand with gravel and scattered cobbles associated with Jimmy Camp Creek.

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 numbers 08041C0956G and 08041C0957G by the Federal Emergency Management Agency (FEMA, 2018); the majority of the site is in Zone X (unshaded – areas of minimal flood hazard). There is a floodway (zone AE) along the irrigation ditch in the western central part of the proposed development (FEMA 2018). Open Space with no development (other than one roadway) is proposed in the floodway area.

HEADWARD ERODING GULLIES

The progression of the headward eroding features along existing and abandoned irrigation ditches 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. Mapped headward eroding gullies are shown on Figure 2 in blue.

SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE

Indications of possible seasonally shallow groundwater were observed along the existing irrigation ditches. 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. It appears that most of the area where seasonally shallow groundwater is possible will be in Open Space areas of the proposed development.

PRE-EXISTING MAN-PLACED FILL

Two abandoned irrigation ditches were observed in the northeastern part of the site and could contain 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 Pierre Shale commonly contains layers of expansive claystone. Swell/consolidation characteristics of the soil and bedrock are expected to vary across the subject site. The surficial valley fill and alluvial deposits could 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 Ute Pass Fault Zone, a high-angle generally north-south trending reverse fault, is mapped approximately 14 miles west of the site. According to Widmann, Kirkham, and Rogers (1998),

there is evidence that the Ute Pass Fault Zone 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 existing and abandoned irrigation ditches and along the stream in the development area exceed 30 percent. These slopes appear to be stable and no signs of recent movement were observed. There is a very steep cut bank into claystone bedrock along the south side of the stream in the southwestern part of the site.

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 'Municipalities' 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 Fort Collins loam, the Manzanst clay loam, the Nelson-Tassel fine sandy loams, the Nunn clay loam, the Razor-Midway complex, the Stoneham sandy loam, and the Wiley silt loam, see Figure 3. The NRCS classifies all of the soil types as Poor suitability as a gravel source. The NRCS classifies all the soil types as Poor suitability as a sand source except the Nelson-Tassel fine sandy loams which are classified as Fair suitability. The NRCS classifies the Ft. Collins loam, the Nunn clay loam, and the Stoneham sandy loam as Fair suitability as a road fill source and the other soil types as Poor suitability. The Ft. Collins loam, the Nunn clay loam, and the Stoneham sandy loam 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 irrigation ditches and streams appear stable and should not be adversely affected by the proposed development if the site grading recommendations below are followed. No development should take place within 50 feet of the very steep cut banks (see Figure 2) along the south side of the stream in the southwest part of the proposed development.

SITE GRADING

Permanent cut and fill slopes should not be steeper than 3:1 (horizontal to vertical). The risk of slope instability will be significantly increased if seepage is encountered in cuts. If seepage is encountered in permanent excavations, an investigation should be conducted to determine if the seepage will adversely affect the cut stability.

Good surface drainage should be provided for all permanent cuts and fills to direct the surface runoff away from the slope faces. Cut and fill slopes and other stripped areas should be protected against erosion by revegetation or other means. Fills should be benched into hillsides exceeding 4 horizontal to 1 vertical. Site grading should be planned to provide positive surface drainage away from all building and pavement areas.

No formal stability analyses were performed to evaluate the slopes recommended above. Published literature and our experience with similar cuts and fills indicate the recommended slopes should have adequate factors of safety. If a detailed stability analysis is required, we should be notified.

LIMITATIONS

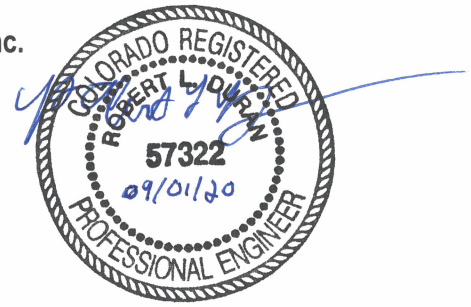
This study has been conducted in accordance with generally accepted geological and geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and preliminary recommendations submitted in this report are based upon our field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

Kumar & Associates, Inc.



Robert L. Duran, P.E.

Reviewed by:

Arben F. Kalaveshi, P.E.

RLD/

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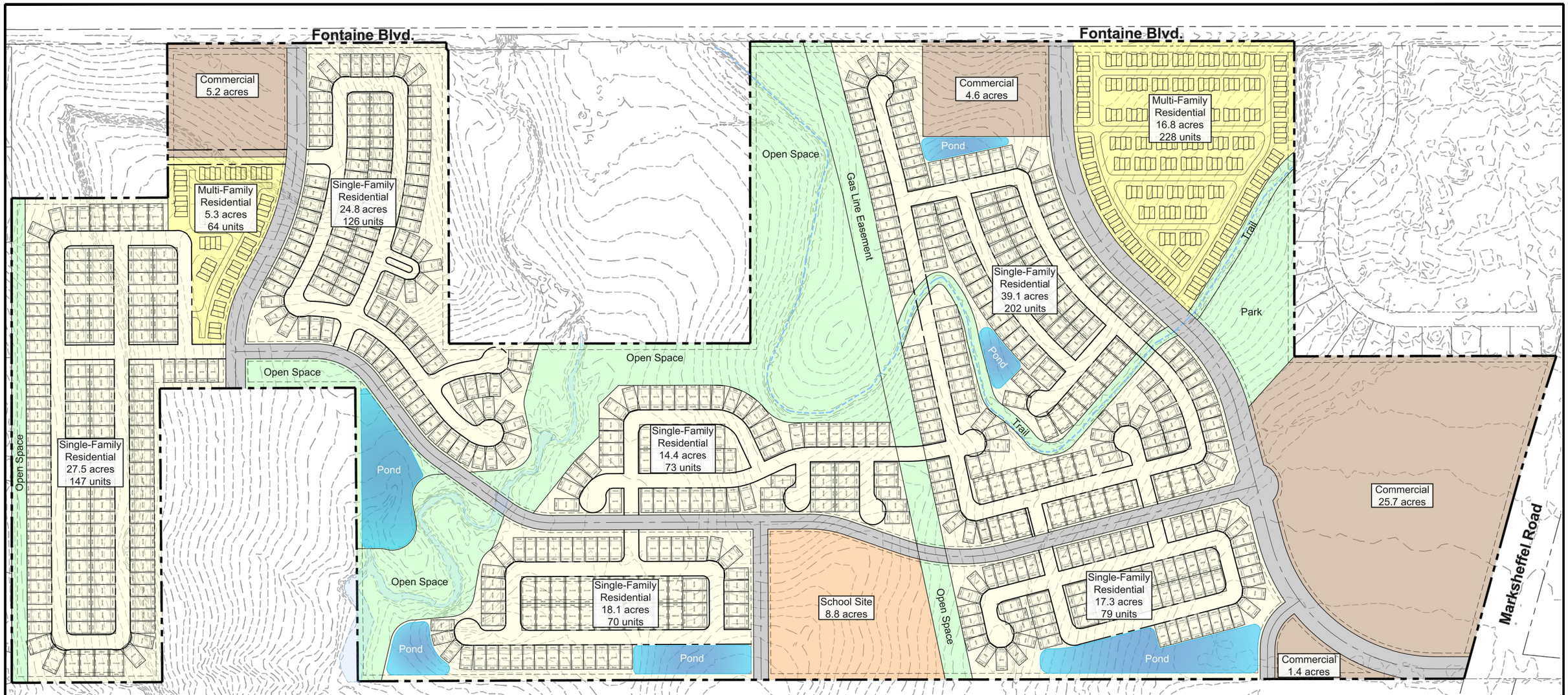

Single Family Lot Breakdown:

Lot Size	Lots	Percentage
45' x 95'	351	35.5%
50' x 100'	284	28.7%
60' x 110'	62	6.3%
Townhomes	292	29.5%
Total Lots	989	100%

Land Use Summary:

Commercial (office / retail)	37	acres
Residential (single family)	141	acres
Residential (multi-family)	22	acres
School Site	9	acres
Collector Roadways	18	acres
Open Space	48	acres
Total	275	acres

GRAPHIC SCALE
200 0 100 200 400
(IN FEET)

CORVALLIS

June 2020

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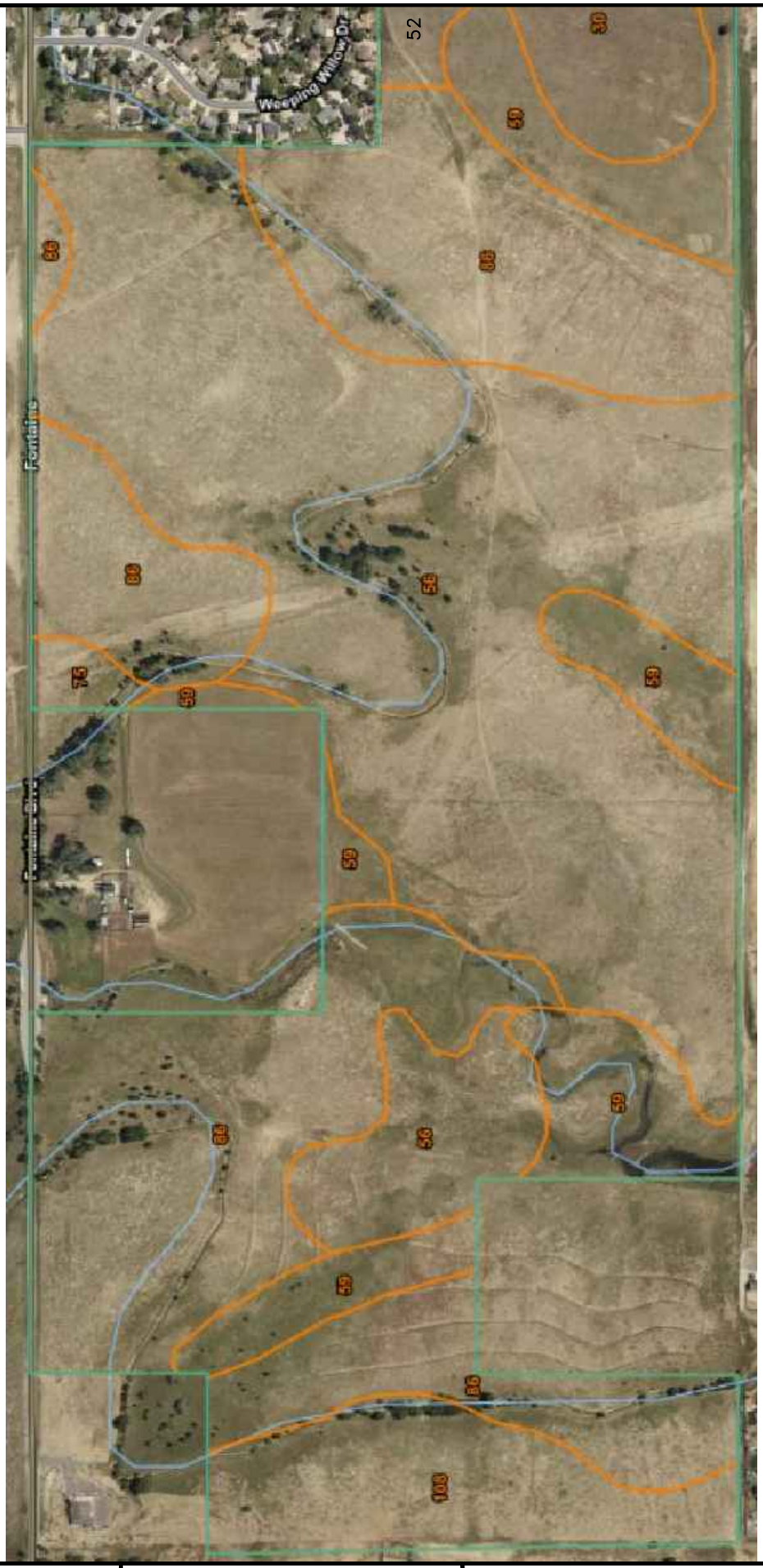
CONCEPT PLAN - REV6 ALT.

20-2-163.A	Kumar & Associates		PROP. DEVELOPMENT AND EXISTING TOPOGRAPHY	Fig. 1

20–2–163.A	Kumar & Associates		MAPPED GEOLOGY	Fig. 2



Map Unit Symbol	Map Unit Name
30	Fort Collins loam, 0 to 3 percent slopes
52	Manzanst clay loam, 0 to 3 percent slopes
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes
59	Nunn clay loam, 0 to 3 percent slopes
75	Razor-Midway complex
86	Stoneham sandy loam, 3 to 8 percent slopes
108	Wiley silt loam, 3 to 9 percent slopes

300 0 300 600

APPROXIMATE SCALE–FEET

20–2–163.A	Kumar & Associates	NRCS SOIL SURVEY MAP	Fig. 3