

# SITE EVALUATION REPORT



## SITE DESCRIPTION

**CLIENT - CIVITAS Resources**

## SOIL SAGE

**DATE:** 31 Jul 2022

<b>Operator/#</b>	BONANZA CREEK ENERGY OPERATING COMPANY LLC 8960	<b>County / State</b>	Weld, CO
<b>Location ID / Name</b>	420769 - Antelope / 23-19 Pad	<b>Field ID</b>	Wattenberg - #90750
<b>Facility Status</b>	TA	<b>Status Date</b>	1/15/2019
<b>Disturbance Extent</b>	.37	<b>Pad Extent / Acres</b>	.37
<b>Reclaimed Extent / Acres</b>	.18	<b>Reference Extent/ Acres</b>	.28
<b>Reclaim Weed Percent</b>	1	<b>Reference Weed Percent</b>	7

## Reference Descriptions

**Coordinates  
Lat/Long**

40.383030  
-104.367910

## Imagery

Chronological

2017 – NAIP Imagery from Weld County, Colorado

2019 – NAIP Imagery from Weld County, Colorado

2022 – Remotely Sensed Imagery Ortho, DSM, NDVI and NDRE

## Map List

NAIP 2017

NAIP 2019

NAIP 2010 - 2019 NDVI Composite

2022 RS Overview

2022 RS Elevation Contour

2022 RS Slope

2022 RS Hydrology

2022 RS NDVI

2022 RS NDRE

# Landscape Summary

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## 2017 – NAIP Imagery

- Landuse mixed use, infrastructure from previous land use activity, well location present

## 2019 – NAIP Imagery

- Landuse mixed use, infrastructure from previous land use activity, well location present

## 2022 – Drone imagery from 9 Jun 2022 – orthomosaic and DSM

- Landuse mixed use, non-agricultural – full pad extent detectable with reclamation area present
- Slope - majority of the extent is within the original 0-6% slope range – slopes greater than 10% are present East of the reclaim site
- Contouring lines 1m
- Elevation gradients 1339 - 1397 meter (4393 - 4583 feet)

## 2022 – Drone imagery from 9 Jun 2022 – NDVI and NDRE (vegetation analysis)

# Soil Properties

## USDA Soil Description

### Reference Soil Information

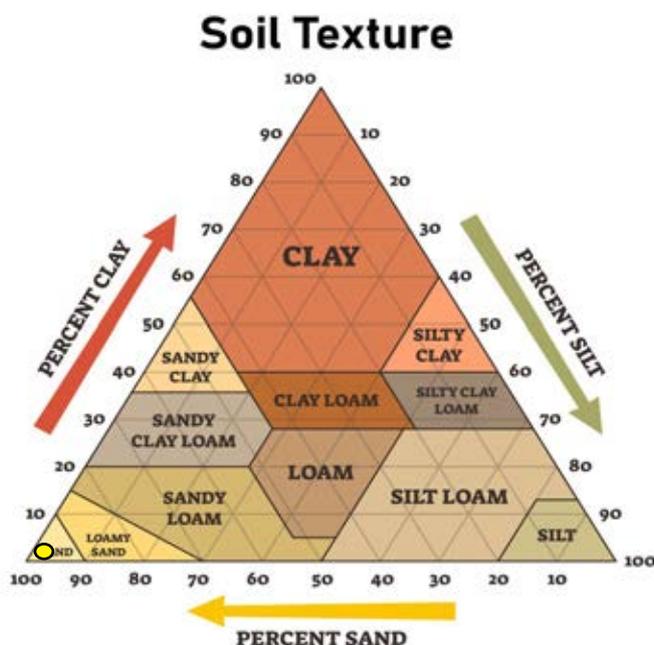
The location of the site is contained within one soil type, Valent sand at two different slopes.

### Map Unit 69 Reference Soil information - Valent sand

This soil is formed from noncalcareous eolian sands. Landform is interdunes, with the Deep Sand Ecological Site. Soils are excessively drained with a very low water holding capacity, and slope 0-3 percent.

Depth (in)	Physical			Chemical			
	Texture	Bulk Density	Partical Size Percent sand, silt, clay	pH	EC	SAR	OM%
0-10	Sand	1.63	96-1-3	6.8	0.1	0.0	0.71
10-20	Sand	1.62	97-1-2	7.0	0.1	0.0	0.26
20-30	Sand	1.62	97-1-2	7.0	0.1	0.0	0.20
30-40	Sand	1.64	97-1-2	7.2	0.1	0.0	0.10
40-50	Sand	1.64	97-1-2	7.2	0.1	0.0	0.10
50 +	Sand	1.64	97-1-2	7.2	0.1	0.0	0.10

### Soil Texture Triangle reflect the 0-10 in depth



### Erosion Potential (10 inches)

- K Factor, Whole soil - .02. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

- Wind Erodibility Group – 1. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

# Soil Properties

## USDA Soil Description

### Reference Soil Information

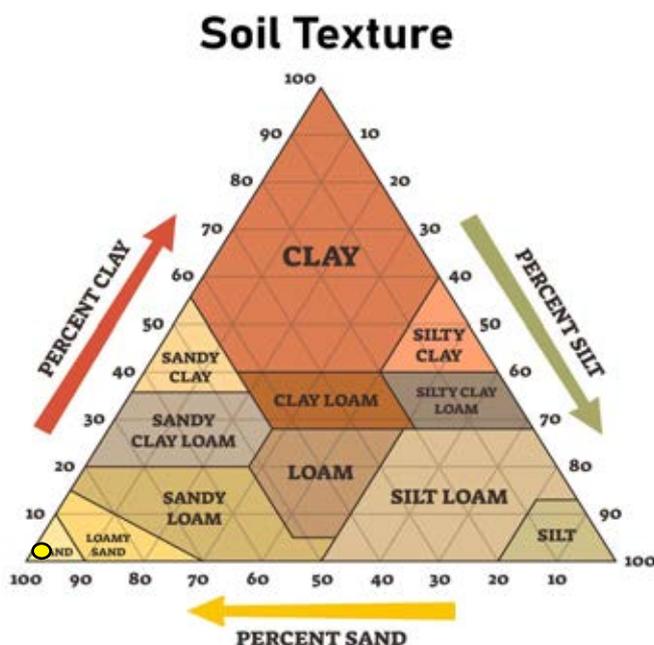
The location of the site is contained within one soil type, Valent sand at two different slopes.

### Map Unit 70 Reference Soil information - Valent sand

This soil is formed from noncalcareous eolian sands. Landform is dunes, hills, with the Deep Sand Ecological Site. Soils are excessively drained with a very low water holding capacity, and slope 3-9 percent.

Depth (in)	Physical			Chemical			
	Texture	Bulk Density	Partical Size Percent sand, silt, clay	pH	EC	SAR	OM%
0-10	Sand	1.63	96-1-3	6.8	0.1	0.0	0.71
10-20	Sand	1.63	97-1-2	7.0	0.1	0.0	0.26
20-30	Sand	1.63	97-1-2	7.0	0.1	0.0	0.20
30-40	Sand	1.63	97-1-2	7.2	0.1	0.0	0.10
40-50	Sand	1.63	97-1-2	7.2	0.1	0.0	0.10
50 +	Sand	1.63	97-1-2	7.2	0.1	0.0	0.10

### Soil Texture Triangle reflect the 0-10 in depth



### Erosion Potential (10 inches)

- K Factor, Whole soil - .02. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

- Wind Erodibility Group – 1. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

## Soil Reference Information

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There is a general relationship of soil bulk density to root growth based on soil texture. Bulk densities ideal for root growth are less than 1.60 g/cc for sandy textures, less than 1.40 g/cc for loamy textures, and less than 1.10 g/cc for clayey textures. Bulk densities that restrict root growth are greater than 1.80 g/cc for sandy textures, 1.65 g/cc for loamy textures, and 1.47 g/cc for clayey textures.

# Vegetation

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## Reference vegetation – Deep Sand Ecology

### Climate

Average Annual Precipitation 14 to 17 inches annually - average 15 inches

Average Annual Air Temperature ranges from 48 to 52 degrees F

Drought conditions in effect

Long-term effects of these latest drought events have yet to be determined. Growth of native cool-season plants begin about April 1 and continue to mid-June. Native warm-season plants begin growth about May 1 and continue to about August 15. Regrowth of cool-season plants occur in September in most years, depending on moisture.

### Reference dynamics

The Reference State is characterized by a dominance of warm-season tall grasses (sand bluestem, prairie sandreed, switchgrass, and Indiangrass). The Shrub State is dominated by sand sagebrush and a minor component of under story species. The Eroded State is characterized by annual forbs and grasses (kochia, Russian thistle, cheatgrass) and early successional plants (sandhill muhly, sand dropseed, Fendler threeawn, and lemon scurfpea).

Drought has increased mortality of blue grama and other bunchgrasses significantly in some locales.

Dominants are sand bluestem, prairie sandreed, switchgrass and Indiangrass. Sub-dominant grasses include needle and thread, blue grama and little bluestem. Significant forbs and shrubs are pacific peavine, prairie clovers, dotted blazing star (aka dotted gayfeather), leadplant, western sandcherry, and sand sagebrush. The potential vegetation is about 70-85% grasses and grass-like plants, 8-15% forbs and 7-15% woody plants.

Not well suited for carbon sequestration.

## Reference Vegetation – Deep Sand Ecology

### At Risk Plant Community

Key species from the Reference Plant Community, sand bluestem, prairie sandreed, yellow Indiangrass, switchgrass, western sandcherry and leadplant have decreased in frequency and production. Blue grama and sand sagebrush are the dominant species. Sand dropseed, red threeawn, slimflower scurfpea, hairy goldenaster, croton, western ragweed, stickleaf, lupine, loco, and milkvetch have also increased.

The risk of losing some of the tall grass species, palatable forbs and shrubs. The reduction of tall grass species, nitrogen-fixing forbs, key shrub component and increased warm season shortgrass has altered the biotic integrity of this plant community. Nutrient cycle, water cycle and energy flow may be impaired. It will require considerable time and expense to return this community once it crosses a threshold to the shrub state.

# Vegetation

## Deep Sand Ecosystem Vegetative Community Composition

Common Name	Scientific Name
Prairie Sandreed	<i>Calamovilfa longifolia</i>
Sand Bluestem	<i>Andropogon hallii</i>
Switchgrass	<i>Panicum virgatum</i>
Indiangrass	<i>Sorghastrum nutans</i>
Blowout grass	<i>Redfeldia flexuosa</i>
Little Bluestem	<i>Schizachyrium scoparium</i>
Sideoats Grama	<i>Bouteloua curtipendula</i>
Sand Dropseed	<i>Sporobolus cryptandrus</i>
Blue grama	<i>Bouteloua gracilis</i>
Western Wheatgrass	<i>Elymus lanceolatus ssp. lanceolatus</i>
Needle and Thread	<i>Hesperostipa comata ssp. comata</i>
Indian ricegrass	<i>Achnatherum hymenoides</i>
Suirreltail	<i>Elymus elymoides ssp. elymoides</i>
Purple Prairie Clover	<i>Dalea purpurea var. purpurea</i>
Painted Milkvetch	<i>Astragalus ceramicus var filifolius</i>
White Prairie Clover	<i>Dalea candida</i>
Dotted Blazing Star	<i>Liatris punctata</i>
Whitest Evening Primrose	<i>Oenothera albicaulis</i>
Upright Prairie Coneflower	<i>Ratibida coumifera</i>
Broadbeard beardtongue	<i>Penstemon angustifolius</i>
Scarlet Globemallow	<i>Sphaeralcea coccinea</i>
Annual Buckwheat	<i>Eriogonum annuum</i>

# Change Detection

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## **Normalized Difference Vegetation (NDVI)**

Section will primarily focus on the NDVI imagery for vegetation reference and current analytics.

The composite NAIP NDVI imagery from 2010-2019, this data set does not contain the NDVI values to perform statistical analysis. The imagery foot print encompasses the site extent and a vegetation reference extent for vegetative analysis.

Remotely sensed data was gathered on 9 Jun 2022, which reflects the current vegetative cover statistics.

NDVI calculations used the Near Infrared and Red bands and the NDRE used the RedEdge band and the Near Infrared from the multispectral sensors. The NDVI reflects the measurements from plants topmost layer of leaves, typically used during spring emergence into mid-season growth. The NDRE reflects the measurements from permanent or later stage growth due to it's ability to measure further down into the canopy. Both analytics were calculated to establish the baseline.

The percent cover calculations reflect the vegetation from the reference area and the reclaimed area. The data reflects 5 bands of reflectance. Classes reflect vegetative and non-vegetative areas. The recovery matrix, which is 80% of the reference vegetation were calculated. The recovery calculation indicate the current rate of recovery at the time of sampling.

All measurements are based on the reclaimed area, the reference area extent and the weed inventory at the time of analysis.

**NDVI - NDRE Stats Antelope 23-19  
Jun-22**

Type	NDVI Class	Reference Percent Cover	Class Sum	Target Recovery 80%	Target - Weeds 7%	Reclaimed Percent Cover	Class Sum	Deficit/Surplus
Veg	1	0.23				0.12		
Veg	2	1.04	1.27	1.02	0.94	0.52	0.65	-0.30
Non-Veg	3	3.45				2.29		
Non-Veg	4	24.32				17.35		
Non-Veg	5	71.53	95.85			80.05	99.69	

**NDVI Red Edge  
Jun-22**

Type	NDRE Class	Reference Percent Cover	Class Sum	Target Recovery 80%	Target - Weeds 7%	Reclaimed Percent Cover	Class Sum	Deficit/Surplus
Veg	1	0.04				0.04		
Veg	2	0.59	0.63	0.50	0.47	0.32	0.36	-0.11
Non-Veg	3	3.43				2.00		
Non-Veg	4	26.41				18.06		
Non-Veg	5	70.11	99.95			79.92	99.98	

Weed Inventory	Class	Reclaimed Percent Cover	Class Sum	Weed Cover 1%	Reclaimed Class Sum	NDVI Actual	Actual - Target %
Veg	1	0.12					
Veg	2	0.52	0.65	0.01	0.65	0.64	-0.30
Non-Veg	3	2.29					
Non-Veg	4	17.35					
Non-Veg	5	80.05	99.69				

## Recommendations

### Monitoring Change Over Time

#### Data of Sampling – 9 Jun 2022

### Vegetation

The site evaluation results indicate the reference vegetative recovery target for NDVI reflected 0.94% and the reference vegetation recovery target for NDRE reflected 0.47%. The recovery status for the reclaim extent was at a .30% deficit for NDVI and 0.11% deficit for NDRE. These data are based on spring emergence values and not permanent/late season plant growth.

The site evaluation indicates the presents of weeds within the reclaim extent that have a percent cover of 7%, reflecting an actual **.30% deficit** in the recovery rate for NDVI in the spring observation (June).

The target recovery was based on one reference extents that fall within the same soil types. Typical land use was observed in this area similar vegetation properties.

#### **Recommendation**

Due to the very low vegetation in the surrounding area and there are no noxious weeds present.

#### **Reference Extent Vegetation Observations**

##### *Native or Endemic in the surrounding area*

Percent cover is determined using random sampling methods within the vegetation extent and using a sampling hoop of 0.5 sq meters in size.

Bractless Blazingstar - *Mentzelia nuda* - 5%

##### *Invasive*

Russian Thistle – *Salsola tragus L.* – 1%

Sunflower - *Helianthus annuus* - 5%

Western Ragweed - *Ambrosia psilostachya* - 1%

#### **Recovery Extent Vegetation Observations**

##### *Native or Endemic*

Bractless Blazingstar - *Mentzelia nuda* - 2%

Unidentifiable Native Grass - 2%

##### *Invasive*

Sunflower - *Helianthus annuus* - 1%

**Weed Summary Reference**

Common Name	Weed List Type	Percent Cover (%)
Russian Thistle	Common	1
Sunflowers	Common	5
Western Ragweed	Common	1

**Weed Summary Recovery**

Common Name	Weed List Type	Percent Cover (%)
Sunflowers	Common	1

**Weed Inventory Criteria**

- Each site is accessed for noxious weeds and common weeds
- Data are aggregated using point locations coupled with percent cover assessments and area measurements as needed
- Governance - Colorado Department of Agriculture - Colorado Noxious Weeds List, effective October 2020
- List A - Designated for eradication, List B - Designed to stop the continued spread, List C - Facilitate more integrated effective weed management, Watch List - Determined to pose a potential threat to ag and natural productivity.
- Common - designates weeds that do not fall within the Colorado Department of Agriculture lists
- Other - designates other identified weeds at the site

**Weed Pressure**

Current weed pressure is dominated by common Sunflowers. The total calculated percent of weed coverage is ~1%. This occurs primarily within the main reclaim extent and is 6% lower than the reference area weed pressure.

Weeds in the reference extent are Russian Thistle, sunflowers and Western Ragweed. Weed pressure in the reference extent is ~7%.

Weed percentages have been accounted for in the Vegetation Section above.

**Hydrology**

Hydrology – Stream Orders 1 – 5 are present - dominant streams are orders are 1, 2 and 3. Order 3-5 are present in locations that have the potential for soil erosion represented by gullying and riling that follow the relic land use activities. These could be major runoff areas for gullying and soil erosion with heavy precipitation events. Soil texture in the area is primarily sanding.

Ponding - potential ponding can occurring were water follows the elevation gradients in low lying areas from previous land use activities. The flow directions is primarily from East to West.

**Soil/Erosion**

Exposed soils have low susceptible to water erosion and are in the high susceptible group for wind erosion due to ecosystem dynamics and vegetative cover.

## Site Recommendation & Re-Evaluation

The site vegetation recovery rate is statically equivalent to the reference extent due to lack of vegetation and relic land use. The weed pressure within the reclaim extent is primarily from Sunflowers, which are common weed. The present of Russian Thistle, Sunflowers and Western Ragweed in the reference extent is higher than the reclaim extent. Bare ground is also equivalent to the reference extent.

Recommend this site for permit closure.

## Seed Mix

### Vegetation Seed Mix

No additional reclamation procedures are recommended at this time.

#### Deep Sand Ecosystem

	Common Name	Scientific Name	#PLS/Acre	% of Mix
	Needle and Thread	<i>Hesperostipa comata</i>	2	8
	Sand Bluestem	<i>Andropogon hallii</i>	3	13
<b>Grasses</b>	Prairie Sandreed	<i>Calamovilfa longifolia</i>	4	17
	Blue Grama	<i>Bouteloua gracilis</i>	2	8
	Western Wheatgrass	<i>Pascopyrum smithii</i>	0.2	1
	Switchgrass	<i>Panicum virgatum L.</i>	5	21
	Sideoats Grama	<i>Bouteloua curtipendula</i>	2	8
		Purple Prairie Clover	<i>Dalea purpurea</i>	0.2
<b>Forbs/Legumes</b>	Scarlet Globemallow	<i>Sphaeralcea coccinea</i>	0.1	0
	Buckwheat	<i>Eriogonum spp.</i>	5	21
	Fourwing Saltbrush	<i>Atriplex canescens</i>	0.5	2
<b>Total</b>	<b>Total</b>		<b>24</b>	<b>100</b>

**NOTE:** The above seed mix is based on the soil type and landscape position. The surrounding area has similar soil properties and this seed mix is subject to change based on land use type.

## Reclaim Area Protocol

<b>Time Frame</b>	<b>Activity</b>	<b>Specifications</b>	<b>Site Totals</b>
<b>Jun 2022</b>	Monitoring	Common weeds Present	6 Jun 2022 – Submitted Weed Control Recommendations
<b>Aug 2022</b>	Permit Closure		.28 acres

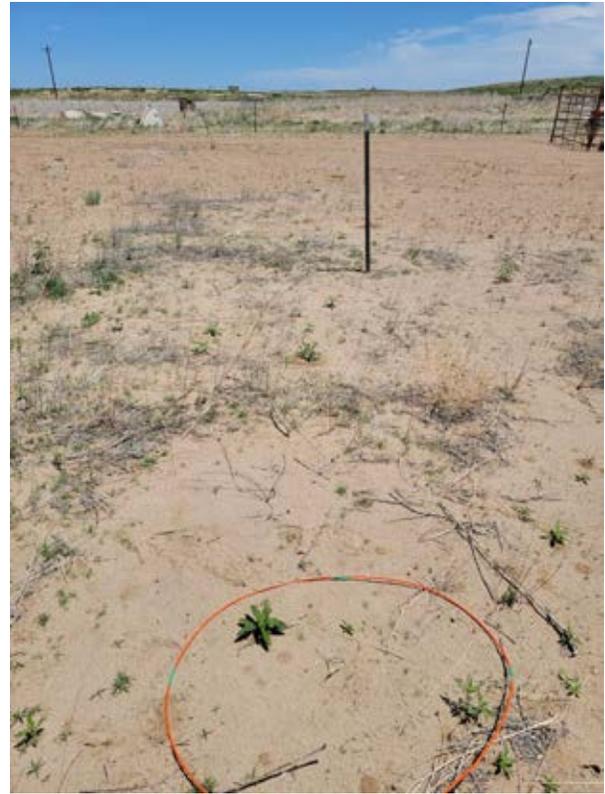
## Site Photos

### *Reference*

40.383057, -104.368142



North



East

Soil Sage



South



West

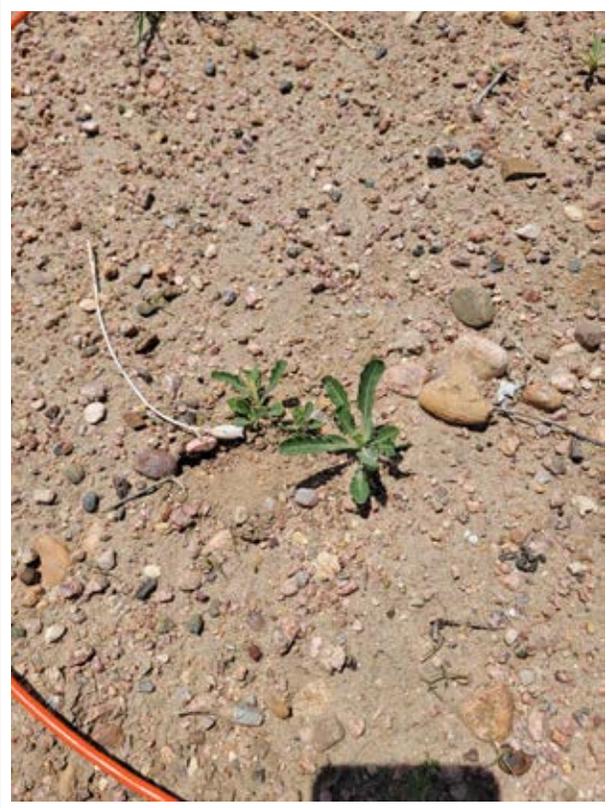
Soil Sage



Vegetation

Soil Sage

Native or Endemic



Bractless Blazingstar - *Mentzelia nuda*

Soil Sage

Invasive



Russian Thistle - *Salsola tragus* L.



Sunflower - *Helianthus annuus*



Western Ragweed - *Ambrosia psilostachya*

**Recovery**

40.383239, -104.367943



North



East



South



West

Soil Sage



Vegetation

Soil Sage

Native or Endemic



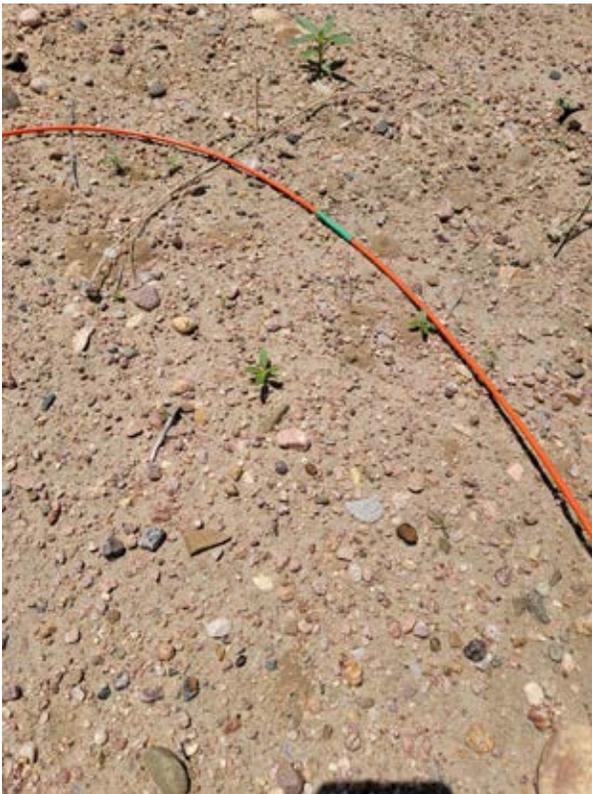
Bractless Blazingstar - *Mentzelia nuda*



Unidentifiable Native Grass

Soil Sage

Invasive



Sunflower - *Helianthus annuus*

Weeds



Russian Thistle - *Salsola tragus* L.



Sunflower - *Helianthus annuus*



Western Ragweed - *Ambrosia psilostachya*

## Site Overview Photo's

Date – 9 Jun 2022

Cardinal Direction – in order from NESW



North



East



South



West



**CIV - 420769 - Antelope 23-19**  
**Map Extent - USDA NAIP 2017**

Imagery: USDA NAIP  
 Imagery Date: 2017  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

### Legend

☆ Wells	Road & Pad Extent
Reclaim Point	Reclaim Extent
Reference Point	Reference Extent

0      0      0.01      0.02 Miles

Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

Service Credits -





**CIV - 420769 - Antelope 23-19**  
**Map Extent - USDA NAIP 2019**

Imagery: USDA NAIP  
 Imagery Date: 2019  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

### Legend

☆ Wells	Road & Pad Extent
Reclaim Point	Reclaim Extent
Reference Point	Reference Extent

0      0      0.01      0.02 Miles

Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

Service Credits -





**CIV - 420769 - Antelope 23-19**  
**Map Extent - USDA NAIP Composite**

Imagery: USDA NAIP  
 Imagery Date: 2010 - 2019  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

### Legend

☆ Wells	▭ Road & Pad Extent
📷 Reclaim Point	▭ Reclaim Extent
▲ Reference Point	▭ Reference Extent

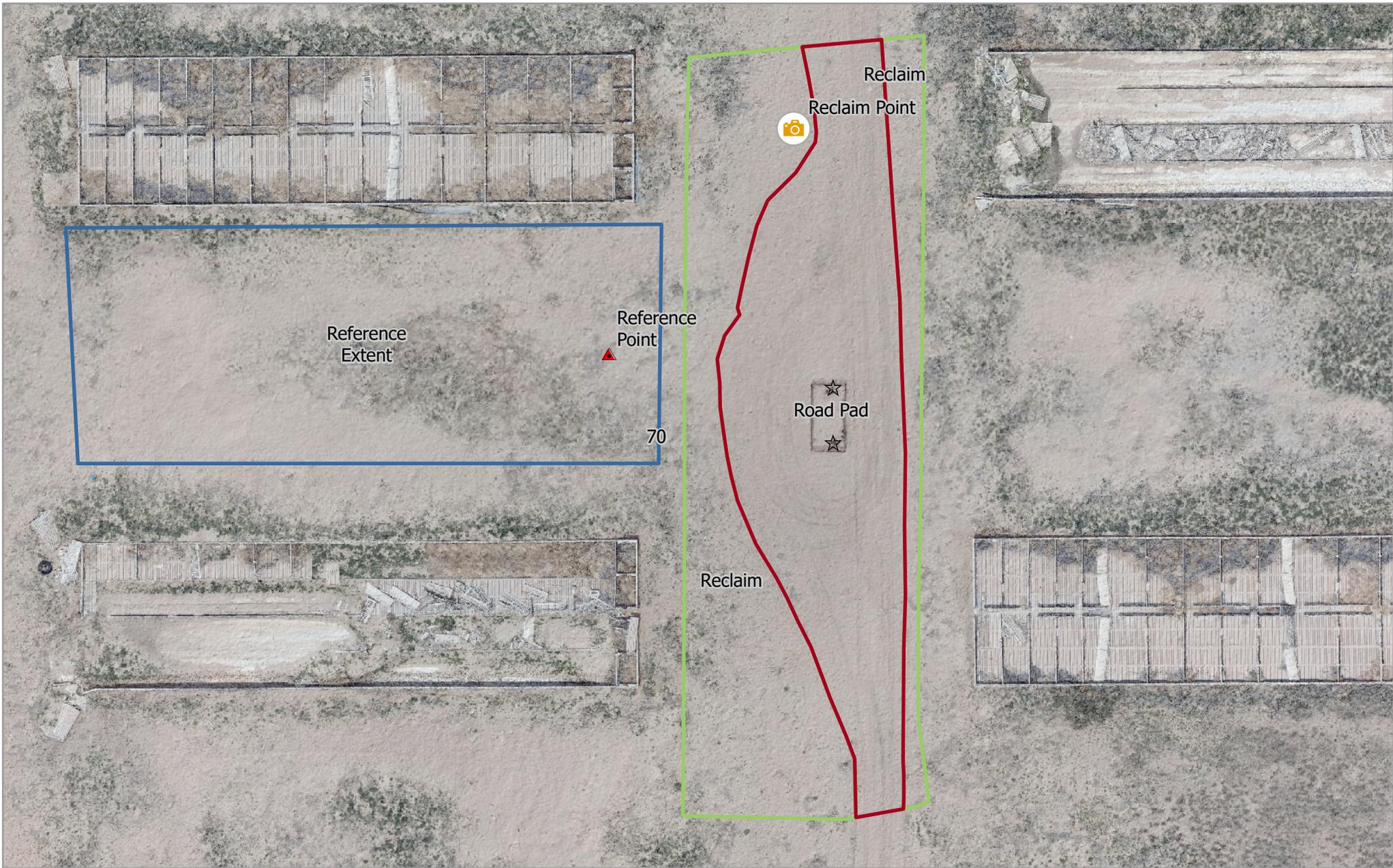
0      0      0.01      0.02 Miles

Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

Service Credits - Esri, USDA Farm Service Agency





**CIV - 420769 - Antelope 23-19**  
**Map Extent - Overview**

Imagery: RS Orthomosaic & DSM  
 Imagery Date: 9 Jun 2022  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

**Legend**

☆ Wells	Red outline Road & Pad Extent
📷 Reclaim Point	Green outline Reclaim Extent
▲ Reference Point	Blue outline Reference Extent
	Yellow outline Soil Survey

0 0.01 0.02 Miles

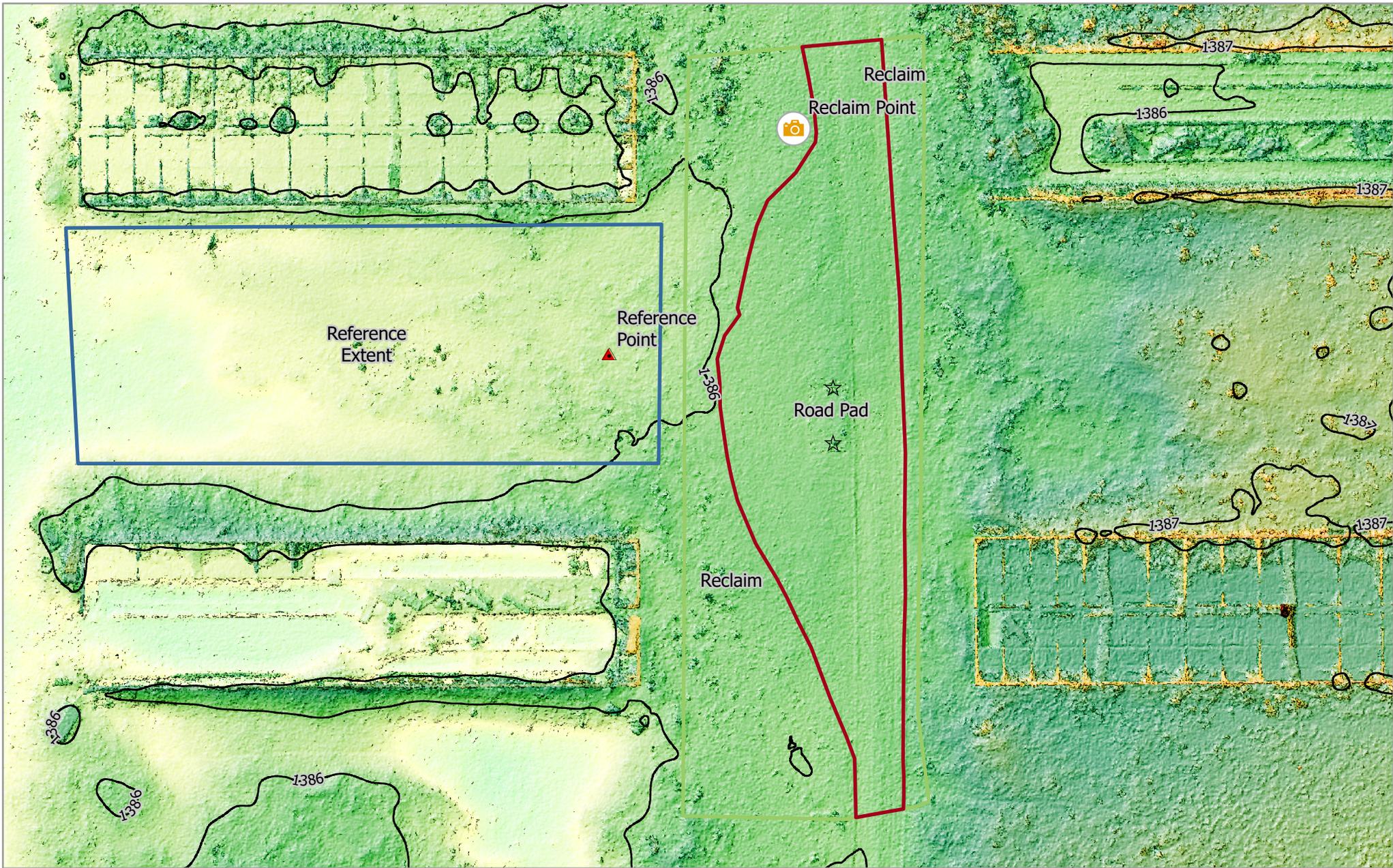
Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

N

Service Credits -





**CIV - 420769 - Antelope 23-19**  
**Map Extent - Elevation & Contours**

Imagery: RS Orthomosaic & DSM  
 Imagery Date: 9 Jun 2022  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

**Legend**

- ☆ Wells
- 📷 Reclaim Point
- ▲ Reference Point
- ▭ Road & Pad Extent
- ▭ Reclaim Extent
- ▭ Reference Extent
- ~ Contour 1m

**Elevation Meters**

1397  
1339

0 0 0.01 0.02 Miles

Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

N



Service Credits -



**CIV - 420769 - Antelope 23-19**  
**Map Extent - Slope**

Imagery: RS Orthomosaic & DSM  
 Imagery Date: 9 Jun 2022  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

☆ Wells	Slope
📷 Reclaim Point	Percent
▲ Reference Point	0.01 - 5.99
🔴 Road & Pad Extent	6 - 15.51
🟢 Reclaim Extent	15.52 - 49.71
🔵 Reference Extent	

0      0      0.01      0.02 Miles

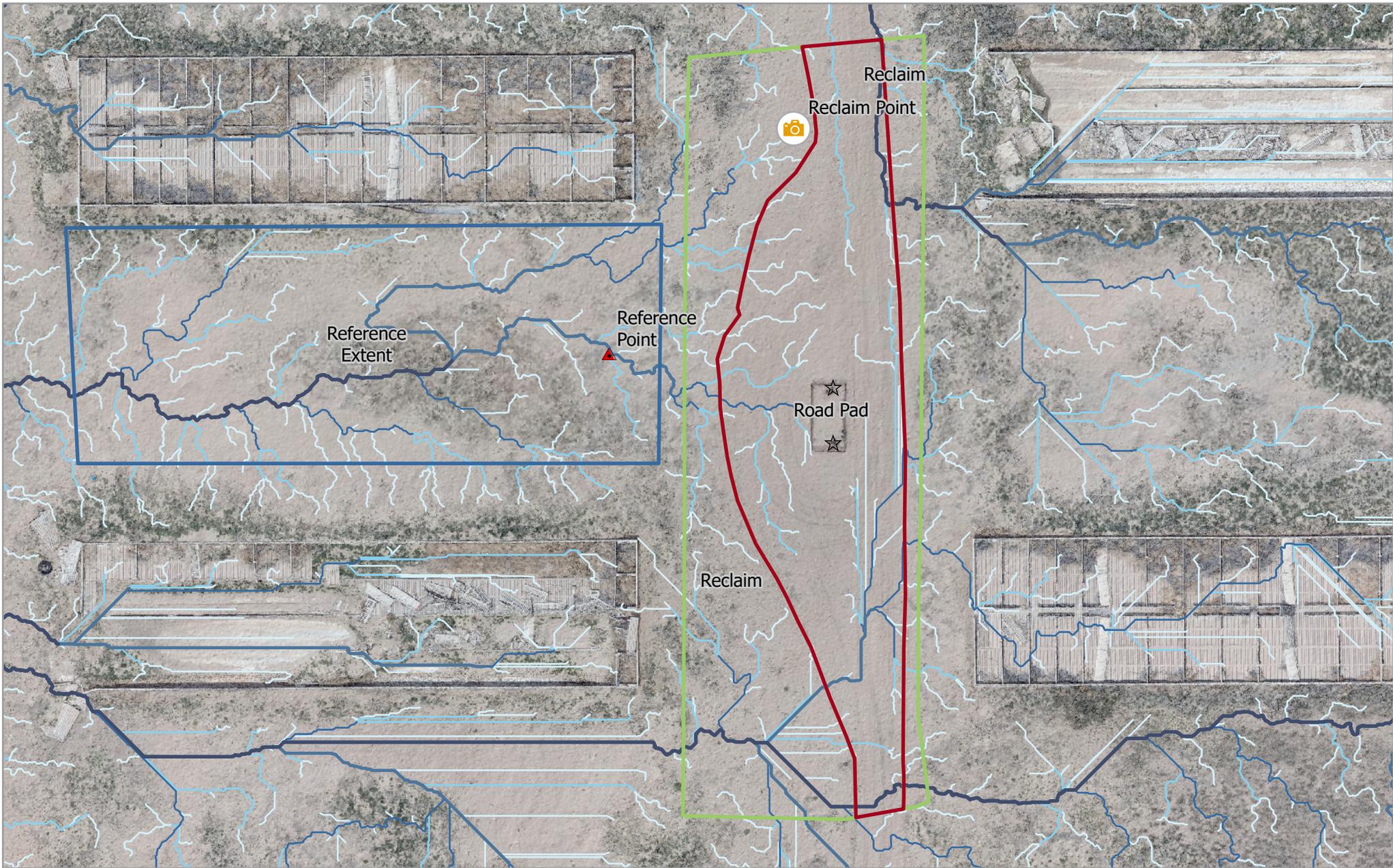
Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

N



Service Credits -



**CIV - 420769 - Antelope 23-19**  
**Map Extent - Hydrology**

Imagery: RS Orthomosaic & DSM  
 Imagery Date: 9 Jun 2022  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

**Legend**

☆ Wells	Reclaim Extent	Stream Order
📷 Reclaim Point	Reference Extent	1
▲ Reference Point	Stream Order	2
📐 Road & Pad Extent	Stream Order	3
	Stream Order	4
	Stream Order	5

0 0 0.01 0.02 Miles

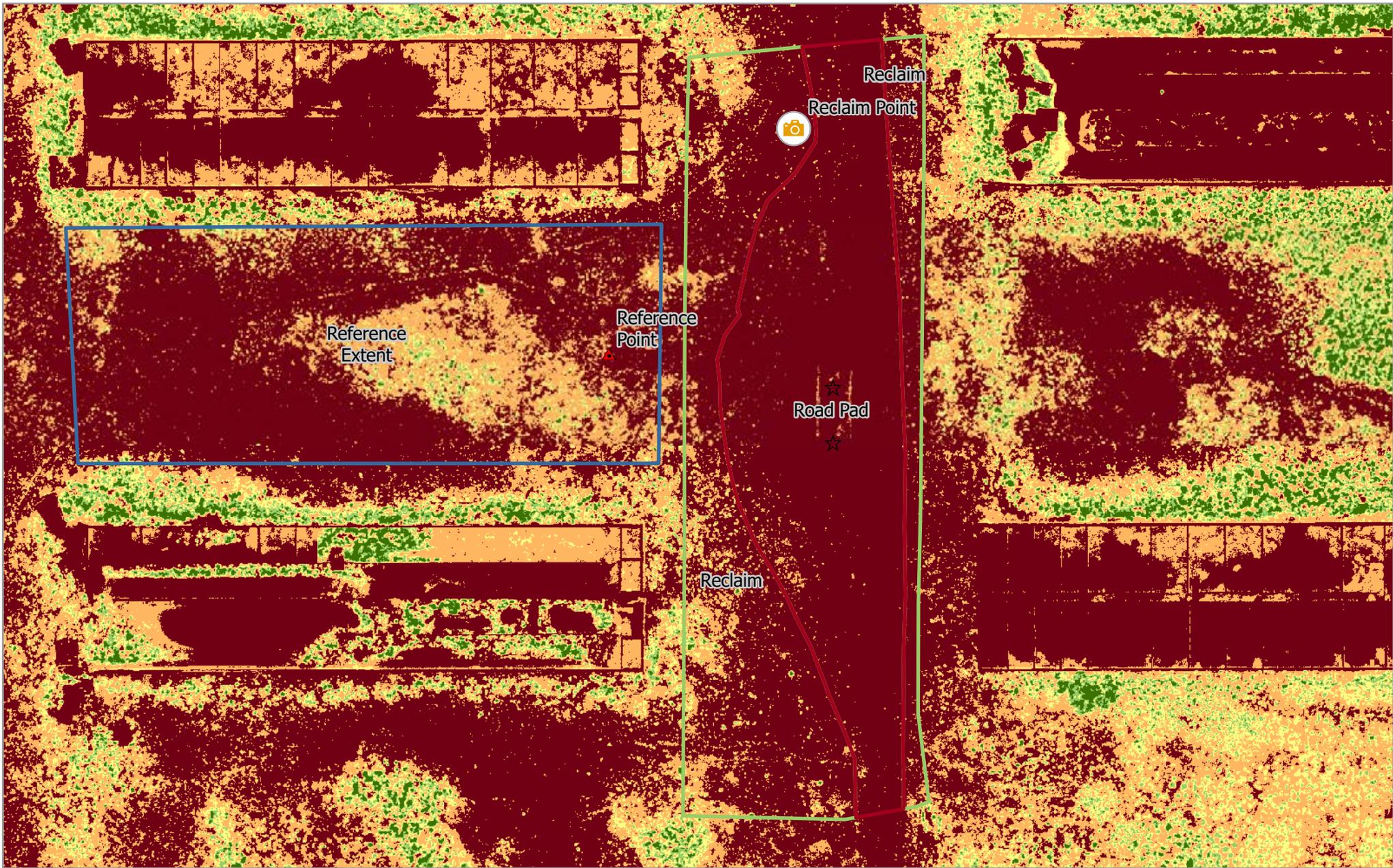
Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

N



Service Credits -



**CIV - 420769 - Antelope 23-19**  
**Map Extent - Jun NDVI**

Imagery: RS Multispectral  
 Imagery Date: 9 Jun 2022  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

**Legend**

☆ Wells	Reclaim Extent	2-Veg
📷 Reclaim Point	Reference Extent	3-Non Veg
▲ Reference Point	NDVI	4-Non Veg
🛣️ Road & Pad Extent	Classes	5-Non Veg
	1-Veg	

0 0 0.01 0.02 Miles

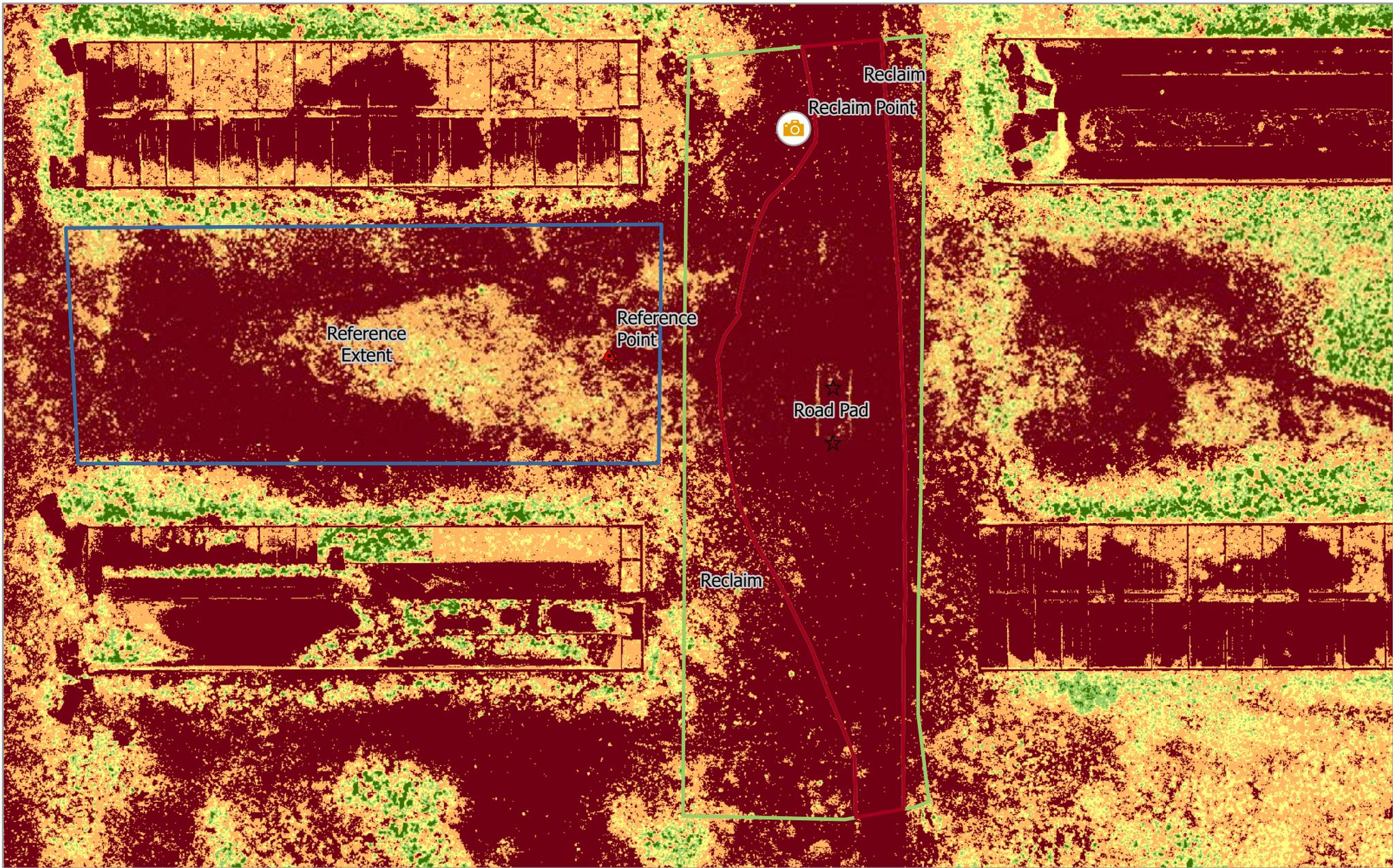
Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

N



Service Credits -



**CIV - 420769 - Antelope 23-19**  
**Map Extent - Jun NDRE**

Imagery: RS Multispectral  
 Imagery Date: 9 Jun 2022  
 Map Date: 02 Aug 2022  
 Datum: NAD\_1983\_UTM\_Zone\_13N  
 POC: Soil Sage

**Legend**

☆ Wells	Reclaim Extent	2-Veg
📷 Reclaim Point	Reference Extent	3-Non Veg
▲ Reference Point	Int_NDRE	4-Non Veg
🛣️ Road & Pad Extent	Classes	5-Non Veg
	1-Veg	

0 0 0.01 0.02 Miles

Scale: 1:463

Pad Location:  
 40.383030  
 -104.367910

N



Service Credits -