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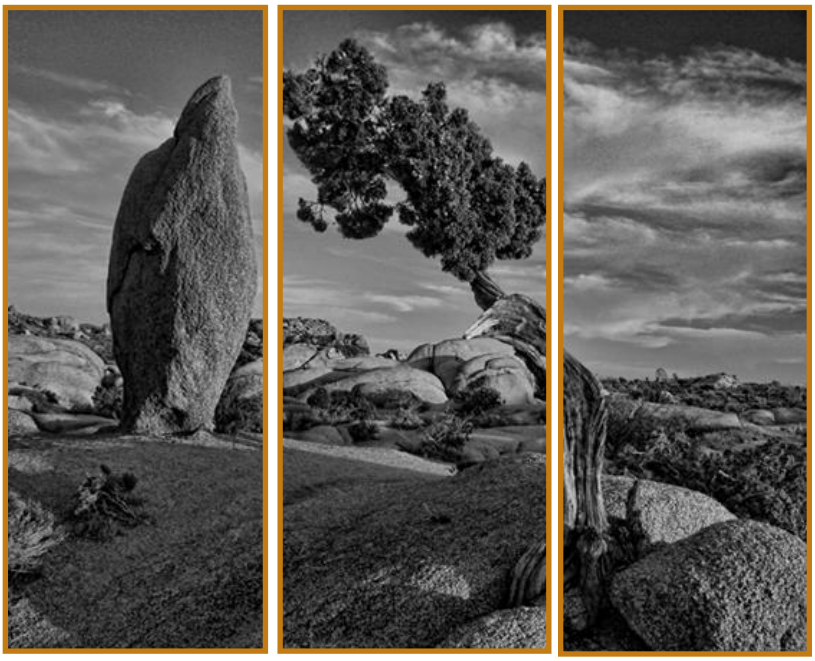
April 20, 2023

# Environmental Evaluation of Noise, Air Quality, and Visual Impacts Associated with the Expansion of Gross Reservoir

**Prepared for:**
Boulder County
1325 Pearl Street
Boulder, CO 80302

**Pinyon Project No.:**
1/22-0133-01



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## Executive Summary

Pinyon Environmental, Inc. (Pinyon) was contracted by Boulder County to develop a methodology and create a ranking rubric to evaluate the noise, air quality, and visual impacts from Denver Water's Gross Reservoir Dam expansion construction. As part of the *Denver Water v. Boulder County* settlement agreement, a $5 million Gross Reservoir Community Impact Mitigation Fund was established to provide money directly to residents most impacted by noise, air quality, and visual effects of the project construction. The ranking rubric identifies the residences impacted by noise with a score of zero to five where zero means there are no expected noise impacts and five means there are the most relative noise impacts. The ranking rubric also identifies the residences impacted by air quality with a score of zero to five where zero means there are fewer relative air quality impacts and five means there are the most relative air quality impacts. Lastly, the rubric identifies the residences with visual impacts of the project construction with a score of zero to five where zero means that there is no visual change at the residence and five means the residence is in the category of visual change nearest to project construction.

The Gross Reservoir Dam expansion construction began in April 2022 and is predicted to last almost five (5) years. The goal of the expansion construction is to raise the height of the dam by 131 feet and increase the capacity of the Reservoir from approximately 42,000 acre-feet to 119,000 acre-feet. Through the almost five-year construction schedule, multiple construction activities including blasting, crushing and screening, a concrete batch plant, tree removal, and multitude of haul truck travel on paved and unpaved roads will occur. Construction activities were modeled using industry-standard predictive models to estimate noise impacts at various nearby residences and contoured to determine farther residences. Construction activities were also modeled using industry-standard predictive models to estimate air quality impacts for specific criteria pollutants including nitrogen oxides (NOx), carbon monoxide (CO), particulate matter with a diameter less than 10 microns ($PM_{10}$), and particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$). Lastly, for potential visual impacts the heights and base elevations of equipment and construction sources were topographically compared to the elevation and hill heights of the residences based on latest National Elevation Dataset (NED) files from the United States Geological Survey (USGS), along with consideration of the residence distance from construction activities, with a focus on construction lighting impacts. The results of the predictive models along with the visual analysis were then ranked by impact area (noise, air quality, and visual) and then overall (total) to provide a "score" for each residence within the study area.

The scores are tabulated in Section 4 and included in Appendix A for each year of analysis. Appendix A includes a table of all residences sorted by total ranking, and the associated figure in Appendix A presents graphically those results.

The goal of the project is to assist Boulder County in the distribution of mitigation funds provided by Denver Water to residents impacted by the expansion to alleviate or compensate for noise, air quality, and/or visual impacts. This report is not meant to define exact dollar values but is meant to inform and assist Boulder County in their decision-making regarding fund distribution.

# 1. Introduction and Purpose

Boulder County contracted Pinyon Environmental, Inc. (Pinyon), to complete an environmental evaluation of noise, air quality, and visual impacts associated with the expansion of Gross Reservoir (Reservoir or Project) on the property located in Boulder County. The analysis includes an evaluation of the air quality, noise, and visual impacts the expansion construction is predicted to have on residences near the Reservoir.

The Reservoir construction started in April 2022 and is predicted to last almost five (5) years. The goal of the expansion construction is to raise the height of the dam by 131 feet and increase the capacity of the Reservoir from approximately 42,000 acre-feet to 119,000 acre-feet. The specific construction activities encompassed within the dam construction include, but are not limited to:

- Drilling and blasting including in the quarry
- Crushing and screening
- Topsoil and overburden storage piles and removal
- Concrete batch plant
- Haul road travel for employees, equipment, and product transfer
- Generators for onsite electric power

In this version of the analysis, the full plan for Denver Water's tree removal phase of construction is not known. Therefore, this analysis and results does not include tree removal activities west of the Reservoir along Lazy Z Road, but Pinyon with Boulder County expects to update the analysis to include those final tree removal activities when appropriate.

The Gross Reservoir Dam expansion construction began in April 2022 and is expected to last through 2026 with demobilization and site reclamation taking place in 2027. Through the almost five-year construction schedule, multiple construction activities including blasting, crushing and screening, a concrete batch plant, and haul truck travel on paved and unpaved roads. The activities are staged throughout the five years, with the majority of the construction activity taking place at or near the dam wall. The majority of the haul road traffic takes place along State Highway 72 to the south travelling up Gross Dam Road with another haul road from Lakeshore Drive to the north travelling down Gross Dam Road. The Project Work Area is included in Figure 1-1.

The following sections detail the existing environment near and around the current Gross Reservoir Dam, the methodology followed to determine noise, air quality, and visual impacts, and then the results of the predictive models and topographical comparison. The discussions and results are expected to assist Boulder County in determining appropriate mitigation measures for the purposes of distributing mitigation funds to alleviate noise, air quality, and visual impacts of the Gross Reservoir Dam expansion construction.

**Figure 1-1. Project Work Area Map**


*This project area diagram was created by Denver Water, and is a representation of the area with all construction areas fully developed

# 2. Existing Conditions

The Gross Reservoir is owned and operated by Denver Water and located in Boulder County, Colorado. It was originally completed in 1954 and primarily serves as a storage facility for water flowing from the Continental Divide through the Moffat Tunnel. Currently, the Gross Reservoir Dam has a height of 340 feet above the South Boulder Creek stream bed. As of late, the Reservoir remains about 65% full of water at 7,282 feet elevation.

Historically, Gross Reservoir is used for recreation year-round with the majority of activity occurring during the summer. Activities such as fishing, canoeing, kayaking, and boating are permitted within the Reservoir while camping, picnicking, and hiking also take place in the area surrounding the Reservoir and Dam. The area is popular with tourists and visitors outside the immediate area, but the area surrounding the Reservoir does have a handful of nearby residences with trails to the Reservoir.

## 2.1 Noise

### *2.1.1 Existing Noise and Measurements*

The Gross Reservoir area is a rural location that includes existing noise from sources such as, but not limited to, vehicle traffic, recreation, wildlife, and other general park activities.

Boulder County contracted Pinyon to complete background noise measurements as part of this project to get an understanding of and document existing noise levels prior to the start of full construction at the Reservoir. Construction of the Reservoir expansion began in April 2022, and while some construction vehicles and activities were both heard and observed, the measurements were taken on a Sunday to get a representation as close to natural conditions as possible. Noise measurements were taken in five separate, agreed upon locations strategically selected to get a representative sample of residential areas around the Reservoir.

**Table 2-1. Noise Measurements**

| Monitor Number | Location Description | Monitoring Result (dBA) |
|---|---|---|
| 1 | Near Lakeshore Dr. approximately ¼ North of the Reservoir | 57 |
| 2 | Near the Walker Ranch trailhead, approximately 1 mile Northeast of the Reservoir | 60 |
| 3 | Near the Crescent Meadows trailhead, 1.5 miles East of the Reservoir | 58 |
| 4 | Along Coal Creek Canyon Road, just under 1 mile South of the Reservoir | 69 |
| 5 | North of Lazy Z Road, 1.5 miles West of the Reservoir | 38 |

**Figure 2-1. Noise Measurement Locations**


## 2.2 Air Quality

Boulder County is a rural location with minimal large industrial or commercial emissions sources impacting local air quality. However, because of its proximity to the City of Denver, air quality in Boulder County has historically been a nonattainment area for one or more pollutants. The Clean Air Act of 1970 establishes National Ambient Air Quality Standards (NAAQS) which are standards for criteria pollutants to promote and protect public and environmental health. If a certain area is repeatedly at or exceeding a standard, the area is considered in nonattainment for the specific pollutant. If the area is below the standard, then the area is considered attainment. If the area was previously nonattainment, but through efforts to reduce emissions and improve air quality consistently show monitoring values below the standard, the area is considered maintenance. At the time of this report, Boulder County is classified as severe nonattainment for ozone ($O_3$) since it has not achieved the 2008 standard (75 parts per billion) for ten years. It is also considered in moderate nonattainment for $O_3$ since it has not achieved the 2015 standard (70 parts per billion) for five years. Boulder County is also a maintenance area for CO and $PM_{10}$, but has achieved the respective standards for over 20 years. It is expected Boulder County will be reclassified as attainment for CO and $PM_{10}$. Below is a table comparing air quality monitor data nearest the Gross Reservoir (Table 2-2) to the current NAAQS. There are no CO monitors in Boulder County.

**Table 2-2. Air Quality Monitor Data Near Gross Reservoir**

| Pollutant | Averaging Period | Nearest Monitor | 2022 Air Quality Monitor Value | NAAQS |
|---|---|---|---|---|
| $O_3$ | 8-hour | Boulder Reservoir | 75 ppb | 70 ppb (2015)<br>75 ppb (2008) |
| $PM_{10}$ | 24-hour | Boulder Chamber of Commerce | 55 µg/m$^3$ | 150 µg/m$^3$ |
| $PM_{2.5}$ | 24-hour | Boulder Chamber of Commerce | 25 µg/m$^3$ | 35 µg/m$^3$ |
| $PM_{2.5}$ | Annual | Boulder Chamber of Commerce | 7.0 µg/m$^3$ | 12 µg/m$^3$ |

Source: CDPHE 2022 Ambient Air Monitoring Network Plan

ppb – parts per billion

µg/m$^3$ – micrograms per cubic meter

## 2.1 Visual

The Gross Reservoir area consists of an outdoor view of woods, wildlife, and the Reservoir. There is existing traffic in some areas due to recreation at the Reservoir, along with views of recreational activity, especially on weekends and other high-traffic days such as summer holidays. There was not consistent construction in view prior to the April 2022 expansion construction start date, and only construction traffic on isolated occasions. Also, the area to the west and south of the Dam face is full of vegetation and trees that are planned to be removed as part of the expansion construction. Figures 2-1 and 2-2 provide existing visual images of the Gross Reservoir prior to the construction.

**Figure 2-2. Gross Reservoir and Dam – View from Southeast**

Source: The Denver Post, 2017

**Figure 2-3. Gross Reservoir and Dam – View from West**

Source: Denver Water, 2022

# 3. Methodology

## 3.1 Noise

### *3.1.1 Noise Sources*

Construction noise sources are input in the noise model to predict impacts. Noise sources include equipment used on the construction site operations categories: crushing and screening plant, concrete batch plant, dam construction, quarry operations, and drilling and blasting. A full list of noise sources with associated adjusted decibel (dBA) levels and other noise level assumptions are presented in Table 3-1 below.

**Table 3-1. Noise Sources and Model Inputs**

| Scenario | Construction Activity | Noise Level | Source Type | Source Height |
|---|---|---|---|---|
| 1 | Aggregate Processing Plant with Haul Trucks on the Haul Route | 127 dBA | Area | 5 feet |
| 2 | Concrete Batch Plant | 125 dBA | Area | 5 feet |
| 3 | Dam Construction | 131 dBA | Area | 5 feet |
| 4 | Quarry Operations | 125 dBA | Area | 5 feet |
| 5 | Dam Hydro Demolition | 117 dBA | Area | 5 feet |
| 6 | Dam Mechanical Demolition | 119 dBA | Area | 5 feet |
| 7 | Truck Alarms/Beeping | 87 dBA | Point | 4 feet |

### *3.1.2 Noise Model*

The SoundPLAN® noise model was used for computing noise levels from the proposed construction noise from equipment under conservative conditions. A noise industry standard, SoundPLAN® was developed by Braunstein + Berndt GmbH to provide estimates of sound levels at distances from specific noise sources considering the effects of terrain features including relative elevations of noise sources, receivers, and intervening objects and terrain (buildings, hills, trees), and ground effects due to areas of hard ground (pavement, water) and soft ground (grass, field, forest). In addition to computing sound levels at specific receiver positions, SoundPLAN® can produce noise contour graphics that show areas of equal and similar sound level.

### *3.1.3 Noise Impact Methodology*

The sound propagation model within SoundPLAN® that was used for this study was International Standards Organization (ISO) 9613-2. This international standard propagation model is used nearly universally in the United States (US) for environmental noise studies, due to its conservative propagation equations. ISO 9613-2 uses worst-case downwind propagation conditions in all directions, and accounts for variations in terrain and the effects of ground type. The equivalent sound pressure level at the receiver, in downwind conditions, is calculated for each point source based on the formula below.

$$Leq = Lw + Dc - A$$

Where:

- Leq is the equivalent sound pressure level at the receiver, in downwind conditions,
- Lw is the sound power level by the point source,
- Dc is the directivity correction that describes the deviation of the sound pressure level in a specific direction from the sound power level, and
- A is the attenuation of the sound propagation. It is a sum of the attenuation due to the geometrical divergence, the ground effect, the atmospheric absorption, the barriers, and miscellaneous other effects.

Geometrical divergence refers to the decline in noise level that occurs in association with increased distance from the receptor. Sounds generated from a point source typically attenuate or decrease at a rate of six adjusted decibels (dBA) for each doubling of distance. For example, a noise level of 80 dBA measured at a distance of five feet from the noise source would be reduced to 74 dBA at ten feet from the source and be further reduced to 32 dBA at 1,280 feet (approximately ¼ mile). Topographic contour lines were input into the model to consider terrain variation.

The propagation of noise is also affected by the intervening ground, known as ground effect. A hard site, such as parking lots or smooth bodies of water, receives no additional ground attenuation, and the changes in noise levels with distance are simply the geometric spreading from the source, which equates to six dBA per doubling distance. A soft site, such as soft dirt, grass, or scattered bushes and trees, provides an additional ground attenuation value of 1.5 dBA per doubling of distance. Thus, a point source over a soft site would drop off at generally 7.5 dBA per doubling of distance. The 7.5 dBA drop off rate is a general industry accepted standard for quick noise level estimation. SoundPLAN® uses a complex formula based on-ground absorption coefficient and other factors such as terrain change to calculate noise levels at the receivers. SoundPLAN® does not use 7.5 dBA drop off rate directly in the model. The model assumed a soft ground surface type.

The sound attenuation due to atmospheric absorption is calculated based on the atmospheric absorption coefficient (α). The absorption coefficient is calculated according to the ISO 9613-1 "Acoustics-Attenuation of sound during propagation outdoors-Part 1: Calculation of the absorption of sound by the atmosphere". The absorption coefficient is dependent on the frequency, air pressure, temperature, and relative humidity.

## 3.2 Air Quality

### *3.2.1 Emissions Sources*

As previously discussed, emissions sources and activities associated with the Gross Reservoir Dam expansion construction include:

- Drilling and blasting including in the quarry,
- Crushing and screening,
- Topsoil and overburden storage piles and removal,
- Concrete batch plant,
- Haul road travel for employees, equipment, and product transfer, and
- Generators for onsite electric power.

These sources were identified from the construction schedule and the air pollutant emission notices (APENs) provided by Denver Water and the technical support document retrieved from the Colorado Department of Public Health and Environment (CDPHE) public records database for the expansion construction. The sources have a combination of pollutant emissions based on their primary purpose. These sources were grouped based on location of the source and schedule of them occurring. In Table 3-1, the sources and their grouping are detailed based on how they were evaluated in the dispersion model.

**Table 3-2. Air Quality Emission Sources**

| Source | Description | Potential Emissions | Schedule | Source Type | Group ID |
|---|---|---|---|---|---|
| Concrete Batch Plant | Two twin-shaft mixers for producing roller compacted concrete and convention concrete | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2023-2025 | Point | CONBAT |
| Generators | Four diesel-fired generators for onsite power generation | NOx, CO, $PM_{10}$, and $PM_{2.5}$, from fuel combustion | 2022-2026 | Point | GEN |
| Blasting | Explosive detonation of rock faces and trees to clear areas | NOx, CO, $PM_{10}$, and $PM_{2.5}$, from blast detonation and fugitive dust | 2022-2025 | Volume | BLAST |
| Drilling | Drilling of rock faces and quarry area to prepare for blasting activities | NOx, CO, $PM_{10}$, and $PM_{2.5}$, from drilling and fugitive dust | 2022-2025 | Volume | BLAST |
| Topsoil Removal and Stockpile | Movement of topsoil from cleared land and temporary onsite storage in pile | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2022-2025 | Volume | TOP&OVER |
| Overburden Operations | Movement of overburden material from cleared land and extracted soils | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2022-2025 | Volume | TOP&OVER |
| Raw Material Extraction and Stockpile | Movement of raw material from quarry and temporary onsite storage in pile | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2022-2025 | Volume | BLAST |
| Crushing and Screening | Series of conveyors, crushers, and screens for sand and gravel processing | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2022-2025 | Volume | C&S |
| Product Stockpile | Temporary storage of finished produce from crushing and screening plant | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2022-2025 | Volume | C&S |

| Source | Description | Potential Emissions | Schedule | Source Type | Group ID |
|---|---|---|---|---|---|
| Wind Erosion | Dust resulting from cleared unpaved land | $PM_{10}$ and $PM_{2.5}$ from fugitive dust | 2022-2026 | Volume | WIND |
| Construction Haul Road | Main truck traffic route for construction at Dam on Gross Dam Road from the North and South | NOx, CO, $PM_{10}$, and $PM_{2.5}$, from fuel combustion and fugitive dust from truck traffic | 2022-2027 | Series of Volume Sources | HAULCON |

Emission totals and release parameters for the sources were identified from the APENs and technical support document downloaded from CDPHE save for the haul truck exhaust. Mobile source exhaust such as those from vehicles are not required to obtain stationary source air quality permits, and therefore were evaluated separately using the Environmental Protection Agency emissions model MOVES 3.0. The MOVES 3.0 model requires project-specific input on vehicle type (passenger trucks and single unit short-haul trucks), road type (rural), location (Boulder County), and fuel (gasoline for passenger trucks and diesel for single unit short-haul trucks). Exhaust emissions rates were output for each construction year of the project (2022-2027) in the units of pounds pollutant per mile travelled. These were multiplied by the number of trips and mileage per roadway travelled to estimate pollutant emissions. It is important to note that for haul road truck traffic, fugitive dust emissions were also included with the potential emissions from haul truck exhaust as determined from the APENs and technical support document downloaded from CDPHE.

### *3.2.2 Unitized Emissions Method*

Since the purpose of this air quality impacts analysis is to determine the relative air quality impact for each of the residences and is not a regulatory analysis for comparison against the NAAQS, a unitized emissions methodology was used. The unitized emissions methodology uses a dispersion model emissions rate of one (1) pound per hour (lb/hr) and then gets an output result of $\mu g/m^3$ per lb/hr. The estimated emissions rate from each source, in lb/hr, is then multiplied by the output result of $\mu g/m^3$ per lb/hr to get a conservative impact result in $\mu g/m^3$. The unitized emissions method is a conservative approach for estimating impacts in that the model provides equal emissions weight for each source on the receptors. The release parameters and meteorological parameters used in a unitized emissions method are the same as if the actual emissions were used instead of 1 lb/hr and become higher indicators for dispersion rather than emissions in a unitized emissions model. This method was chosen not only for its conservative estimation of impacts, but also so that each construction year with different activities and emissions totals can be evaluated separately.

Sources were grouped in the dispersion model (Group ID) as shown in Table 3-2 based on location of the sources and when the emissions would occur. The output results were provided by Group ID so that emissions sources and activities that occur in the same area and at the same time have a single impact result for each receptor that was then multiplied by the total emissions rate for those same activities and sources and then cumulatively added for a total air quality impact for each pollutant.

### *3.2.3 Dispersion Model*

#### *3.2.3.1 Model Selection Justification and Settings*

The most recent version of the AERMOD air dispersion model (version no. 22112) was chosen to assess the potential air quality impacts at each receptor. AERMOD is the USEPA approved refined modeling tool that analyzes near-field impacts. Supplemental programs within AERMOD including AERMAP version 18081 for receptor processing was used to appropriately model the Facility impacts. Meteorological data was processed through AERMET and provided by CDPHE.

#### *3.2.3.2 Terrain Options*

Terrain elevations were obtained using National Elevation Dataset (NED) data files from the United States Geologic Survey (USGS). These files were generated from elevation imagery in 2022. The NED files were used with AERMAP (version 18081) to estimate elevation and hill heights for the receptor network and for all of the emissions sources.

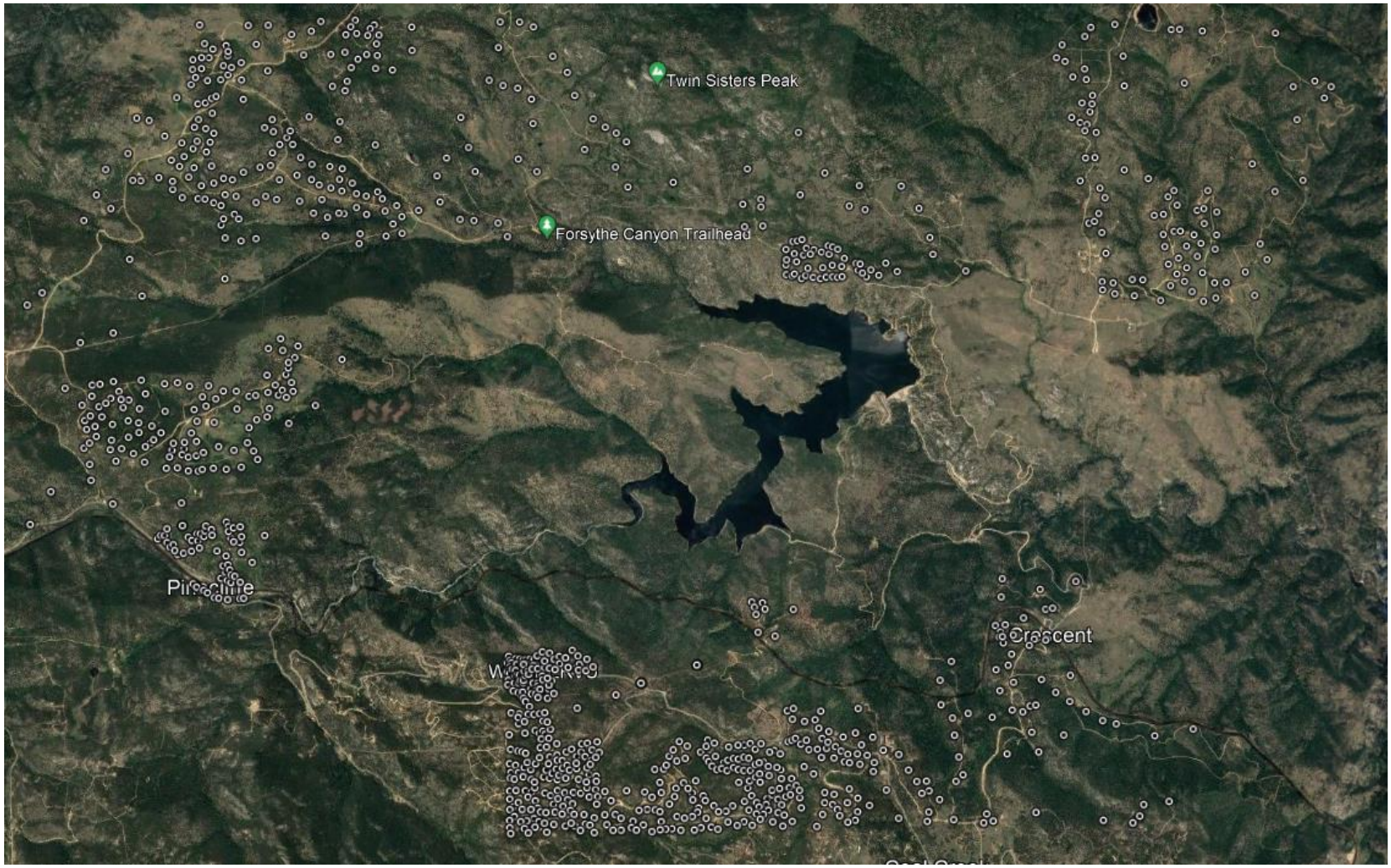
#### *3.2.3.3 Meteorology*

Representative meteorological data was provided by CDPHE based on the unique wind patterns, inversion, and dispersion potential near the Gross Reservoir. Gross Reservoir is at the confluence of Forsythe Canyon and South Boulder Creek Valley. It is expected during the night to early morning hours the air flow along South Boulder Creek will create a wind travelling from the southwest to the northeast from Gross Reservoir Dam to the southwest over the reservoir and adjacent shore. This air flow is then expected to merge with the air flow out of Forsythe Canyon that travels to the southeast from the northwest over the Gross Reservoir Dam and down the South Boulder Creek Valley. During the day, the air flow will reverse and travel uphill. The first set of meteorological files provided were from the surface Montrose Station south of Gunnison and upper air Grand Junction station from the years 2006 through 2010. Due to the disparate location, CDPHE advised, the wind direction be translated 180 degrees in the model to account for expected wind direction of the Gross Reservoir area. The second meteorological data set is from the surface Henderson Mill Station and upper air Denver International Airport Station from 1997. Similarly, the wind direction was translated -85 degrees in the model to account for the expected wind direction in the Gross Reservoir area. The data was processed using AERMET version 21112 without the ADJ_U* function utilized. Each receptor's unitized impact for each Group ID was determined from the maximum result of both modeled meteorological data sets. Therefore, some receptors used results from the Montrose meteorological data set and some receptors used results from the Henderson Mill meteorological data set for each Group ID.

#### *3.2.3.4 Receptors*

Receptors were placed at each of the residences in the Gross Reservoir Dam expansion construction project area. The receptors were defined through review of early impact results, along with coordination with Boulder County. Elevations of the sources and residential receptors were estimated using the NED files downloaded (see Section 3.2.3.2) and AERMAP version 18081. A full figure of the modeled receptors (residences) is shown below.

**Figure 3-1. Receptor Locations**



#### *3.2.3.5 Operation Schedule*

The maximum hourly emissions rate for each source was applied to the unitized emissions model output in an effort to capture the maximum potential hourly emissions. The APENs provided a seasonal breakdown of when the sources will operate: 10% during the winter months (December, January, and February), 35% during the spring months (March, April, and May), 35% during the summer months (June, July, and August), and 20% during the autumn months (September, October, and October). Therefore, in the model a monthly factor was applied to account for more activity in the spring and summer months, and less in the winter months. Assuming the maximum hour of emissions occurs at all times during the spring and summer months, a scaling factor of 1 was used (100%). For the winter months, a scaling factor of 0.29 was used (if 35% is a scaling factor of 1, then 10% is 0.29 [10%/35%]). For the autumn months, a scaling factor of 0.57 was used (if 35% is a scaling factor of 1, then 20% is 0.57 [20%/35%]).

## 3.3 Visual

This analysis incorporates visual impacts predicted to take place during construction of the expansion at the Reservoir. The amount of visual change for a residence was addressed by analyzing elevation and topographical data with consideration of line of sight for each residence, along with incorporation of distance from the construction activity and/or light source. The light sources were determined to be at the Dam Face, at the Office Complex, and at the Quarry (see Figure 1-1). Residence visual impacts were also finalized in coordination with Boulder County based on experience visiting multiple locations near residences near the Reservoir.

A summary of visual impacts is presented in Section 4.3, and a full table of all residences in the study area with an identification of visual impact rankings is presented in Appendix A.

*(Note: The visual analysis is based on elevation data gathered from best available online resources, but which, in some cases, may not be as detailed as needed. For example, elevation differences between a roadway and household were attempted to be accounted for but may not be fully representative in this report. Boulder County will be working to resolve individual situations where a visual impact may exist, but where no visual impact (a ranking of "0") is reflected in this report.)*

## 3.4 Ranking Criteria

Each receptor had a model output for noise, each air quality pollutant (NOx, CO, $PM_{10}$, and $PM_{2.5}$,), and a ranking for visual as described above. An air quality ranking was determined based on weighting of the individual pollutants. Based on potential mitigation resolutions, and expected impacts, NOx and CO were given a 10% weight, and $PM_{10}$ and $PM_{2.5}$ (e.g., fugitive dust) were each given a 40% weight. NOx and CO have lower impacts and emissions estimates due to improved fuel standards and historic low ambient levels of those pollutants in Boulder County. NOx, and CO are sources that result from combustion and therefore mitigation would be difficult for Boulder County and its residents to implement. $PM_{10}$ and $PM_{2.5}$ impacts were given the highest weight because they result primarily from fugitive dust from uncontrolled land clearing, high winds, and vehicle traffic. These impacts can be felt for prolonged periods of time (whereas combustion from truck exhaust will likely be short-lived due to continued movement along the roadways and prohibited idling) and can be mitigated through measures by individual residences and neighborhoods.

Rankings for noise and air quality were ranked from zero to five based on the percentage of the modeled results to the minimum and maximum impacts.

The noise ranking system is as follows:

- A ranking of 0 was applied to receptors that had no noise impacts (see Section 4.1)
- A ranking of 1 was applied to modeled impacts between 1% and 20% of the impact's results range
- A ranking of 2 was applied to modeled impacts between 21% and 40% of the impact's results range
- A ranking of 3 was applied to modeled impacts between 41% and 60% of the impact's results range
- A ranking of 4 was applied to modeled impacts between 61% and 80% of the impact's results range
- A ranking of 5 was applied to modeled impacts greater than 81% of the impact's results range

The air quality ranking system is as follows:

- A ranking of 0 was applied to modeled impacts less than 10% of the impact's results range
- A ranking of 1 was applied to modeled impacts between 11% and 24% of the impacts results range
- A ranking of 2 was applied to modeled impacts between 25% and 37% of the impact's results range
- A ranking of 3 was applied to modeled impacts between 37% and 51% of the impact's results range
- A ranking of 4 was applied to modeled impacts between 52% and 64% of the impact's results range
- A ranking of 5 was applied to modeled impacts greater than 65% of the impact's results range

The visual ranking system is as follows:

- A ranking of 0 was applied to residences with no line-of-sight potential and/or a distance of 2.51 miles or greater from the nearest light source
- A ranking of 1 was applied to residences with line-of-sight potential and at a distance between 2.35 and 2.50 miles from the nearest light source
- A ranking of 2 was applied to residences with line-of-sight potential and at a distance between 1.94 and 2.34 miles from construction activity or the light source
- A ranking of 3 was applied to residences with line-of-sight potential and at a distance between 1.52 and 1.93 miles from the nearest light source
- A ranking of 4 was applied to residences with line-of-sight potential and at a distance between 1.10 and 1.51 miles from the nearest light source
- A ranking of 5 was applied to residences with line-of-sight potential and at a distance less than 1.09 miles from the nearest light source

Finally, a total ranking was calculated for each resident receptor where noise was given a 35% weight, air quality was given a 30% weight, and visual was given a 35% weight. These weightings were coordinated with Boulder County based on feedback received from Boulder County residents and community meetings.

# 4. Results

The following sections provide high-level results of the individual environmental analyses for noise, air quality, and visual impacts. The results presented are based on construction year 2024, which was determined to be the maximum impact year. Detailed results for each modeled residence for the highest impact year are provided in Appendix A with figures of the results in Appendix C for noise, Appendix E for air quality, and Appendix F for visual.

## 4.1 Noise

Noise levels and traffic noise impact associated with the proposed site access haul route were evaluated. The existing traffic volumes were derived from traffic counts during the noise monitoring. The future year (2026) background traffic volumes and projected future year (2026) traffic volumes from the proposed site access haul route on the east side and west side were derived from the Traffic Impact Study (dated April 29, 2020). Modeled inputs are included in Appendix B. On the east side of the proposed site access haul route (Gross Dam Road), traffic noise would increase between 0.2 dBA and 17.5 dBA due to project delivery trucks in 2026. There would be no project traffic impact on State Highway 72 west of Gross Dam Road.

The tabulated groupings by ranking of the most impacted residences by noise are tabulated below following the ranking methodology in Section 3.4. There is a total of 325 households identified as having a noise impact.

**Table 4-1. Noise Model Results by Ranking**

| Ranking | Number of Residences | Resident Approximate Locations |
|---|---|---|
| 1 | 19 addresses | Pika Road<br>Copperdale Lane<br>Flagstaff Road |
| 2 | 35 addresses | Pine Road<br>Crescent Lake Road<br>Signal Rock Road<br>Hummingbird Lane |
| 3 | 131 addresses | Coal Creek Canyon Drive<br>Wonderland Avenue<br>Flagstaff Road<br>Crescent Lake Road<br>Outlook Drive |

| Ranking | Number of Residences | Resident Approximate Locations |
|---|---|---|
| 4 | 70 addresses | Juniper Heights Road<br>Coal Creek Canyon Drive<br>Gross Dam Road<br>Lakeshore Drive<br>Tunnel 19 Road |
| 5 | 70 addresses | Gross Dam Road<br>Lakeshore Park Road<br>Lakeshore Drive<br>Miramonte |

Due to noise impact methodology, diminishing ability for sound energy to travel far distances, and model limitations, residents considered past the project area boundary are assumed for the purposes of this study to have no noise impacts. While this may not always be accurate in practice, it was determined the project area is defined appropriately to encompass residences with noticeable noise impacts. Contour maps of noise impacts are provided in Appendix C section to further demonstrate the drop-off of noise impacts as distance from the noise source increases.

## 4.2 Air Quality

The air quality methodology was followed and maximum impacts by source were evaluated for each year during the construction period (2022 through 2027) and multiplied by the corresponding emissions rate of each activity. The maximum impact was derived from the maximum modeled result of the two meteorological data sets; for the most part, the highest modeled result was from the Montrose meteorological data set. The weights for each pollutant were applied to determine the overall air quality ranking. With the predominant winds coming from the southwest travelling northeast, many of the air quality impacted receptors are on the east and northeast side of the Reservoir.

The tabulated groupings by ranking of the most impacted residences by air quality are tabulated below following the ranking methodology in Section 3.4. There is a total of 254 households identified as having an air quality impact.

**Table 4-2. Air Quality Model Results by Ranking**

| Ranking | Number of Residences | Resident Approximate Locations |
|---|---|---|
| 1 | 102 addresses | Lakeshore Park Road<br>Lakeshore Drive<br>Miramonte<br>Crescent Lake Road<br>Pine Road<br>Bison Drive<br>Flagstaff Road |

| Ranking | Number of Residences | Resident Approximate Locations |
|---|---|---|
| 2 | 89 addresses | Gross Dam Road<br>Lakeshore Park Road<br>Tunnel 19<br>Flagstaff Road<br>Hummingbird Lane<br>Bison Drive<br>Cougar Drive |
| 3 | 49 addresses | Pika Road<br>Juniper Heights Road<br>Gross Dam Road<br>Crescent Lake Road<br>Chute Road |
| 4 | 9 addresses | Gross Dam Road<br>Juniper Heights Road<br>Chute Road |
| 5 | 5 addresses | Gross Dam Road<br>Juniper Heights Road |

## 4.3 Visual

Visual impacts were analyzed by reviewing elevation and topographical data with consideration of line of sight for each residence, along with incorporation of distance from the three identified light sources: Dam Face, Office Building, and Quarry (see Figure 1-1). It is important to note that only visual impacts from construction and construction lighting were evaluated and not the permanent fixture of the completed and operating Gross Reservoir Dam.

The tabulated groupings by ranking of the most impacted residences by visual effects are tabulated below following the ranking methodology in Section 3.4. There is a total of 154 households identified as having a visual impact.

**Table 4-3. Visual Results by Ranking**

| Ranking | Number of Residences | Resident Approximate Locations |
|---|---|---|
| 1 | 6 addresses | Flagstaff Road<br>Spruce Canyon Circle |
| 2 | 16 addresses | Flagstaff Road |

| Ranking | Number of Residences | Resident Approximate Locations |
|---|---|---|
| 3 | 25 addresses | Gross Dam Road<br>Tunnel 19<br>Lichen Lane<br>Flagstaff Road |
| 4 | 44 addresses | Juniper Heights Road<br>Gross Dam Road<br>Tunnel 19<br>Lakeshore Drive<br>Coal Creek Canyon Drive |
| 5 | 63 addresses | Lakeshore Park Road<br>Flagstaff Road<br>Lakeshore Drive<br>Miramonte<br>Coal Creek Canyon Drive |

## 4.4 Overall Ranking

Using the weights of noise, air quality, and visual impact, an overall ranking was created for each evaluated residence. Based on the percentages of impacts, all residences with at least 50% of the impact's range would have a ranking of 3 or higher. These residences would most benefit from mitigation measures to alleviate impacts from either noise, air quality, or visual, or a combination of the three. The table below indicates the number of residences with a ranking greater than 0, their approximate location, and whether their modeled impacts from noise, air quality, or visual was the largest indicator for their overall ranking. Detailed results for the overall ranking and individual resource rankings are included in Appendix A. There is a total of 404 households identified as having an overall impact.

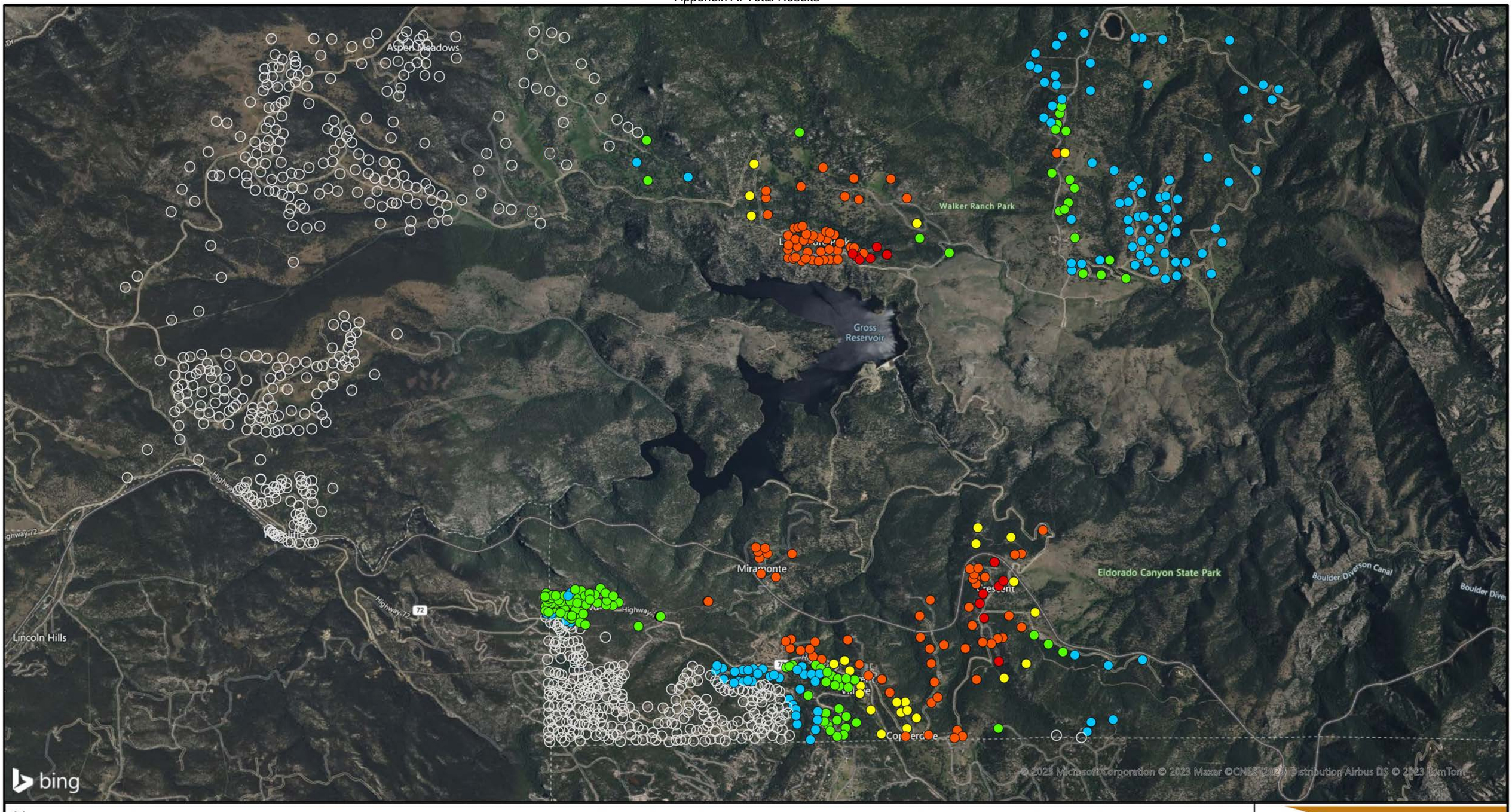
**Table 4-4. Overall Results by Ranking**

| Ranking | Number of Residences | Resident Approximate Locations | Largest Resource Impact |
|---|---|---|---|
| 1 | 122 addresses | Flagstaff Road<br>Bison Drive<br>Pika Road<br>Cougar Drive<br>Copperdale Lne | Noise and Air |

| Ranking | Number of Residences | Resident Approximate Locations | Largest Resource Impact |
|---|---|---|---|
| 2 | 139 addresses | Flagstaff Road<br>Pika Road<br>Hummingbird Lane<br>Wonderland Ave<br>Signal Rock Road<br>Wonder Trail<br>Outlook Drive | Noise and Air |
| 3 | 25 addresses | Lichen Lane<br>Lakeshore Drive<br>Coal Creek Canyon Drive<br>Gross Dam Road | Noise, Visual, and Air |
| 4 | 105 addresses | Lakeshore Park Road<br>Lakeshore Drive<br>Miramonte<br>Juniper Heights Road<br>Coal Creek Canyon Drive<br>Tunnel 19 Road<br>Gross Dam Road | Noise and Visual |
| 5 | 13 addresses | Lakeshore Park Road<br>Lakeshore Drive<br>Gross Dam Road<br>Juniper Heights Road | Noise, Visual, and Air |

# Appendices

# Appendix A. Total Results




N

**Legend**

Total Ranking

- 0
- 1
- 2
- 3
- 4
- 5

0 1,500 3,000 Feet

Pinyon Environmental, Inc.

***GROSS RESERVOIR TOTAL IMPACT RANKINGS***

*Gross Reservoir*

*Boulder County, Colorado*

| | |
|---|---|
| Site Location: Multiple Sections and Townships, Range 70, 69, 68, 67 W, 6th Principal Meridian | Drawn By: CJB \| Figure 1 |
| Pinyon Project Number: 1/22-045-001.001 | Reviewed By: DC \| Date: 4/20/2023 |



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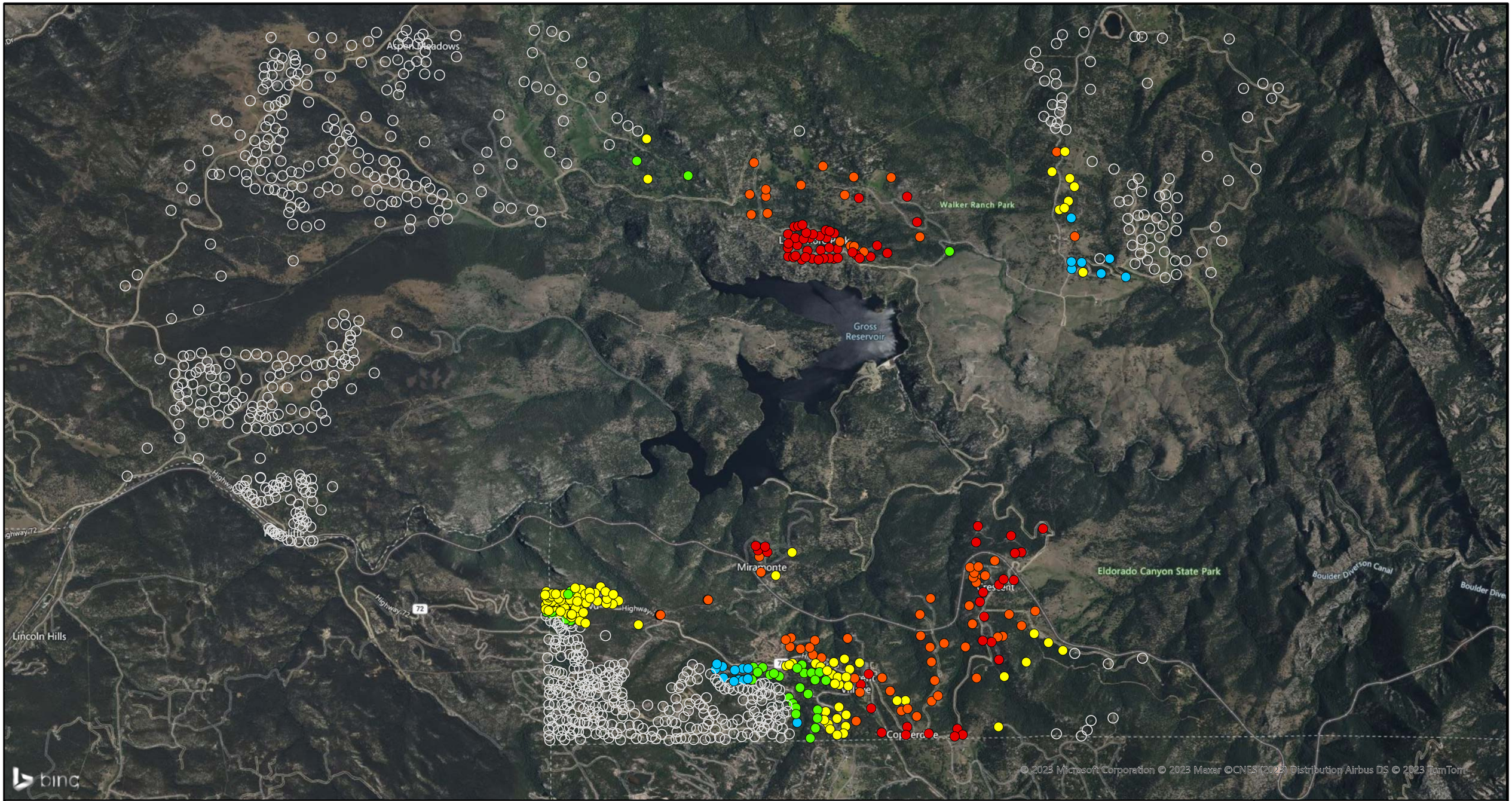
# Appendix B. Noise Model Summary




N

**Legend**

Noise Ranking

- 0
- 1
- 2
- 3
- 4
- 5

0 1,500 3,000 Feet

Pinyon Environmental, Inc.

***GROSS RESERVOIR NOISE IMPACT RANKINGS***

*Gross Reservoir*

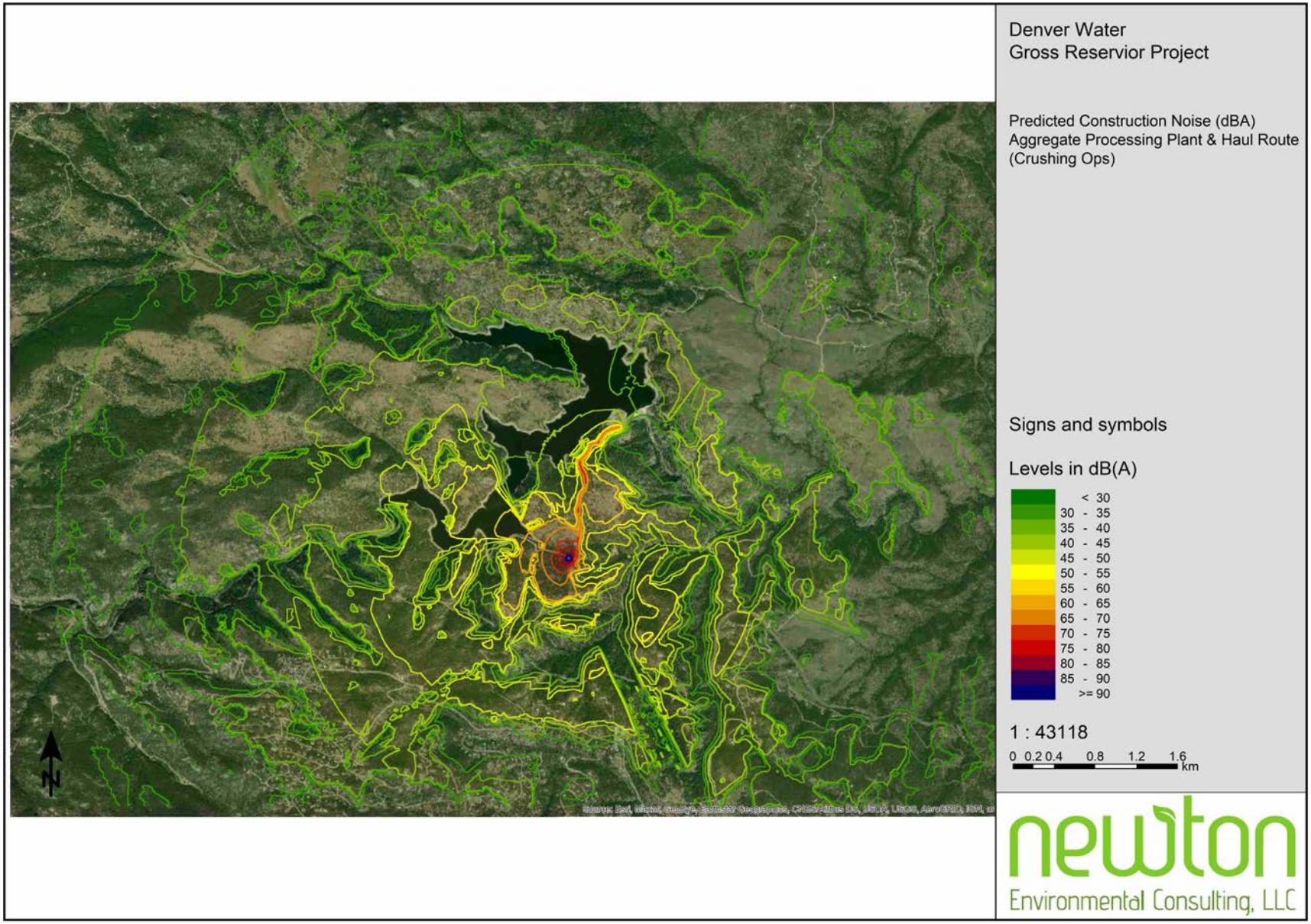
*Boulder County, Colorado*

| | | |
|---|---|---|
| Site Location: Multiple Sections and Townships, Range 70, 69, 68, 67 W, 6th Principal Meridian | Drawn By: CJB | Figure 1 |
| Pinyon Project Number: 1/22-045-001.001 | Reviewed By: DC | Date: 4/18/2023 |

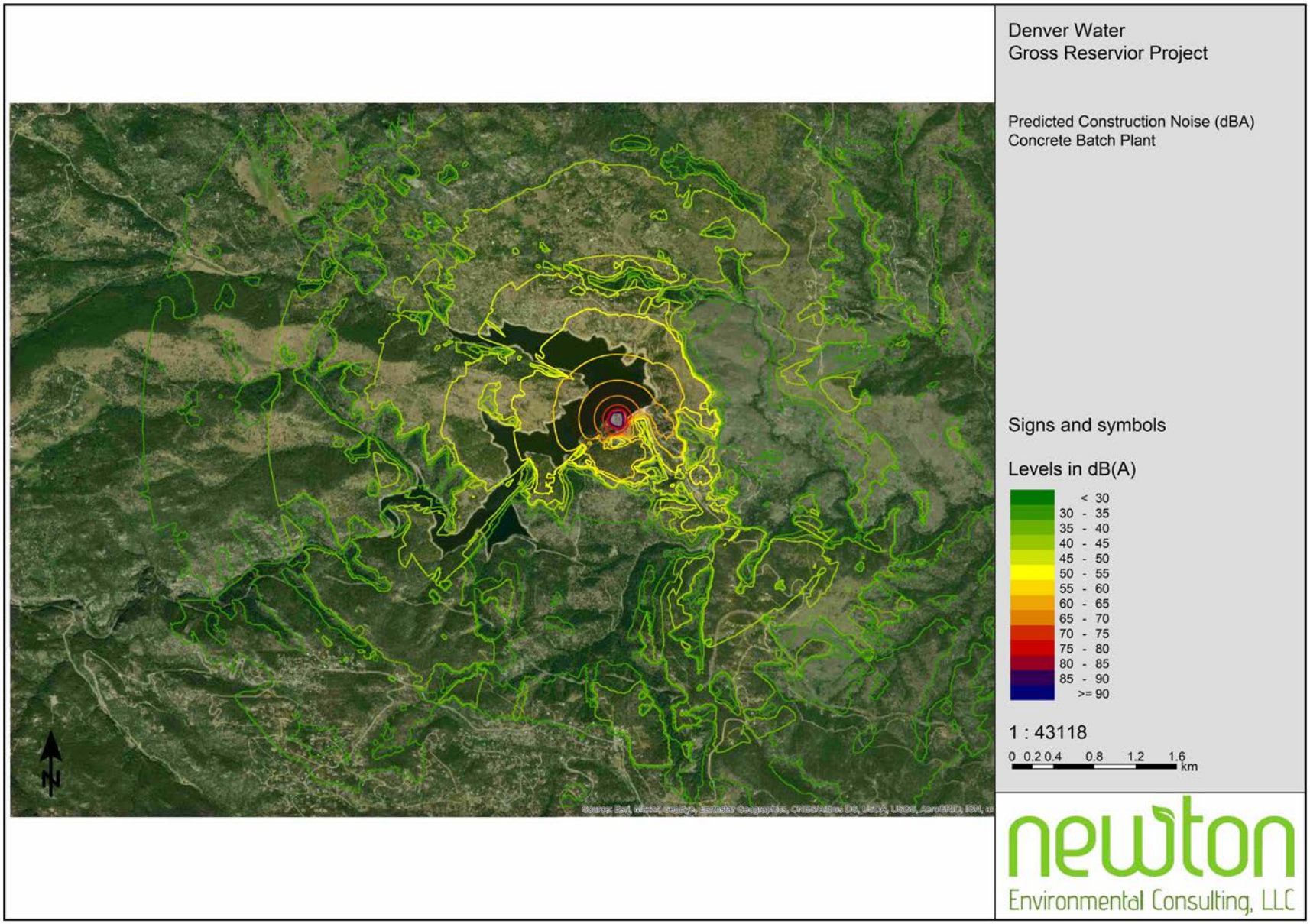
Document Path: \\192.168.2.10\company2\PROJECTS\2022\122013301 Boulder County Gross Reservoir Air, Noise, and Visual\Figures\ArcPro\122013301 Boulder County Gross Reservoir_Working\122013301 Boulder County Gross Reservoir_Working.aprx

# Appendix C. Noise Results Figures

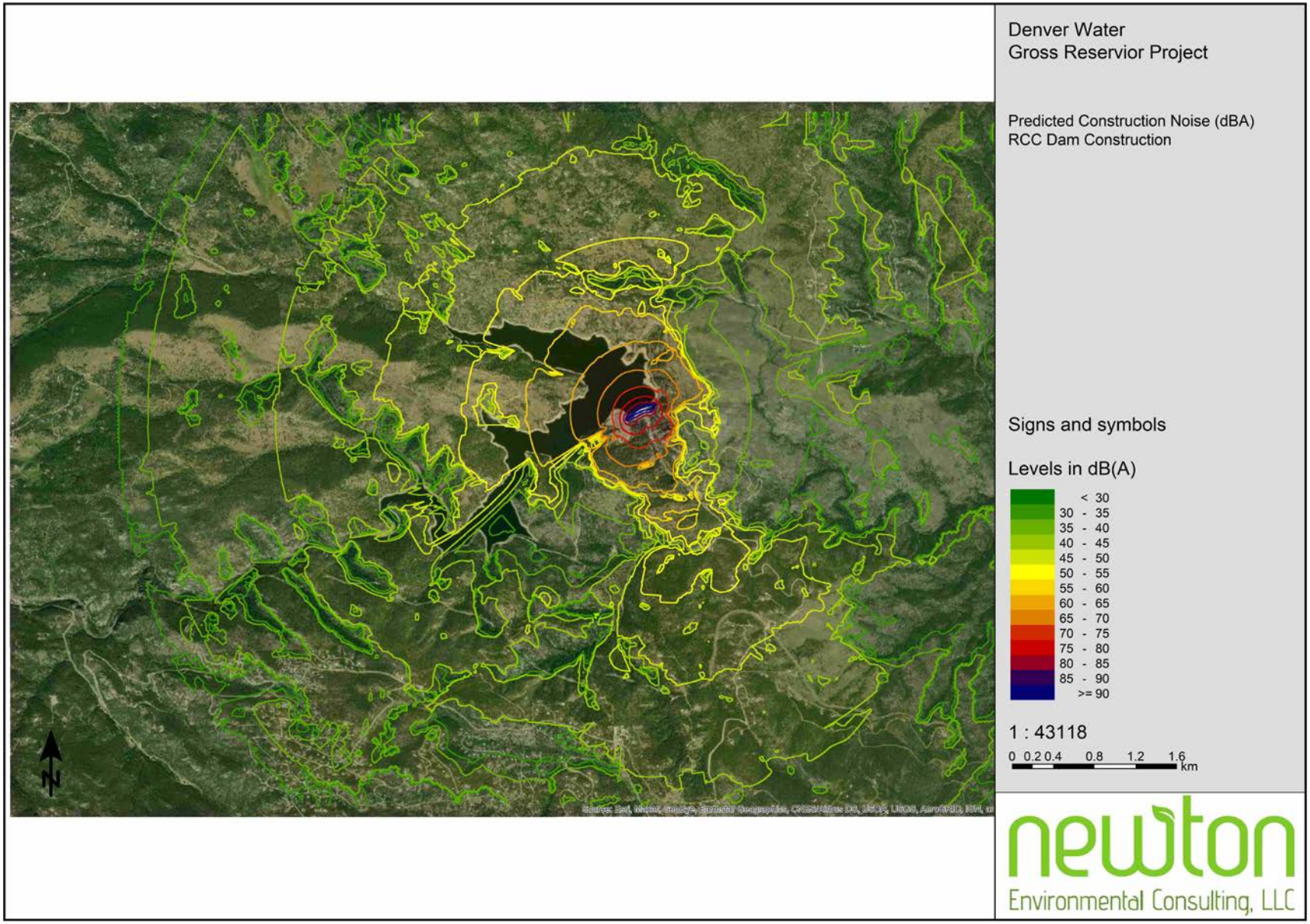
## Construction Noise Contour Map for Aggregate Processing Plant & Haul Route (Scenario 1)



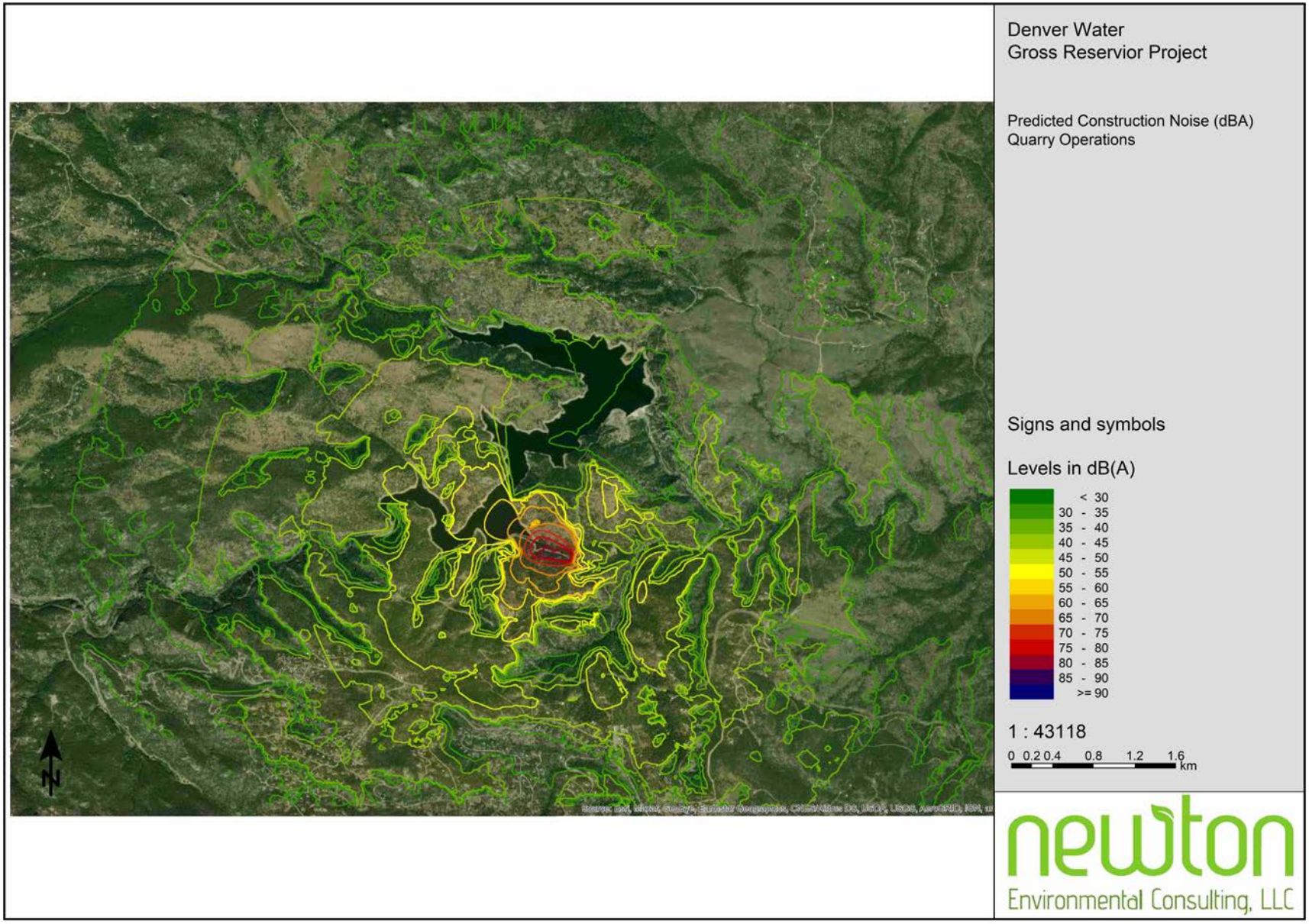
## Construction Noise Contour Map for Concrete Batch Plant (Scenario 2)



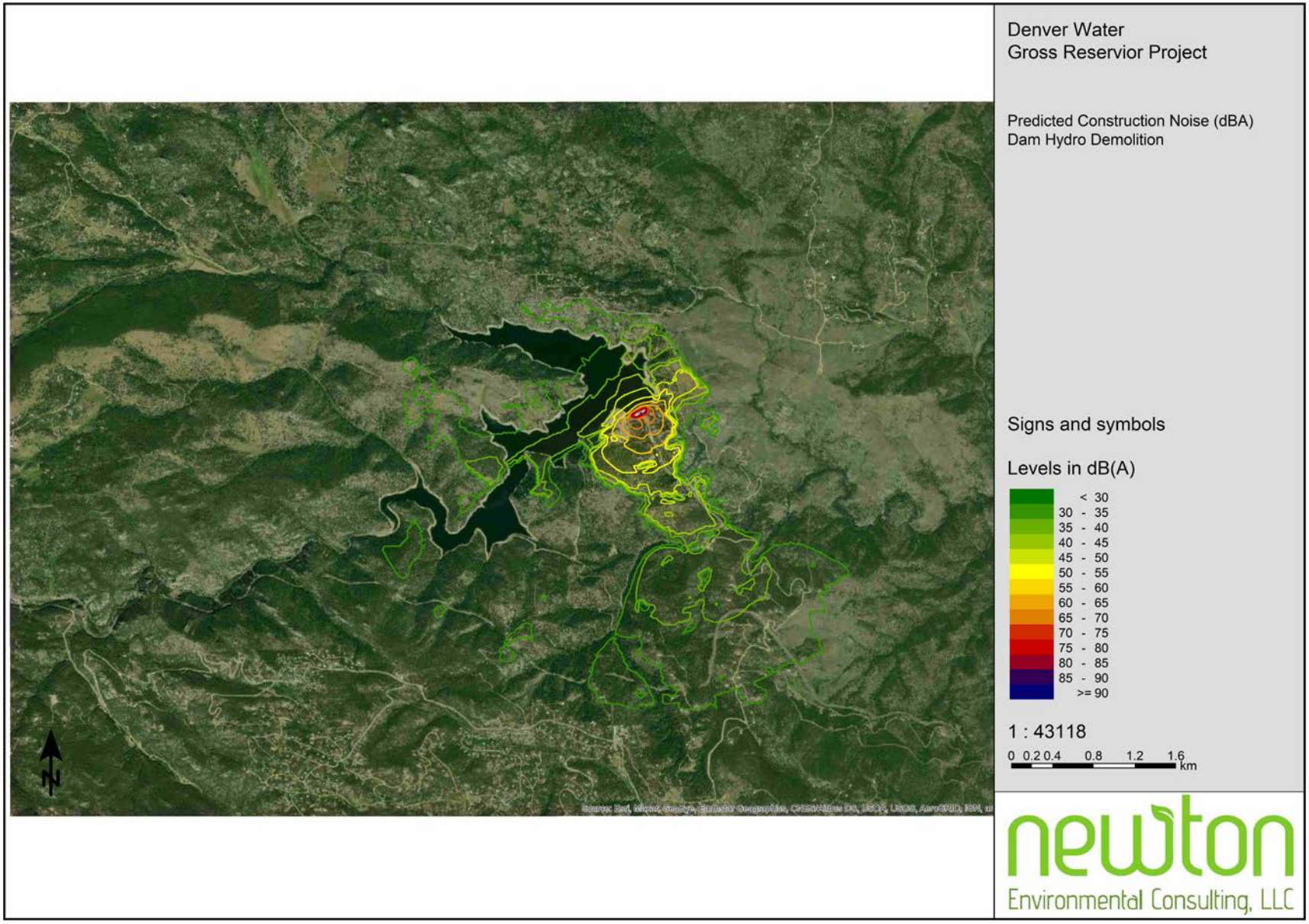
## Construction Noise Contour Map for RCC Dam Construction (Scenario 3)



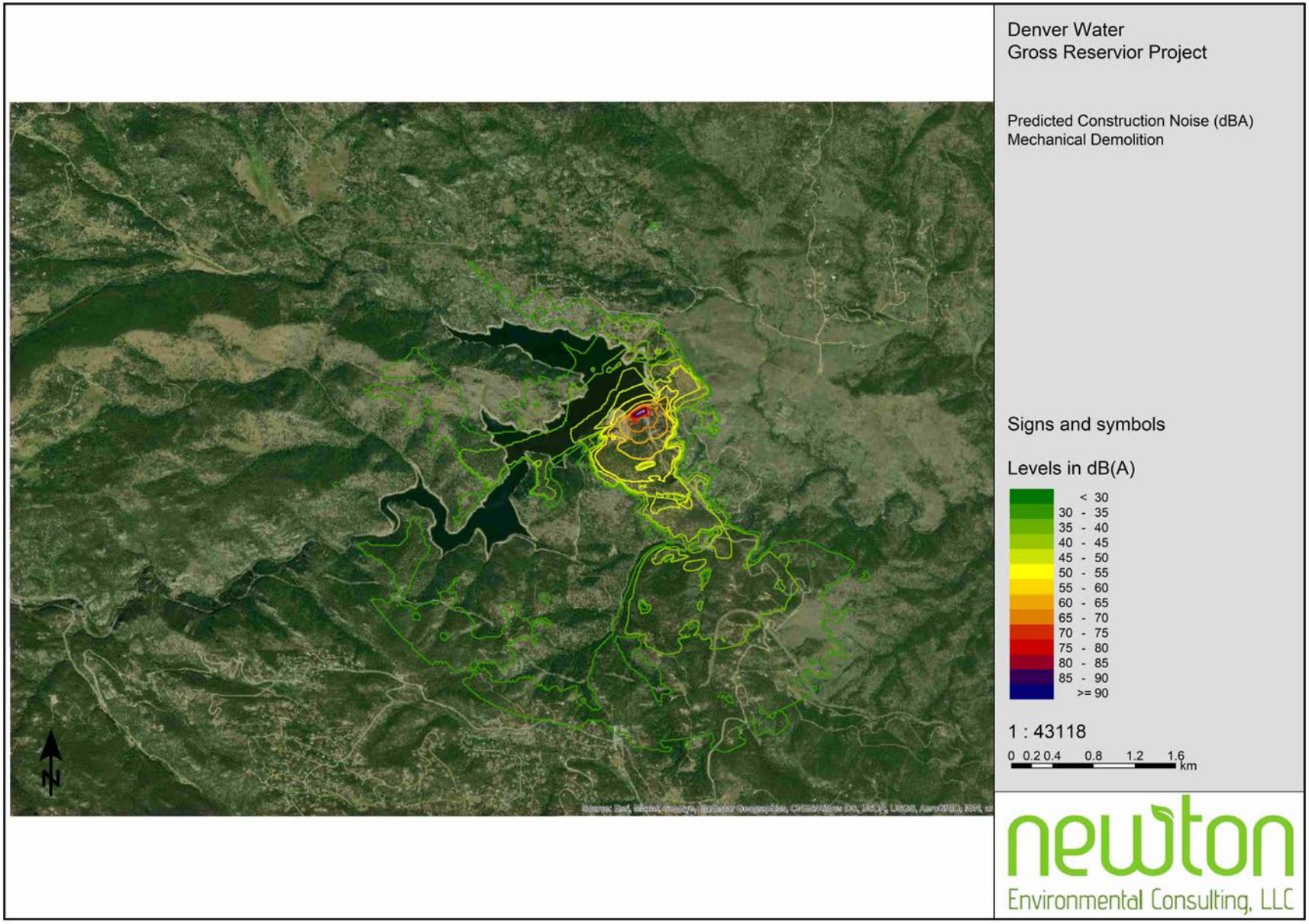
## Construction Noise Contour Map for Quarry Operations (Scenario 4)



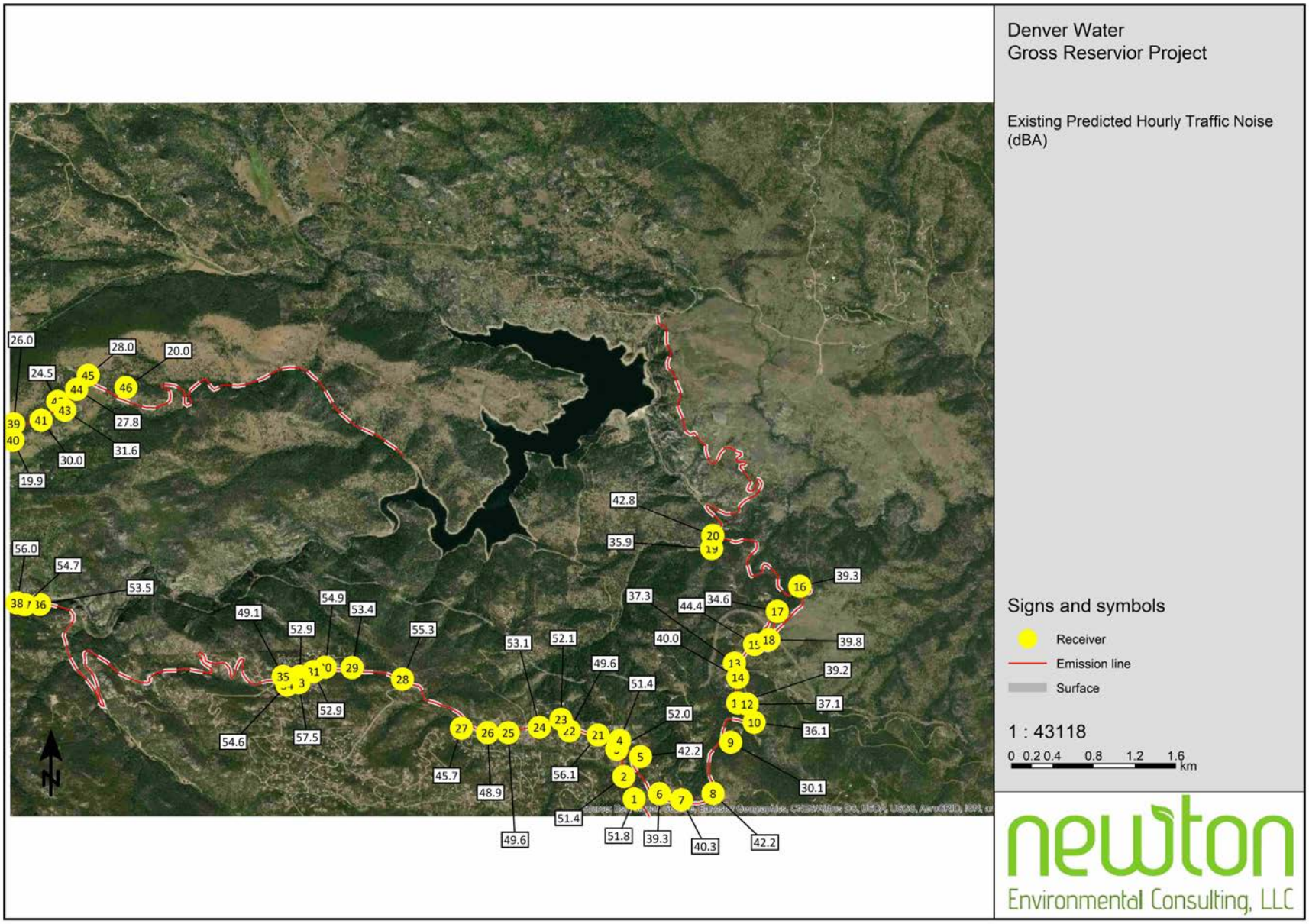
## Construction Noise Contour Map for Dam Hydro Demolition (Scenario 5)



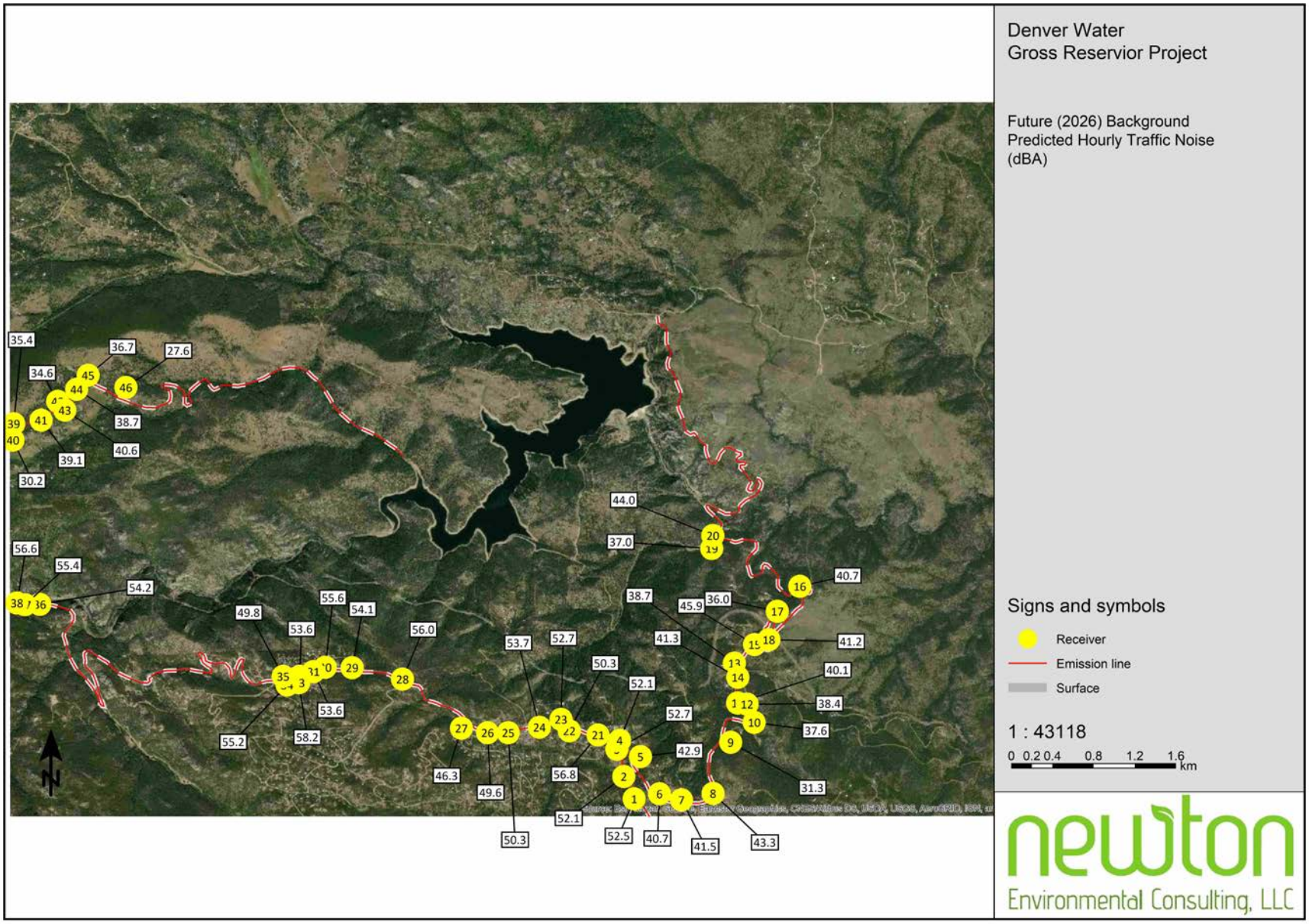
## Construction Noise Contour Map for Dam Mechanical Demolition (Scenario 6)



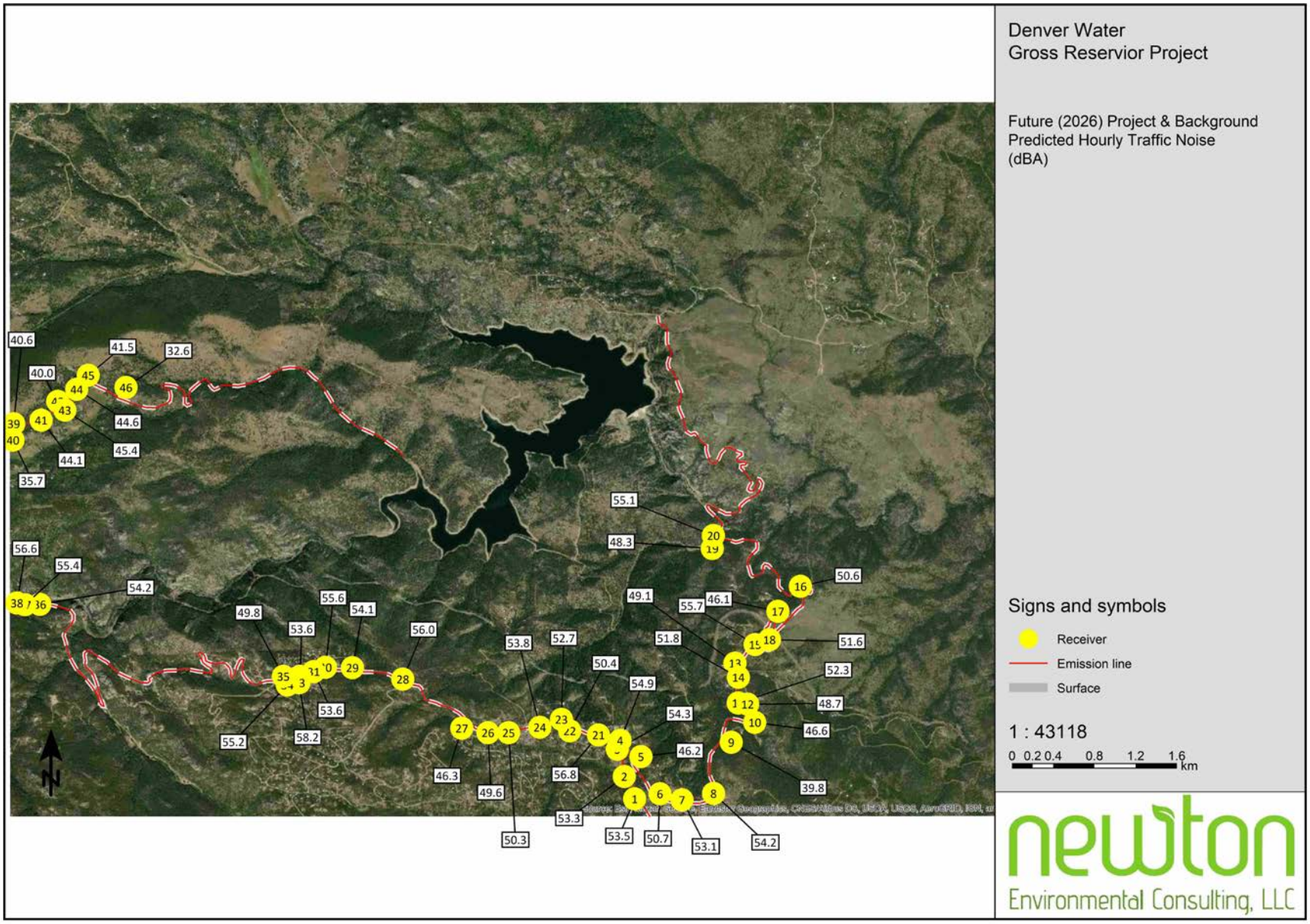
# Existing Predicted Hourly Traffic Noise (dBA)



# Future (2026) Background Predicted Hourly Traffic Noise (dBA)



# Future (2026) Project & Background Predicted Hourly Traffic Noise (dBA)



# Appendix D. Air Quality Model Summary

Emissions_NOx

| Source | 2022 lb/hr | 2023 lb/hr | 2024 lb/hr | 2025 lb/hr | 2026 lb/hr | 2027 lb/hr |
|---|---|---|---|---|---|---|
| Haul Roads - Dam Construction | 326.2 | 310.6 | 295.8 | 284.5 | 274.8 | 6.1 |
| Haul Roads - Tree Removal | | | | 10.9 | 10.6 | |
| Concrete Batch Plant | | 0.0 | 0.0 | 0.0 | | |
| Generator | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | |
| Blasting & Drilling & Raw Material Extraction | 4.0 | 4.0 | 4.0 | 4.0 | | |
| C&S & Product Stock Pile | 0.0 | 0.0 | 0.0 | 0.0 | | |
| Disturbed Area | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Topsoil Removal & Overburden | 0.0 | 0.0 | 0.0 | 0.0 | | |

1. Uses maximum hourly emissions without accounting for annualization.
2. Haul road emissions calculating using MOVES 3.0 with truck trips and route from Traffic Management Plan and assumptions on vehicles travelling.

| Source | 2022 lb/hr | 2023 lb/hr | 2024 lb/hr | 2025 lb/hr | 2026 lb/hr | 2027 lb/hr |
|---|---|---|---|---|---|---|
| Haul Roads - Dam Construction | 365.2 | 348.8 | 333.6 | 320.1 | 305.0 | 134.9 |
| Haul Roads - Tree Removal | | | | 6.5 | 6.4 | |
| Concrete Batch Plant | | 0.0 | 0.0 | 0.0 | | |
| Generator | 37.7 | 37.7 | 37.7 | 37.7 | 37.7 | |
| Blasting & Drilling & Raw Material Extraction | 38.0 | 38.0 | 38.0 | 38.0 | | |
| C&S & Product Stock Pile | 0.0 | 0.0 | 0.0 | 0.0 | | |
| Disturbed Area | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Topsoil Removal & Overburden | 0.0 | 0.0 | 0.0 | 0.0 | | |

1. Uses maximum hourly emissions without accounting for annualization.
2. Haul road emissions calculating using MOVES 3.0 with truck trips and route from Traffic Management Plan and assumptions on vehicles travelling.

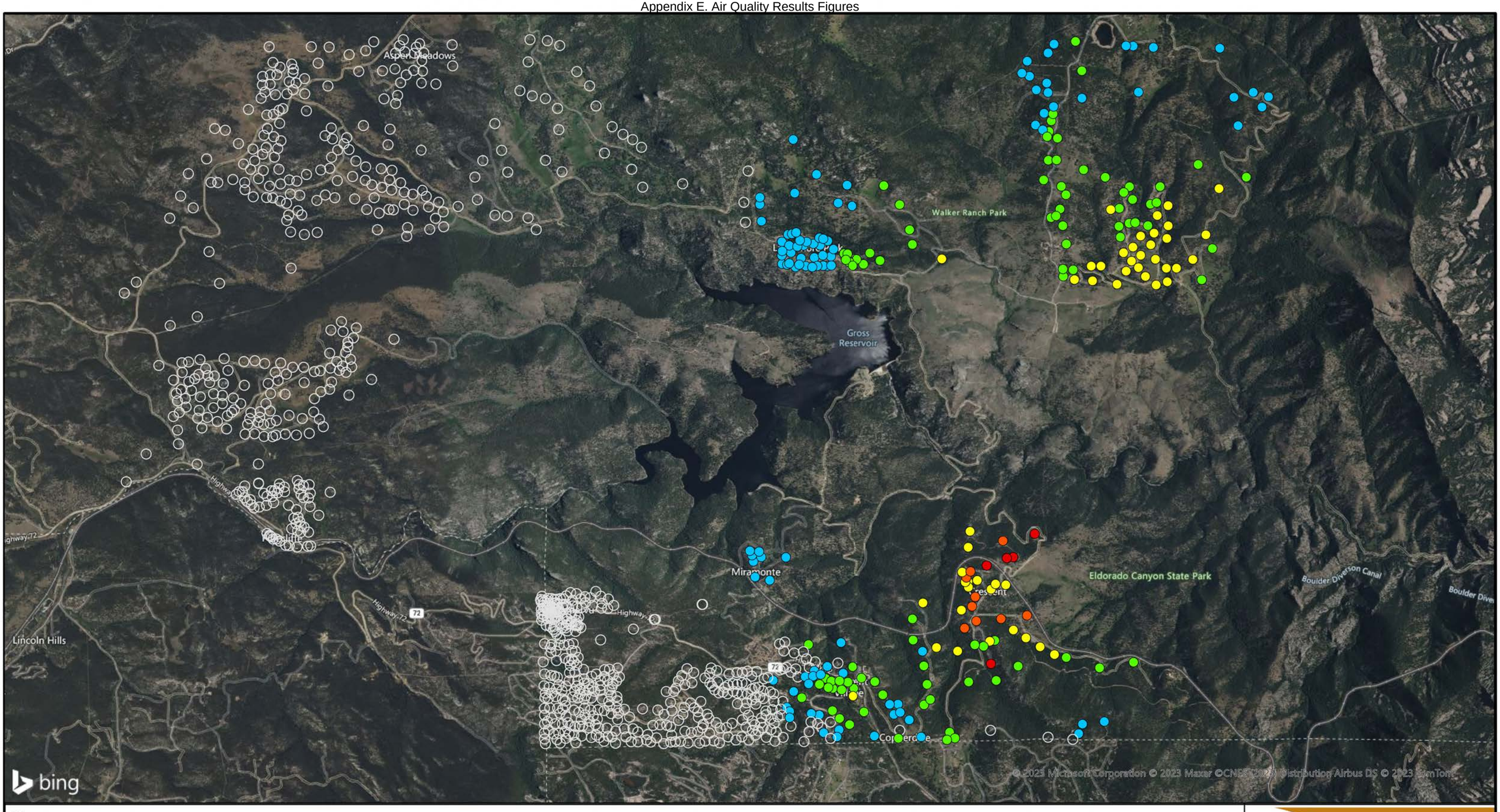
| Source | 2022 lb/hr | 2023 lb/hr | 2024 lb/hr | 2025 lb/hr | 2026 lb/hr | 2027 lb/hr |
|---|---|---|---|---|---|---|
| Haul Roads - Dam Construction | 33.7 | 32.6 | 31.7 | 30.9 | 30.3 | 8.9 |
| Haul Roads - Tree Removal | | | | 0.9 | 0.8 | |
| Concrete Batch Plant | | 4.6 | 4.6 | 4.6 | | |
| Generator | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | |
| Blasting & Drilling & Raw Material Extraction | 10.5 | 10.5 | 10.5 | 10.5 | | |
| C&S & Product Stock Pile | 2.6 | 2.6 | 2.6 | 2.6 | | |
| Disturbed Area | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 | |
| Topsoil Removal & Overburden | 11.5 | 11.5 | 11.5 | 11.5 | | |

1. Uses maximum hourly emissions without accounting for annualization.
2. Haul road emissions calculating using MOVES 3.0 with truck trips and route from Traffic Management Plan and assumptions on vehicles travelling.
3. Fugitive dust from truck traffic are included in PM10 emissions estimates in the haul roads source category.

| Source | 2022 lb/hr | 2023 lb/hr | 2024 lb/hr | 2025 lb/hr | 2026 lb/hr | 2027 lb/hr |
|---|---|---|---|---|---|---|
| Haul Roads - Dam Construction | 9.3 | 8.3 | 7.6 | 6.8 | 6.2 | 1.2 |
| Haul Roads - Tree Removal | | | | 0.2 | 0.2 | |
| Concrete Batch Plant | | 0.7 | 0.7 | 0.7 | | |
| Generator | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | |
| Blasting & Drilling & Raw Material Extraction | 1.2 | 1.2 | 1.2 | 1.2 | | |
| C&S & Product Stock Pile | 0.4 | 0.4 | 0.4 | 0.4 | | |
| Disturbed Area | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | |
| Topsoil Removal & Overburden | 2.1 | 2.1 | 2.1 | 2.1 | | |

1. Uses maximum hourly emissions without accounting for annualization.
2. Haul road emissions calculating using MOVES 3.0 with truck trips and route from Traffic Management Plan and assumptions on vehicles travelling.
3. Fugitive dust from truck traffic are included in PM2.5 emissions estimates in the haul roads source category.

# Appendix E. Air Quality Results Figures




N

**Legend**

Air Quality Ranking
- 0
- 1
- 2
- 3
- 4
- 5

0 1,500 3,000 Feet

Pinyon Environmental, Inc.

***GROSS RESERVOIR AIR QUALITY IMPACT RANKINGS***

*Gross Reservoir*
*Boulder County, Colorado*

| | | |
|---|---|---|
| Site Location: Multiple Sections and Townships, Range 70, 69, 68, 67 W, 6th Principal Meridian | Drawn By: CJB | Figure 1 |
| Pinyon Project Number: 1/22-045-001.001 | Reviewed By: DC | Date: 4/14/2023 |



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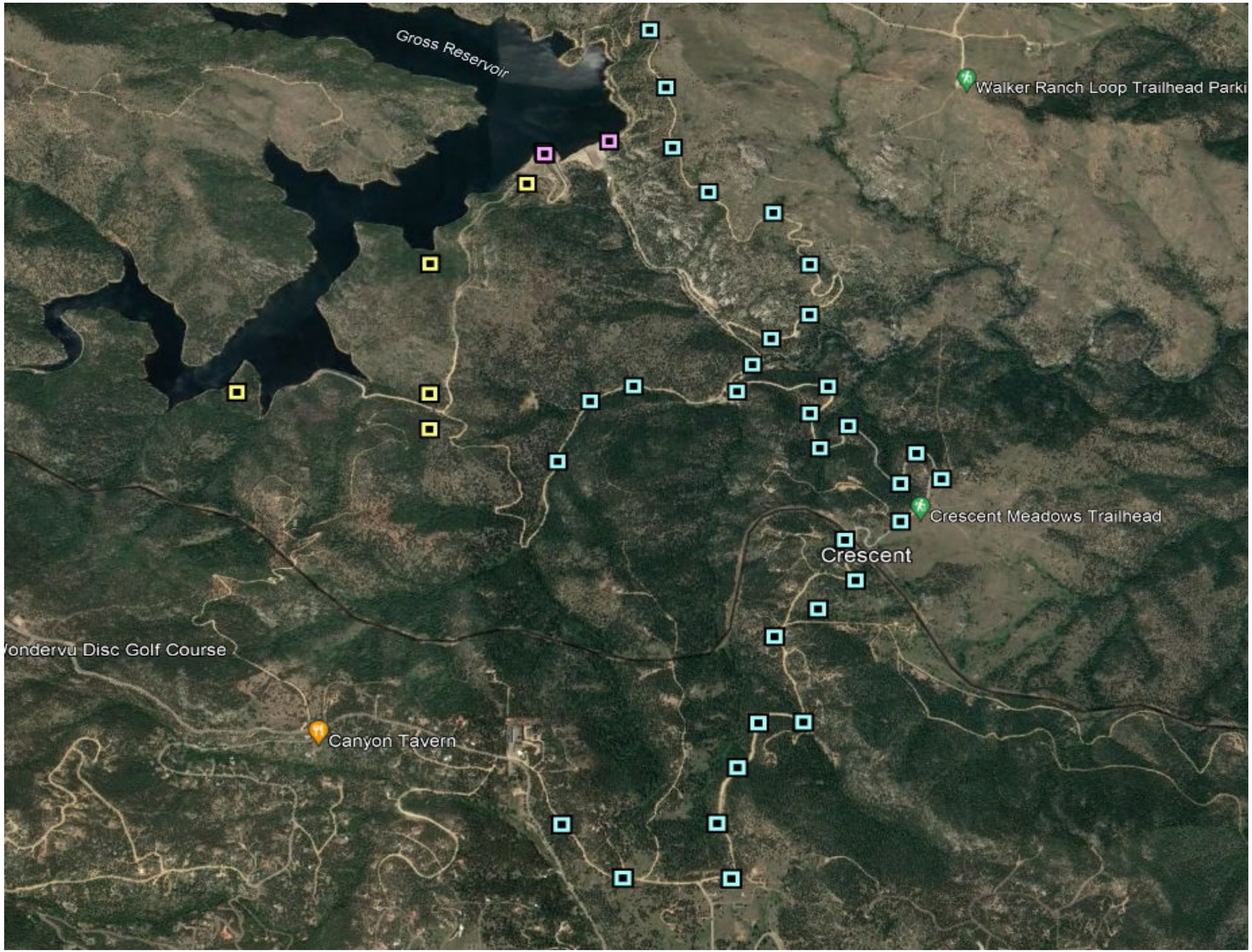


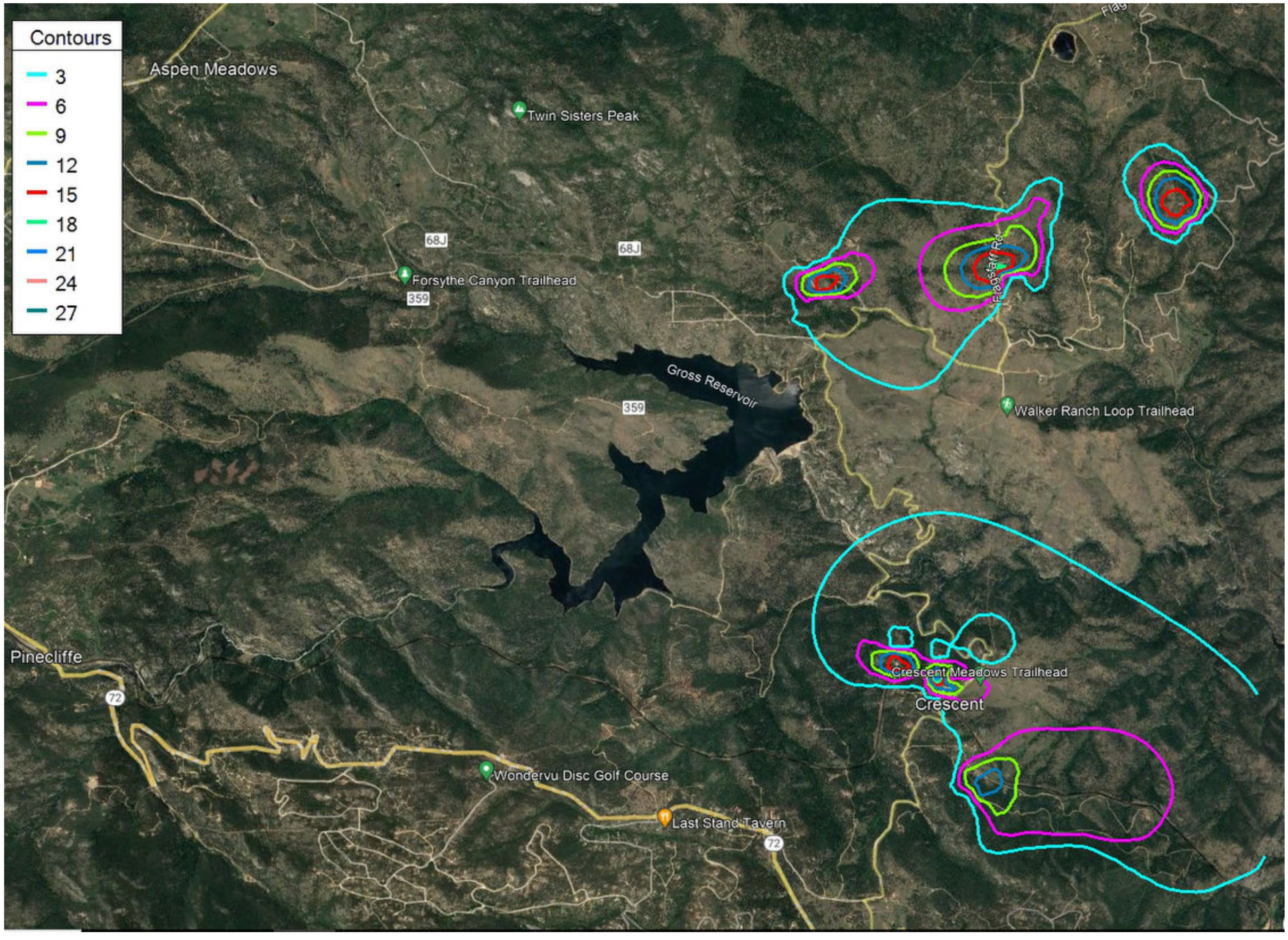

Road Sources
Point Sources
Area/Volume Sources

Pinyon Environmental, Inc.

*Air Quality Modeling - Source Origins*

Gross Reservoir Dam Construction
Boulder County, Colorado

| | | |
|---|---|---|
| Site Location: 39.9510, -105.3614 | Drawn By: KAM | |
| Pinyon Project Number: 1/22-0133-01 | Reviewed By: DJC | Date: 11/10/2022 |

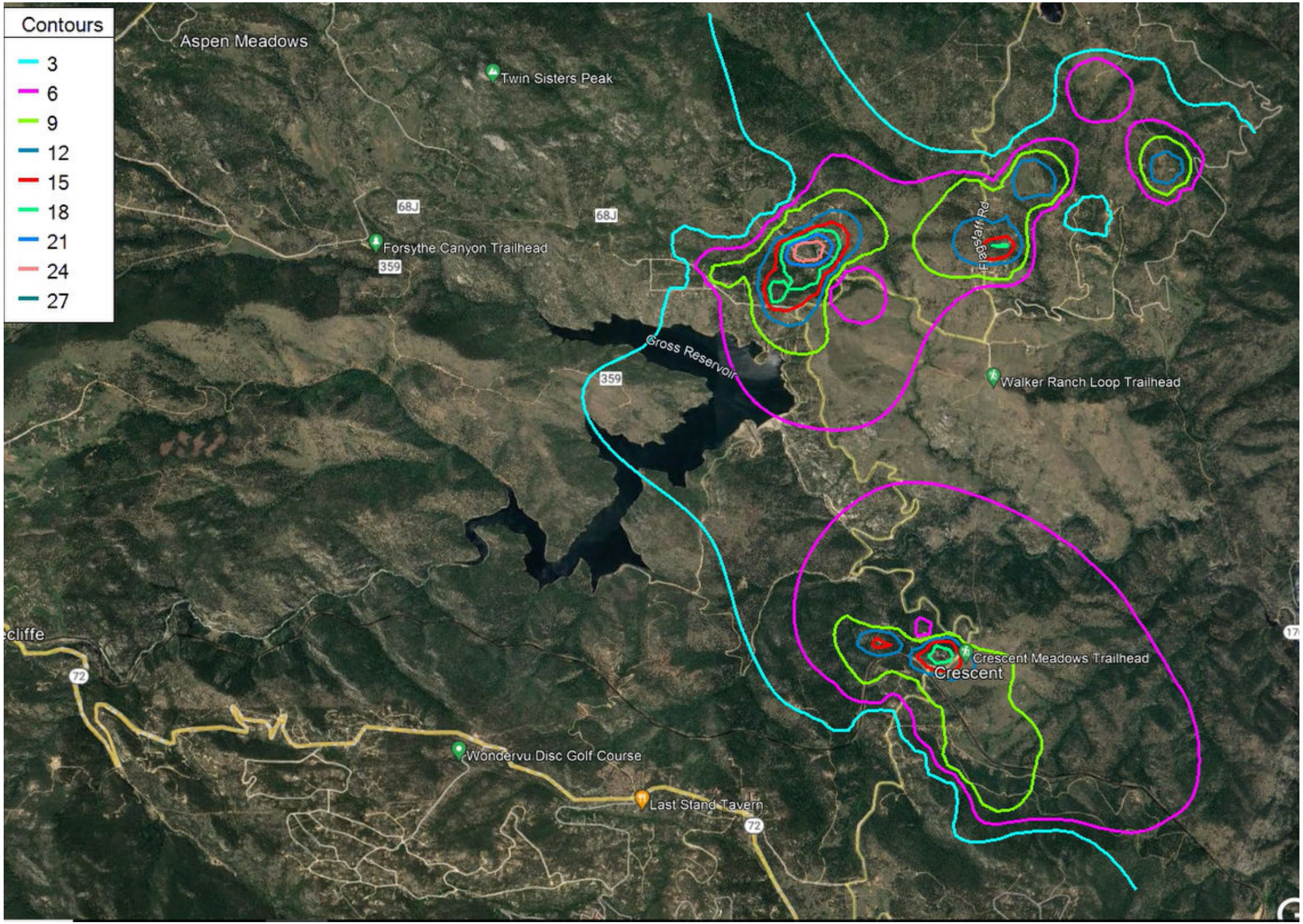



*Contour Map - Concrete Batch Plant*
Dispersion Results CONBAT
Gross Reservoir Dam Construction
Boulder County, Colorado

Site Location: 39.9510, -105.3614
Pinyon Project Number: 1/22-0133-01



Drawn By: KAM
Reviewed By: DJC
Date: 11/10/2022

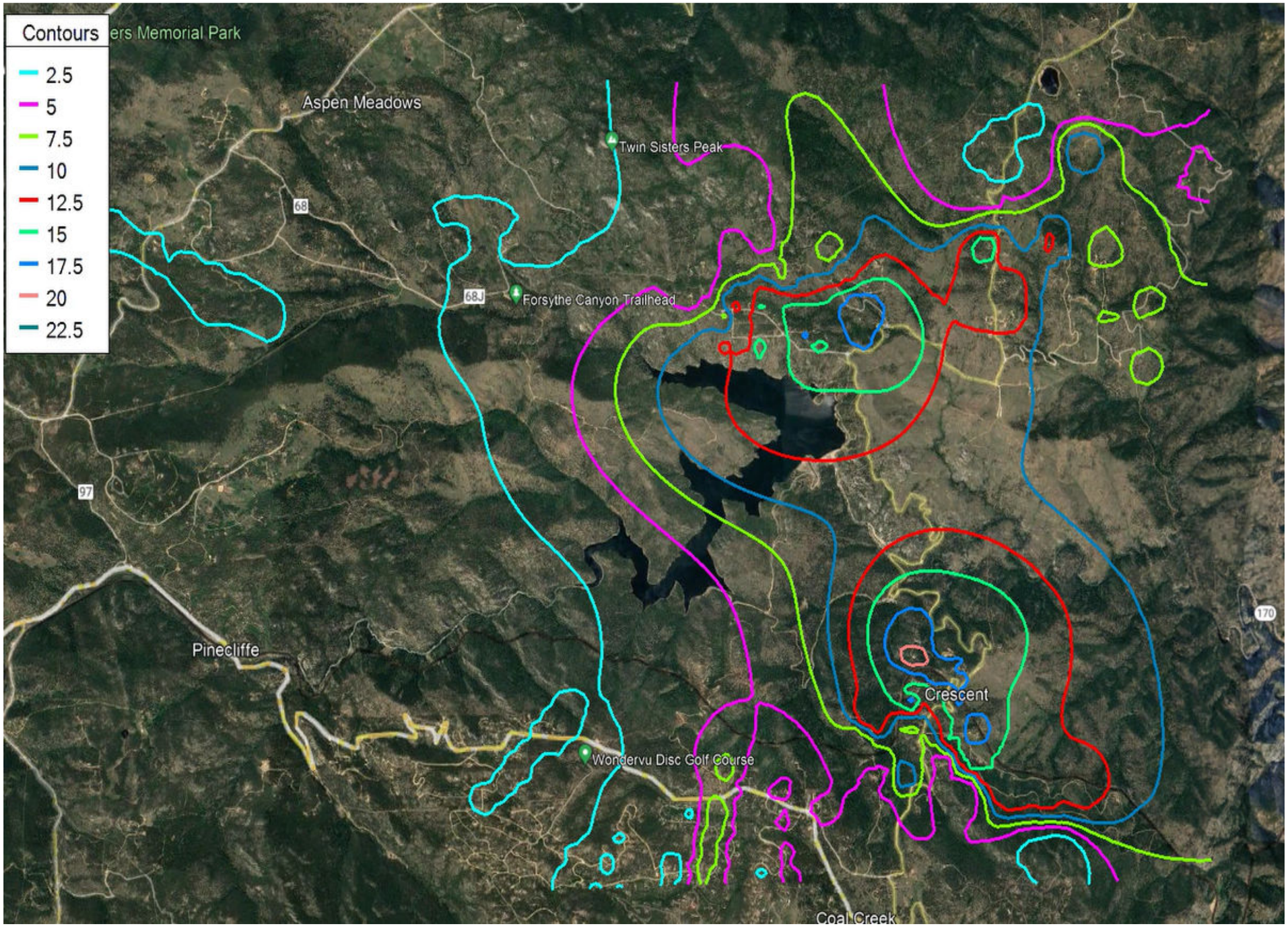



Pinyon Environmental, Inc.

*Contour Map - Generators*

Dispersion Results GEN
Gross Reservoir Dam Construction
Boulder County, Colorado

| | | |
|---|---|---|
| Site Location: 39.9510, -105.3614 | Drawn By: KAM | |
| Pinyon Project Number: 1/22-0133-01 | Reviewed By: DJC | Date: 11/10/2022 |

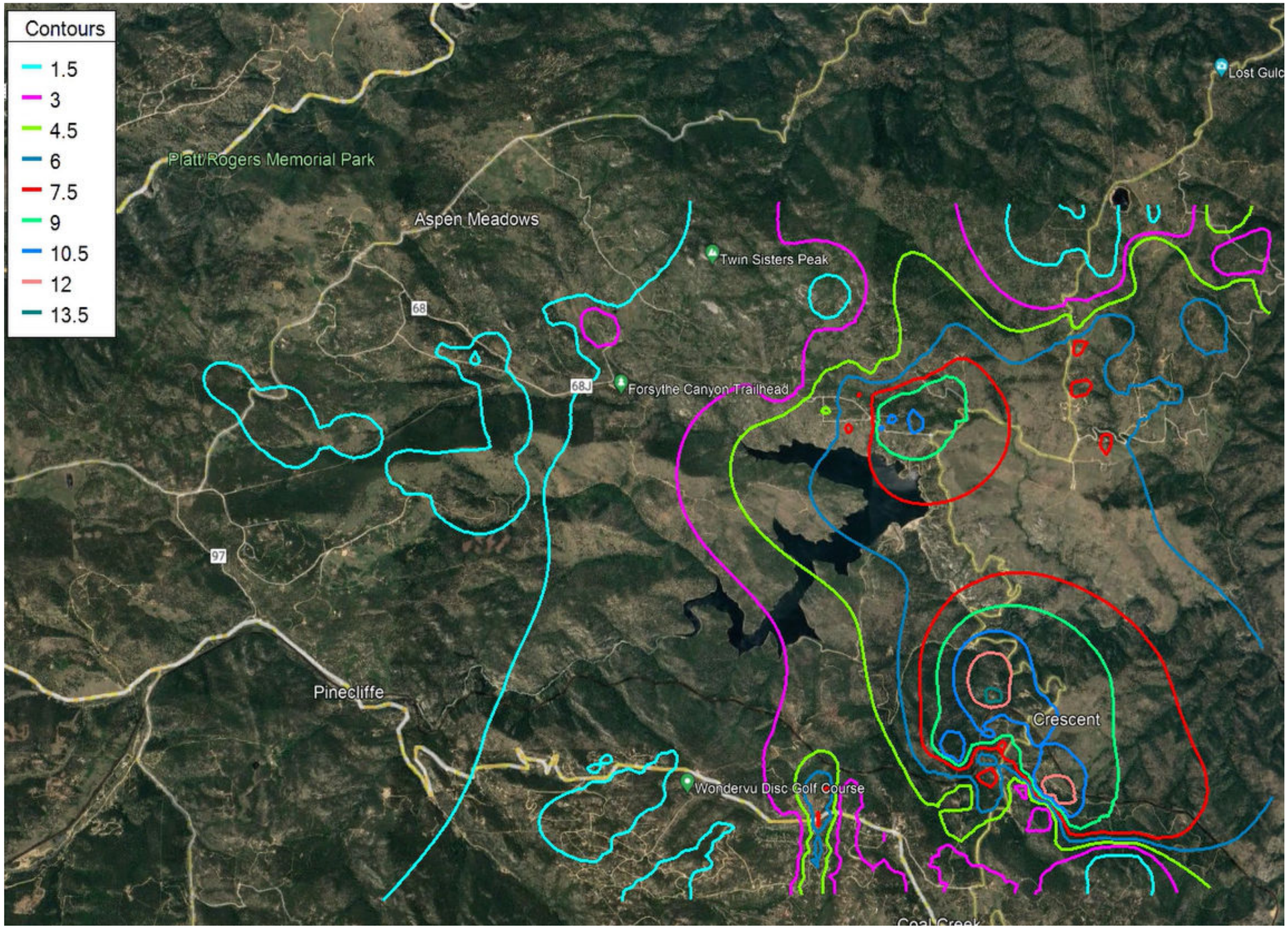



Pinyon Environmental, Inc.

*Contour Map - Blasting & Drilling*

Dispersion Results BLAST
Gross Reservoir Dam Construction
Boulder County, Colorado

| | | |
|---|---|---|
| Site Location: 39.9510, -105.3614 | Drawn By: KAM | |
| Pinyon Project Number: 1/22-0133-01 | Reviewed By: DJC | Date: 11/10/2022 |



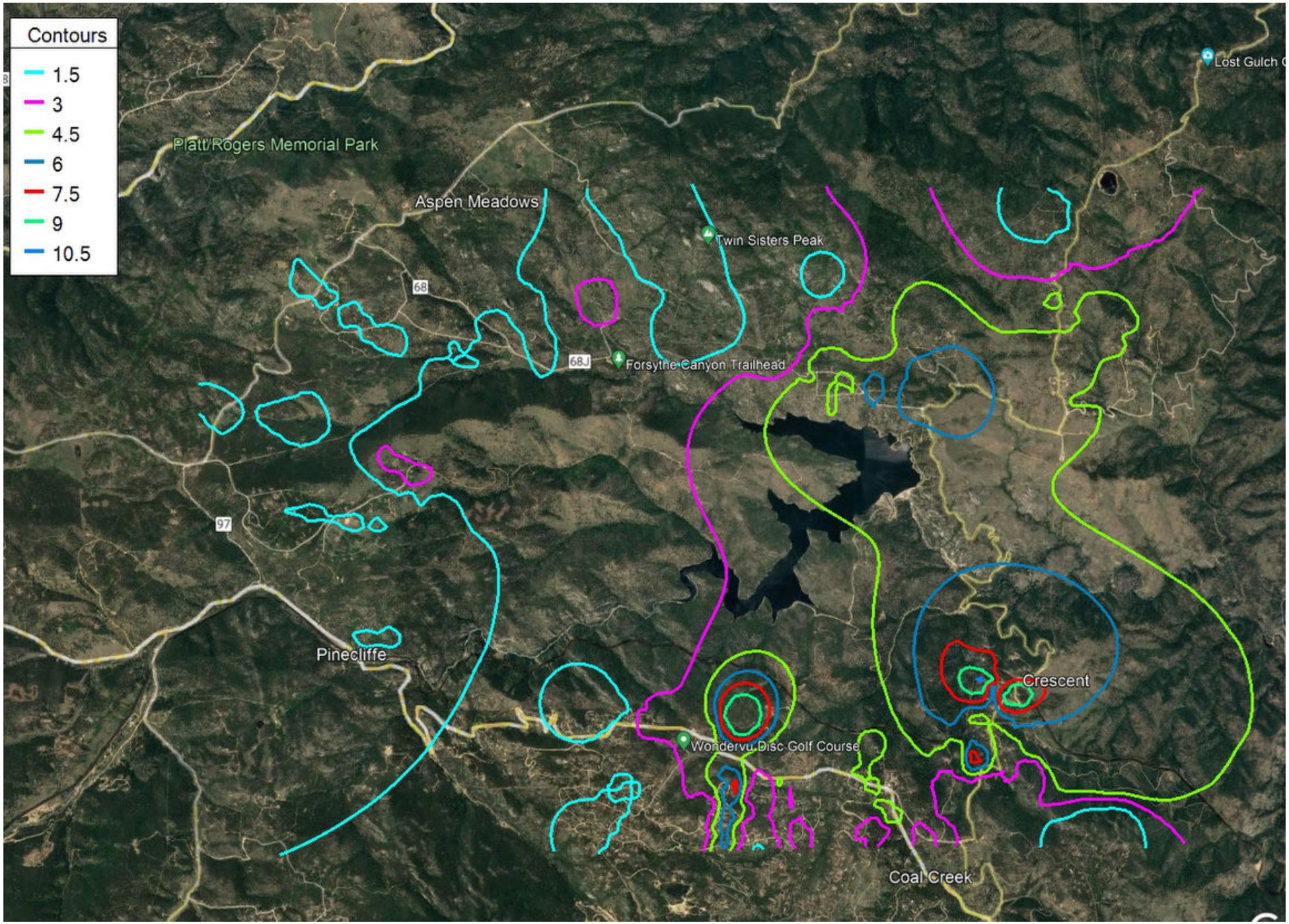

Pinyon Environmental, Inc.

*Contour Map - Crushing & Screening*
Dispersion Results CANDS
Gross Reservoir Dam Construction
Boulder County, Colorado

Site Location: 39.9510, -105.3614
Pinyon Project Number: 1/22-0133-01



Drawn By: KAM
Reviewed By: DJC
Date: 11/10/2022




Pinyon Environmental, Inc.

*Contour Map - Topsoil & Overburden*

Dispersion Results TOP&OVER
Gross Reservoir Dam Construction
Boulder County, Colorado

Site Location: 39.9510, -105.3614

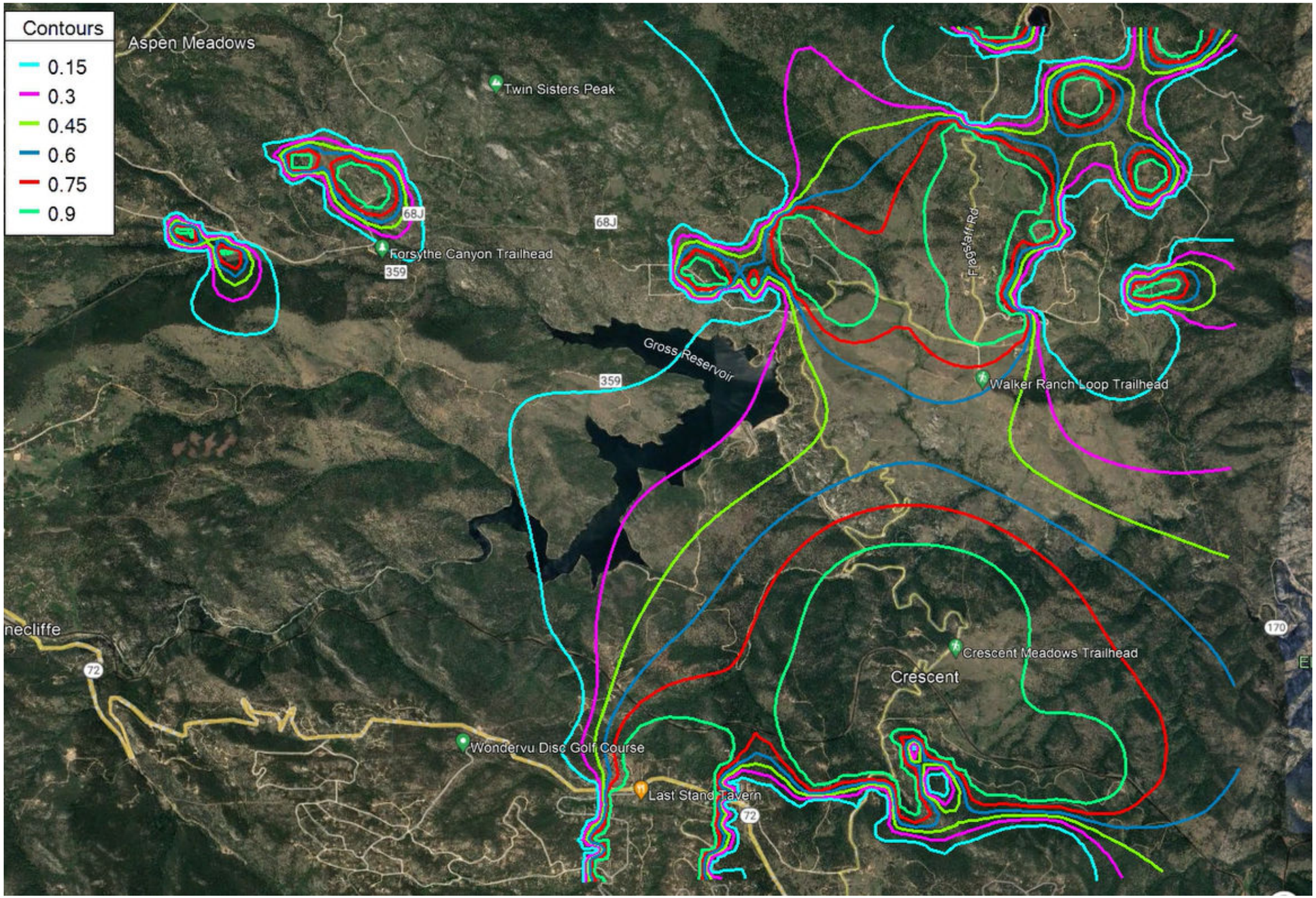
Pinyon Project Number: 1/22-0133-01



Drawn By: KAM

Reviewed By: DJC

Date: 11/10/2022

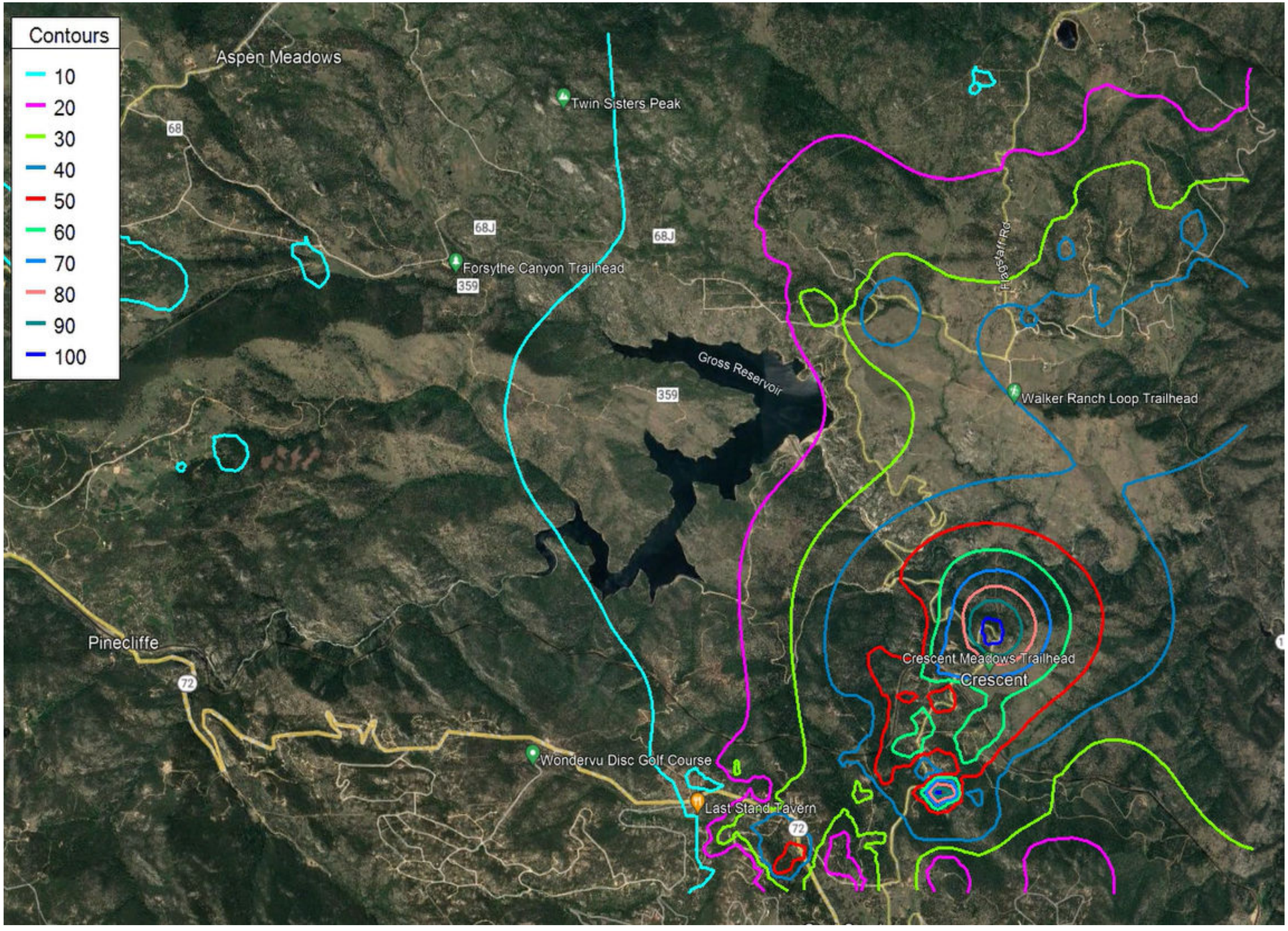



Pinyon Environmental, Inc.

*Contour Map - Disturbed Area*

Dispersion Results WIND
Gross Reservoir Dam Construction
Boulder County, Colorado

| | | |
|---|---|---|
| Site Location: 39.9510, -105.3614 | Drawn By: KAM | |
| Pinyon Project Number: 1/22-0133-01 | Reviewed By: DJC | Date: 11/10/2022 |

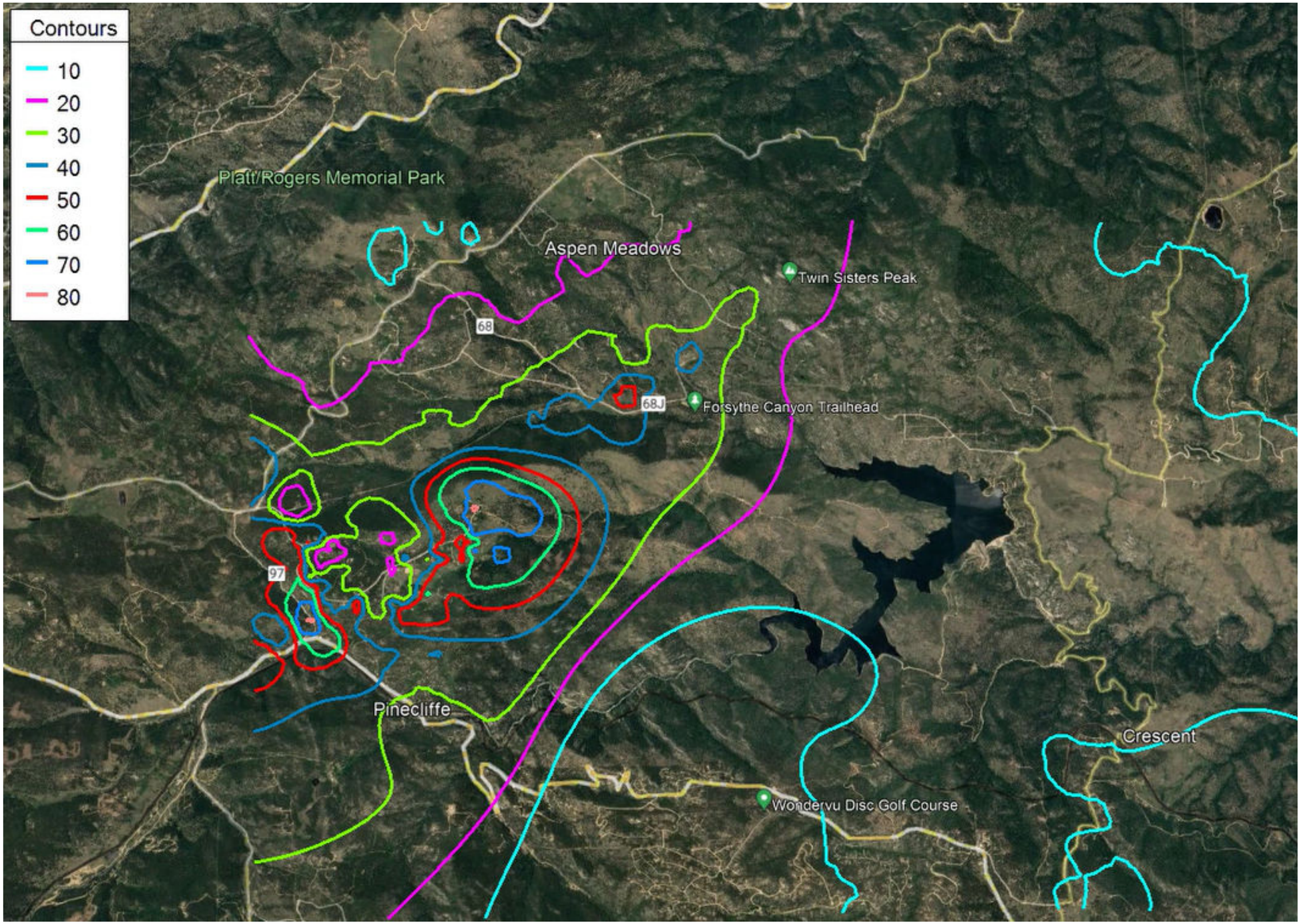



Pinyon Environmental, Inc.

*Contour Map - Construction Haul Road*

Dispersion Results HAULCON
Gross Reservoir Dam Construction
Boulder County, Colorado

| | | |
|---|---|---|
| Site Location: 39.9510, -105.3614 | Drawn By: KAM | |
| Pinyon Project Number: 1/22-0133-01 | Reviewed By: DJC | Date: 11/10/2022 |



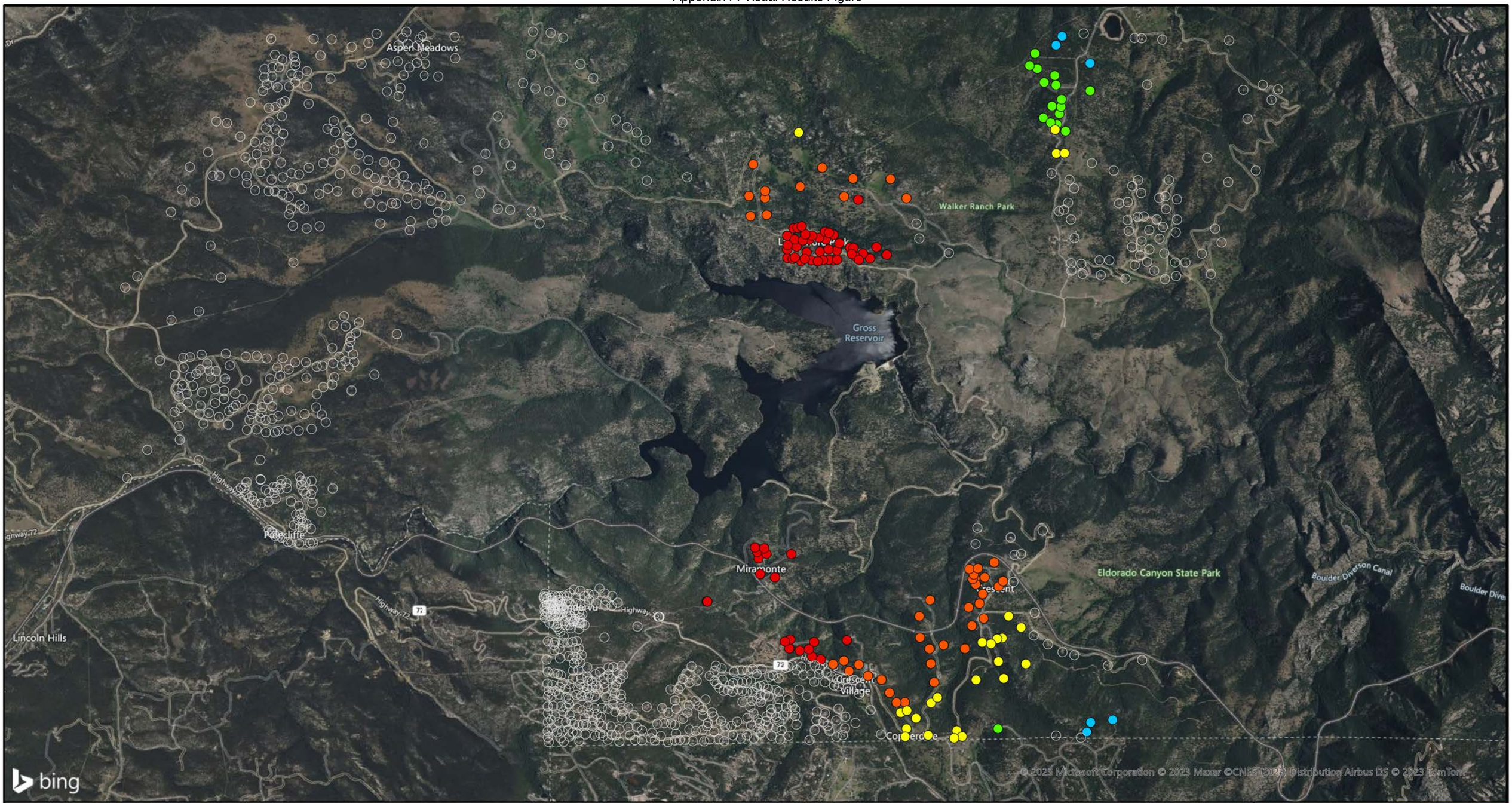

Pinyon Environmental, Inc.

*Contour Map - Tree Removal*
*Haul Road*
Dispersion Results HAULTREE
Gross Reservoir Dam Construction
Boulder County, Colorado

| | | |
|---|---|---|
| Site Location: 39.9510, -105.3614 | Drawn By: KAM | |
| Pinyon Project Number: 1/22-0133-01 | Reviewed By: DJC | Date: 11/10/2022 |

# Appendix F. Visual Results Figure

Appendix F. Visual Results Figure




N

**Legend**

Visual Ranking
0
1
2
3
4
5

0 1,500 3,000 Feet

Pinyon Environmental, Inc.

***GROSS RESERVOIR VISUAL IMPACT RANKINGS***

*Gross Reservoir*

*Boulder County, Colorado*

| | | |
|---|---|---|
| Site Location: Multiple Sections and Townships, Range 70, 69, 68, 67 W, 6th Princpal Meridian | Drawn By: CJB | Figure 1 |
| Pinyon Project Number: 1/22-045-001.001 | Reviewed By: DC | Date: 4/20/2023 |

Document Path: Z:\PROJECTS\2022\122013301 Boulder County Gross Reservoir Air, Noise, and Visual\Figures\ArcPro\122013301 Boulder County Gross Reservoir_Working\122013301 Boulder County Gross Reservoir_Working.aprx