BASIS OF DESIGN REPORT
(DRAFT)

FOR THE

TOWN OF EMPIRE

WELL IMPROVEMENTS

JUNE 2021

BASIS OF DESIGN REPORT

FOR THE

TOWN OF EMPIRE
Well Improvements

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JVA Project No. 1085.2e

JUNE 2021

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SECTION 1 – BASIC PROJECT INFORMATION

This Basis of Design Report (BDR) was prepared following the Colorado Department of Public Health and Environment's (CDPHE) State of Colorado Design Criteria for Potable Water Systems. As an existing system before October 1, 1999, this system is exempt from the requirements of the New Public Water System Capacity Planning and Manual and does not require demonstration of technical, managerial and financial capacity.

WATER SYSTEM INFORMATION

The Town of Empire (Town) operates a community water system under PWSID No. CO0110010 with approximately 194 taps. The Water Treatment Facility (WTF) treats surface water from Mad Creek. The Town also maintains a groundwater source for backup and emergency conditions. The WTF consists of a filter building containing the slow sand filtration process (two filters) and a treatment building containing bag filtration, UV disinfection, and chlorine disinfection processes. The Town area and treatment locations are depicted in Figure 1.

PROJECT LOCATION

The Town's service area is located off U.S. Highway 40. The mailing address for the Town Hall is P.O. Box 100, Empire, CO 80438. The location of the filter building, the treatment building, well and growth boundary are shown in Figure 1.

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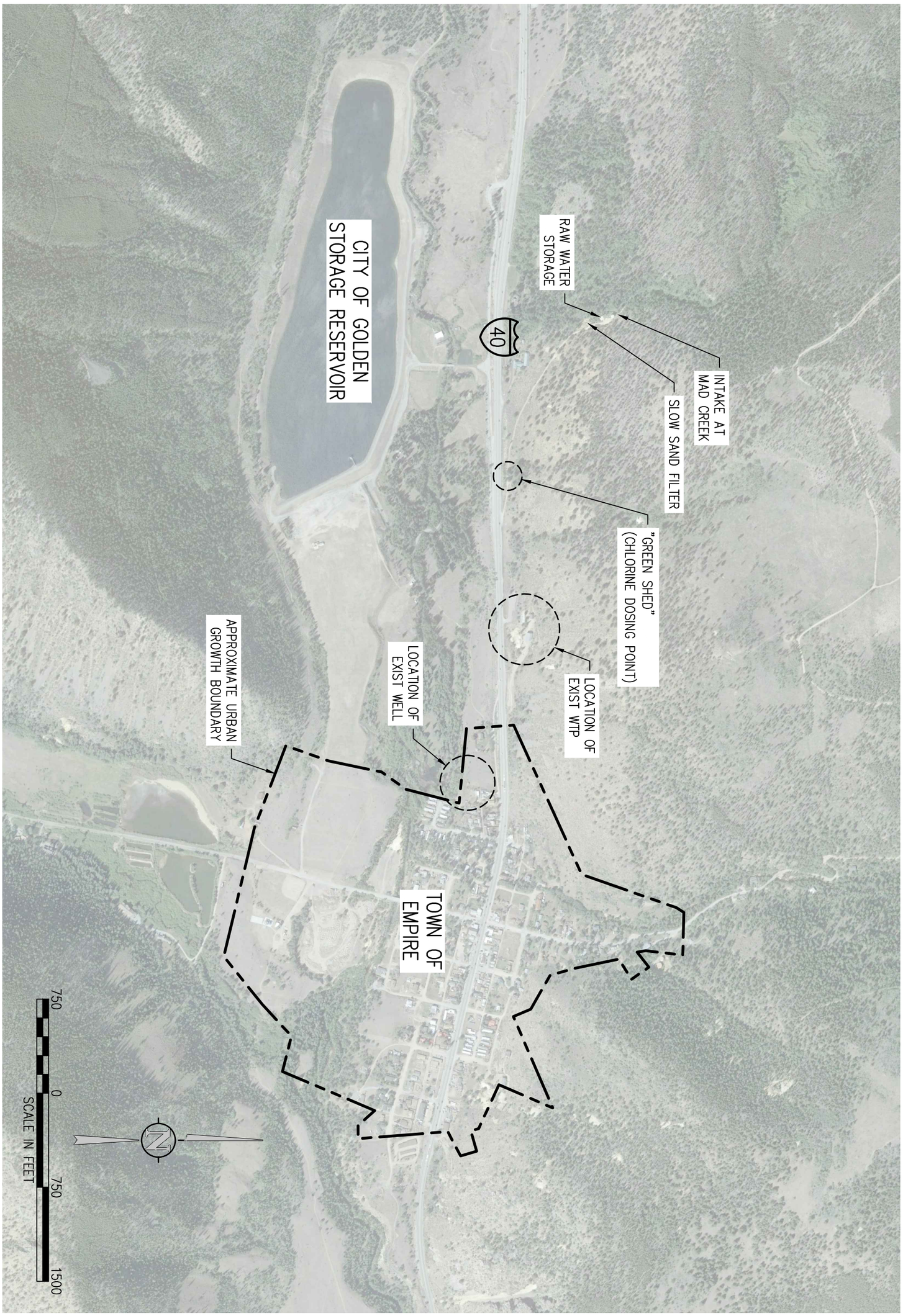

FIGURE 1 - EXIST WATER SYSTEM
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PROJECT PURPOSE AND SCOPE

EXISTING FACILITIES

The Town's current water treatment facilities are located at two separate buildings, the filter building and the disinfection building. The existing process consists of slow sand filtration, bag filtration, UV disinfection, and chlorine disinfection. Raw water from Mad Creek is stored in a 100,000-gallon raw water storage tank. Raw water then flows by gravity to one of two slow sand filters. Filtrate flows by gravity from the slow sand filters to a chlorine dosing shed and then to the treatment building. The treatment building includes a multi-bag filter followed by two UV disinfection units. After UV disinfection, the water is dosed with caustic soda for corrosion control before going to the distribution system. The Town also maintains a groundwater well for back-up and emergency conditions. The existing process flow diagram is depicted in Figure 2.

PROJECT DESCRIPTION

Under normal operating conditions, the Town uses the Mad Creek supply via the intake upstream of the slow sand filters. In the winter, Mad Creek can freeze over, and the in-Town well must be activated. The water quality of this well is poor (high iron and manganese concentrations) and discolored. To solidify a reliable secondary supply, the Town is proceeding with groundwater supply improvements.

ALTERNATIVES EVALUATION – GROUNDWATER SUPPLY

In working with the Town, the team wanted to explore the development of a new higher quality source. Potential options included an infiltration gallery and a number of new well sites. These areas are depicted in Figure 3.

The following three alternatives were considered.

A. No action,
B. Infiltration Gallery
C. New Well

ALTERNATIVE A: NO ACTION

OVERVIEW

In this alternative the Town would maintain operations of the current well. The water quality is poor and may exceed State standards for some constituents. The secondary/emergency supply will be unreliable.

CAPITAL COST

No capital costs are presented, and the maintenance costs will remain and most likely increase over time.

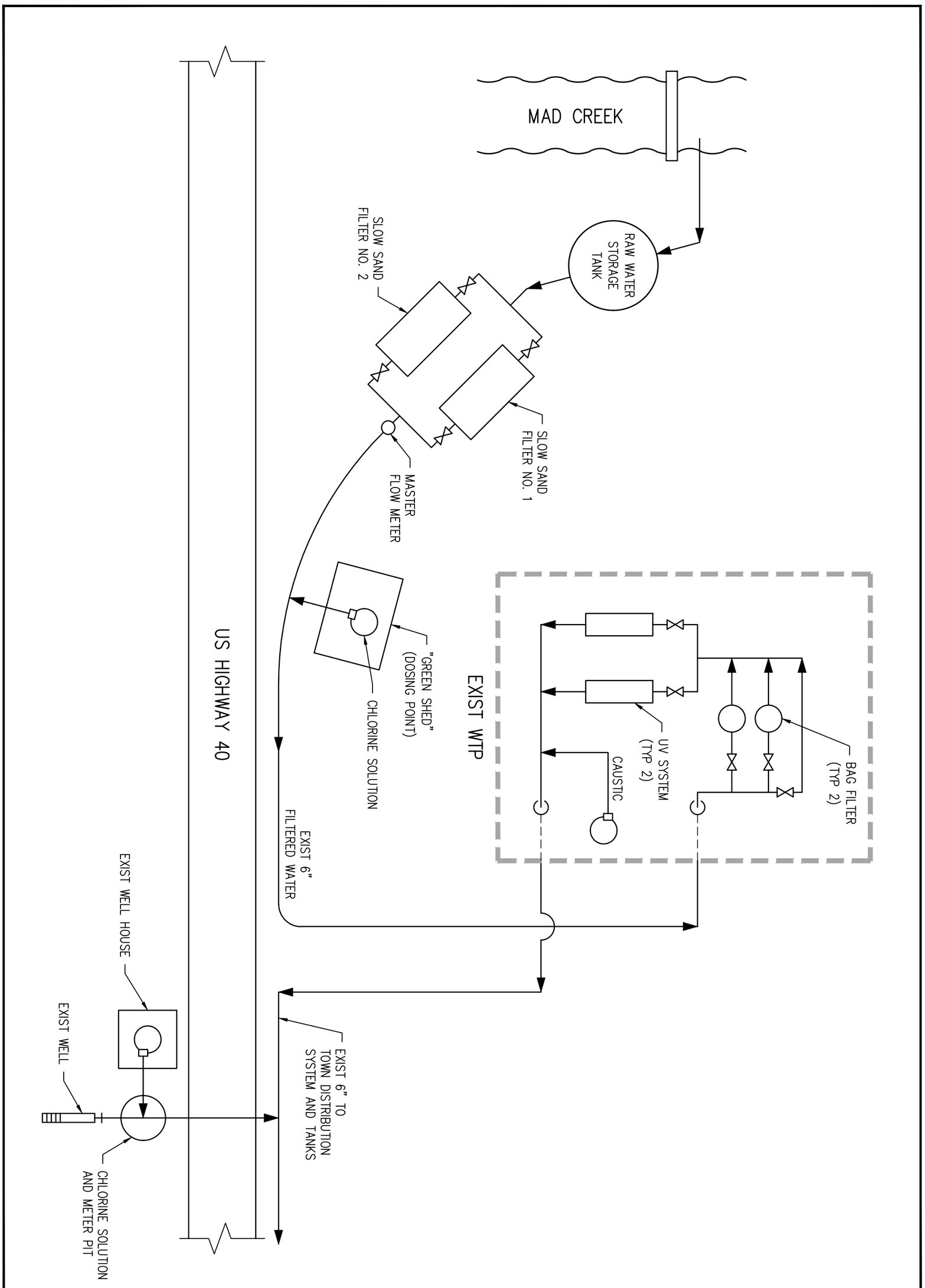

FIGURE 2 - EXIST WATER SYS. PROCESS FLOW DIAGRAM

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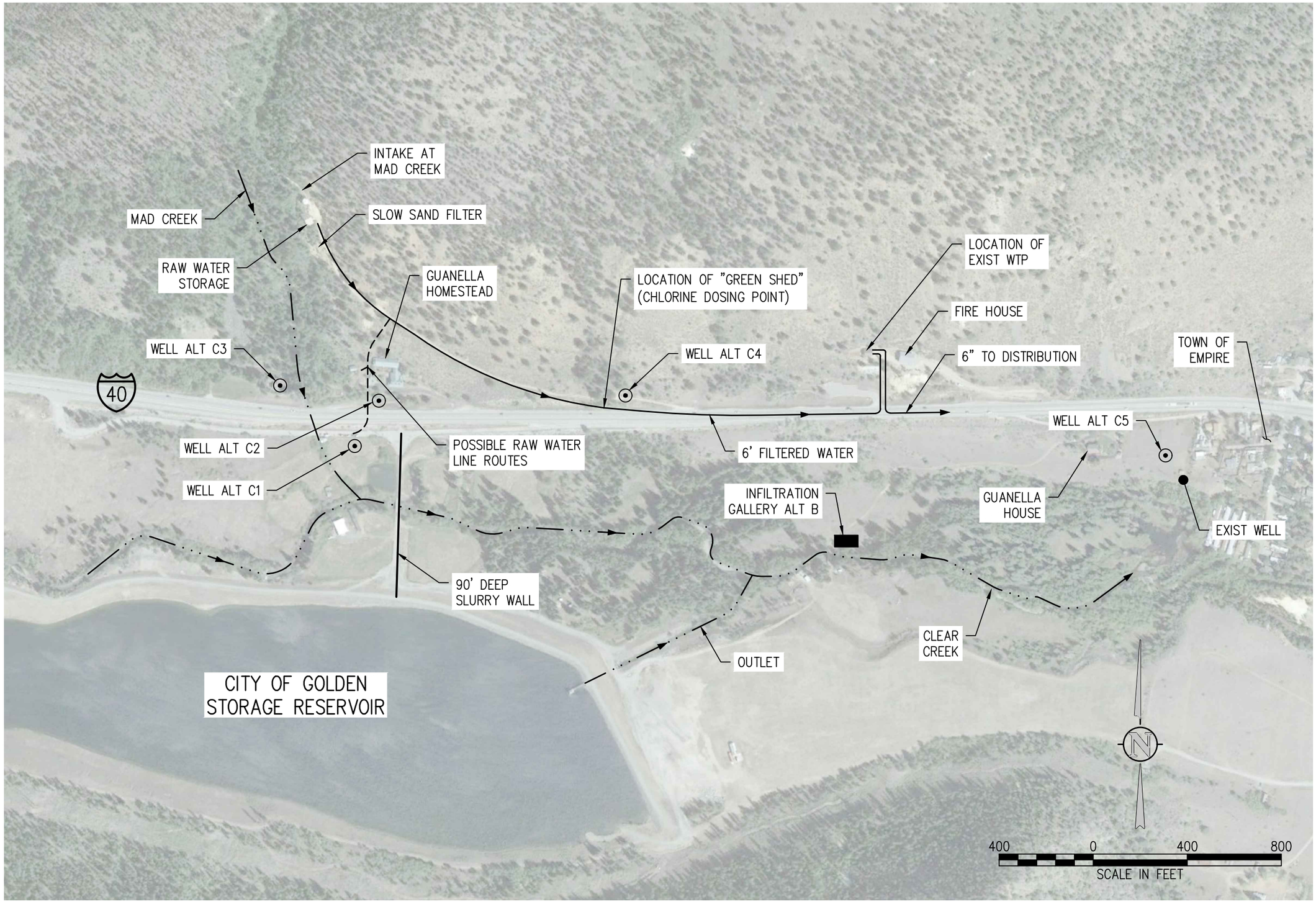

FIGURE 3 - GROUNDWATER SUPPLY ALTERNATIVES
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Advantages

- No capital expenditure

Disadvantages

- Unreliable poor-quality secondary groundwater source
- Potential State water quality violations

Alternative B: Infiltration Gallery

Overview

Considering access and stream location, there is a potential infiltration gallery site on the Guanella property. The infiltration gallery would include an alluvial screened intake on Clear Creek and a pump station. The secondary supply is most needed in the winter months when Clear Creek is low and therefore Golden Reservoir releases would need to be coordinated in times of demand. There is no current access to the site off HWY 40 and due to the sever grade, a costly maintenance road would be required.

Capital Cost

The cost of an infiltration gallery is estimated to be over three times that of the proposed alluvial wells presented in Alternative C and operations are predicted to be much more complicated. Construction of the infiltration gallery is impractical and therefore costs are not presented.

Advantages

- Use acquired water storage rights

Disadvantages

- Most expensive
- May result in lost water after Golden Reservoir release
- Must coordinate with the City of Golden in timing releases
- Expensive access road required

Alternative C: New Well

Overview

The project team consisting of the Town, JVA, HRS and the Guanella family field reviewed a number of potential well sites. These sites are numbered as C1, C2, C3, C4 and C5 and are shown on Figure 3. All of the potential sites are located on Guanella property. C1, C2 & C3 are located upstream of the slurry wall and would tap into the Golden subgrade storage. C4 is located next to the existing chlorine dosing station and includes an established power supply. C5 is near the existing well house. There are

advantages and disadvantages at all sites and these were reviewed with the team. We also coordinated calls with the State of Colorado and the Town water rights attorney and interacted with the City of Golden. Well sites C1, C2 and C3 are challenging from a water rights perspective, because of the locations up stream of the slurry wall. Well site C4 has good access and an established power supply but tapping the Clear Creek alluvium maybe a challenge. Based on the probability of a sufficient yield and the ease of permitting, a new well near the existing well, site C5 was selected. The addition of iron and manganese treatment will be required, but most likely required at the other sites also.

Capital Cost

Operational costs between the well sites are similar and have not been presented. The construction cost of the well and treatment is estimated at $587,000.

Advantages

- Construction costs less than Alternative B
- Minimized operational and maintenance requirements
- No access road needed

Disadvantages

- A capital expenditure for the Town

Project Cost

The estimated construction cost for the new well and improvements to the well house totals $587,000.

Proposed Deviations

There are no proposed deviations.

Implementation Plan and Schedule

The schematic design presented in this BDR will be used to finalize the bidding documents for the project. The anticipated implementation schedule is provided in Table 1.

Table 1- Anticipated Implementation Schedule

Task	Anticipated Date
CDPHE BDR Submittal	August 6, 2021
CDPHE Approval	October, 2021
Commence Construction	November, 2021
Completion Improvements – Start-up	March, 2022

SECTION 2 – SOURCES OF POTENTIAL CONTAMINATION

FLOODPLAIN INFORMATION

Based on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel 0480C, the proposed project site is not located in the 100-year flood plain.

POTENTIAL CONTAMINATION SOURCES

The existing well and proposed new well will be completed in the adjacent Clear Creek aquifer. There are no identifiable potential sources of contamination within 500 feet of the proposed well, although the following has been considered:

- Surface runoff from the surrounding roads and driveways may be present. However, the proposed well will be drilled into the Clear Creek aquifer and the wellhead will be situated on a concrete pad. Therefore, runoff is not anticipated to be a source of contamination.

RISK MITIGATION

The new groundwater well will be constructed in accordance with design criteria, as described in 2 CCR 402-2, *Rules and Regulations for Water Well Construction, Pump Installation, Cistern Installation, and Monitoring and Observation Hole/Well Construction*. A 4-feet by 4-feet concrete pad will be installed around the well head with ground sloping away. The wellhead will be sealed to prevent tampering.

SECTION 3 – WATER QUALITY DATA

GROUNDWATER SOURCES

In accordance with CDPHE, a grab sample of the groundwater was collected and tested for standard constituents. The water quality summary is presented in 2.

Table 2 – Existing Well - Water Quality Results

Constituent	Value	Suggested Maximum
Total Alkalinity (as CaCO3)	75.7 mg/L	250 mg/L
Bicarbonate (as CaCO3)	75.7 mg/L	250 mg/L
Carbonate (as CaCO3)	< 4 mg/L	-
Hydroxide (as CaCO3)	< 4 mg/L	-
Chloride	55.5 mg/L	250 mg/L
Iron	0..60 mg/L	0.3 mg/L
Manganese	0..387 mg/L	0..05 mg/L
Fluoride	0.6 mg/L	4.0 mg/L
Potassium	2.2 mg/L	50 mg/L
Nitrate Nitrogen	0.29 mg/L	10 mg/L
pH	7.08	8.5
Calcium	49.4 mg/L	200 mg/L
Magnesium	10.84 mg/L	125 mg/L
Sodium	16.4 mg/L	100 mg/L
Sodium Adsorption Ratio	0.6	4
Total Hardness (as CaCO3)	167.9mg/L	500 mg/L
Sulfate	51.4 mg/L	250 mg/L
Total Dissolved Solids	299 mg/L	500 mg/L

IMPACTS TO CORROSIVITY

Table A.2 of the Design Criteria classifies a project's potential to impact corrosivity. Category 2, Possible Impact to Corrosivity, is the default classification for a new groundwater source. A Category 2 classification requires no additional information in the BDR submittal.

SECTION 4 – PROCESS FLOW AND HYDRAULIC DESCRIPTION

PROCESS FLOW

Groundwater from the proposed new well will be pumped into the modified well house for treatment and connected to the existing flow metering/chlorine dosing vault. Pressure and flow will be monitored at the modified facility. The well will be equipped with a pressure transmitter for continuous level monitoring. A schematic of the proposed improvements is presented in Figure 4.

HYDRAULIC DESCRIPTION

The new well will be completed to a depth of about 300 feet. The new well pump will be set an approximate depth of 250 feet and sized at a flow rate of 20 gpm. The head pressure will be sufficient to feed the new filtration units and have residual pressure to feed the distribution system.

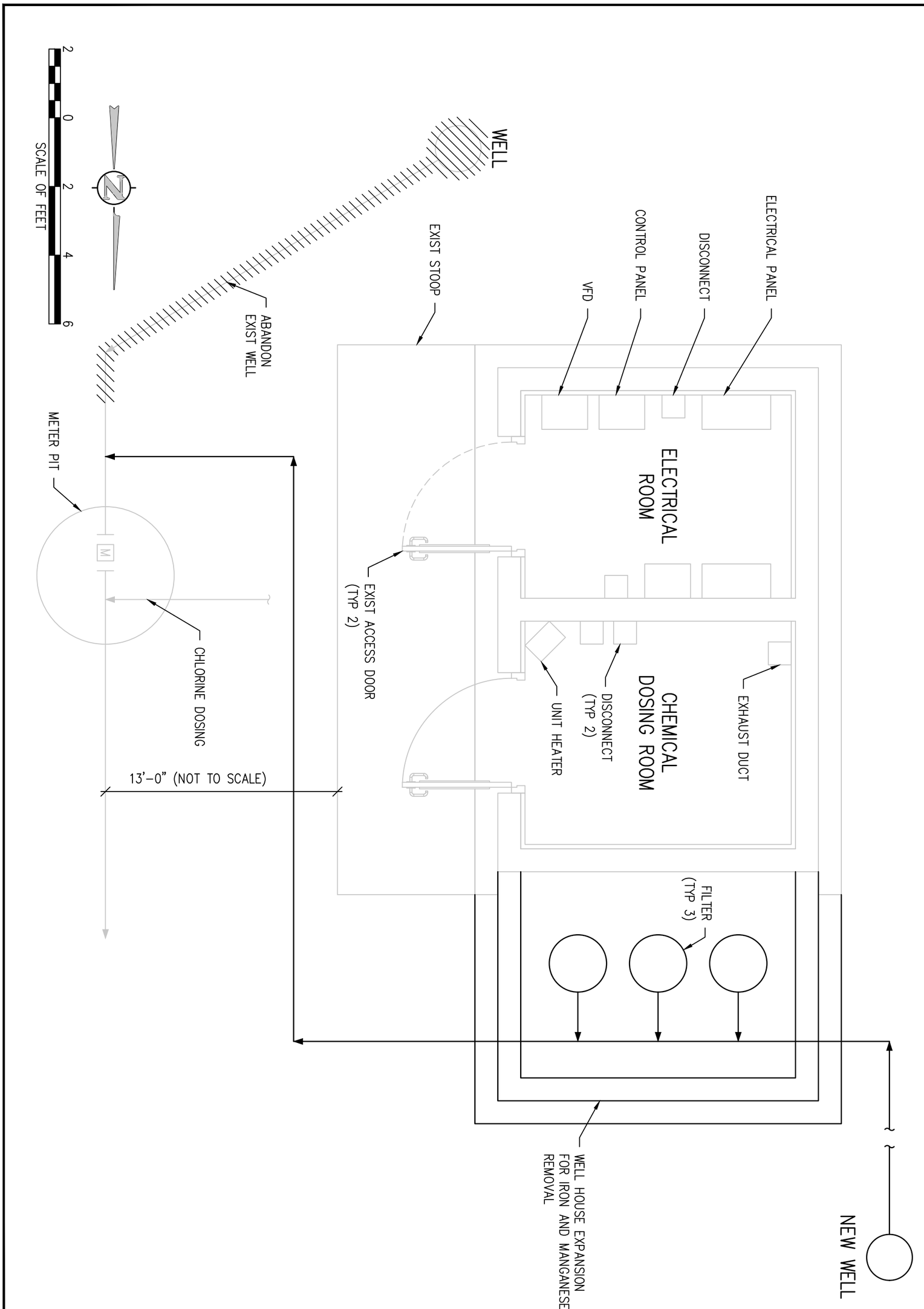

FIGURE 4 - PROPOSED WELL HOUSE SITE / FLOOR PLAN

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SECTION 5 – CAPACITY EVALUATION AND DESIGN CALCULATIONS

WATER SOURCES

The Town has water rights on Mad Creek which are sufficient to meet Town demands. Mad Creek is the Towns primary water source. The basin has no development, and the surface water is pristine. When available the Town prefers to use the Mad Creek supply. The Town also has rights in Clear Creek, via Henderson Mine. The alluvial Clear Creek water is pumped directly to the distribution system via an in-town well. The Town has sufficient water rights to meet existing maximum day demands in the summer. However, in the winter months, Mad Creek can freeze, requiring the Town to rely on poor quality alluvial groundwater. The Town purchased water storage rights in Golden Reservoir in 2019.

Table 3 – Town of Empire Water Rights Summary

Source Name	Source Classification	Source Description
Mad Creek	Surface	1.82 cfs (3.61 ac-ft/day) of water rights
Guanella Reservoir	Surface	Town has 10 ac-ft of storage capacity that can be used to augment Mad Creek and alluvial well water rights. Can store water from Henderson Mine and other water sources that become available. Additional 6.3 ac-ft supply provided by Golden
Alluvial Wells	Groundwater	Water is from Henderson Mine 35863-F and 41458-F from Case No. 82CW227 May = 15.3 ac-ft June = 10.8 ac-ft July = 11.9 ac-ft August = 13.1 ac-ft September = 16.7 ac-ft
Henderson Mine Water		Leased for 20 gpm (2.65 ac-ft/month)

The Town has very senior water rights and sufficient water rights for the Town's current and future projected water demand.

The storage rights were purchased to augment the existing water rights from Mad Creek. The Town can use the stored water when Mad Creek water is unavailable.

Demand Projections

The DOLA population estimates from 2010 through 2018 were used with the Clear Creek County estimated growth rate to project the population during the 20-year planning period. The number of taps was estimated using 1.73 persons per tap from DOLA. The number of taps in 2019 was then divided by the maximum daily flow per day in 2019 to get 2.4 (units). The number of tap projections were then divided by 2.4 to estimate the water demand. Based on the estimated population, persons per household, growth rate, and number of taps from DOLA the town is expected to grow from 305 people to 361 people in 20 years. This is equivalent to 176 taps to 209 taps.

According to the Town the system serves 194 taps and a population of approximately 410. Based on these initial values in 2019, projections were made using 2.11 persons per tap and the DOLA Clear Creek County estimated growth rate, a population of 486 and 230 taps is projected in 2040.

Based on 63 gallons per day (gpd) from 176 taps, this results in a peak day flow of approximately 75 gpd in 20 years.

Treatment

As depicted in the water quality results, the well water is anticipated to have elevated iron and manganese levels. The iron and manganese will be reduced using pressure green sand filters with an oxidant addition. The filters will require backwashing and this waste will be discharged to the local sewer.

In addition, treatment for the new groundwater sources will consist of disinfection with sodium hypochlorite to achieve 4.0-Log virus inactivation. Chlorine Contact Time (CT) will be achieved in the existing pipeline feeding the distribution system.

The process goals chosen for the disinfection were based on the regulatory compliance requirements set for the State of Colorado Design Criteria for Potable Water Systems as presented in Table 4.

Table 4 – Disinfection & Chemical Application Design Criteria

Criteria	CDPHE	Empire
DISINFECTION		
Maximum free chlorine residual	5 mg/L	2.0 mg/L
Automatic proportioning chlorinators provided	Yes	Yes
3-Log removal of Giardia lamblia, 4-Log removal of viruses	Yes	Yes
Continuous chlorine residual monitor	Yes	Yes
Chlorine Room Ventilation[1]	1 air change per 2 minutes	Yes
Heater provide to maintain min 60 F	Yes	Yes
Sufficient capacity to replace largest unit/ spare parts available	Yes	Yes
CHEMICAL APPLICATION		
Backflow prevention devices provided	Yes	Yes
Redundant feeder provided	Yes	Will use old feeder as spare
Means must be provided to measure liquid level in liquid storage tank	Yes	Visual
Tanks must be vented	Yes	55-gal drum
Automatic or manual control options	Yes	Both
Feed rate proportional to flow	Yes	Yes
Sufficient storage for 30 day supply	Yes	Yes
Secondary containment provided	Not required for 55-gal drums	No

[1] Design for chlorine ventilation is based on the Ten States Standards guideline of 1 air change per minute

SECTION 6 – MONITORING AND SAMPLING EVALUATION

PROPOSED FLOW METERING

The Town will continue to use the flow metering device at the well house site. The new well will be piped to the existing flow meter vault.

WATER QUALITY SAMPLING

SAMPLING LOCATIONS

The Town will sample for residual chlorine at the first customer. The Town will continue to sample at all other required locations.

WATER QUALITY PARAMETERS

Water quality parameters set forth by CDPHE for sources classified as groundwater will continue to be monitored.

SECTION 7 – GEOTECHNICAL REPORT

Based on Appendix A Table A.1 ES DW Design Review Matrix, Section 7 – Geotechnical Report, is not applicable.

SECTION 8 – RESIDUALS HANDLING PLAN

The iron and manganese filters will require backwashing. The residual solids will be metered and disposed in the local sewer system.

SECTION 9 – IMPACT TO CORROSIVITY

Based on Appendix A Table A.1 ES DW Design Review Matrix, Section 9 – Impact to Corrosivity, is not applicable.

SECTION 10 - PRELIMINARY PLAN OF OPERATION

STAFFING AND OPERATOR CERTIFICATION

The Town's Operator in Responsible Charge (ORC) is Robert Wayne Ramey (Lic #5225). The ORC has a Class A Water Treatment Operator certification that will expire in September 22, 2022. The proposed new well and treatment additions will not change the operating license needed by the ORC.

OPERATING CONSIDERATIONS

OPERATING CONFIGURATION AND PROCESS CONTROL PROCEDURES

The ORC operating procedures will be modified to include iron and manganese filtration.

PHASED OPERATION DURING CONSTRUCTION

During construction operations will not be changed since the new well and treatment system can be constructed without taking the treatment system offline.

EMERGENCY RESPONSE AND PROCEDURES

The current emergency response plans will be unchanged.

OPERATIONAL SAFETY

Current safety procedures will be unchanged

SECURITY PROVISIONS

The expanded well house building will have locking doors.