AQUA ENGINEERING

Indian Hills Water District

MASTER PLAN ENGINEERING REPORT

Planning & Capital Improvements

April 2020

1. EXECUTIVE SUMMARY

1.1. PURPOSE AND SCOPE

The purpose of this Drinking Water Master Plan Update (Master Plan) document is to update the 1972 Water System Master Plan prepared by Wright-McLaughlin Engineers and provide an assessment and capital improvements plan for the District's drinking water system infrastructure. The Drinking Water Master Plan (Master Plan) includes the following information:

- Demographics and Planning Conditions
    - The number and type of existing service connections and population, and projected future population and connections.
- Existing Conditions and Water System Infrastructure
    - Description of active and inactive ground water supply sources (wells), storage tanks, distribution system piping, supervisory control and data acquisition (SCADA) system, and treatment facilities.
    - Current (Year 2019) water consumption (demand)
- Water System Analysis
    - Evaluation Parameters and Basis of Design
    - Current (2019) and Future (2029) Demand and Service Requirements
    - Water Rights Review
    - Hydraulic Water Modeling – current and future conditions
    - Current and future water system deficiencies
- Capital Improvement Projects
    - capital improvement projects required to mitigate current and projected service deficiencies.
- Funding
    - Discussion of funding options to pay for capital improvement projects.

1.2. DEMOGRAPHICS

The first step before analyzing the drinking water system is to establish the District's demographics and project these demographics into the future. A 10-year planning period was used with the District's projected future connections. Based on demographic discussions with the District, two (2) connections, or two (2) Single-Family Equivalents (SFEs), are anticipated to connect to the District's drinking water system each year throughout the planning period.

SFEs will be the primary units used in this plan for the water system analysis. One SFE represents a single-family dwelling with defined demand characteristics or requirements. Other types of uses, such as commercial or industrial uses, are converted to SFE's based on their demand compared to a residential single-family unit. The current (Year 2019), 3-, 5-, and 10-year SFE projections can be found in Table E1.

Table E1: Current and Projected SFEs

Year	Cumulative SFEs
2019	408
2022	414
2024	418
2029	428

Source: Table 11 in Section 4

The information established in the demographics section of the plan was used to determine future demands and establish future capital facility projects. Users on private wells or inactive connections are also future potential connections to the District but were not evaluated in the existing drinking water system analysis, as the District has the first right of refusal and will evaluate the proposed connections on a case by case basis.

1.3. DRINKING WATER SYSTEM OVERVIEW

The District's water system includes water rights and ground water supply sources, treatment, booster pumping and pressure control, finished water storage tanks, and distribution piping.

1.3.1. Water Rights

The District's water attorney Matt Machado verified that the District can legally pump at least 103.8 ac-ft from their wells, subject at times to limits imposed by the augmentation plan (Appendix S). The wells have flow rate limits, but not volumetric limits. Table E2 summarizes the current and projected water demands. The District also has a limit of 5 acres that can be irrigated.

Table E2: Water Rights

Requirement	SFEs	gpd/ SFE[1]	Ac-ft / Year/ SFE	Water Usage Ac-ft/Year	Surplus Water Rights Ac-ft/Year	SFE Surplus
Current Demand	408	115.1	0.129	52.6	51.2	397
Projected Demand	428	115.1	0.129	55.2	48.6	377

[1]Water usage per SFE uses an Average Day Demand.
Source: Table 13 in Section 4

1.3.2. Water Supply

The District currently has a total of thirteen wells, including five drinking water sources in service. Table E3 and list the District's active drinking water sources and Table E4 lists the District's inactive drinking water sources. The firm capacity of the wells was discussed with the District and in an emergency the District could utilize their inactive wells to supplement their source capacity. However, this could require a significant amount of work to bring these inactive wells online. A cost analysis between constructing a new well and bringing an existing well online would need to be evaluated.

Table E3: Existing Online Drinking Water Sources

Source	Location	Type	Depth (feet)[2]	Equipped Capacity (gpm)[1]	Actual Pumping Rate (gpm)[2]	Decreed Pumping Rate (gpm)[3]
Well No. 5	Upper Well Field (Parmalee Gulch WTP)	Well	18	25	17.00	45
Well No. 10	Upper Well Field (Parmalee Gulch WTP)	Well	303	26	11.00	15
Well No. 11R	Turkey Creek Well Field	Well	1,100	10	8.50	32
Well No. 12	Turkey Creek Well Field	Well	1,000	7	3.75	15
Turkey Creek Gallery Well	Turkey Creek Well Field	Well	N/A	30	21.50	56
			Total	98	61.75	163
			Firm Capacity[4]	68	40.25	107

[1] Information obtained from Indian Hills Water District Record of Approved Water Works (RAW) (Appendix C).
[2] The actual pumping rate is what the District currently pumps each well.
[3] Information obtained from IHWD's Water Attorney Matt Machado (Appendix D).
[4] Firm capacity assumes the largest well is offline.
Source: Table 5 in Section 3

Table E4: Offline Drinking Water Sources

Source	Location	Type	Depth (feet)[1]	Decreed Pumping Rate (gpm)[2]
Well No. 1	Parmalee Gulch	Well	24	45
Well No. 2	Parmalee Gulch	Well	10	45
Well No. 4	Upper Well Field	Well	190	10
Well No. 6	Upper Well Field	Well	50	10
Well No. 7	Upper Well Field	Well	48	15
Well No. 8	Upper Well Field	Well	70	15
Well No. 9	Upper Well Field	Well	30	15
Well No. 11	Turkey Creek Well Field	Monitoring Well	702	N/A

[1] Information obtained from Indian Hills Water District SWPP 3/14/17 (Appendix E)
[2] Information obtained from IHWD's Water Attorney Matt Machado (Appendix D).
Source: Table 6 in Section 3

1.3.3. Treatment

The District (PWSID# CO0130065) operates two water treatment facilities: the Parmalee Gulch Water Treatment Plant (WTP) and the Turkey Creek WTP. The wells that supply water to both WTP's are classified by the Colorado Department of Public Health and Environment (CDPHE) as Ground Water Under the Direct Influence (GWUDI) of surface water. Thus, both the Parmalee Gulch WTP and Turkey Creek WTP are subject to CO Primary Drinking Water Regulation 11, Section 11.8, which mandates compliance with the Surface Water Treatment Rule. Accordingly, both the Parmalee Gulch WTP and the Turkey Creek WTP use membrane filtration plus chlorine disinfection treatment techniques. Turkey Creek WTP also treats for iron and manganese using potassium permanganate along with a greensand filter prior to the membrane process. Parmalee Gulch WTP uses a magnetic ion exchange resin (MIEX) for nitrate treatment prior to the membrane process. The increased nitrates in the source water supply

is due to the District not having a centralized wastewater treatment facility (WWTF) and residents utilizing localized septic and leach field systems for their wastewater discharge. The nitrates have potentially leached into the groundwater supply at Well No. 10 and Well No. 5. Due to the cost prohibitive nature for disposal of the MIEX system's waste, an alternative nitrate treatment system will be proposed. The capacity of the Memcor filtration system at each of the WTPs is summarized below in Table E5.

Table E5: Memcor Capacity

Water Treatment Plant	Unit Flux Rate (gpm)	Number of Units	Capacity (gpm)
Turkey Creek WTP	4.5	9	40.5
Parmalee Gulch WTP		6	27
		Total	67.5

Source: Table 8 in Section 3

1.3.4. Booster Pumping / Pressure Control

The District has a total of four booster pump stations, three distribution pumps, and two pressure control valve stations. The 1-2 booster pump supplies water from the lower Zone 1 pressure zone to Zone 2. The 2-3 booster pump supplies water from the lower Zone 2 pressure zone to Zone 3. This pump was added after the water model was completed; thus, this pump was not included in the system's analysis. A booster pump is located in both Zone 2 and Zone 3 that supply water to connections above the hydraulic grade line of the storage tanks. Two distribution pumps are located at the Turkey Creek WTP and one is located at the Parmalee Gulch WTP. The pressure control stations allow water to be transferred between the three pressure zones depending on system demands and allows the District to use the distribution/booster pumps in Zone 1 or 3 to supply water to all of the District's storage tanks (in all three pressure zones).

1.3.5. Treated Water Storage

The District has a total of six storage tanks that provide a total storage volume of 474,000 gallons. Each of the three pressure zones have two storage tanks. The storage tanks are listed below in Table E6.

Table E6: Existing Drinking Water Storage Tanks

Tank	Diameter / Dimensions (feet)	Height (feet)	Approximate Elevation at Bottom of Tank (ft)	Approximate Elevation of High-Water Level (ft)	Primary Supply Source(s)	Equipped Capacity (Gallons)
Zone 1 Tank 1	26.8	28.5	7115.00	7138.00	Well No. 11R, 12, and Turkey Creek Gallery	100,000
Zone 1 Tank 2	26.8	28.5	7115.00	7138.00	Well No. 11R, 12, and Turkey Creek Gallery	100,000
Zone 2 Tank 1	18.0	16.0	7359.00	7375.00	Well No. 11R, 12, and Turkey Creek Gallery	32,000
Zone 2 Tank 2	18.0	16.0	7359.00	7375.00	Well No. 11R, 12, and Turkey Creek Gallery	32,000
Zone 3 Tank 1	25.0	28.5	7578.00	7605.80	Well No. 5 and 10	100,000
Zone 3 Tank 2	26.8	28.4	7578.00	7605.80	Well No. 5 and 10	110,000
					Total	474,000
					Firm Capacity[1]	364,000

[1] Firm capacity assumes the largest tank is offline. Source: Table 7 in Section 3

1.3.6. Distribution System

The District's finished water distribution system consists of three pressure zones, containing pipelines ranging from 3/4-inch to 6-inches in diameter. The distribution system consists of three pressure zones and is supplied by gravity flow from the storage tanks. The order of the pressure through the system's zones from highest to lowest is Zone 3, Zone 2, and Zone 1, respectively.

A water distribution system model was developed and calibrated as part of the Water Master Plan project. Detailed maps of the water system are included in this plan. Currently, the District's water distribution system has approximately 11.5 miles of pipe with the majority of pipe being between 2-inches and 6-inches in diameter. The District reported the existing system's data to Merrick and GIS data was created. Merrick recorded the District currently having 32 fire hydrants at the time of this Master Plan. The District has recently added 2 new hydrants.

1.3.6.1. *Fire Flow Service Capability*

Due to the restrictions in the existing distribution system created by 2-inch and 4-inch pipes, the District has not yet determined or confirmed all the fire hydrants are able to meet the required minimum fire flow of 1,000 gpm. At the time of when the water model was completed, only one fire hydrant could meet this requirement. Pipe improvement projects are recommended based on the water model results to remove these restrictions. Fire hydrants are also recommended as a Capital Improvement Project to meet the requirements of a hydrant placed every 1,000 feet throughout the distribution system (Indian Hills Fire Department).

1.4. CAPACITY EVALUATION

A site visit was conducted to assess the District's existing water system infrastructure, and the system was evaluated and assessed with regard to its ability to serve the District's needs for a 10-year planning period (Year 2029). The capacity, capability, and criticality of the Town's water rights, water supply, well pumps, treatment, booster pumping/pressure control, storage and distribution was evaluated. The assessment used various tools including spreadsheets and a computer water model (WaterGEMs) to identify capacity deficiencies and needs.

1.4.1. Basis of Design

In 2018, the District used (sold) 10,656,111 gallons of water. (32.7 ac-ft). Due to the implementation of updated water meters over the course of 2016-2020, accurate historical District water consumption data is limited. The latest leak was also repaired in March of 2019. Due to this leak, the data used to establish the Basis of Design was from April through July of 2019. The drinking water system was analyzed using existing demands and future demands. The demands listed below were established as the District's Basis of Design. The master planning process uses the following water demands to project future demand needs:

1.4.1.1. *Existing and Future Design Parameters:*

- Average Day Demand (ADD) = 115.1 gpd/SFE or 0.08 gpm/SFE
- Peak Day Demand Peaking Factor = 1.7
- Peak Day Demand (PDD) = 195.7 gpd/SFE or 0.14 gpm/SFE
- Peak Hour Demand Peaking Factor = 4.0
- Peak Hour Demand (PHD) = 460.4 gpd/SFE or 0.32 gpm/SFE

Source: Section 4.1.1

Table E7: Future Drinking Water Source Requirements

Total Future SFEs	Increase in SFEs from Year 2019	Existing Source Demand (gpm)	Future Peak Day Demand (gpm/SFE)	Future Demand (gpm)	Total Future, Demand (gpm)	Current Source Pumping Rate (gpm)	SFE Capacity [1]	Surplus/ (Deficit) Source Capacity (gpm)	Surplus/ (Deficit) SFEs
3-year Planning Period (Year 2022)									
414	6	57.12	0.14	0.84	58	61.75	441	3.75	27
5-year Planning Period (Year 2024)									
418	10	57.12	0.14	1.4	58.5	61.75	441	3.25	23
10-year Planning Period (Year 2029)									
428	20	57.12	0.14	2.8	59.9	61.75	441	1.85	13

[1]SFE Capacity uses a Peak Day Demand of 0.14 gpm/SFE or 195.7 gpd/SFE.
Source: Table 19 in Section 5

Table E8: Future Drinking Water Storage Requirements

Total Future SFEs	Increase in SFEs from Year 2019	Existing Storage Demand (gallons)	Future Peak Day Demand (gpd/SFE)	Fire Storage, 1,000 gpm for 2 hours (gallons)	Future Storage Peak Day Demand (gallons)	Total Future Storage Demand (gallons)	Current Storage (gallons)	Current SFE Capacity	Surplus/ (Deficit) Storage Capacity (gallons)	Surplus/ (Deficit) SFE
3-year Planning Period (Year 2022)										
414	6	79,846	195.7	120,000	1,174	201,020	474,000	1,809	272,980	1,395
5-year Planning Period (Year 2024)										
418	10	79,846	195.7	120,000	1,957	201,803	474,000	1,809	272,197	1,391
10-year Planning Period (Year 2029)										
428	20	79,846	195.7	120,000	3,914	203,760	474,000	1,809	270,240	1381

[1]SFE capacity uses a Peak Day Demand of 195.7 gpd /SFE.
Source: Table 20 in Section 5

After analysis, it was determined that no water storage or source projects were required in the 10-year planning period (Table E7 and Table E8). As previously mentioned, the firm capacity of the wells was discussed with the District and in an emergency situation the District could utilize their inactive wells to supplement their source capacity. The existing and future water model analysis showed fire flow deficiencies throughout the District. Additional projects would be required to service undeveloped areas within the District Boundary.

1.5. CAPITAL IMPROVEMENT PROJECTS

After the site visit and water model was complete, capital improvement projects were established based on the District's current and future deficiencies. A preliminary list of capital improvement projects was reviewed and prioritized with the District, based on financial capacity of the District and importance. Capital improvement projects are organized into 3-, 5-, and 10-year planning periods. 15 additional projects are recommended that would be outside the 10-year planning period, due to the District's financial capacity. The recommended projects address the District's pipe improvement projects to meet the required fire flow, add additional fire hydrants, and address deficiencies at the Zone 2 and Zone 3 booster pump station for leak detection monitoring.

It is also recommended that the District upgrade their fire hydrant standard to a "mountain" fire hydrant with a 5-foot hydra finder to provide fire hydrant access during winter months. However, due to the District's limited financial capabilities, the project cost to upgrade the existing hydrants was not included in the capital improvement projects analysis.

A summary of the 3-, 5-, and 10-year planning period, as well as recommended projects, is provided in Table E9. Table E10 lists the cost and description of each project inside the planning period and the recommended projects outside of the planning periods. Construction costs for the projects have been inflated to their expected construction year. The inflation rate was established from the past 10 years of United States inflation data. The average inflation rate for this period was 1.55%. For conservatism, an annual inflation rate of 3% will be used in this plan. The capital improvement projects have been identified by the project type as follows:

- D= Distribution System
- PS=Pump Station
- S= Source
- ST=Storage
- T=Treatment

Table E9: Summary of Capital Improvement Projects

Planning Period	Number of Projects	Total Cost
3-Year	8	$741,800
5-Year	2	$706,000
10-Year	2	$221,000
3-, 5-, and 10-Year Total	12	$1,668,000
Recommended (Outside 10-Year Planning Period)	15	$11,821,000

Table E10: Drinking Water Capital Improvement Projects

3-Year Planning Period						
Project Name	Type*	Description	Year 2020 Cost Estimate	Project Need	Construction Year	Construction Year Cost**
Zone 3 Tank Site Improvements	ST	Tank mixers, ladder extensions, vent extensions, handrails, and SCADA upgrades	$67,000	Reduce freezing and leaks in tanks. Improve site safety and integrate SCADA.	2020	$67,000
Zone 1 Tank Site Improvements	ST	Tank mixers, ladder extensions, vent extensions, handrails, power supply to site, and SCADA upgrades	$105,000	Reduce freezing and leaks in tanks. Improve site safety and integrate SCADA.	2020	$105,000
Turkey Creek Water Treatment Plant Improvements	T	Iron/manganese removal system upgrades and backwash discharge improvements	$20,000	Achieve proper contact time for iron/manganese removal.	2020	$20,000
Zone 3 Tank Site Fence and Level Transmitters	ST	Security fence, gate, and level transmitters for tank	$85,000	Increase site security and proper control of tank levels.	2021	$87,600
Zone 1 Tank Site Fence and Level Transmitters	ST	Security fence, gate, and level transmitters for tank	$94,000	Increase site security and proper control of tank levels.	2021	$96,900
Turkey Creek Water Treatment Plant SCADA Upgrades	T	Upgrading existing SCADA equipment	$87,000	SCADA upgrades for system monitoring/alerts.	2021	$89,700
1-2 Booster Pump Station Improvements	PS	Sodium hypochlorite booster station, generator, and SCADA upgrades	$79,000	Assist residual chlorine concentrations in the system, provide redundant power supply, and system monitoring.	2021	$81,400
Parmalee Gulch Water Treatment Plant SCADA Upgrades	T	Upgraded SCADA and generator	$183,000	SCADA upgrades for system monitoring/alerts.	2022	$194,200
3-Year Planning Period Total			$720,000	N/A	N/A	$741,800

Table E10 (Continued): Future Water Capital Facility Projects						
5-Year Planning Period						
Project Name	Type*	Description	Year 2020 Cost Estimate	Project Need	Construction Year	Construction Year Cost**
Zone 2 Tank Site Improvements	ST	Ladders, level control, security fencing, overflow extension, handrails, and SCADA upgrades	$131,000	Create tank site security and access.	2023	$143,200
Parmalee Gulch Water Treatment Plant Nitrate Removal System	T	Microvi Nitrate treatment system	$500,000	Reduce nitrate treatment waste.	2024	$562,800
5-Year Planning Period Total			$631,000	N/A	N/A	$706,000
10-Year Planning Period						
Turkey Creek Water Treatment Plant Improvements	T	Laser turbidimeter, well flowmeters, generator, automation for potassium permanganate dosing system	$170,000	Improve control for iron/manganese removal and supply redundant power.	2025	$197,100
Parmalee Gulch Water Treatment Plant Improvements	T	Laser turbidimeter and well flowmeters	$20,000	Improve monitoring of Memcor filtration system and more accurate well flow measurement	2026	$23,900
10-Year Planning Period Total			$190,000	N/A	N/A	$221,000
3-, 5-, and 10-Year Total			$1,541,000	N/A	N/A	$1,668,800
Recommended Projects						
Project Name	Type *	Description	Year 2020 Cost Estimate	Project Need		
Zone 3 Tanks Supply Improvements	D	Upsize existing 6-inch line to 10-inch from Zone 3 tanks to Parmalee Gulch Road	$867,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.		

Table E10 (Continued): Future Water Capital Facility Projects				
Project Name	Type *	Description	Year 2020 Cost Estimate	Project Need
Zone 3 – Zone 2 Loop and PRV	D	Connect Zone 3 to Zone 2 through a PRV station. Upsize 4-inch to 8-inch from Zone 3 tank site and Kiowa Street. New 8" line connecting Zone 3 tank site to Kiowa Street	$2,311,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Parmalee Gulch Road Improvements	D	Upsize existing 2-inch line to 8-inch along Parmalee Gulch Road. Add 2 new 8-inch lines to connect existing 6-inch Parmalee Gulch Road line to 4-inch in Ute Road	$1,162,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Zone 2 - Zone 1 Loop and PRV	D	Connect Zone 2 to Zone 1 through a PRV station. Upsize 4-inch to 8-inch along Cherokee Road to Parmalee Gulch Road. New 8-inch line along Parmalee Gulch Road to Seminole Road	$1,391,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Matterhorn and Weisshorn Dr. Improvements	D	Upsize 2-inch and 4-inch along Matterhorn and Weisshorn Drive to fire hydrants	$873,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Aztec and Weisshorn Dr. Improvements	D	Upsize 4-inch along Aztec Road, 4-inch along Parmalee Gulch Road and Weisshorn Drive, and 4-inch from Weisshorn Drive to IHFD to 8-inch pipe	$717,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Ute Road Improvements	D	Upsize 4-inch along Ute Road to 8-inch to fire hydrant	$212,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Santa Clara Road to Highway 285 Improvements	D	Upsize existing 4-inch along Santa Clara Road to 8-inch to Highway 285	$943,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.

Table E10 (Continued): Future Water Capital Facility Projects				
Project Name	Type *	Description	Year 2020 Cost Estimate	Project Need
Seminole Road Improvements	D	Upsize 4-inch pipe to 8-inch along Seminole Road from to Parmalee Gulch Road	$490,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Zone 2 Supply Improvements (Recommended)	D	Upsize 2-inch and 4-inch lines to 8-inch from Zone 2 tanks to Parmalee Gulch Road along Picutis Road	$393,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Zone 1 Supply Improvements (Recommended)	D	Upsize 4-inch pipe to at least 8-inch from Zone 1 Tanks to Seminole Road	$243,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
South Highway 285 Supply Improvements (Recommended)	D	Upsize 4-inch pipe under and south of Highway 285 to at least 8-inch	$1,092,000	Remove existing flow restrictions for the required fire flow to the District's fire hydrants.
Zone 2 Booster Pump Station Improvements	PS	Flow monitoring, SCADA integration, and high-speed radio	$12,000	Leak monitoring and system monitoring/alarms.
Zone 3 Booster Pump Station Improvements	PS	Flow monitoring, SCADA integration, and high-speed radio	$12,000	Leak monitoring and system monitoring/alarms.
Fire Hydrant Improvements	D	Install additional fire hydrants every 500 feet in existing system	$1,103,000	Allow increased access to fire flow for quicker emergency response.

* D= Distribution System, S= Source, ST=Storage, PS=Pump Station, T=Treatment
** Inflation rate was assumed at 3%. This value is conservative as the average interest rate in the last 10 years was 1.55%.
Source: Table 23 in Section 5