CITY WATER AD-HOC COMMITTEE MEETING AGENDA

City Hall, City Hall Conference Room, 251 E. Honolulu St., Lindsay, CA 93247

Notice is hereby given that the City Water Ad-Hoc Committee will hold a meeting on **September 14, 2023**, at **6:00 PM** in person at the Lindsay City Hall Conference Room located at 251 East Honolulu Street Lindsay California 93247. The webinar address for members of the public is https://us06web.zoom.us/j/2725789470 .

Persons with disabilities who may need assistance should contact the City Clerk prior to the meeting at (559) 562-7102 ext. 8034 or via email at lindsaycityclerk@lindsay.ca.us.

1. CALL TO ORDER

2. ROLL CALL

3. PUBLIC COMMENT

The public is invited to comment on any subject under the jurisdiction of the City Sign Ordinance Ad-Hoc Committee. Please note that speakers that wish to comment on a Regular Item or Public Hearing on tonight's agenda will have an opportunity to speak when public comment for that item is requested by the Committee. Comments shall be limited to three (3) minutes per person, with thirty (30) minutes for the total comment period, unless otherwise indicated by the Committee. The public may also choose to submit a comment before the meeting via email. Public comments received via email will be distributed to the Committee prior to the start of the meeting and incorporated into the official minutes; however, they will not be read aloud. Under state law, matters presented under public comment cannot be acted upon by the Committee at this time.

4. INTRODUCTIONS

4.1 Introductions of Committee Members (p. 3)

5. ACTION ITEMS

5.1 Consider Approval of Ad-Hoc Committee Guidelines (pp. 4 – 7)

Presented by Joseph M. Tanner, City Manager

5.2 Consider Approval of City Water Ad-Hoc Committee Meeting Schedule for 2023 (p. 8)

Presented by Francesca Quintana, City Clerk & Assistant to the City Manager

6. DISCUSSION ITEMS

6.1 Historical Overview of Lindsay Water & Water Project Funding

Presented by Joseph M. Tanner, City Manager

6.2 Water Update

Presented by Neyba Amezcua, Director of City Services & Planning

6.3 Introduction and Overview of Studies (pp. 9 – 99)

Presented by Neyba Amezcua, Director of City Services & Planning

7. ADJOURNMENT

City Water Ad-Hoc Committee meetings are held in the City Council Conference Room at 251 E. Honolulu Street in Lindsay, California beginning at 6:00 P.M. once a month unless otherwise noticed. Materials related to an Agenda item submitted to the legislative body after distribution of the Agenda Packet are available for public inspection in the office of the City Clerk during normal business hours. A complete agenda is available at www.lindsay.ca.us. In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting, or to be able to access this agenda and documents in the agenda packet, please contact the office of the City Clerk at (559) 562-7102 x 8034. Notification prior to the meeting will enable the City to ensure accessibility to this meeting and/or provision of an alternative format of the agenda and documents in the agenda packet.

Table 1: Committee Composition *(As Approved by Lindsay City Council)*

	Group	Name	Email
1	Lindsay City Council	Yolanda Flores, Mayor Pro Tem	yflores@lindsay.ca.us
2	Lindsay City Council	Rosaena Sanchez, Council Member	rsanchez@lindsay.ca.us
3	Lindsay Community Member	Mayra Magallanes	m.magallanes016@gmail.com
4	Lindsay Community Member	Jose Soria	josesoriajr@gmail.com
5	Lindsay Community Organization	Brenda Gonzalez	gonzalez.brenda2003@gmail.com
6	Lindsay Unified School District	Grant Schimelpfening	gschimelpfening@lindsay.k12.ca.us

Table 2: Advisory City Staff

	Title	Name	Email	Phone
1	City Manager	Joseph M. Tanner	jtanner@lindsay.ca.us	559-562-7102 x 8010
2	Director of City Services & Planning	Neyba Amezcua	namezcua@lindsay.ca.us	559-562-7102 x 8040
3	Director of Finance	Salvador Guzman	sguzman@lindsay.ca.us	559-562-7102 x 8020
4	City Clerk	Francesca Quintana	fquintana@lindasy.ca.us	559-562-7102 x 8034

City of Lindsay

City Water Ad-Hoc Committee

Guidelines

Approved and Adopted:

MM,DD, 2023

Table of Contents

Section 1. General

1.1 Purpose. The purpose of the City Water Ad-Hoc Committee Guidelines is to outline the responsibilities and expectations of the Committee. The Committee shall serve a single purpose that is not perpetual, have a defined purpose and timeframe to accomplish that purpose, dissolve once the specific task is complete or the time has expired.

1.2 Expectations.
The Committee shall:

- Meet, review, and discuss the Well 11 Feasibility Study Report and identified findings and recommendations.
- Meet, review, and discuss the Water Feasibility Study Report and identified findings and recommendations.
- Meet, review, and discuss City infrastructure, supply, and financials.
- Discuss and identify potential funding sources to address Well 11 and Water Feasibility Studies recommendations and make recommendations to the City Council.
- Act as an advisor to the City Council.

Section 2. Decorum

2.1 Committee Members. Committee Members shall accord the utmost courtesy to each other, City employees, and the public. When speaking, a Committee Members tone should remain neutral and non-verbal communication aspects should be considerate and polite.

Section 3. Posting Notice & Agenda

3.1 Posting of Notice and Agenda. For every meeting, the City Clerk or other authorized person shall post a notice of the meeting, specifying the time and place at which the meeting will be held, and an agenda containing a brief description of all items of business to be discussed at the meeting. This notice and agenda may be combined in a single document. The City Clerk shall post each agenda for a City Sign Ordinance Ad-Hoc Committee meeting no less than 72 hours in advance of the meeting online and in the official bulletin board.

3.2 Location of Posting. The notice and agenda shall be posted on a bulletin board, publicly accessible, at City Hall, 251 E. Honolulu Street, Lindsay, California, and on the City website.

Section 4. Meetings

4.1 Meeting Time and Location. As a matter of general principle, the Committee shall typically conduct its meetings at 6:00 p.m. once a month in the City Hall Conference Room located at City Hall, unless noticed otherwise. The time, date, or place of a meeting may be altered as published in the Committee meeting agenda.

4.2 Adjournment. It shall be the policy of the Committee to adjourn meetings by 7:30 p.m. unless the Committee elects to continue past the adjournment hour by unanimous consent of all members in attendance. If at the hour of 7:30 p.m. the Committee has not concluded its business, the Committee will review the balance of the agenda and determine by vote whether to continue any remaining items to the next meeting or adjourn the meeting to another date and time.

City Water Ad-Hoc Committee
Meeting Schedule
Year 2023

Meeting Date	Tentative Topics
Thursday, September 14, 2023	• Introductions of Committee Members • Goals of Committee • Overview of Studies
Saturday, October 7, 2023 *(morning)*	• Water & Sewer Facilities Tour
Wednesday, October 18, 2023	• Review and discuss Well 11 Feasibility Study Report and identified findings and recommendations. • Review and discuss submitted funding requests.
Wednesday, November 8, 2023	• Review and discuss Water Feasibility Study Report and identified findings and recommendations.
Wednesday, December 6, 2023	• Review and discuss City infrastructure, supply, and financials. • Discuss and identify potential funding sources to address Well 11 and Water Feasibility Studies recommendations. • Follow-up

City of Lindsay
Well 11 Feasibility Study

January 12, 2023

REGISTERED PROFESSIONAL ENGINEER
RONALD KEVIN BERRYHILL
No. 70415
Civil
STATE OF CALIFORNIA

Kevin Berryhill

DATE SIGNED 1/12/2023

Prepared for:
City of Lindsay
Lindsay, California

Prepared by:
Provost & Pritchard Consulting Group
455 West Fir, Clovis, California 93611

Table of Contents

List of Figures

List of Tables

1 Background

1.1 Purpose of Report

The City of Lindsay operates a community water system located in Tulare County, California that is regulated by the California State Water Resources Control Board Division of Drinking Water (DDW). The system's sources of supply are Central Valley Project (CVP) Friant Kern Canal water treated at a single surface water treatment plant and two active groundwater wells (Wells 14 and 15). A third well (Well 11) is currently inactive due to nitrate and perchlorate contamination at levels exceeding their respective maximum contaminant levels (MCLs). The distribution system is operated as a single pressure zone and includes one 4-million-gallon at-grade water storage reservoir located on a hill near the north end of the City.

During normal years, the City's contracted CVP water allocation is 2,500 acre-feet, which is sufficient for the City to supply most of its water needs using its surface water treatment plant. However, during years of severe or extreme drought, including 2022, the City's Friant Kern Canal water allocation can be severely reduced. Unless a special Health & Safety CVP water allocation is granted to the City, it will be necessary to reactivate Well 11 to meet system demands, even if water conservation measures are implemented. Without mitigation of the nitrate and perchlorate contamination at Well 11, any use of the well would result in a violation of two primary drinking water standards, both of which have the potential to result in acute health effects.

The purpose of this report is to evaluate non-treatment and treatment alternatives to mitigate the perchlorate and nitrate contamination at Well 11 so that this source can be returned to active service or a replacement source developed; to recommend a preferred solution; and to estimate capital and operations & maintenance (O&M) costs associated with that solution.

1.2 Well 11 Description

Well 11 is located at the north end of a City storm water detention basin south of W. Mariposa Street approximately 900 feet east of Highway 65. The well was drilled in 1980 to a total depth of 668 feet, includes a 150-foot sanitary seal, and is perforated from 300 to 550 feet. The well is equipped with a 125-horsepower submersible pump capable of producing a flow rate of approximately 1,400 gpm into an on-site hydropneumatic pressure tank.

1.3 Water Quality

1.3.1 Water Quality

Water quality characteristics for Wells 11, 14, and 15 are summarized in Tables 1-1, 1-2, and 1-3 respectively. Tables 1-4 and 1-5 contain individual nitrate and perchlorate results for Well 11.

Notable geochemical characteristics of the Well 11 water include intermittently elevated iron levels and moderate sulfate and chloride levels. Iron levels exceeding the 0.3 mg/L secondary drinking water standard are interspersed with non-detect results. It is likely that these elevated iron levels are a result of the well not being pumped long enough to purge stagnant water prior to sampling events. Sulfate levels, and to a lesser extent chloride levels, have a significant impact on the anion exchange process typically used to remove nitrate and perchlorate from water. The highest recorded sulfate level was 90 mg/L in 1984. All twenty-four subsequent sulfate results were 57 mg/L or less. Chloride levels average 233 mg/L.

Well 11 is contaminated with perchlorate and nitrate at levels exceeding their respective MCLs. The synthetic organic chemical (SOC) 1,2-dibromo-3-chloropropane (DBCP) has also been detected, but is present at levels below one-half of the MCL. Perchlorate results from 2001 through 2020 range from 8 to 13 µg/L and are relatively stable. The levels are consistently greater than the 6 µg/L MCL. The single non-detect perchlorate result from the sample collected on January 22, 2008, is suspect. Nitrate levels have typically been within 20% of the 10 mg/L MCL value since 2007 with four out of the 67 results measuring at, or greater than, the 10 mg/L MCL.

The SOC 1,2,3-trichloropropane (TCP), which has been regulated in drinking water since 2017, has been detected extensively throughout the Central Valley, including in the nearby communities of Tulare and Woodville. A single detection of TCP at a concentration of 34 ng/L was reported at Well 11 in 2001. Eight TCP results reported between the 2001 detection and 2017 were non-detect, but are suspect as reporting limits significantly greater than the MCL value were commonly used until 2017. At the beginning of this study, only one sample had been analyzed for TCP since 2017 and that result was non-detect. The City recently re-tested the well for TCP with another non-detect result.

The water quality characteristics at Wells 14 and 15, which are located approximately 2.5 miles to the northwest of Well 11 were considered when evaluating potential blending and well replacement mitigation alternatives. Nitrate levels at Wells 14 and 15 have recently been in the range of 6.5 – 7.3 mg/L. Perchlorate has not been detected at either Well 14 or Well 15. Well 14 is also contaminated with DBCP and levels have only been consistently below the 0.2 µg/L MCL since 2017. Well 15 has notably higher hardness than the other two wells.

Table 1-1: Well 11 General Water Quality

ANALYTE	UNITS	DATA POINTS AVAILABLE	MIN	AVERAGE	MAX
GENERAL					
AGGRESSIVE INDEX		1	12	12	12
ALKALINITY, BICARBONATE AS CACO3	MG/L	9	110	250.84	1230
ALKALINITY, CARBONATE AS CACO3	MG/L	9	0	0	0
ALKALINITY, HYDROXIDE AS CACO3	MG/L	8	0	0	0
ALKALINITY, TOTAL AS CACO3	MG/L	9	110	257.89	1300
ALUMINUM	UG/L	7	0	8.57	60
ANTIMONY	UG/L	5	0	0	0
ANTIMONY, TOTAL	UG/L	1	0	0	0
ARSENIC	UG/L	11	0	1.38	7
BARIUM	UG/L	9	0	210	260
BENZENE	UG/L	8	0	0	0
BERYLLIUM, TOTAL	UG/L	1	0	0	0
BORON	UG/L	2	0	140	280
CADMIUM	UG/L	9	0	0	0
CALCIUM	MG/L	9	60	68.56	73
CHLORIDE	MG/L	12	150	233.17	305
CHROMIUM (TOTAL CR-CRVI SCREEN)	UG/L	1	5	5	5
CHROMIUM, HEX	UG/L	2	0.9	2.6	4.3
CHROMIUM, TOTAL	UG/L	10	0	5.50	30
COLOR		9	0	1.56	8
COPPER	UG/L	9	0	0	0
CYANIDE	UG/L	6	0	0	0
FLUORIDE	UG/L	9	0	120	310
HARDNESS, TOTAL AS CACO3	MG/L	9	280	314.67	340
IRON	UG/L	11	0	196.36	1000
LANGELIER INDEX		1	0.27	0.27	0.27
LANGELIER INDEX @ 60 C		4	0.23	0.72	0.97
LEAD	UG/L	9	0	0	0
MAGNESIUM	MG/L	9	28	34.44	39
MANGANESE	UG/L	9	0	0	0
MERCURY	UG/L	9	0	0.02	0.2
NICKEL	UG/L	6	0	0	0
NITRATE (AS N)	MG/L	67	0.2	7.86	11.75
NITRATE + NITRITE (AS N)	MG/L	5	1.7	7.08	10
NITRITE (AS N)	MG/L	7	0	0	0
ODOR THRESHOLD		1	0	0	0
ODOR THRESHOLD @ 60 C		7	0	0.29	1
PERCHLORATE	UG/L	14	0	10.11	13
PH @23C		1	8	8	8
PH, LAB		8	7.4	7.85	8.1
POTASSIUM	MG/L	8	3.8	19.18	120
SELENIUM	UG/L	9	0	0	0
SILVER	UG/L	9	0	0.22	2
SODIUM	MG/L	9	4	73.44	140
SPECIFIC CONDUCTANCE	UMHOS/CM	19	840	1030.89	1800
SULFATE	MG/L	9	25	42.22	90
TDS	MG/L	9	500	657.67	764
THALLIUM, TOTAL	UG/L	6	0	0	0
TURBIDITY, LAB		8	0	0.47	1.8
ZINC	UG/L	9	0	0	0
RADIOACTIVE					
GROSS ALPHA PARTICLE ACTIVITY	PCI/L	16	0	2.41	13.1
RADIUM-226	PCI/L	1	0.126	0.13	0.126
RADIUM-228	PCI/L	4	0	0.28	1.1
URANIUM	PCI/L	3	0	1.14	2.07
VANADIUM	UG/L	2	20	22	24
ORGANIC					
1,1-DICHLOROETHANE (1,1-DCA)	UG/L	8	0	0	0
1,2,3-TRICHLOROPROPANE	UG/L	14	0	0.0024	0.034
BROMOFORM (THM)	UG/L	8	0	0	0
CHLOROMETHANE	UG/L	8	0	0	0
DIBROMOCHLOROPROPANE	UG/L	55	0	0.09	0.19
DICHLOROMETHANE (METHYLENE CHLORIDE)	MG/L	9	0	0.00013	0.0012
TETRACHLOROETHYLENE (PCE)	UG/L	8	0	0	0

Table 1-2: Well 14 General Water Quality

ANALYTE	UNITS	DATA POINTS AVAILABLE	MIN	AVERAGE	MAX
GENERAL					
AGGRESSIVE INDEX		5	12	12.60	13
ALKALINITY, BICARBONATE AS CACO3	MG/L	5	190	224	260
ALKALINITY, CARBONATE	MG/L	5	0	0	0
ALKALINITY, TOTAL AS CACO3	MG/L	5	180	190	210
ALUMINUM	UG/L	4	0	0	0
ANTIMONY, TOTAL	UG/L	4	0	0	0
ARSENIC	UG/L	4	0	2.03	3.1
BARIUM	UG/L	4	160	172.50	190
BENZENE	UG/L	4	0	0	0
BERYLLIUM, TOTAL	UG/L	4	0	0	0
BORON	UG/L	1	220	220	220
CADMIUM	UG/L	4	0	0	0
CALCIUM	MG/L	5	48	51.60	57
CHLORIDE	MG/L	5	180	206	220
CHROMIUM, HEX	UG/L	2	4.2	4.45	4.7
CHROMIUM, TOTAL	UG/L	4	0	0	0
COLOR		4	0	1.25	5
COPPER, FREE	UG/L	5	0	0	0
CYANIDE	UG/L	4	0	0	0
FLUORIDE	UG/L	4	150	170	190
FOAMING AGENTS (SURFACTANTS)	UG/L	5	0	0	0
HARDNESS, TOTAL AS CACO3	MG/L	6	250	261.67	290
HYDROXIDE AS CALCIUM CARBONATE	UG/L	5	0	0	0
IRON	UG/L	5	0	280	1200
LANGELIER INDEX (PH(S))		5	0.49	0.55	0.67
LANGELIER INDEX @ SOURCE TEMP		1	1.1	1.10	1.1
LEAD	UG/L	4	0	0	0
MAGNESIUM	MG/L	5	30	32.40	36
MANGANESE	UG/L	5	0	6.80	34
MERCURY	UG/L	4	0	0	0
NICKEL	UG/L	4	0	0	0
NITRATE (AS N)	MG/L	45	5.6	6.57	8.36
NITRATE + NITRITE (AS N)	MG/L	2	6.6	6.95	7.3
NITRITE (AS N)	MG/L	4	0	0	0
ODOR THRESHOLD		4	0	0	0
PERCHLORATE	UG/L	5	0	0	0
PH, LAB		5	8	8.14	8.3
POTASSIUM	MG/L	5	3.6	3.66	3.8
SELENIUM	UG/L	4	0	0	0
SILVER	UG/L	5	0	0	0
SODIUM	MG/L	5	110	124	130
SPECIFIC CONDUCTANCE	UMHOS/CM	8	1000	1125	1200
SULFATE	MG/L	5	36	40.80	43
TDS	MG/L	5	590	614	660
THALLIUM, TOTAL	UG/L	4	0	0	0
TURBIDITY, LAB		4	0	0.42	0.88
ZINC	UG/L	5	0	0	0
RADIOACTIVE					
GROSS ALPHA PARTICLE ACTIVITY	PCI/L	7	0.95	3.12	6.29
RADIUM-228	PCI/L	2	0	0	0
ORGANIC					
1,1-DICHLOROETHANE (1,1-DCA)	UG/L	4	0	0	0
1,2,3-TRICHLOROPROPANE	UG/L	6	0	0	0
BROMOFORM (THM)	UG/L	4	0	0	0
CHLOROMETHANE	UG/L	4	0	0.25	1
DIBROMOCHLOROPROPANE	UG/L	69	0.053	0.23	0.53
DICHLOROMETHANE (METHYLENE CHLORIDE)	MG/L	4	0	0	0
TETRACHLOROETHYLENE (PCE)	UG/L	4	0	0	0
TTHM	UG/L	4	0	0	0

Table 1-3: Well 15 General Water Quality

ANALYTE	UNITS	DATA POINTS AVAILABLE	MIN	AVERAGE	MAX
GENERAL					
AGGRESSIVE INDEX		5	13	13	13
ALKALINITY, BICARBONATE AS CACO3	MG/L	5	170	178	190
ALKALINITY, CARBONATE	MG/L	5	0	0	0
ALKALINITY, TOTAL AS CACO3	MG/L	5	140	146	150
ALUMINUM	UG/L	4	0	0	0
ANTIMONY, TOTAL	UG/L	4	0	0	0
ARSENIC	UG/L	4	0	0.58	2.3
BARIUM	UG/L	4	430	497.50	570
BENZENE	UG/L	11	0	0	0
BERYLLIUM, TOTAL	UG/L	4	0	0	0
BORON	UG/L	2	150	195	240
CADMIUM	UG/L	4	0	0	0
CALCIUM	MG/L	5	120	144	170
CHLORIDE	MG/L	21	600	875.71	1100
CHROMIUM, HEX	UG/L	1	4.2	4.20	4.2
CHROMIUM, TOTAL	UG/L	4	0	0	0
COLOR		4	0	0	0
COPPER, FREE	UG/L	5	0	0	0
CYANIDE	UG/L	4	0	0	0
FLUORIDE	UG/L	4	0	102.50	150
FOAMING AGENTS (SURFACTANTS)	UG/L	5	0	0	0
HARDNESS, TOTAL AS CACO3	MG/L	5	650	778	910
HYDROXIDE AS CALCIUM CARBONATE	UG/L	5	0	0	0
IRON	UG/L	5	0	134	670
LANGELIER INDEX (PH(S))		5	0.58	0.68	0.74
LANGELIER INDEX @ SOURCE TEMP		1	0.32	0.32	0.32
LEAD	UG/L	4	0	0	0
MAGNESIUM	MG/L	5	86	103.80	120
MANGANESE	UG/L	5	0	0	0
MERCURY	UG/L	4	0	0	0
NICKEL	UG/L	4	0	0	0
NITRATE (AS N)	MG/L	33	3.16	5.48	7.2
NITRATE + NITRITE (AS N)	MG/L	2	5	5.80	6.6
NITRITE (AS N)	MG/L	4	0	0	0
ODOR THRESHOLD		4	0	0	0
PERCHLORATE	UG/L	4	0	0	0
PH, LAB		5	7.9	7.98	8.1
POTASSIUM	MG/L	5	4.9	5.62	6.3
SELENIUM	UG/L	4	0	0	0
SILVER	UG/L	5	0	0	0
SODIUM	MG/L	5	220	244	270
SPECIFIC CONDUCTANCE	UMHOS/CM	22	2400	2840.91	3200
SULFATE	MG/L	5	30	35.40	38
TDS	MG/L	39	1500	1805.13	2300
THALLIUM, TOTAL	UG/L	4	0	0	0
TURBIDITY, LAB		4	0	0.09	0.25
ZINC	UG/L	5	0	12	60
RADIOACTIVE					
GROSS ALPHA PARTICLE ACTIVITY	PCI/L	9	0.18	4.34	9.99
RADIUM-226	PCI/L	1	0.024	0.02	0.024
RADIUM-228	PCI/L	5	-0.077	0.32	1.7
COMBINED URANIUM	PCI/L	1	3.3	3.30	3.3
ORGANIC					
1,1-DICHLOROETHANE (1,1-DCA)	UG/L	11	0	0.10	0.61
1,2,3-TRICHLOROPROPANE	UG/L	6	0	0	0
BROMOFORM (THM)	UG/L	7	0	0.21	1.5
CHLOROMETHANE	UG/L	7	0	0	0
DIBROMOCHLOROPROPANE	UG/L	5	0	0	0
DICHLOROMETHANE (METHYLENE CHLORIDE)	MG/L	11	0	0	0
TETRACHLOROETHYLENE (PCE)	UG/L	11	0	0.10	0.56
TTHM	UG/L	7	0	0.21	1.5

Table 1-4: Well 11 Nitrate Levels

DATE	RESULT (µg/L)
6/7/1984	7
1/18/1989	4.38
9/25/1989	2.71
10/16/1990	6.33
4/28/1992	6.62
2/11/1993	0.2
7/1/1994	6.44
12/22/1994	1.69
3/8/1995	6.55
7/26/1995	7.45
11/28/1995	7.68
6/26/1996	7.68
9/19/1996	7.45
12/12/1996	7.45
3/28/1997	6.1
6/30/1997	8.13
4/7/1998	7.45
7/1/1998	6.78
12/10/1998	7.91
2/5/1999	7.45
6/30/1999	7.68
12/28/1999	7.45
3/9/2000	7.68
6/21/2000	7
9/13/2000	8.13
12/19/2000	7.23
3/14/2001	7.91
5/30/2001	7
9/25/2001	8.36
12/13/2001	9.04
3/12/2002	8.58
6/11/2002	8.36
9/4/2002	8.36
12/11/2002	7.91
2/12/2003	7.45
5/19/2003	8.81
8/4/2003	8.81
10/27/2003	8.58
2/2/2004	9.04
5/3/2004	8.58
8/2/2004	8.58
11/15/2004	8.36
2/14/2005	8.58
5/9/2005	8.81
8/9/2005	8.58
11/28/2005	8.81
2/13/2006	8.13
5/15/2006	9.04
7/24/2006	8.81
10/16/2006	8.58
2/12/2007	3.61
6/4/2007	11.75
7/16/2007	7.45
8/6/2007	9.71
8/13/2007	9.49
8/20/2007	9.26
9/4/2007	9.71
9/17/2007	9.04
10/1/2007	9.71
10/15/2007	9.04
10/29/2007	9.04
11/19/2007	9.04
1/7/2008	7.91
4/21/2014	10.62
5/21/2014	11.07
9/24/2020	10

Table 1-5: Well 11 Perchlorate Levels

DATE	RESULT (µg/L)
5/30/2001	8
12/13/2001	9.2
12/21/2007	10
1/4/2008	11
1/22/2008	ND
1/28/2008	11
2/4/2008	13
2/11/2008	11
2/19/2008	11
2/25/2008	11
2/18/2010	9.3
4/21/2014	11
5/21/2014	13
9/24/2020	13

1.3.2 2022 Water Quality Cycle Testing

The water quality data considered in Section 1.3.1 represents data available at the start of this study. Provost & Pritchard subsequently recommended that the City conduct additional testing to confirm the 2017 non-detect result for TCP and to characterize how nitrate levels vary with the duration of pumping.

It has been the experience of some Central Valley utilities that nitrate levels in certain wells drop as the well is pumped for longer periods of time. In these cases, blending the water produced by the well in a storage tank can be considered as a potential means of mitigating short-duration nitrate spikes. In order to determine if this is the case at Well 11, a cycle test was performed. On November 29, 2022, the well was pumped to waste for 10 minutes to purge the well casing after more than two years of non-operation. On November 30th, the well pump was again flushed to waste while samples were collected for nitrate analysis immediately following start-up and 5 minutes, 20 minutes, 1 hour, and 1 day following start-up. The nitrate concentrations measured during all five intervals of this cycle test were the same, 11 mg/L (as N). This indicates that nitrate levels are unlikely to change significantly with well run time and buffering of the water in a storage tank would be of no benefit to water quality.

Additional samples were collected on December 1st, at the conclusion of the 24-hour cycle test. Those samples were analyzed for TCP, DBCP, and EDB. TCP and EDB were not detected. DBCP was detected at a concentration of 0.075 µg/L, less than one-half of the 0.2 µg/L MCL

1.4 Applicable Regulations

Nitrate is regulated at the federal and state level with a MCL of 10 mg/L (reported as nitrogen). The Detection Limit for Purposes of Reporting (DLR) is 0.4 mg/L.

Perchlorate in drinking water is not regulated at the federal level but is regulated in California with a MCL of 6 µg/L. The DLR was recently reduced from 4 µg/L to 1 µg/L and the State Water Resources Control Board has stated that they will use new occurrence data resulting from the lower DLR to make a determination whether the MCL value should be lowered.

Both nitrate and perchlorate are regulated as acutely toxic substances and, as a result, any confirmed exceedance of their respective MCL values results in a violation of drinking water standards and the need for public notification. Compliance is not determined based on running annual average values as is the case for most regulated inorganic and organic contaminants.

1.5 Production and System Demand

Prior to Well 11 being taken out of service due to perchlorate contamination in 2008, the well was a significant source of supply for the system. Table 1-1 summarizes annual water production in million gallons per year for the City's water sources over the period of 2001 through August 31, 2020.

Table 1-6: Historical Water Production by Source

	Well 11		Well 14		Well 15		Water Treatment Plant		2,500 AF Contract USBR Allocation %
	MG	AF	MG	AF	MG	AF	MG	AF	
2001	173.01	530.95	0.08	0.26	236.62	726.17	305.39	937.21	
2002	50.44	154.8	0.05	0.16	37.24	114.28	689.42	2115.75	
2003	66.61	204.41	0.00	0.00	118.91	364.91	694.78	2132.2	
2004	9.11	27.95	0.00	0.00	129.27	396.72	672.85	2064.90	
2005	27.09	83.15	0.00	0.00	236.60	726.10	631.16	1936.96	
2006	233.15	715.51	0.00	0.00	0.00	0.00	537.00	1647.99	
2007	231.53	710.54	0.00	0.00	135.58	416.09	452.55	1388.82	
2008	0.00	0.00	0.00	0.00	297.71	913.64	671.96	2062.17	
2009	0.00	0.00	137.83	422.98	110.05	337.73	662.14	2032.03	
2010	0.00	0.00	219.46	673.51	75.98	233.18	591.17	1814.23	
2011	0.00	0.00	235.40	722.42	181.35	556.54	437.72	1343.31	
2012	0.00	0.00	193.75	594.59	298.43	915.85	382.71	1174.49	
2013	0.00	0.00	262.38	805.21	259.21	795.48	420.12	1289.30	55%
2014	0.00	0.00					198.77	610	0%
2015	0.00	0.00	170.94	524.59	313.2	961.17	246.35	756.02	0%
2016	0.00	0.00	110.22	338.25	251.6	772.13	431.41	1323.95	100%
2017	0.00	0.00	139.63	428.51	269.51	827.09	396.62	1217.18	100%
2018	0.00	0.00	64.7	198.56	175.09	537.33	548.25	1682.51	88%
2019	0.00	0.00	82.95	254.56	135.5	415.83	572.7	1757.55	100%
2020*	0.00	0.00	67.34	206.66	136.86	420.01	340.99	1046.46	65%

2 Non-Treatment Alternatives

2.1 Consolidation

The closest water system serving a population larger than Lindsay's is the City of Tulare, which is more than 10 miles away. Consolidation is therefore not a viable alternative.

2.2 Well Modification or Replacement

Well completion reports for the City's three wells are not available. However; the construction details in Table 2-1 were reported in DDW's 2013 Sanitary Survey Engineering Report for the City's system.

Table 2-1: Well Construction Characteristics

	Well 11	Well 14	Well 15
Capacity	1,400 gpm	750 gpm	1,100 gpm
Sanitary Seal Depth	150 ft	255 ft	200 ft
Well Depth	668 ft	415 ft	530 ft
Perforations	300-550	285-405	210-510

The source of both the nitrate and perchlorate contamination was likely the land application of fertilizers in the region surrounding Well 11. The origin of the contamination, the fact that a 150-foot sanitary seal has not prevented the contamination from migrating down to the aquifer supplying the well; and the single interval of continuous perforations indicate that modifying the existing well by filling in the bottom portion of the well or blinding off a portion of perforated casing is unlikely to be successful at mitigating the contamination.

The City investigated replacing Well 11 in 2019 by drilling a test well at the City park located northwest of the intersection of Avenue 232 and N Elmwood Avenue. Water quality analyses were performed on water collected at five discrete depth intervals (i.e. zone testing). Key water quality results are summarized in Table 2-2.

Table 2-2: 2019 Test Well Results

Depth Interval (feet bgs)	Units	MCL	213-225	276-283	330-335	357-368	462-468
Nitrate	mg/L (as N)	*10*	12	14	8.8	8.5	7.9
Perchlorate	µg/L	*6*	14	9.0	11	7.8	5.9
Aluminum	mg/L	*0.2/1**	0.053	ND	0.28	ND	1.8
Arsenic	µg/L	*10*	ND	ND	2.7	2.2	7.6
Chromium***	µg/L	*50/10**	25	ND	ND	ND	11
DBCP**	µg/L	*0.2*	ND	0.5	0.027	0.022	ND
Hardness	mg/L (as $CaCO_3$)	*NA*	420	220	260	240	150
Iron	mg/L	*0.3*	0.23	0.17	0.54	0.15	3.2
Manganese	mg/L	*0.05*	ND	ND	0.012	ND	0.046

* Primary/Secondary MCL

** All zones were also analyzed for TCP with a reporting limit of 0.7 ng/L and non-detect results.

*** The water was not specifically tested for hexavalent chromium, which has a proposed MCL of 10 µg/L. It is unknown whether the chromium is predominantly trivalent or hexavalent.

The test well results indicate that nitrate levels may drop below the MCL deeper than 330 feet bgs, however, levels are not expected to be lower than approximately 80% of the MCL. The lowest measured nitrate concentration of 7.9 mg/L occurred in the deepest zone. Perchlorate was present above the MCL at all depths except for the deepest zone, where the measured level was only 0.1 µg/L below the MCL value. The water quality observed at the deepest zone (462-468 bgs) also indicates that metals, including aluminum, arsenic, iron, manganese, and potentially chromium are all likely to be problematic at depths greater than the 468-foot test well. The results of the test well indicate that construction of a replacement well in the central part of the City is not a feasible solution.

Wells 14 and 15 currently produce water meeting all drinking water standards. However, Well 14 is contaminated with DBCP and was out of compliance with the DBCP standard from 2012 through 2016. Tetrachloroethylene (PCE) was detected at Well 15 as recently as 2019. Well 15 has also historically produced water with non-fecal coliform bacteria and, as a result, DDW requires that disinfection of the water produced by the well be achieved through chlorination and contact time within the transmission pipeline between the well and the City's water distribution system. Despite the water quality challenges at Wells 14 and 15, the area surrounding these wells would be the most likely location for construction of a new well to replace Well 11. However, even if the City could be certain that acceptable water quality would be produced by a new well located near Wells 14 and 15, there are several logistical challenges associated with construction of another well in that area. Wells 14 and 15 are located approximately 2.5 miles outside of the City limits. The City would need to acquire property for construction of the well, and this property would need to be situated such that the new well would not interfere with operation of the two existing City wells or the numerous private agricultural and domestic wells in the area. The existing 12-inch water transmission pipeline from Wells 14 and 15 into the City is not large enough to accommodate the additional flow from a third well. Therefore, additional right-of-way would need to be acquired and a new approximately 2.5-mile-long parallel transmission pipeline constructed to bring the water into the City. Modifications to the western portion of the City's water distribution system would also likely be required to efficiently distribute the concentrated flow coming from three wells.

2.3 Blending

Blending of the water from different sources is often considered for mitigation of nitrate contamination in order to avoid the high costs associated with treatment of that contaminant. Blending is also, on occasion, considered for anthropogenic contaminants, such as perchlorate, when no other feasible alternatives exist. For blending to be feasible, there must be a source of water with low enough concentrations of the targeted contaminants so that combining that water with the contaminated water will result in blended concentrations that are comfortably below the MCL values. The only potential source of blending water in this instance is the water being produced by Wells 14 and 15. The City's surface water treatment plant is located too far away from Well 11 for blending with surface water to be practical. Furthermore, as noted in Section 1, the City needs the water from Well 11 most when the surface water supply is unavailable. Wells 14 and 15 are located west of Well 11 outside of the City limits. Water from the two wells is conveyed to the city through a 12-inch transmission main along Highway 65 (W Tulare Road). The first service connection off of that transmission main is located approximately 1/8 of a mile east of Cedar Avenue. Approximately 3,200 feet of pipe would need to be constructed between Well 11 and the first service connection if blending was to be implemented.

Prior to the Well 11 being taken off-line due to perchlorate contamination in 2008, nitrate levels had trended gradually upward from approximately 6.8 mg/L (as N) in 1994 to 9 mg/L in 2008. The well has been tested for nitrate three times since 2008: twice in 2014 and once in 2020. Those three results ranged from 10 to 11 mg/L (as N). The recent cycle testing confirmed a current concentration of 11 mg/L. Nitrate concentrations at Wells 14 and 15 have ranged between 4.5 and 7.5 mg/L over the past five years. If the concentration of nitrate at Wells 14 and 15 is assumed to be 7.5 mg/L and Wells 14 and 15 are assumed to produce 750 and 1,200 gpm respectively, the nitrate concentration that would result if the water from all three wells was blended together would be 9 mg/L. The 1 mg/L difference between the potential blended nitrate concentration and the MCL provides inadequate margin of safety. A small rise in nitrate levels at any of the three wells would result in blending not being effective.

Over the period of 2001 through 2020, the perchlorate levels at Well 11 have varied between 8 and 13 μg/L with the two most recent samples measuring 13 μg/L. Perchlorate has not been detected at Wells 14 and 15 with reporting limits ranging from 2 to 4 μg/L. Even if the concentration of perchlorate in the water produced by Wells 14 and 15 is truly 0 μg/L, which is not certain, the perchlorate concentration that would result from all three wells being blended together would be 5.4 μg/L, or 90% of the current MCL. The 10% difference between the potential blended perchlorate concentration and the current MCL provides inadequate margin of safety. Furthermore, DDW is actively evaluating lowering the perchlorate MCL. Any decrease in the perchlorate MCL would result in blending being infeasible.

Irrespective of the fact that blending provides unacceptably low margins between blended nitrate and perchlorate levels and their respective MCLs, there are several additional issues associated with blending as a potential solution:

1. Blending would not work if either Well 14 or Well 15 were out of service. In essence the loss of either one of those two wells would also result in the loss of Well 11 or the need to violate the nitrate and perchlorate standards.

2. Tying operation of Well 11 to operation of the City's other two wells results in significantly less operational flexibility than if Well 11 were treated and remained an independently operated source.
3. Even if the surface water treatment plant were located closer to Well 11 so that blending could be considered, the surface water supply is not available when Well 11 would be needed most.

Blending is not a viable solution to either the nitrate or perchlorate contamination issues.

2.4 Surface Water

The City's existing CVP surface water supply is not reliable during drought years so replacing water from Well 11 with additional surface water is not feasible. During drought years, such as this year (2022), the City's allocation of CVP water is significantly curtailed and can be reduced to 0%. This is the primary reason for the city conducting this study and exploring alternatives to recover or replace the lost production from Well 11.

3 Treatment Alternatives

3.1 Treatment Process Alternatives

Three treatment processes have been demonstrated to be effective at removing perchlorate from drinking water: ion exchange, biological treatment, and reverse osmosis. The same three technologies are also those that have been demonstrated to be effective at removing nitrate from drinking water. Each of the three processes is discussed in more detail in the following sections.

3.1.1 Reverse Osmosis

Reverse osmosis (RO) treatment has been demonstrated to be effective at removing both perchlorate and nitrate from water. However, this process is impractical to implement at the municipal level in the Central Valley due to issues associated with waste disposal. RO membrane treatment produces a continuous "concentrate" waste stream. The percentage of the source water that becomes concentrate is a function of the water chemistry and the number of RO stages that are operated in series. Multiple RO stages involve the concentrate from one stage becoming the feed water for a subsequent stage. Even when three RO stages are used to minimize the generation of waste concentrate, the concentrate will comprise approximately 15% of the source water flow rate. Therefore, for Well 11, which produces approximately 1,400 gpm, a continuous concentrate waste stream of 210 gpm would be generated. The concentrate would contain levels of perchlorate, nitrate, and other raw water constituents at more than 8 times the raw water levels. It is unlikely that the Central Valley Regional Water Quality Control Board would permit this water to be discharged to land and the volumes involved are too great for evaporation to be economical. For these reasons, RO is not considered a viable solution.

3.1.2 Biological Treatment

Biological treatment under anaerobic conditions has been demonstrated to be effective for the treatment of both perchlorate and nitrate. Biological treatment has been used for remediation of perchlorate contamination of groundwater at several facilities in California. However, in most cases, perchlorate levels are significantly higher than at Well 11 and the treated water has not been used as a source of drinking water. One exception to that is a treatment plant at the West Valley Water District in Rialto, CA. West Valley operates a fluidized bed reactor biological treatment plant for drinking water contaminated with both nitrate and perchlorate. The only other California biological drinking water treatment plant Provost & Pritchard is aware of is a nitrate removal treatment plant operated by the City of Delano.

Biological treatment has the advantage of destroying the perchlorate and nitrate by converting them to carbon dioxide, nitrogen, chloride, and oxygen, meaning that no contaminated waste needs to be disposed of. However, biological treatment results in several permitting and operability issues. Some of the more significant obstacles to implementation of biological treatment of drinking water include:

- Biological treatment systems function most reliably when operated continuously or near-continuously. If biological treatment were added to Well 11, the City would need to modify its water supply approach such that Well 11 would become a primary source of supply, which would limit operational flexibility.
- Biological treatment processes are operationally complex and typically involve the addition of several chemicals and extensive instrumentation. For example, 6 chemicals are used at the Delano nitrate treatment plant. Figure 3-1 illustrates a typical fixed bed bioreactor process flow diagram.
- The City of Delano reports that significant operator attention is required to keep their treatment plant operational. Delano assigns a near full-time operator to the nitrate treatment plant when it is in operation.
- There is the potential for the bacteria to convert sulfate to sulfide, which would then need to be removed through post-treatment.
- In permitting a biological treatment plant, DDW will impose post-treatment requirements similar to those imposed on a surface water treatment plant. This will include filtration, disinfection log-inactivation through CT, and monitoring requirements.
- Given the limited operational experience with biological treatment in California, it is recommended, and anticipated that DDW will require, that a pilot study be performed before proceeding with a full-scale biological treatment process.

While it is technologically feasible to treat Well 11 for both nitrate and perchlorate using biological treatment, this process is not recommended due to the significant operability and permitting concerns.

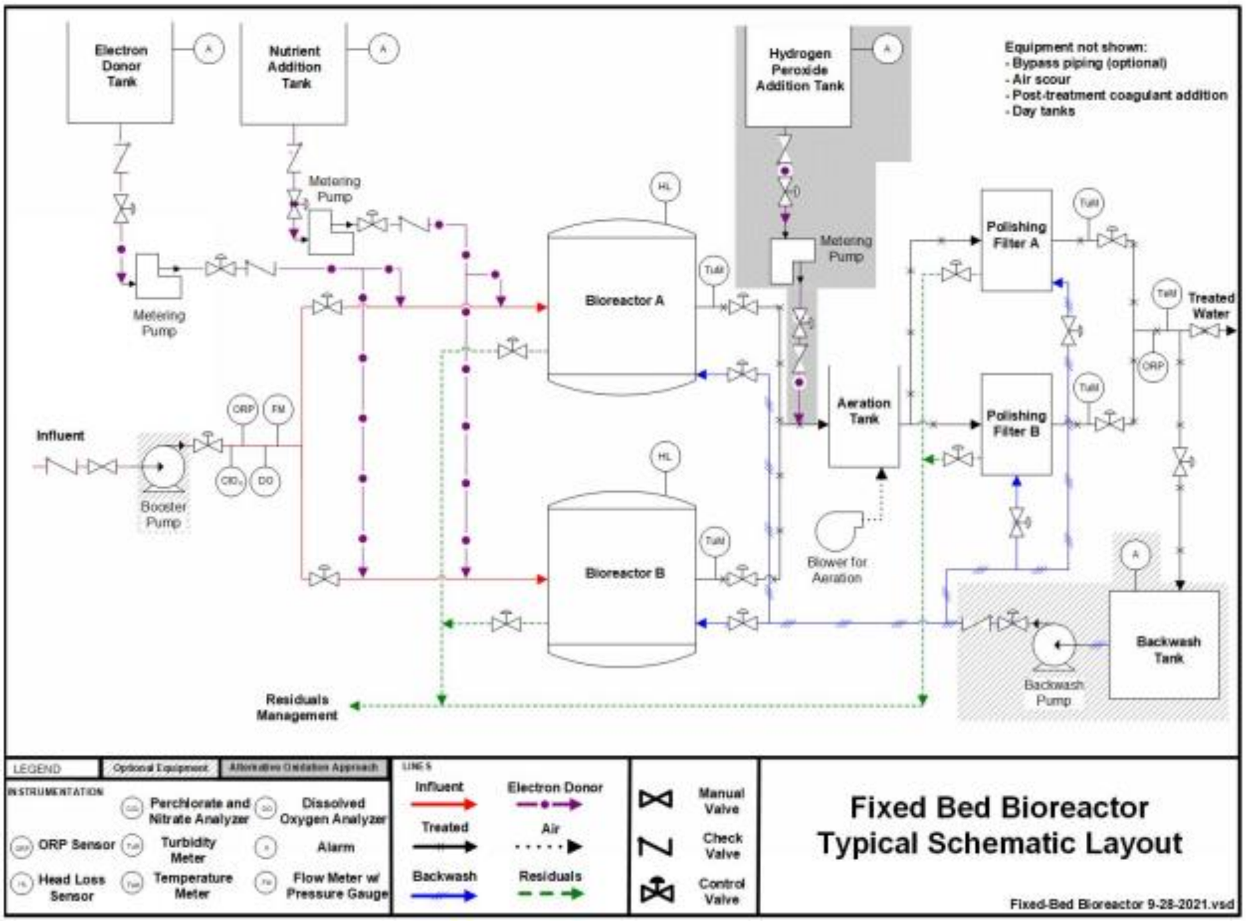


Figure 3-1: Fixed Bed Bioreactor Typical Layout (Source: EPA WBS Cost Model)

3.1.3 Ion Exchange

Ion exchange is the most commonly used treatment process for removal of perchlorate and/or nitrate from drinking water. Ion exchange - more specifically anion exchange, utilizes a synthetic resin to exchange negatively charged nitrate and/or perchlorate ions in the water for negatively charged chloride ions pre-loaded on the resin. Typical anion exchange resins preferentially remove anions other than nitrate and perchlorate from the water (e.g. sulfate and bicarbonate), which results in a reduction in the resin capacity available to remove the nitrate and/or perchlorate being targeted. To help improve the resin performance in the presence of high concentrations of these competing ions, resin manufacturers have developed special "nitrate-selective" and "perchlorate-selective" resins. As described below, the approach to implementing ion exchange for nitrate and perchlorate is different.

For nitrate treatment, irrespective of whether a nitrate-selective resin is used, the resin will become exhausted and no longer efficiently remove nitrate from the water in a relatively short period of time - on the order of hours or a few days. When this occurs, the resin will need to be regenerated by soaking it in a concentrated salt brine solution. A solution of approximately 10% sodium chloride is often used. The brine solution left over from regeneration of the resin, which will contain high concentrations of nitrate and other anions removed from the water, must then be disposed of.

Waste brine generation can be partially minimized using techniques such as recycling of regeneration rinse water. The brine generated by a nitrate treatment plant incorporating brine-minimization techniques typically comprises between 0.25 and 0.5% of the volume of water treated. Because the nitrate levels at Well 11 are only slightly greater than the MCL value, another approach to minimizing brine waste would be to only treat a portion of the flow produced by the well (i.e. side stream treatment). If a raw water nitrate level of 13 mg/L is assumed and a treated water nitrate level of 8 mg/L (as N), is targeted, only approximately 45% of the water produced by the well would need to be treated through the ion exchange system. The remaining 55% of the flow could be bypassed around the nitrate treatment process. This bypass ratio could be adjusted to compensate for higher or lower raw water nitrate levels. Implementing both rinse water reclaim and side-stream treatment at Well 11 would result in the generation of approximately 4,770 gallons of waste brine per 24 hours of operation. In inland areas such as the Central Valley, the two most feasible means of disposing of this brine are to discharge it into evaporation ponds or to haul it off to an approved disposal facility, which will typically be a coastal wastewater treatment plant.

Because raw water perchlorate levels are so much lower than nitrate levels (µg/L compared to mg/L), it is economical to use perchlorate-selective resin in a single-use mode that involves disposing of the resin when it becomes exhausted instead of regenerating it. Once the perchlorate resin is exhausted and perchlorate is detected in the lead vessel effluent, the resin must be changed out and the spent resin incinerated. Placing a separate perchlorate treatment system upstream of nitrate treatment also offers the significant benefit of avoiding contamination of the nitrate treatment waste brine with perchlorate. The approach of placing non-regenerable perchlorate-selective ion exchange treatment upstream of regenerable nitrate ion exchange treatment is one that has been successfully implemented by other California water utilities and is the approach recommended at Well 11 if treatment is the solution ultimately selected.

3.2 Treatment Plant Design Parameters

As noted in Section 3.1, it is recommended that treatment of the water be accomplished in two stages. The first stage would consist of a single-use perchlorate-selective ion exchange system for removal of perchlorate from the water. The second stage would consist of a regenerable ion exchange system for removal of nitrate from the water. The full 1,400-gpm flow from the well would be treated by the perchlorate removal system whereas only approximately 630 gpm would be treated through the downstream nitrate removal system. Following are preliminary design parameters for both treatment systems.

3.2.1 Perchlorate Treatment

Ion exchange resins are susceptible to being blinded off by even low levels of sediment of other suspended solids that may be present in the raw water. In single-use resin applications, the vessels cannot be backwashed after being placed into service to remove solids accumulated on top of the resin. Doing so would disrupt the mass transfer zone and likely result in premature breakthrough of perchlorate in the treated water. For this reason, manufacturers recommend that five-micron bag or cartridge filters be placed upstream of the perchlorate treatment ion exchange system.

Purolite, a manufacturer of specialized ion exchange resins, was contacted to assist in establishing preliminary system operational parameters and to estimate resin life. Based on Purolite's recommendations, a single pair of 12-foot diameter vessels operated in series has been assumed. This results in the following operating conditions:

Table 3-1: Perchlorate Treatment Process Design Parameters

Parameter	Recommended Range	Proposed Value
Design raw water perchlorate		13 ppb
Treatment objective		Non-detect (< 1 ppb)
Flow Rate		1,400 gpm
Resin		Purolite A532E (Perchlorate Selective)
Vessel configuration	Lead-lag	Lead-lag
Number of vessels		2
Vessel diameter		12 ft
Vessel area		113 ft^2
Resin load per vessel		420 ft^3
Bed depth	3.7 ft min.	3.7 ft
Loading rate	6 - 18 gpm/ft^2	12.4 gpm/ft^2
Specific flowrate	1 – 5 gpm/ft^3	3.3 gpm/ft^3
Empty bed contact time	1.5 -2.5 minutes (lead vessel)	2.2 minutes

Based on the water quality characteristics at Well 11, Purolite estimates that the resin in the lead vessel will last for 60,000 bed volumes (BV), which is equivalent to 188 million gallons (MG) treated before needing to be replaced.

3.2.2 Nitrate Treatment

Preliminary sizing of a regenerable ion exchange nitrate treatment system was established using Purolite's Resin System Modeling (PRSM) software. The results of the PRSM analysis were also confirmed with a Purolite technical expert. The PRSM analysis resulted in the preliminary treatment system configuration described in Table 3-2. It is noted that, for the relatively low sulfate levels at Well 11, use of a higher capacity Type 1 resin (such as Purolite A600E/9149) is predicted to result in lower waste volumes than if a nitrate selective resin was used.

Table 3-2: Nitrate Treatment Process Design Parameters

Parameter	Proposed Value
Design raw water nitrate	13 mg/L as N
Treatment objective	8 mg/L as N
Design plant flow rate	1,400 gpm
Resin	Purolite A600E/9149 (High cap. Type 1)
Flow treated through IX	630 gpm
Flow bypassed around IX	770 gpm
Number of vessels	3 (2 in service)
Flow rate per vessel	315 gpm
Vessel diameter	7 ft
Vessel area	38.5 ft^2
Resin load per vessel	155 ft^3
Bed depth	4 ft
Loading rate	8.2 gpm/ft^2
Specific flowrate	2.03 gpm/ft^3
Regeneration water reclaim	50% of slow rinse and 100% of fast rinse water reclaimed

This vessel configuration – three 7-foot diameter vessels with 2 in service at any given time, represents one of several possible system arrangements. Configurations with two larger vessels with only one vessel in service or configurations incorporating more than three vessels could also be used. Generally, systems utilizing a greater number of vessels should result in some increase in process efficiency and waste reduction. However, this would come at the expense of greater capital costs, a larger footprint, and increased operational complexity. Because disposal of waste brine is anticipated to be the largest operating cost item, it is recommended that the system include brine minimization features including a system that permits all of the high-rate rinse and approximately half of the slow-rate rinse water used during regeneration to be reclaimed. Only the brine and a portion of the slow-rate rinse water would be sent to the waste tank for disposal.

The process performance parameters resulting from the configuration described above are summarized in Table 3-3.

Table 3-3: Nitrate Treatment Process Performance

Parameter	Predicted Value (In terms of water treated through IX vessels)	Predicted Value (In terms of water produced by well)
Vessel cycle duration	29 hours	-
Net water per vessel/cycle[1]	548.1 kgal	1,234 kgal
Salt dosage	10 lbs/ft^3	-
Salt load per vessel/cycle[2]	1,550 lbs	-
Salt usage	2.83 lbs/kgal	1.4 lbs/kgal
Percent of water through IX that becomes waste brine	0.53%	0.23%
Waste generated per vessel/cycle[2]	2,890 gal	-
Waste generated per full day of operation	4,770 gal	

[1] This value represents the volume of water that will be produced by one of the three vessels before regeneration of that vessel is required.

[2] This value is for regeneration of one vessel only. Regeneration of the three vessels will be staggered with two vessels in service at any one time.

3.2.3 Nitrate Treatment Waste Management

The perchlorate treatment system will generate only a small volume of waste during backwashing, which only occurs when resin is changed out. This backwash waste will be nonhazardous, will not include brine, and should be of a quality that can be discharged into the adjacent storm water basin. Conversely, the nitrate treatment process will generate waste brine daily. Provided the perchlorate is removed upstream of the nitrate treatment plant, the nitrate treatment brine should be classified as nonhazardous. However, the brine will be very high in total dissolved solids (i.e. salt) and will also contain elevated levels of nitrate and other anions the treatment system removes from the water. The two most feasible brine disposal alternatives for inland water systems are lined evaporation ponds and hauling the brine off to be disposed of at a coastal wastewater treatment plant.

On-Site Evaporation Ponds:

For the on-site evaporation alternative, a total of approximately 1.5 acres of ponds would be required. This assumes the monthly production volumes, evaporation rates, and rainfall amounts listed in Table 3-4. The monthly production values represent approximately 100% duty cycle during the summer months and 33% duty cycle during winter months, with spring and fall months falling in between.

Table 3-4: Evaporation Pond Sizing Assumptions

Month	Assumed Well 11 Production (MG)	Monthly Evaporation (inches)[1]	Monthly Precipitation (inches)[2]
January	20	1.0	2.25
February	20	1.5	2.18
March	30	2.6	2.00
April	40	3.9	1.25
May	50	5.3	0.49
June	60	6.0	0.10
July	60	6.2	0.08
August	60	5.5	0.01
September	50	4.2	0.07
October	40	2.9	0.65
November	30	1.4	1.11
December	20	0.4	1.92
TOTAL	**480**	**41.1**	**12.11**

[1] From California Irrigation Management Information System (CIMIS) reference evapotranspiration zones (2012). A factor of 1.1 was applied to the evapotranspiration values to account for an open water body based on UC Publication 21427. A factor of 0.7 was applied to the evapotranspiration values to account for the reduced evaporation rates as brine concentration increases.

[2] From NOAA climate data for Lindsay, CA

The following evaporation pond design features have been preliminarily assumed. These assumptions would need to be confirmed through coordination with the Central Valley Regional Water Quality Control Board during pre-design:

- The pond depth required for operational storage (balancing inflows and evaporation throughout the year) would be minimal (less than 1 foot). However, several feet of additional depth would be required for solids accumulation and freeboard. A 6-foot total depth has been assumed.
- The ponds would need to be lined to prevent percolation of salts into the underlying groundwater. The most practical lining material for this pond configuration would be polyethylene. It has been assumed that the ponds will need to be double-lined
- A pond leakage detection system, including lysimeters, will likely be required.
- Netting over the ponds and potentially other wildlife deterrents may be required.

Operation and maintenance associated with the evaporation pond alternative would consist of monitoring the ponds for leakage, occasional removal of crystalized salt from the bottom of the ponds and repair of the liner as necessary. The rate that solids will build up in the ponds can be approximated by the salt load used for regeneration of the ion exchange resin: 1.4 lbs per 1,000 gallons of water produced by the well.

The well is located adjacent to an approximately 8-acre storm water basin. The City also owns an additional approximately 3-acre parcel adjacent to the southwestern portion of the storm water basin (refer to Figure 3-2). This additional parcel should be large enough to accommodate the proposed evaporation ponds.

Off-Site Disposal of Brine

The other alternative for managing the brine waste is to haul it to a coastal wastewater treatment plant where it would ultimately be discharged into the ocean. East Bay Municipal Utility District (EBMUD) in Oakland accepts brine. There may also be facilities in Southern California that accept brine. Infrastructure required for off-site disposal of the brine would consist of waste holding tanks with air-gap inlets and truck hook-ups. Waste brine would need to be hauled off approximately daily during periods when the well was in service at a 100% duty cycle.

Between these two alternatives, disposal into evaporation ponds will result in significantly lower operating costs compared to hauling the brine to a coastal wastewater treatment plant. Capital and O&M cost differences for the two disposal alternatives are presented in Section 4.

Figure 3-2: Well 11 Vicinity Map and City Property

3.3 Incidental Water Quality Impacts

The addition of any treatment process that results in a change to the raw water chemistry has the potential to result in unintended impacts to distribution system water quality. The ion exchange process proposed for Well 11 will result in the exchange of anions such as nitrate, sulfate, and bicarbonate, with chloride ions pre-loaded onto the resin. Nitrate and sulfate levels will be lower in the treated water than in the raw water. Bicarbonate levels will also be lower during the early phase of a vessel operational cycle. Chloride levels will be correspondingly higher in the treated water than in the raw water.

California drinking water standards include secondary consumer acceptance contaminant level ranges for chloride. The recommended, upper, and short-term limits are 250, 500, and 600 mg/L respectively. If ion exchange treatment is implemented at Well 11, the resulting chloride level will exceed the recommended value of 250 mg/L. This exceedance, by itself, is unlikely to result in the treatment plant not being permitted by DDW.

Elevated ratios of chloride to sulfate (Cl/SO_4), known as the chloride-to-sulfate mass ratio (CSMR), have been associated with galvanic corrosion and leaching of lead from lead-tin solders and consumer plumbing. The current CSMR at Well 11 averages 5.5, which is considered high. Implementing ion exchange treatment will result in an increase in the CSMR. Raw and treated water alkalinity, chloride, sulfate, and CSMR values are summarized in Table 3-5. The values of these parameters at Well 15 have also been included for the purpose of comparison.

Table 3-5: Chloride and Sulfate Levels

	Well 11 Raw Water	Well 11 Ion Exchange Effluent	Well 11 Treatment Plant Effluent	Well 15 Raw Water
Alkalinity (mg/L as $CaCO_3$)	128	128	128	146
Chloride (mg/L)	233	317	270	876
Sulfate (mg/L)	42	0	23	35
CSMR	5.5	-	11.7	25

The actual impact of the increase in CSMR at Well 11 on lead levels is difficult to predict, particularly given the water's moderate alkalinity level, which may act to mitigate the effects of elevated CSMR. Well 15, which has been in active use for many years, produces water with chloride and CSMR values that are significantly higher than those predicted for the Well 11 treatment plant. However, it is noted that the City experienced a lead action level exceedance during the 2019-2021 monitoring period.

At a minimum, if ion exchange treatment is added to Well 11, the City should provide increased lead monitoring at consumer taps following treatment plant startup to quickly identify any potential rise in lead levels. It is also recommended that the treatment plant design include provisions for the addition of a corrosion control chemical such as an orthophosphate or silica-based corrosion inhibitor if lead levels do rise.

4 Cost Estimates

4.1 Capital Costs

The estimated capital project costs for the perchlorate and nitrate treatment plant described in Section 3.2 are summarized in Table 5-1.

Table 4-1: Capital Cost Opinion (Evaporation Ponds)

Bid Item	**Cost**
Site demolition, clearing and grubbing	$20,000
Perchlorate treatment vessels w/ initial load of resin	$750,000
Perchlorate vessel installation and testing	$45,000
Perchlorate IX vessel foundation	$45,000
Pre- and post-treatment cartridge filters	$100,000
Nitrate IX system with tanks, resin, controls, and softener	$1,000,000
Nitrate IX system foundations	$75,000
Installation of IX system	$100,000
Yard piping	$250,000
Pipe to evaporation pond (500 ft)	$50,000
Electrical and controls	$400,000
Well pump upgrades (to overcome head loss)	$100,000
Miscellaneous site work, paving, vaults, fences	$200,000
Evaporation ponds (1.5 acres, double lined)	$650,000
Mobilization (5%)	$157,000
Subtotal Estimated Bid Cost	$3,942,000
Estimate contingency (25%)	$985,500
Subtotal Estimated Construction Cost	$4,927,500
Engineering Design (8%)	$394,200
Construction Management and Inspection (7%)	$344,900
Environmental, Legal, Administration (5%)	$246,400
Operations Plan and permitting	$30,000
Total Capital Cost	**$5,943,000**

If the City was to haul brine off-site to a coastal wastewater treatment plant for disposal, the capital cost would be reduced as shown in Table 5-2.

Table 4-2: Capital Cost Opinion (Off-Site Brine Disposal)

Bid Item	**Cost**
Site demolition, clearing and grubbing	$20,000
Perchlorate treatment vessels w/ initial load of resin	$750,000
Perchlorate vessel installation and testing	$45,000
Perchlorate IX vessel foundation	$45,000
Pre- and post-treatment cartridge filters	$100,000
Nitrate IX system with tanks, resin, controls, and softener	$1,000,000
Nitrate IX system foundations	$75,000
Installation of IX system	$100,000
Yard piping	$250,000
Pipe to evaporation pond (500 ft)	$50,000
Electrical and controls	$400,000
Well pump upgrades (to overcome head loss)	$100,000
Miscellaneous site work, paving, vaults, fences	$200,000
Waste tanks	$50,000
Mobilization (5%)	$157,000
Subtotal Estimated Bid Cost	$3,342,000
Estimate contingency (25%)	$835,500
Subtotal Estimated Construction Cost	$4,177,500
Engineering Design (8%)	$334,200
Construction Management and Inspection (7%)	$292,400
Environmental, Legal, Administration (5%)	$208,900
Operations Plan and permitting	$30,000
Total Capital Cost	**$5,043,000**

4.2 O&M Costs

O&M costs associated with the proposed treatment plant include replacement of perchlorate system resin, purchasing salt for nitrate system resin regeneration, an increase in pumping power, labor, laboratory fees, replacement cartridge filters, brine disposal, and maintenance. Of these costs, labor, laboratory fees, and maintenance have been considered fixed costs and resin, salt, power, cartridge filters, and brine disposal have been considered variable – a function of the volume of water treated.

The estimated O&M costs assuming on-site brine disposal in evaporation ponds is summarized in Table 4-3. It should be noted that there is significant uncertainty in the cost to dispose of the dried salt that will accumulate in the bottom of the evaporation ponds. O&M costs for two assumed annual production volumes: 100 MG and 250 MG have been presented to illustrate the economies of scale associated with higher annual production volumes. These economies of scale result from spreading the fixed costs (labor, laboratory, and maintenance over a larger volume of water produced.

Table 4-3: O&M Cost Opinion (Evaporation Ponds)

Item	**Annual Cost**
Labor[1]	$39,000
Laboratory[2]	$1,690
Maintenance[3]	$79,000
Subtotal fixed O&M costs	**$119,690/Year**
Item	**Cost/kgal**
Power[4]	$0.03
Perchlorate Resin[5]	$0.74
Salt[6]	$0.25
Solids Disposal[7]	$0.04
Subtotal variable O&M costs	**$1.06/kgal**
Total O&M Cost (100 MG/year)	**$225,690/year ($2.26/kgal)**
Total O&M Cost (250 MG/year)	**$384,690/year ($1.53/kgal)**

[1] Labor cost is based on 10 hours per week plus 15 minutes per perchlorate sample at $70/hour.

[2] Laboratory perchlorate testing. Assumes raw, lead vessel, and finished water are sampled monthly at a cost of $47/sample.

[3] 2% of estimated construction cost.

[4] Assumes 15 psi total head loss across treatment plant

[5] Assumes 60,000 BV life and \$330/f^3 resin replacement cost.

[6] Based on Purolite PRSM output (2.83 lbs NaCl per kgal through IX vessels / 1.4 lbs NaCl per kgal produced by well with 55% bypass. Assumes $400/ton for salt.

[7] Assumes 1.4 lbs solids consisting primarily of NaCl per kgal produced by well and $50/ton disposal cost.

Resin replacement will be the largest O&M cost item. Based on the historical geochemical water quality at Well 11, Purolite predicts that breakthrough of perchlorate into the effluent of the lead vessel will occur after 60,000 bed volumes have been treated. This is equivalent to 188 million gallons treated. The cost of changing out the resin in the lead vessel, including service and disposal of the spent resin, is estimated to be $140,000.

Table 4-4: O&M Cost Opinion (Off-Site Brine Disposal)

Item	**Annual Cost**
Labor[1]	$39,000
Laboratory[2]	$1,690
Maintenance[3]	$67,000
Subtotal fixed O&M costs	**$107,690/Year**
Item	**Cost/kgal**
Power[4]	$0.03
Perchlorate Resin[5]	$0.74
Salt[6]	$0.25
Brine Disposal[7]	$1.07
Subtotal variable O&M costs	**$2.09/kgal**
Total O&M Cost (100 MG/year)	**$316,690/year ($3.17/kgal)**
Total O&M Cost (250 MG/year)	**$630,190/year ($2.52/kgal)**

[1] Labor cost is based on 10 hours per week plus 15 minutes per perchlorate sample at $70/hour.

[2] Laboratory perchlorate testing. Assumes raw, lead vessel, and finished water are sampled monthly at a cost of $47/sample.

[3] 2% of estimated construction cost.

[4] Assumes 15 psi total head loss across treatment plant

[5] Assumes 60,000 BV life and \$330/f^{3} resin replacement cost.

[6] Based on Purolite PRSM output (2.83 lbs NaCl per kgal through IX vessels / 1.4 lbs NaCl per kgal produced by well with 55% bypass. Assumes $400/ton for salt.

[7] Assumes $450 per 1,000 gallons of brine including transportation and disposal.

The payback for the additional capital costs associated with construction of on-site evaporation ponds is anticipated to be less than 10 years.

5 Recommendation

Non-treatment alternatives including consolidation, well replacement, blending, and increased reliance on surface water were considered and determined to be not feasible. There are no nearby large water systems with which consolidation can be considered. An analysis of blending Well 11 water with water produced by Wells 14 and 15 was conducted, and under the best-case blending conditions, with both Wells 14 and 15 assumed to be in service and operating at their design capacity, blending results in nitrate and perchlorate concentrations within 10% of their respective MCL values. The City's existing surface water allocation is not reliable and hence increasing reliance on surface water is not a solution to the City's problem. Among the non-treatment alternatives, constructing a new well 2.5 miles west of the City appears to be the only potentially feasible alternative. However, other water quality issues have been encountered in that area and there are numerous logistical challenges with constructing a third well outside of the city limits.

Treating Well 11 appears to be the best alternative available to the City and is the project that could be implemented in the shortest period of time. Treatment for both perchlorate and nitrate would be accomplished utilizing ion exchange treatment processes. Perchlorate would first be removed utilizing a single-use perchlorate-selective ion exchange resin. Nitrate would then be removed using a regenerable ion exchange treatment system. The most economical means of managing the waste brine from the nitrate treatment process is to discharge it to new evaporation ponds located southwest of the well on property already owned by the City.

CITY OF LINDSAY
WATER FEASIBILITY STUDY

JANUARY 2023

Prepared for:

City of Lindsay

Prepared by:

Provost & Pritchard Consulting Group
Chico, California

TABLE OF CONTENTS

APPENDIX

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AB 1668	California Assembly Bill 1668
ADD	average day demand
af	acre-feet
af/year	acre-feet per year
CIP	capital improvement project
City	City of Lindsay
cfs	cubic feet per second
County	County of Tulare
fps	feet per second
GIS	geographic information system
gpcd	gallons per capita per day
gpm	gallons per minute
gpd/na	gallons per day per net acre
IRWM	Integrated Regional Water Management
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
ROW	right-of-way
SB 1157	California Senate Bill 1157 (Hertzberg)
SB 606	California Senate Bill 606
SBx7-7	California Senate Bill x7-7 (Water Conservation Act of 2009)
SRF	State Revolving Funds
USBR	United States Bureau of Reclamation

EXECUTIVE SUMMARY

The City of Lindsay (City) has a recognized potential water supply shortage. The City initiated this Water Feasibility Study (Study) to better understand the extent of the situation, explore the alternatives, and the schedule of improvements to mitigate the shortage.

The evaluation of the City’s water system included a review of the water supplies and demands, the surface water treatment facility, the distribution system and storage systems for existing and future (through 2040) system characteristics.

Water System Demand

The historic supply and demand numbers were taken from City records and used to determine the average water use and future demand projections for the City. The 2020 water use was evaluated against a 20 percent reduction of the 10-year calculated baseline. Future demands were calculated based on three scenarios: indoor water use conservation requirements, 15% per capita demand reduction below current use, and “status quo” without any implemented water conservation beyond current measures.

Water System Supply

The City’s water is supplied from both surface and groundwater sources. Evaluation of the water supply looked at the total quantity of water available during the winter months, when surface water supplies are not available, during the summer months when surface water is usually available, as well as a ‘firm’ groundwater supply. ‘Firm’ groundwater assumes the largest producing well is unavailable to account for the potential of that well being temporarily offline for maintenance activities or due to an unanticipated well failure.

Surface Water Treatment Facility

The Surface Water Treatment Facility (SWTF) provides water to the City primarily during the summer months. The SWTF’s current operations were reviewed and deficiencies noted. Recommendations for potential short- and long-term solutions are described.

Distribution System

The water distribution system was evaluated in 2013 using a computer model to simulate operation of the system. The water model helped to identify areas with substandard operating pressures under high-flow conditions. These deficiencies are due primarily to undersized mains or too few points of interconnection. Based on this data, current recommendations for water main improvements are listed and described.

Storage System

The storage components of the water system provide redundancy, peak demand supply and fire flow for the City. Evaluation of the storage components revealed the water system has sufficient available storage volume and will not require improvement within the horizon of this study.

Recommendations

Based on the evaluations discussed above, if the City maintains its current per capita water usage rate, this study recommends the addition of three new wells (one in 2024, one in 2026, and one in 2030) in addition to the restoration of Well 11 in 2024. Significant water conservation efforts could reduce the need down to two new wells (one in 2024 and one in 2036) in addition to the restoration of Well 11 in 2024. Additionally, several capital improvement projects were identified based on information in the City's budget plan and as identified through the 2013 water model analysis. These include main line replacements and dead-end eliminations, DBP mitigation efforts, water plant upgrades, and clarifier renovations.

1 BACKGROUND

This section presents the objectives for this Study in addition to reference materials and acknowledgements to assist the reader in understanding the content presented. Abbreviations used throughout the Study are listed on Page vi.

1.1 Objectives

The primary objective of the water feasibility study is to provide a thorough review of current and projected water demand and supply, and the capacity of the existing water supply and distribution system to meet future needs.

The study includes recommendations to effectively manage the City's water supply, treatment, distribution, and demand in order to secure and maintain a sustainable system through the year 2040.

1.2 Report Organization

The feasibility study is organized into three overall sections.

Section 1 – Background This section presents the objectives and planning horizon for this Study in addition to a list of reference materials to assist the reader in understanding the content presented.

Section 2 – City of Lindsay Characteristics This section presents a description of the study area, zoning classifications, and details the historical and projected population.

Section 3 – Water System This section is divided into seven primary subsections including demand, supply, treatment system, distribution system, storage system, capital improvement projects, and other factors affecting the water system. The subsections include information on the following:

- Demand and Supply Subsections present discussions on the historic and projected demand and supply capacity and anticipated improvements needed to meet future demands;

- Treatment System Subsection evaluates the surface water treatment plant and future improvements that will be necessary to maximize the use of surface water;

- Distribution System Subsection presents results of the system's 2013 water model and evaluates the distribution system based on model outcomes;

- Storage System Subsection discusses the current and future storage requirements for the system to run optimally; and

- Capital Improvement Projects Subsection presents a list of necessary capital improvement projects based on the discussions presented in the previous subsections. This subsection also discusses prioritization of capital improvement projects and timing-based needs of the community and water system.

- Other Factors Affecting the Water System Subsection presents topics that have a current or future impact on the water system, including socio-economic factors, factors affecting the water supply, and water quality.

1.3 Reference Material

The following documents were referenced in the preparation of this feasibility study:

- City of Lindsay General Plan, 1989, Grunwald & Associates
- Supplemental Water Supply Feasibility Study, 1991, Charles Roberts Engineers
- Water and Sewer Master Plan, 1992, Metcalf & Eddy
- Water Supply and Storage Requirements Update, 1998, Carollo Engineers
- Water Supply and Storage Capacity Requirements, 2013, Akel Engineering Group, Inc.
- Water Feasibility Study, 2013, Provost & Pritchard Consulting Group
- Integrated Regional Water Management Plan, 2018, Kaweah River Basin Regional Water Management Group

2 CITY OF LINDSAY CHARACTERISTICS

This section presents a description of the Study Area, City land use and zoning classifications, and details the historical and projected population.

2.1 Study Area

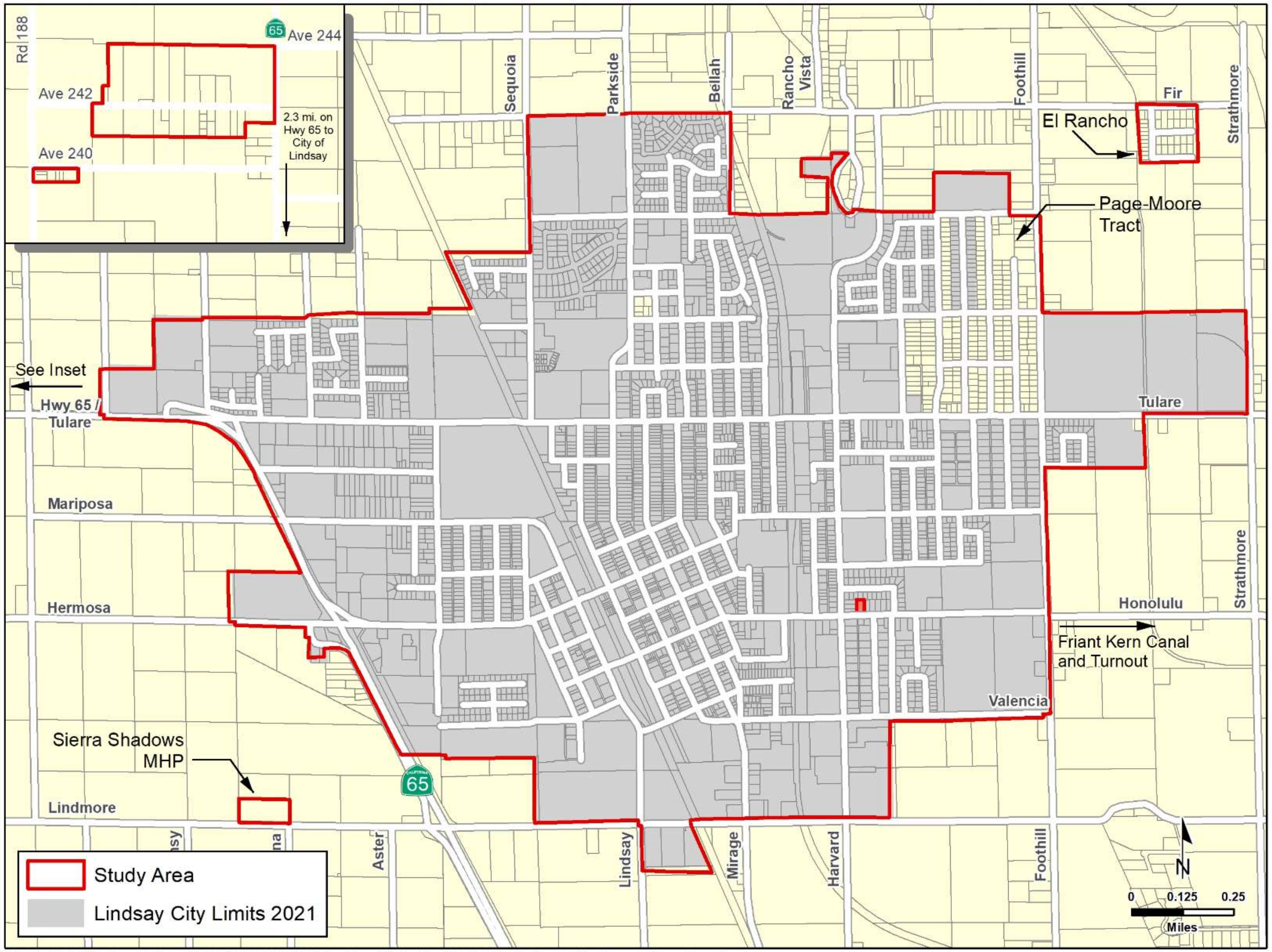
The City is located in Tulare County, near the base of the Sierra Nevada Mountains in the San Joaquin Valley. The Study Area encompasses the area within the city limits, three developments outside the City limits that receive City water service, known locally as Page-Moore Tract, the Sierra Shadows Mobile Home Park, and El Rancho, and an area west of the City near the intersection of Road 188 and Avenue 242 (“Avenue 240 and 242 Connection”). The City encompasses approximately 1,747 acres and is home to nearly 13,000 residents, with an average of 3.29[1] people per household; the service areas outside the City limits contribute over 1,300 additional residents. This additional population has been considered for this Study.

The Study Area is delineated in Figure 2-1 by the red border; the gray areas are within the City limits, while the pale yellow area is County of Tulare. The county ‘island’ in the northeast portion of the study area is the area referred to above as Page-Moore Tract. Sierra Shadows Mobile Home Park is in the southwest portion of the Study Area and is not contiguous to the City limits; it is located on the north side of West Lindmore Street near Canna Avenue, approximately 0.5 miles west of the City limits. The El Rancho area is just to the northeast of the City, south of Fir Street, but not contiguous to the City limits. The “Avenue 240 and 242 Connection” area is shown as an inset in the map due to its distance from the City of approximately 2.3 miles.

---

[1] 2020 United States Census

Figure 2-1: Study Area



1/9/2023 G:\Lindsay_City of-3257\32571201-Water Feasibility Study\GIS\Map\City_8x11_Same_Format.mxd

2.2 Land Use

The City's predominant land use is residential. There are industrial use areas along the railroad right-of-way and commercial use areas both within the downtown and near the State Route 65 alignment. Of the 1,747 acres within the Study Area, over three-quarters are developed, leaving 151 acres of undeveloped area comprised of a variety of land uses including residential, mixed use and commercial.

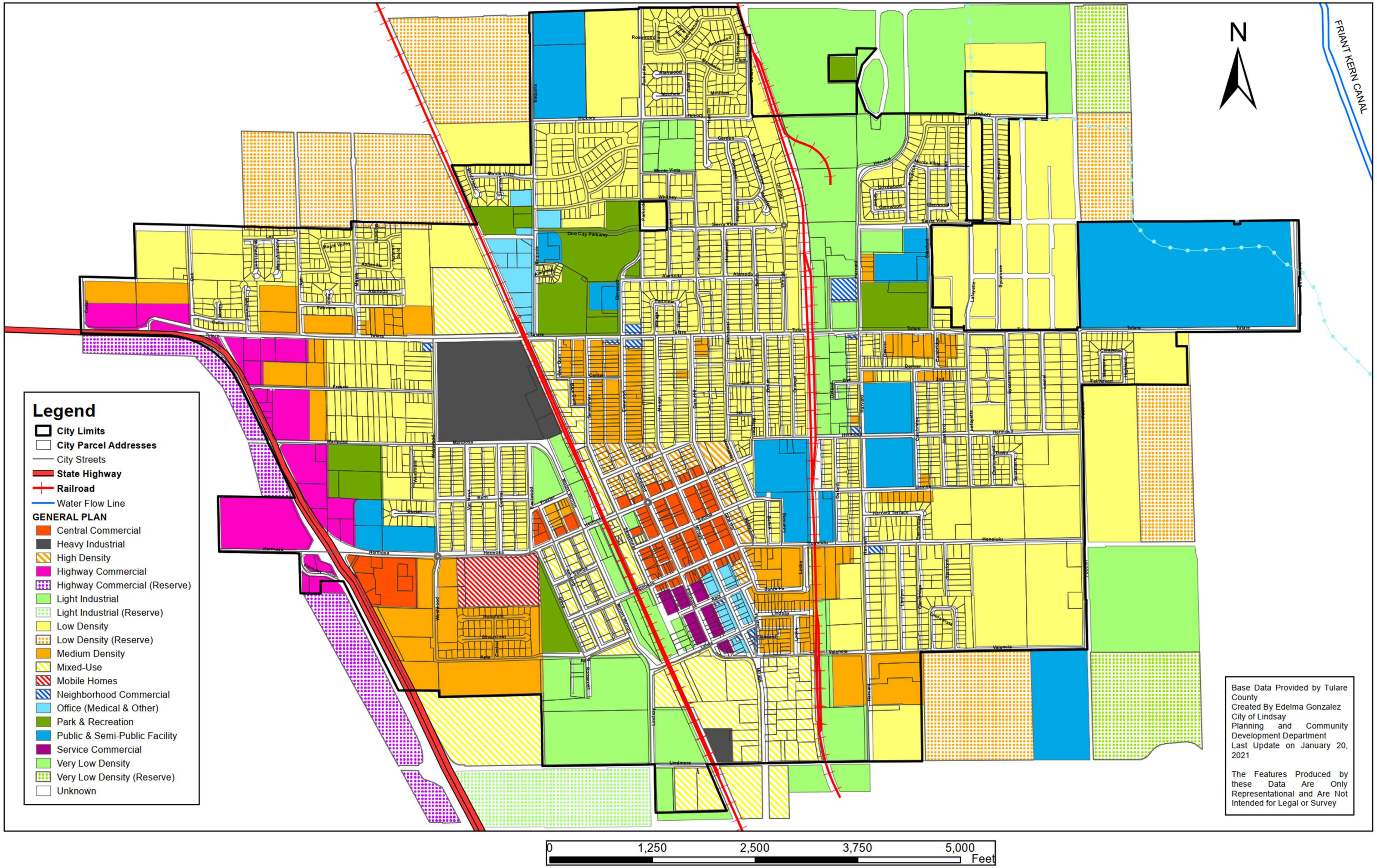
The City of Lindsay updated components of their General Plan and Land Use Maps in 2021. The updated Land Use Map is shown in Figure 2-2 and a summary of acreages by zoning designation is detailed in Table 2-1. This Study has a planning horizon of 2040.

Table 2-1: Land Use Acreages

Land Use Category	Total Developed Acres[1]	Percent of Total Acreage	Total Un-Developed Acres[1]	Percent of Total Acreage	Total Acreage
Residential					
Single Family Residential (R-1-7)	604.1	95%	29.8	5%	633.9
Multi-Family Residential (RM-3)	145.5	83%	28.9	17%	174.4
Multi-Family Residential (RM-MH8)	12.5	100%	0	0%	12.5
Non-Residential					
Central Commercial (CC)	28.6	89%	3.6	11%	32.2
Highway Commercial (CH)	48.7	74%	17.3	26%	66
Neighborhood Commercial (CN)	3.1	53%	2.7	47%	5.8
Service Commercial (CS)	8.5	85%	1.5	15%	10
Professional Offices (PO)	43.4	95%	2.2	5%	45.6
Office/High Density (RM-1.5)	15	96%	0.7	4%	15.7
Mixed Use	93.3	90%	10.8	10%	104.1
Heavy Industry (IH)	42.8	95%	2.1	5%	44.9
Light Industry (LI)	129.5	89%	16.7	11%	146.2
Resource, Conservation & Open Space (RCO)	203.5	96%	9.1	4%	212.6
Railroad	0	0%	20.3	100%	20.3
Unknown	0	0%	5.7	100%	5.7
Right-of-Way	217.2	100%	0	0%	217.2
Totals	**1595.7**	**77%**	**151.4**	**23%**	**1747.1**

[1] Data Provided by the City based on Zoning, Land Use, and Parcel Data (10/7/2022).

Figure 2-2: City of Lindsay General Plan Map



Base Data Provided by Tulare County
Created By Edelma Gonzalez
City of Lindsay
Planning and Community Development Department
Last Update on January 20, 2021

The Features Produced by these Data Are Only Representational and Are Not Intended for Legal or Survey

2.3 Historical and Projected Population

The City of Lindsay has a small but growing population. From 1975 through 1995, the population averaged a growth rate of approximately 2.5%; however, the growth rate began decreasing in 1995 and was only 0.8% from 2010 to 2020. Due to this slowing of growth, a future annual City population growth projection of 0.8% through 2040, and 1% after 2040 were used for this Study. Table 2-2 presents the historical population and future population assumptions. The data presented in Table 2-2 is used to estimate water usage later in the Study. The service population for the City's water system includes the City of Lindsay population as well as the populations of the Page-Moore Tract, Avenue 240 & 242 connections, and Sierra Shadow Mobile Home Park through 2015; after its addition in 2015, the El Rancho connections were also included.

Table 2-2: Population – Historical and Projected

Year	Service Population[1]
1975	7,036[2]
1980	8,106[2]
1985	8,876[2]
1990	9,504[3]
1995	10,484[4]
2000	11,463[3]
2005	12,106[5]
2010	12,934[3]
2015	13,380[4]
2020	14,024[3]
2025	14,539[6]
2030	15,074[6]
2035	15,631[6]
2040	16,211[6]
2045	16,969[6]
2050	17,765[6]
2055	18,601[6]
2060	19,480[6]

[1] Service Population includes City of Lindsay population, Page-Moore Tract, Ave 240 & 242 connections and Sierra Shadow Mobile Home Park through 2015 and includes El Rancho after 2015
[2] City population from 1989 General Plan
[3] City population from Census Data
[4] City population Interpolated
[5] City population from California Dept of Finance E-4 & E-5 Estimates
[6] Projection using 0.8% annual growth through 2040, and 1% after

3 WATER SYSTEM

This section is divided into seven primary subsections including demand, supply, treatment system, distribution system, storage system, capital improvement projects, and other factors affecting the water system. The subsections present information concerning the historic and projected water system demands and supply characteristics, an evaluation of the water treatment system, discussion of the 2013 water system model results and capital improvement projects needed to sustain the City's water supply efficiently and reliably.

3.1 Water System Demand

The following presents a progressive analysis of how the City has historically used water and, based on that history, project demands into the future. Actual historical water usage data was collected from the City and distributed using two data sets: land use and population. Compliance with Senate Bill x7-7 (SBx7-7) was evaluated. Finally, the distribution of water use was conducted to provide a relativity analysis and help provide an approximation of future demand. The objective is to provide the City with two valid trends to evaluate and track current and future water usage.

3.1.1 Historical Demand

Historical water demand was calculated in two ways. The first method used actual water production statistics and made use of the population for each year from 2001 through 2021 on a per-person (or per capita) basis. Annual water production records were obtained from the City for years 2013-2016. Monthly water production records were obtained from the City for years 2017-2021. The historical water demand and average demand per capita for 2012-2021 are detailed in Table 3-1.

The second method used to document historical water demand was Land Use, which calculated water unit factors based on existing developed land using net acreages. For the year 2021 the total water demand was distributed across the developed residential, non-residential, and non-metered acreages within the City's water service area. As shown in Table 3-2, the recommended existing unit factors for residential areas are 1,600[2] gallons per day per net acre (gpd/na), 2,000[2] gpd/na for non-residential areas, and 1,400[2] for non-metered areas.

While the first method may be used to estimate future water demand based on population, the second method, calculated water unit factors, could prove useful if the City grows through land acquisition.

---

[2] Values rounded in Table 3-2.

Table 3-1: Historical Water Use and Daily Demand

Year	Annual Water Production		Population	
	Total Annual (MGY) [3]	Daily Average (MGD)	System Population[1,2]	Per Capita Consumption (gpcd)
2012	901	2.47	13,112	188
2013	941	2.58	13,202	195
2014	818	2.24	13,291	169
2015	730	2.00	13,380	150
2016	793	2.17	13,667	159
2017	806	2.21	13,756	160
2018	804	2.20	13,846	159
2019	791	2.17	13,935	156
2020	731	2.00	14,024	143
2021	807	2.21	14,127	156

Notes:

[1] United States Census data in Census Year (2020) & Interpolated in other years

[2] Service Population includes City of Lindsay, Page-Moore Tract and Sierra Shadows Mobile Home Park, as the City provides water to these areas outside the city limits

[3] Million Gallons per Year

Table 3-2: Existing Demands and Unit Demand Factors

Land Use Classification	Existing Net Acreage (na)	Existing Production (gpd)[1]	Unadjusted Unit Factor (gpd/na)	Vacancy Rate (%)	Adjusted Unit Factor (gpd/na)	Recommended Unit Factor (gpd/na)	Balance Using Recommended Unit Factors (gpd)
Residential	762	1,170,234	1,540	3.2%[2]	1,590	1,600	1,220,000
Non-Residential	404	746,386	1,850	7.5%[1]	1,990	2,000	810,000
Non-Demand Generating[3]	217.2						
Non-Metered Demand[4]	212	293,407	1,380		1,380	1,400	300,000
Totals	**1,595.2**	**2,210,027**					**2,330,000**

Notes:

[1] Data provided by City staff

[2] E-5 Population Estimates for 2021

[3] Non-demand generating land use refers to the total right-of-way (roads) acreage.

[4] Non-metered demand is calculated as recorded production minus consumption (i.e. includes losses). See Section 3.1.3 for more detail.

3.1.2 SBx7-7 Baselines, Targets, and Compliance

The Water Conservation Act of 2009 (SBx7-7) required that all water suppliers increase their water use efficiency by 20% by the year 2020. The baseline water use efficiency for the City was set in its 2013 Water Feasibility Study as 199 gpcd. This value, reproduced in Table 3-3, was calculated using 10 years (2001-2010) of historical demand per capita data in accordance with the guidelines set in SBx7-7. The 2020 water use target was 160 gpcd, calculated as a 20% reduction from this baseline.

The City's 2020 actual water use was compared to the baseline and the 2020 target to evaluate compliance with SBx7-7. As demonstrated in Table 3-3, both the 5-year (2016-2020) average and the actual 2020 per capita consumption were compliant with the SBx7-7 requirements.

Table 3-3: Water Conservation Baselines & Targets Summary

Baseline Period	Baseline Years	Baseline (gpcd)	Calculated 2020 SBx7-7 Target (gpcd)	5-Year Average Per Capita Consumption (gpcd)[1]	Actual 2020 Per Capita Consumption (gpcd)
10-Year Base Daily Per Capita Water Use	2001-2010	199	160	155	143
[1] Calculated as the average of 5 years leading up to and including the compliance date: 2016-2020					

3.1.3 Current Demand

The City meters its residential, multi-family, commercial, institutional, industrial, and church customers and as it recently became an urban water user, has plans to meter all of its deliveries. Metered customers accounted for greater than 95% of service connections as of May 2022. Currently non-metered customers include government-owned facilities, city-owned facilities, landscaping areas, and the SWTP backwash, where less than 1 acre-foot (af) is required to backwash the SWTP approximately once every 7 days. Non-metered demand is calculated here as recorded production minus consumption (i.e. includes losses). Water use types are shown in Table 3-4 along with 2021 volumes.

Current conservation efforts abide by the City's Water Conservation Plan. The City is currently limiting water according to Phase IV – Drought Response Alert.

Table 3-4: Current Demand by Use Type

Use Type Consumption	Volume (MG)
Residential + Multi-Family	427
Landscape Districts + Commercial + Institutional + Churches	162
Industrial	110
Un-metered + Losses	107
Total	**806**

3.1.4 Projected Demand

Three scenarios have been evaluated to identify the most reasonable and prudent range of Projected Demands for the City. The first scenario was developed using California Assembly Bill 1668 (AB 1668) and California Senate Bill 606 (SB 606) indoor water use reduction requirements. The second scenario calculated the 15% water reduction called for by the Governor of California. The third scenario was derived by extending the current water use patterns into the future. While the horizon of this study only extends to 2040, projected demand is extended through 2060.

3.1.4.1 Water Use Targets

It is unrealistic to predict with a single scenario how the City will grow and use water resources. By extending the three scenarios described above into the future, the demand for water resources and infrastructure will have a higher probability of falling within the bounds established by these scenarios. As time passes, this range will provide the City with flexibility to make adjustments to their operations and infrastructure. The development of the demand projections for these scenarios is discussed below. Finally, the selected scenario is later shown jointly with water supply and maximum day demand in Figure 3-1.

Scenario No. 1 – Required Conservation Water Use Target (119 gpcd)

Recent water conservation legislation (AB 1668, SB 606) required decreases in indoor residential water use to 55 gpcd by January 2025 and 50 gpcd by January 2030. The Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB) submitted a report to the legislature recommending that urban water suppliers achieve further water savings. In September 2022, the Governor signed this recommendation into law through California Senate Bill 1157 (SB 1157) (Hertzberg), requiring further reduction of indoor residential per capita consumption to 47 gpcd by January 2025 and 42 gpcd by January 2030.

To calculate this, projected water use was divided into the four consumption categories shown in Table 3-5. Future water consumption for these categories was projected based on the following: population growth, 5-year average per capita consumption, and projected residential demand. Population growth and 5-year average per capita consumption are shown in Tables 2-2 and 3-3, respectively. For projected residential demand, a 50:50 (outdoor: indoor) ratio[3] was used to determine the proportion of the residential demand subject to the legislation requirements for indoor consumption. The results of these calculations are shown in Table 3-5. For 2030 onward, the per capita water use in this scenario is 119 gpcd. The 2040 ADD would be 1.93 MGD in this scenario.

---

[3] According to the Department of Water Resources (DWR), outdoor water use accounts for 50 percent of urban resident water use on average.

Table 3-5: Projected Demand by Use Type

Use Type Consumption	2025 Water Use (MG)	2030 Water Use (MG)	2035 Water Use (MG)	2040 Water Use (MG)
Residential + Multi-Family	264	245	254	263
Landscape Districts + Commercial + Institutional + Churches	170	176	182	189
Industrial	115	120	124	129
Un-metered + Losses	112	116	120	125
Total Water Use (MG)	**661**	**656**	**681**	**706**

Scenario No. 2 – 15% Conservation Water Use Target (136 gpcd)

In 2021, the Governor of California requested voluntary reductions of 15% across the State. This 15% per capita water use conservation target was selected as the second scenario for comparison. This percentage would require the City to continue its conservation efforts and is also achievable for the City to reach. This scenario yields a 2030 onward annual per capita consumption of 136 gpcd. This water usage scenario is shown in Table 3-6. By sustaining this usage rate, the City's 2040 ADD would be 2.20 MGD.

Scenario No. 3 – "Status Quo" Per Capita Demand Without Conservation (155 gpcd)

The City already fully meters water services for non-government owned properties and employs many conservation methods, leading to a comparatively low[4] 5-year per capita consumption of 155 gpcd. A fully metered system has an innate conservation component by illustrating to customers through their monthly bills, their individual water usage and how water and money can be saved by employing conservation techniques. A "status quo" water use scenario of 155 gpcd (based on 5-year average 2016-2020 demands) has been selected as a third water use target and alternative. The 2040 ADD for the City under this scenario would be 2.51 MGD.

Selected Scenario

Scenario No. 3 was selected as the target for infrastructure planning purposes. This scenario is appropriately conservative, based on existing usage characteristics. The water supply infrastructure and capital plan described in Sections 3.2 and 3.6 are based on the "status quo" per capita water use of 155 gpcd.

---

[4] Data from the State Water Resources Control Board indicate the average per capita use for the Tulare Lake region was 199, 207, and 207 gpcd for the years 2019, 2020, and 2021, respectively; this yields an average of 205 gpcd for that time period.

Table 3-6: Projected Water Demand - Water Use Target Methods

Year	Projected Population	Scenario No. 1: Required Conservation (119 gpcd)		Scenario No. 2: 15% Conservation (136 gpcd)		Scenario No. 3: "Status Quo" (155 gpcd)	
		Per Capita Demand (gpcd)	ADD (MGD)	Per Capita Demand (gpcd)	ADD (MGD)	Per Capita Demand (gpcd)	ADD (MGD)
2022	14,230	155	2.21	155	2.21	155	2.21
2023	14,333	145	2.08	153	2.19	155	2.22
2024	14,436	135	1.94	150	2.17	155	2.24
2025	14,539	125	1.81	148	2.15	155	2.25
2026	14,646	124	1.81	145	2.13	155	2.27
2027	14,753	122	1.81	143	2.11	155	2.29
2028	14,860	121	1.80	140	2.09	155	2.30
2029	14,967	120	1.80	138	2.07	155	2.32
2030	15,074	119	1.80	136	2.04	155	2.34
2031	15,185	119	1.81	136	2.06	155	2.35
2032	15,297	119	1.82	136	2.07	155	2.37
2033	15,408	119	1.84	136	2.09	155	2.39
2034	15,520	119	1.85	136	2.10	155	2.41
2035	15,631	119	1.86	136	2.12	155	2.42
2036	15,747	119	1.88	136	2.14	155	2.44
2037	15,863	119	1.89	136	2.15	155	2.46
2038	15,979	119	1.91	136	2.17	155	2.48
2039	16,095	119	1.92	136	2.18	155	2.49
2040	16,211	119	1.93	136	2.20	155	2.51
2041	16,360	119	1.95	136	2.22	155	2.54
2042	16,510	119	1.97	136	2.24	155	2.56
2043	16,661	119	1.99	136	2.26	155	2.58
2044	16,814	119	2.01	136	2.28	155	2.61
2045	16,969	119	2.02	136	2.30	155	2.63
2046	17,125	119	2.04	136	2.32	155	2.65
2047	17,282	119	2.06	136	2.34	155	2.68
2048	17,441	119	2.08	136	2.36	155	2.70
2049	17,602	119	2.10	136	2.39	155	2.73
2050	17,765	119	2.12	136	2.41	155	2.75
2051	17,929	119	2.14	136	2.43	155	2.78
2052	18,094	119	2.16	136	2.45	155	2.80
2053	18,261	119	2.18	136	2.48	155	2.83
2054	18,430	119	2.20	136	2.50	155	2.86
2055	18,601	119	2.22	136	2.52	155	2.88
2056	18,774	119	2.24	136	2.55	155	2.91
2057	18,948	119	2.26	136	2.57	155	2.94
2058	19,123	119	2.28	136	2.59	155	2.96
2059	19,301	119	2.30	136	2.62	155	2.99
2060	19,480	119	2.32	136	2.64	155	3.02

3.2 Water System Supply

3.2.1 Current Supply Capacity

This Study analyzed the adequacy of current water supplies to meet present and future demands. The City employs two types of water supplies: groundwater and surface water. The reliability of each is affected by a variety of outside factors.

The City relies heavily on surface water, which is affected by climate factors, canal maintenance periods, and high demand periods during the summer. Also, the relatively fixed flow rate of surface water limits its usefulness in dealing with the variability between winter and summer demands, straining the system's supply capacity and its ability to meet the demands, especially during times when the surface water supply is completely unavailable. The demand discussion above focused on ADD; however, the City must be able to meet consecutive Maximum Day Demands (MDD) during the summer months. Also, a critical time for the City is created by the maintenance cycle of the Friant Kern Canal, which is taken out of operation for two to four months in the fall of every third year, making surface water completely unavailable for that time. Because of these supply irregularities, summer and winter months are evaluated separately. Surface water supply records from 2013-2021 suggested that April through October should be considered summer months while November through March should be considered winter months.

Naturally, the demand in the summer months is substantially higher than the winter months. Fortunately, this higher summer demand occurs when the available water supply consists of both surface and groundwater. The winter supply is limited to the capacity of the groundwater wells for the time when the Friant Kern Canal is offline for maintenance. The City's water supply capacity is detailed in Table 3-7. Table 3-7 also shows operational capacity compared to rated capacity. Each of the active wells have operational capacity listed when only one well is pumped at a time. In addition, because of the interaction between Wells 14 and 15, when both wells are being pumped, their operational capacities are further decreased.

The City's supply capacity is calculated both as Total Capacity and Firm Capacity. Total Capacity is the simple addition of all water supply sources available during the winter or summer months. Firm Capacity is equal to the total capacity minus the capacity of the largest source available during the summer or winter months. The Firm Capacity is considered the readily available supply used to meet MDD. Due to maintenance activities, emergency situations, and/or water quality problems the Firm Capacity is used to evaluate supply adequacy.

The current Firm Capacity for the summer months is 3.67 MGD, while it is only 1.08 MGD for the winter months.

Table 3-7: Water Supply Capacity

Supply Source	Status[2]	Rated Capacity[1]		Water Supply Capacity: Single Groundwater Well Operational Capacity		Water Supply Capacity: Multiple Groundwater Wells Operational Capacity		Water Supply Capacity: Surface Water Treatment Capacity	Water Supply Capacity: Emergency Supply[3]
		(gpm)	(MGD)	(gpm)	(MGD)	(gpm)	(MGD)	(MGD)	(MGD)
Well 2	Abandoned	600	0.86	-	-	-		-	-
Well 4	Abandoned	800	1.15	-	-	-		-	-
Well 6	Abandoned	800	1.15	-	-	-		-	-
Well 11	Inactive	1,000	1.44	-	-	-		-	-
Well 13	Landscape Irrigation Only	1,100	1.58	-	-	-		-	-
Well 14	Active	750	1.08	750	1.08	520	0.75	-	0.75
Well 15	Active	1,200	1.73	900	1.30	800	1.15	-	1.15
Water Treatment Plant	Active	1,800	2.59	-	-	-		2.59	-
	Totals				**2.38**		**1.90**	**2.59**	**1.90**

Available Supply									
		Summer Supply			**Winter Supply**				
		(gpm)	**(MGD)**		**(gpm)**	**(MGD)**			
Firm Capacity[6]		2,550	3.67		750	1.08			
Total Capacity		3,120	4.49		1,320	1.90			

[1] *Water Supply and Storage Requirements Update, June 1998, Carollo Engineers.*
[2] *Wells 2, 4, and 6 have been abandoned due to water quality issues; Well 13 is utilized for landscape irrigation purposes only.*
[3] *Total emergency supply excludes the SWTP.*
[4] *The SWTP production ranges from 1,600 to 1,800 but for purposes of identifying total capacity, 1,800 has been utilized.*
[5] *Winter Months Supply excludes the SWTP.*
[6] *Firm Capacity excludes the largest production well. Therefore, the Working Capacity Single Well Operation supply capacity is used.*
[7] *Total Capacity includes the largest production well. Therefore, the total capacity is calculated based on multiple well operational capacity.*

3.2.2 Projected Supply Capacity

For comparison, the projected supply capacity was evaluated on the demand assumptions described in Scenario No. 1 Required Conservation Water Use Target (119 gpcd) and Scenario No. 3 “Status Quo” Water Use (155 gpcd) water demands. The California Water Works Standards require that public water systems have the capacity at all times to meet the system’s MDD. For the reasons discussed in Section 3.2.1, peaking factors for MDD were calculated separately for summer and winter. The ADD for each of these periods was adjusted based on the peaking factors for MDD. The MDD from 2013- 2021 occurred in August 2013 for the summer period and in December 2013 for the winter period. The calculation protocol set forth in the California Water Works Standards was followed, and monthly data made available by the California Division of Drinking Water were used. For this Study, these peaking factors were calculated as 2.3 for summer Maximum Day and 2.1 for winter Maximum Day.

These calculations reveal an immediate supply deficit which must be addressed, as demonstrated in Table 3-8. Table 3-8 also tracks the supply deficit to determine at which point, for each water demand scenario, an additional water supply is needed. As shown in Table 3-8, the aggressive indoor water conservation efforts of Scenario No. 1 would require an immediate need for a 2,000 gpm (2.88 MGD) water supply. This could potentially be met with the immediate addition of two wells to the City’s water supply. The City is currently restoring Well 11, which will provide an additional 1,000 gpm (1.44 MGD) water source upon completion. To address the immediate need, another 1,000 gpm (1.44 MGD) well is also needed in 2024. With population growth, it is estimated that a third well (750 gpm or 1.08 MGD) would be needed in 2036. Alternatively, if the status quo per capita water use is maintained, Table 3-8 reveals an immediate need for three wells totaling 2,750 (3.96 MGD): Well 11, a 1,000 gpm (1.44 MGD) well, and a 750 gpm (1.08 MGD) well; these well additions are discussed further in Sections 3.6.2 and 3.6.3. Under Scenario No. 3. A fourth well of at least 750 gpm (1.08 MGD) capacity would be required in 2034.

Additional calculations were performed to model a reduced allocation in the surface water supply during the summer months, which has been experienced over the last several years. Since 2012 the City has only received 100% allocation in three (3) years, with the range varying between 0% (2014, 2015) and 100% (2016, 2017, 2019). Note that both scenarios in Table 3-8 reflect this 40% allocation during summer months. Further discussion of this reduced allocation can be found in Section 3.7.2.

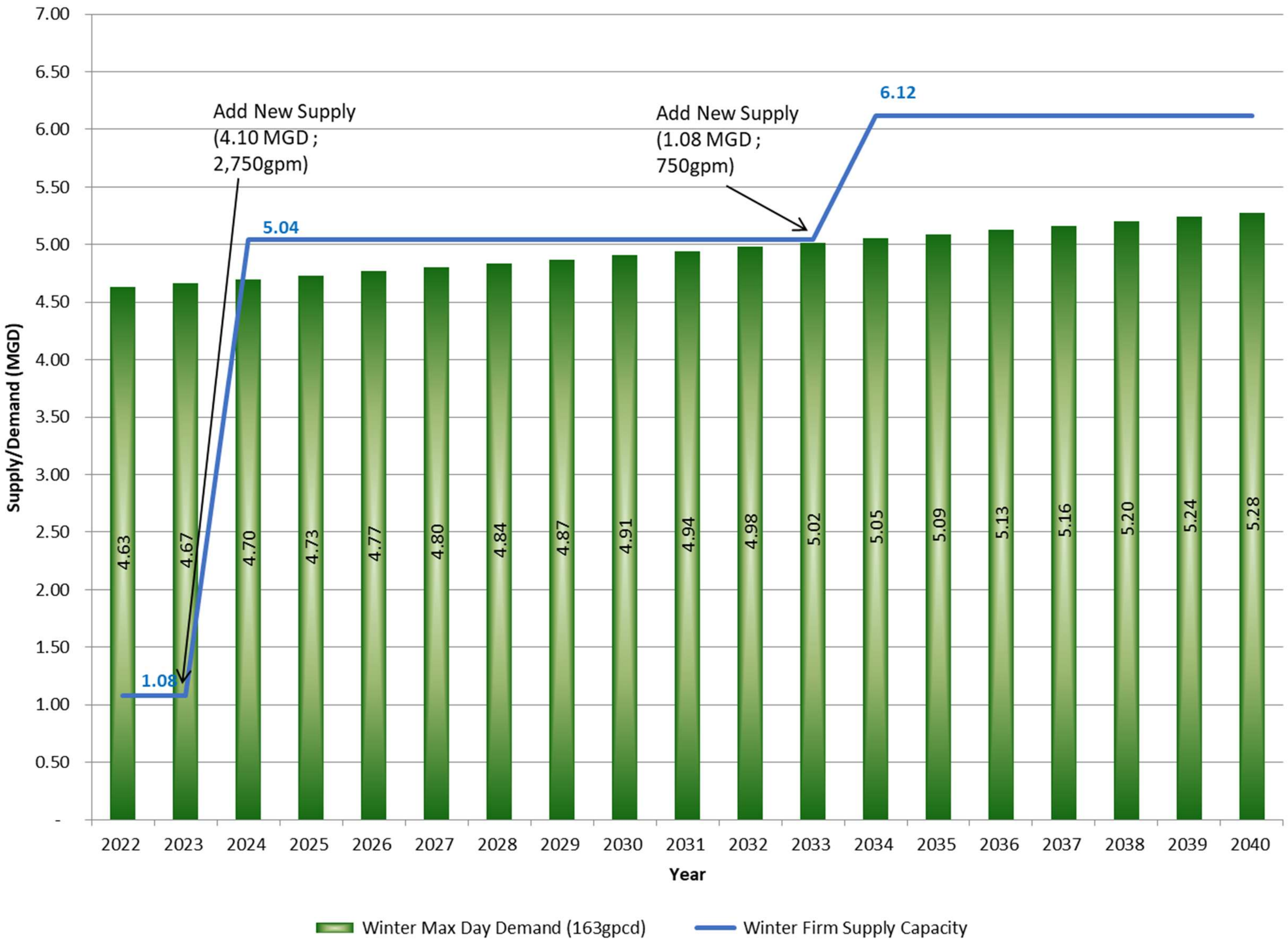
Calculation of the available supply using a reduced allocation of 40% still showed that the winter months, when no surface water is available, are the critical time for water supply and will control the need for additional water supply sources. Figure 3-1 illustrates the controlling scenario for MDD and how the deficit is corrected through addition of groundwater wells to the water supply. This figure corresponds to winter Scenario No. 3 in Table 3-8.

Table 3-8: Projected Demand and Supply Capacity

		Scenario No. 1: Required Water Conservation Target (119 gpcd)								Scenario No. 3: Voluntary Water Conservation Target (155 gpcd)							
Year	Population	Average Daily Per Capita Water Use	Average Daily Demand	Maximum Day Demand		Maximum Day Supply Deficiency		Total Winter Water Supply	New Supply	Average Daily Per Capita Water Use	Average Daily Demand	Maximum Day Demand		Maximum Day Supply Deficiency		Total Winter Water Supply	New Supply
				Summer	Winter	Summer	Winter					Summer	Winter	Summer	Winter		
		gpcd	MGD	MGD	MGD	MGD	MGD	MGD	gpm	gpcd	MGD	MGD	MGD	MGD	MGD	MGD	gpm
2022	14,230	155	2.21	5.07	4.63	-2.96	-3.55	1.08		155	2.21	5.07	4.63	-2.96	-3.55	1.08	
2023	14,333	145	2.08	4.78	4.36	-2.66	-3.28	1.08		155	2.22	5.11	4.67	-2.99	-3.59	1.08	
2024	14,436	135	1.94	4.47	4.08	-	-0.12	3.96	2,000	155	2.24	5.15	4.70	-	-	5.04	2,750
2025	14,539	125	1.81	4.17	3.80	-	-	3.96		155	2.25	5.18	4.73	-	-	5.04	
2026	14,646	124	1.81	4.16	3.80	-	-	3.96		155	2.27	5.22	4.77	-	-	5.04	
2027	14,753	122	1.81	4.16	3.79	-	-	3.96		155	2.29	5.26	4.80	-	-	5.04	
2028	14,860	121	1.80	4.15	3.79	-	-	3.96		155	2.30	5.30	4.84	-	-	5.04	
2029	14,967	120	1.80	4.14	3.78	-	-	3.96		155	2.32	5.34	4.87	-	-	5.04	
2030	15,074	119	1.80	4.14	3.78	-	-	3.96		155	2.34	5.37	4.91	-	-	5.04	
2031	15,185	119	1.81	4.17	3.80	-	-	3.96		155	2.35	5.41	4.94	-	-	5.04	
2032	15,297	119	1.82	4.20	3.83	-	-	3.96		155	2.37	5.45	4.98	-	-	5.04	
2033	15,408	119	1.84	4.23	3.86	-	-	3.96		155	2.39	5.49	5.02	-	-	5.04	
2034	15,520	119	1.85	4.26	3.89	-	-	3.96		155	2.41	5.53	5.05	-	-	6.12	750
2035	15,631	119	1.86	4.29	3.92	-	-	3.96		155	2.42	5.57	5.09	-	-	6.12	
2036	15,747	119	1.88	4.32	3.94	-	-	5.04	750	155	2.44	5.61	5.13	-	-	6.12	
2037	15,863	119	1.89	4.35	3.97	-	-	5.04		155	2.46	5.66	5.16	-	-	6.12	
2038	15,979	119	1.91	4.38	4.00	-	-	5.04		155	2.48	5.70	5.20	-	-	6.12	
2039	16,095	119	1.92	4.42	4.03	-	-	5.04		155	2.49	5.74	5.24	-	-	6.12	
2040	16,211	119	1.93	4.45	4.06	-	-	5.04		155	2.51	5.78	5.28	-	-	6.12	

[1] The 2,750 gpm (3.96 MGD) additional supply is from Well 11 (1,000 gpm) and from two supplementary new wells (1,000 gpm & 750 gpm)

Figure 3-1: Winter Maximum Day Demand and Supply

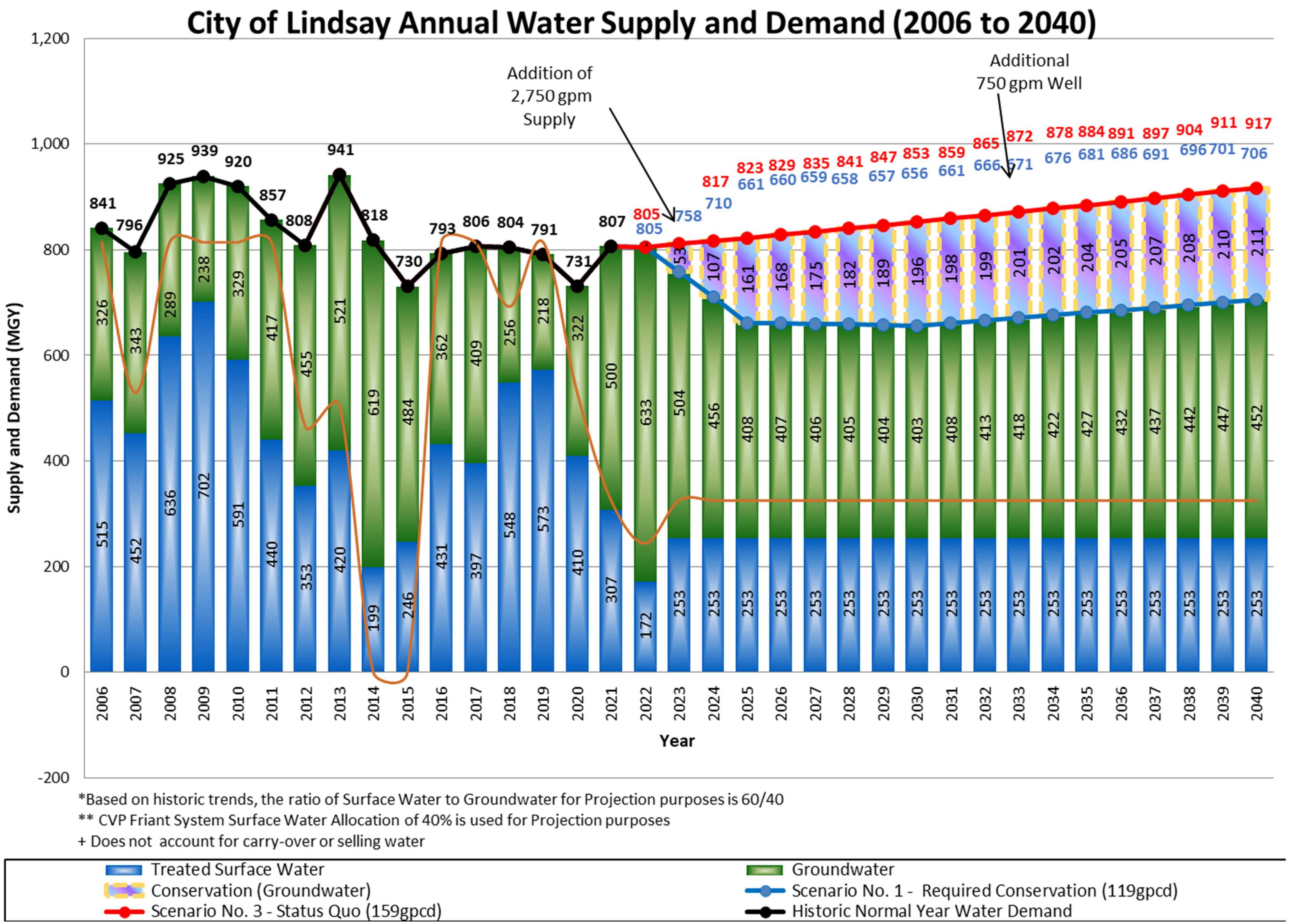


Projected demands and associated additional supply needs are both shown in Figure 3-2. The black, blue and red lines show the historical demand, Scenario No. 1 projected demand, and Scenario No. 3 projected demand, respectively. The envelope that opens between the two scenarios represents the area where the City's actual demand will likely fall; it allows the reader to see the range and potential effect of additional conservation measures.

The blue bars represent the historical and projected treated surface water, based upon available water. As noted in Figure 3-2, based on historic trends, the ratio of Surface Water to Groundwater for projection purposes is 60/40. The green bars represent pumped groundwater required under both scenarios. Because there is no additional supply of surface water identified, it is assumed the differential between the two demand scenarios would be supplied using groundwater.

It must be noted that the orange curve is a reconstruction of historical events, i.e., the rainfall and subsequent CVP Class 1 water allocations from 2006 to 2022. While in the future the City will surely see variations in the magnitude of CVP allocations, an allocation of 40% is projected here. Moreover, the order and duration of full and partial allocation will be dependent on actual hydrological occurrences and will not be exactly what is illustrated here. The final information presented in the figure are the supply improvement projects that are already planned by the City or are being proposed as a result of this Study (see Section 3.6)

Figure 3-2: Historic and Projected Supply and Demand



*Based on historic trends, the ratio of Surface Water to Groundwater for Projection purposes is 60/40

** CVP Friant System Surface Water Allocation of 40% is used for Projection purposes

+ Does not account for carry-over or selling water

3.3 Water Treatment System

The City retains surface water supply and conveyance contracts with the United States Bureau of Reclamation (USBR), Friant Water Users Authority and potentially has access to 2,500 acre-feet per year, depending on annual water supply allocations established by USBR. Upon delivery of the surface water, the City treats and distributes potable water throughout the community, in addition to the groundwater supply. During the peak demand periods in the summer, when the surface water supply is available, the City's supply is primarily surface water, with groundwater augmenting the supply as necessary depending on the annual water supply allocations in effect each year. Surface water deliveries are halted while the Friant Kern Canal is taken off-line for general maintenance and dewatering, typically during every third year from November through as late as February; the supply scenario switches during this period and the City is entirely dependent on groundwater.

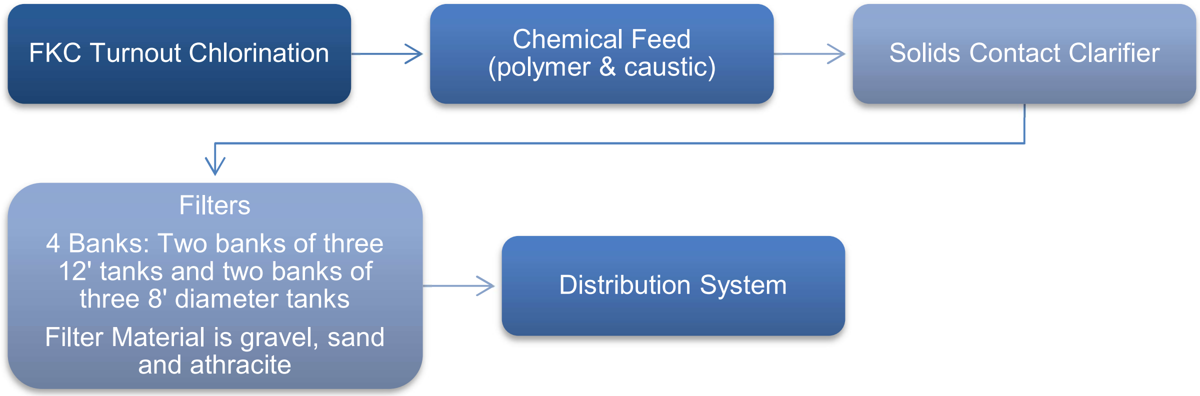
3.3.1 Surface Water Treatment System Evaluation

3.3.1.1 Current Operations

The surface water enters the City's infrastructure through a turnout at the Friant-Kern Canal, located approximately 1.3 miles east of the city limits, and travels through dual 12-inch pipes to the SWTP. At the turnout, chlorine is added in sufficient quantity to maintain a residual through the treatment process and into the distribution system. The SWTP treatment process is shown in Figure 3-3.

The SWTP is capable of handling flows between 1,600 and 1,800 gpm. The filters are backwashed approximately every seven days, based on source water turbidity levels that vary throughout the delivery year. The backwash is accomplished by backwashing one bank of filters at a time for 42 or 35 minutes per bank at 1,700 gpm or 750 gpm, for the 12' diameter and 8' diameter filters, respectively. Approximately 50 to 65 acre-feet of water is annually for backwash purposes. Backwash water is discharged via piped storm drain line to the City's stormwater basins.

Figure 3-3: SWTP Process



3.3.1.2 Current Deficiencies

The SWTP is operating with several deficiencies currently including decreased output during peak flows due to backwashing, ineffective floc formation, loss of backwash water, and elevated DBP levels at the storage tank.

- During peak flows, filter run times are reduced to a point where the filters are constantly backwashing, which decreases the output of the plant. It appears that, during peak flows, coagulation polymer is short-circuiting through the clarifier and carrying over to the filters, contributing to clogging and therefore shortening time between backwashes.
- No rapid mixing occurs following addition of the coagulant. This injection happens approximately 15 feet before the clarifier. This setup may not allow for optimal or even effective floc formation.
- The backwash wastewater is lost to the storm water basin and is not available for reuse. Surface water treatment plants can be designed and permitted to recycle backwash water in quantities up to 10% of the incoming plant flow.
- Levels of disinfection byproducts (DBPs) are elevated above the MCL at multiple sampling locations throughout the City starting in 2016. The City is conducting quarterly sampling and notifying the public until the DBP levels drop below the MCL. The City might also consider disinfection after filtration. The City identified funding in their Capital Improvement Plan (CIP) matrix to construct identified mitigation measures.

3.3.2 Short- and Long-Term Improvements

The four issues listed above can be partially mitigated or solved temporarily through several short-term options while permanent solutions may require longer-term planning and fund sourcing. The following noted observations were key in determining possible solutions.

- An analysis of the filter loading rates indicates that at 1,600 gpm, the filters are being loaded at 1.63 gpm/SF of filter area. This is well below the typical design rate of 3.0 gpm/SF. The carryover of solids from the solids contact clarifier appears to be leading to lower loading rates.
- When feeding a coagulant into the flow upstream of the clarifier, rapid mix is critical for effective floc formation. Flocculation is typically done in a separate chamber or baffled zone with the clarifier unit and that allows for at least 30 minutes of flocculation.
- The backwashing rates, times and volume of water appear to be normal for the diameter of the pressure filters.

Short Term Solutions

- If the City's solids contact clarifier can be retrofitted or upgraded, modify the solids contact clarifier by installing a rapid mix device such as a static mixer and installing a flocculation zone.
- If the City's solids contact clarifier can be retrofitted or upgraded, modify the solids contact clarifier by installing some sections of plate or tube settlers to allow for longer contact time in the clarifier.
- The recommended addition of a static mixer upstream of the clarifier should aid in organics removal, decreasing DBPs. Another potential option would be to replace two inches of anthracite in the pressure filters with two inches of granular activated carbon.

Long Term Solutions

- Add Additional Pressure Filters: In order to meet peak demand, more pressure filters could be added. However, there is very limited space available at the current water treatment plant site. Any additional filters would need to be placed at a different location.
- Relocate the point of chlorination from the canal turnout to the treatment plant. Preliminary design work has already been completed for a sodium hypochlorite feed system at the treatment plant, but final design and construction are not currently funded.
- Reuse the Backwash Wastewater: A new pond would need to be constructed to collect the backwash wastewater. The settled wastewater could then be returned to the head of the water treatment plant and mixed with the incoming raw water. A conceptual design has been prepared and is included in Appendix B.

3.4 Water Distribution System

The City's existing water distribution system is comprised of steel, asbestos-cement (AC) and polyvinyl-chloride (PVC) water mains, ranging in size from 4-inch through 12-inch. The water mains are typically located within the street rights-of-way; however, in some portions of town, mains are located within easements along the rear property line in residential back yards.

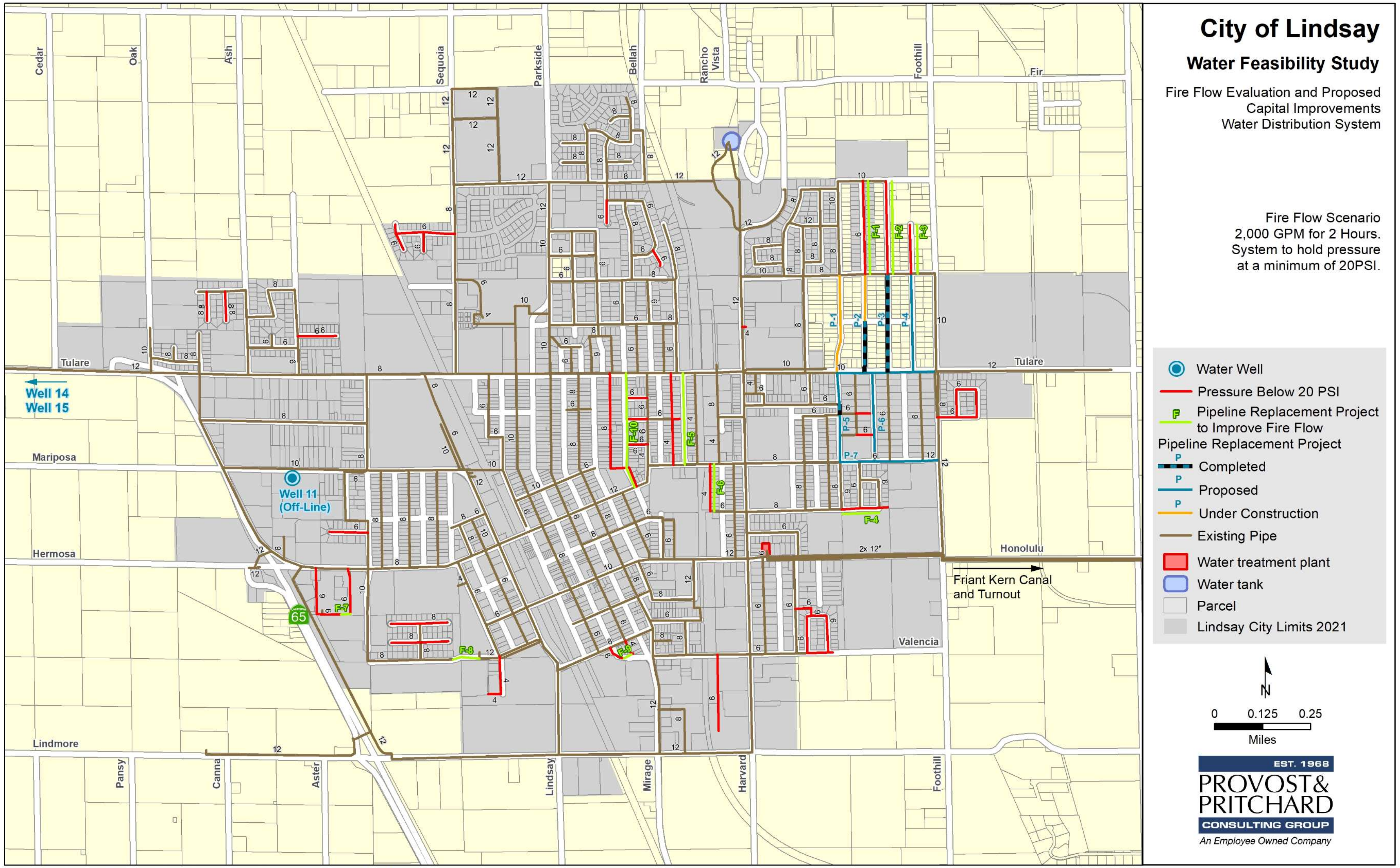
A system wide water model was completed with the Water Feasibility Report provided in 2013. Since the 2013 report, while some minor changes were made, no significant improvements to the water distribution system were made. Therefore, the existing model wasn't updated as part of this report. Similar conclusions from the 2013 water model analysis can be made and are discussed below.

Based on the evaluation from the 2013 model, there were several areas of concern within the distribution system that were noted to have pressure deficits during a fire event. A fire event pressure deficit is defined as the measured pipe pressure being lower than 20 psi during a 2-hour, 2,000 gpm fire event. The National Fire Protection Association and American Water Works Association recommend that a residual pressure of at least 20 psi be maintained to be effective for firefighting and public safety. If this minimum pressure is not met, it can become a public safety concern, where insufficient water supply can play a significant role.

As noted in the 2013 report, several of these deficits can be mitigated by installing additional water mains to complete system loops or by upsizing existing undersized water mains. The 2013 Fire Flow Evaluation figure has been updated to reflect 2021 City boundaries and updates to completed pipeline replacement projects (Figure 3-4), but the model has not been re-run. Figure 3-4 illustrates the areas of concern by showing the existing deficient water mains in red. A red line with green parallel line indicates the need for an existing water main improvement project to resolve the fire event deficiency. Additionally, in Figure 3-4 blue areas represent projects to improve the overall system efficiency by replacing or augmenting non-standard and undersized water mains. Furthermore, red areas are those areas with an identified pressure deficiency but without a readily apparent solution. These are areas where a ‘loop’ option is not readily available, generally those with only a single point of connection (i.e. a residential cul-de-sac) or those at dead-end locations.

Further details of possible water main improvement solutions are discussed in Section 3.6 Capital Improvement Projects and are listed in Table 3-10 CIP Matrix.

Figure 3-4: Fire Flow Evaluation



1/9/2023 G:\Lindsay_City of-3257\32571201-Water Feasibility Study\GIS\Map\Water_Model.mxd

3.5 Water Storage System

The City's water storage requirements include operational, emergency and fire storage. The available storage consists of a single 4-million-gallon storage tank, at the north end of town. As suggested in the 2013 water modeling report, the Operational and Emergency storage requirements are each calculated at fifty percent of the ADD (Table 3-9). The Fire Storage requirement is based on fighting the largest possible fire, considered to be an industrial fire, requiring 3,000 gpm for three (3) hours (0.54 MG). The current and future storage requirements are detailed in Table 3-9 and illustrate that the existing storage capacity of 4.0 MG is sufficient to 2040 and possibly beyond.

Table 3-9: Water System Storage

Year	Population	Scenario No. 1: Required Conservation Target - 119 gpcd								Scenario No. 3: "Status Quo" - 155 gpcd							
				Storage Requirements								Storage Requirements					
		Average Daily Per Capita Water Use (gpcd)	Average Daily Demand (MG)	Operational (MG)	Fire (MG)	Emergency (MG)	Total (MG)	Available Storage (MG)	Remaining Storage[1] (MG)	Average Daily Per Capita Water Use (gpcd)	Average Daily Demand (MG)	Operational (MG)	Fire (MG)	Emergency (MG)	Total (MG)	Available Storage (MG)	Remaining Storage[1] (MG)
2022	14,230	155	2.21	1.10	0.54	1.10	2.75	4.0	1.25	155	2.21	1.10	0.54	1.10	2.75	4.0	1.25
2023	14,333	145	2.08	1.04	0.54	1.04	2.62	4.0	1.38	155	2.22	1.11	0.54	1.11	2.76	4.0	1.24
2024	14,436	135	1.94	0.97	0.54	0.97	2.48	4.0	1.52	155	2.24	1.12	0.54	1.12	2.78	4.0	1.22
2025	14,539	125	1.81	0.91	0.54	0.91	2.35	4.0	1.65	155	2.25	1.13	0.54	1.13	2.79	4.0	1.21
2026	14,646	124	1.81	0.90	0.54	0.90	2.35	4.0	1.65	155	2.27	1.14	0.54	1.14	2.81	4.0	1.19
2027	14,753	122	1.81	0.90	0.54	0.90	2.35	4.0	1.65	155	2.29	1.14	0.54	1.14	2.83	4.0	1.17
2028	14,860	121	1.80	0.90	0.54	0.90	2.34	4.0	1.66	155	2.30	1.15	0.54	1.15	2.84	4.0	1.16
2029	14,967	120	1.80	0.90	0.54	0.90	2.34	4.0	1.66	155	2.32	1.16	0.54	1.16	2.86	4.0	1.14
2030	15,074	119	1.80	0.90	0.54	0.90	2.34	4.0	1.66	155	2.34	1.17	0.54	1.17	2.88	4.0	1.12
2031	15,185	119	1.81	0.91	0.54	0.91	2.35	4.0	1.65	155	2.35	1.18	0.54	1.18	2.89	4.0	1.11
2032	15,297	119	1.82	0.91	0.54	0.91	2.36	4.0	1.64	155	2.37	1.19	0.54	1.19	2.91	4.0	1.09
2033	15,408	119	1.84	0.92	0.54	0.92	2.38	4.0	1.62	155	2.39	1.19	0.54	1.19	2.93	4.0	1.07
2034	15,520	119	1.85	0.93	0.54	0.93	2.39	4.0	1.61	155	2.41	1.20	0.54	1.20	2.95	4.0	1.05
2035	15,631	119	1.86	0.93	0.54	0.93	2.40	4.0	1.60	155	2.42	1.21	0.54	1.21	2.96	4.0	1.04
2036	15,747	119	1.88	0.94	0.54	0.94	2.42	4.0	1.58	155	2.44	1.22	0.54	1.22	2.98	4.0	1.02
2037	15,863	119	1.89	0.95	0.54	0.95	2.43	4.0	1.57	155	2.46	1.23	0.54	1.23	3.00	4.0	1.00
2038	15,979	119	1.91	0.95	0.54	0.95	2.45	4.0	1.55	155	2.48	1.24	0.54	1.24	3.02	4.0	0.98
2039	16,095	119	1.92	0.96	0.54	0.96	2.46	4.0	1.54	155	2.49	1.25	0.54	1.25	3.03	4.0	0.97
2040	16,211	119	1.93	0.97	0.54	0.97	2.47	4.0	1.53	155	2.51	1.26	0.54	1.26	3.05	4.0	0.95

[1] Remaining Storage shown as a positive number indicates a surplus of storage capacity; the system does not have any storage deficiencies.

3.6 Capital Improvement Projects

Through the process of analyzing supply, demand, storage capacity, treatment and modeling the system, several possible capital improvement projects presented themselves. These projects are described in the following sections and are separated into five categories: pipelines, groundwater wells, groundwater treatment, surface water treatment and tank improvements.

The Draft CIP from the City includes several projects. These are shown in Table 3-10, along with the proposed projects developed through this Study. It should also be noted that while additional water supplies are immediately needed, as demonstrated in Table 3-8, practical considerations (permitting, design, construction, bidding, etc.) restrict the immediate implementation of all suggested projects. The schedule proposed in the Draft CIP represents a suggestion of an expedient practical solution.

Table 3-10: CIP Matrix

Project No.	Project Type	Project Description	Notes	Project Limits	Project Specifics				Project Timing							Estimated Grand Total	Possible Funding Source
					Ex. Size/ Diam.	New Size/ Diam.	Replace/ New	Length	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028-2029	2029-2030		
Pipelines																	
Varies (See Table 3-11)	C	Main Line Replacement/ Dead End Elimination	1, 2	TBD	8 in	8 in	Replace	1,300 ft	$988,000	$988,000	$988,000	$988,000	$988,000	$988,000	$988,000	$6,916,000	Enterprise
Groundwater Wells																	
GW-1	C	Drinking Water Test Well #1	1	TBD			New		$300,000							$300,000	Enterprise
GW-2	C	New Well #1 (Winter Demand)	2, 4	TBD		850 gpm	New			$2,220,000						$2,220,000	Enterprise
GW-3	C	New Well #1 Infrastructure	2	TBD			New			$2,700,000						$2,700,000	Enterprise
GW-4	C	Drinking Water Test Well #2	1	TBD			New				$300,000					$300,000	Enterprise
GW-5	C	New Well #2 (Winter Demand)	2,4	TBD		1,000 gpm	New					$2,220,000				$2,220,000	Enterprise
GW-6	C	New Well #2 Infrastructure	2	TBD			New					$2,700,000				$2,700,000	Enterprise
GW-7	C	Drinking Water Test Well	1	TBD			New						$300,000			$300,000	Enterprise
GW-8	C	Replacement Well	2, 3	TBD		750 gpm	Replace							$2,220,000		$2,220,000	Enterprise
GW-9	C	New Well #3 (Winter Demand)	2, 3, 5	TBD		750 gpm	New								$2,220,000	$2,220,000	Enterprise
GW-10	C	New Well #3 Infrastructure	2	TBD			New								$2,700,000	$2,700,000	Enterprise
GW-11	C	Harvard Park Irrigation Well	1	TBD			New								$1,500,000	$1,500,000	Enterprise
GW-12	C	City Park Irrigation Water Well	1	TBD			New								$1,500,000	$1,500,000	Enterprise
Ground Water Well Treatment																	
WT-1	P	Well 11 - Treatment Alts	1, 2	Well 11			New		$25,000							$25,000	Enterprise
WT-2	P	Well 11 - Treatment PS&E	1, 2	Well 11			New		$150,000							$150,000	SRF[6]
WT-3	C	Well 11 - Water Treatment	1, 2	Well 11			New			$5,943,000						$5,943,000	SRF[6]
WT-4	C	Well 14 - Upgrades	1	Well 14			New		$150,000							$150,000	Enterprise
Surface Water Projects																	
SW-1	C	DBP Mitigation	1, 2	SWTP			New		$500,000							$500,000	Enterprise
SW-2	C	Filter Bank D Renovations	1	SWTP			Replace		$400,000							$400,000	Enterprise
SW-3	C	Water Plant Upgrades	1, 2	SWTP			Replace			$100,000						$100,000	Enterprise
SW-4	C	Clarifier Renovations	1, 2	SWTP			Replace			$10,000						$10,000	Enterprise
SW-5	C	Turnout Upgrades	1	Canal Turnout			Replace				$100,000	$100,000				$200,000	Enterprise
SW-6	C	Appurtenances (Approved CIP)	1	TBD			Replace		$120,000	$766,800	$472,000	$570,000	$20,000			$1,948,800	Enterprise
SW-7	C	Water Meters Digital Upgrade	1	TBD			Replace								$2,000,000	$2,000,000	Enterprise
Tank Improvements																	
T-1	C	Storage Tank Improvements	1	TBD			Replace				$450,000					$450,000	Enterprise
Totals									**$2,633,000**	**$12,727,800**	**$2,310,000**	**$6,578,000**	**$1,308,000**	**$3,208,000**	**$10,908,000**	**$39,672,800**	

P = Planning Project; C = Construction Project

[1] *Project Listed in Draft Capital Improvement Plan Provided by the City.*

[2] *Project Proposed for Inclusion in CIP; additional details in Water Feasibility Study.*

[3] *Supply Projects are potentially interchangeable based on timing and demand needs.*

[4] *Planned well replacement by the year 2030, as a result of reaching useful life expectancy.*

[5] *Additional well will be needed sometime after 2030 to address supply needs, as illustrated in Figure 3-1.*

[6] *SRF refers to the California State Revolving Fund*

3.6.1 Pipeline Projects

The Draft CIP lists one pipeline project; the pipeline projects proposed as a result of this Study are listed in Table 3-11 and stem directly from the water model analysis conducted in 2013 (see Figure 3-4). These projects are divided into two categories: Fire Flow and Pipeline Replacement Projects. The Fire Flow Projects aim to correct pressure problems that limit the ability to meet fire standards in certain areas. The Pipeline Replacement Projects aim to replace old or undersized water mains or to complete loops in areas that limit system functionality. The projects proposed in Table 3-11 are proposed over a 7-year span.

Table 3-11: Pipeline Projects (From Water Model)

Project No.	Project Description	Project Limits	Project Specifics			
			Ex. Diam. (in)	New Diam. (in)	Replace / New	Length (ft)
Fire Flow Projects						
F-1	Replace existing undersized, old main	Sycamore Ave from Hickory St to Sierra View St	6	8	Replace	1,275
F-2	Replace existing undersized, old main	Laurel Ave from Hickory St to Sierra View St	4	6	Replace	1,275
F-3	Replace existing undersized, old main	Page Ave from Sierra View St north to end of cul-de-sac	4	6	Replace	630
F-4	Replace existing undersized, old main	Samoa St from Lafayette Ave to Sycamore Ave	6	8	Replace	525
F-5	Replace existing undersized, old main	Orange Ave from Tulare Rd to Hermosa St	4	8	Replace	675
F-6	Replace existing undersized, old main	Oxford Ave from Hermosa St to Samoa St	4	8	Replace	1,300
F-7	Install new main to complete loop	Behind shopping center near Hermosa St and Westwood Ave	---	8	New	180
F-8	Install new main to complete loop	Apia St along edge of Olive Grove Ball Park	---	8	New	380
F-9	Install new main to complete loop	Easement from Elmwood Ave to alley off Lewis St between Elmwood Ave and Mirage Ave	---	8	New	200
F-10	Relocate existing rear yard main to street ROW; complete loop	Homassel Ave from Tulare Rd to Hermosa St	8	8	Replace	1,625
Pipeline Replacement Projects						
P-1	Replace existing undersized, old main	Lafayette Ave from Sierra View St to Tulare Rd	4	6	Replace	1,300
P-2[1]	Replace existing undersized, old main	Sycamore Ave from Sierra View St to Tulare Rd	4	6	Replace	1,300
P-3[2]	Replace existing undersized, old main	Laurel Ave from Sierra View St to Tulare Rd	4	6	Replace	1,300
P-4	Replace existing undersized, old main	Page Ave from Sierra View St to Tulare Rd	4	6	Replace	1,300
P-5	Relocate existing rear yard main to street ROW and upsize	Lafayette Ave from Hermosa St to Tulare Rd	6	8	Replace	1,275
P-6	Relocate existing rear yard main to street ROW and upsize	Sycamore Ave from Hermosa St to Tulare Rd	6	8	Replace	1,250
P-7	Replace undersized main	Hermosa St from Lafayette Ave to Foothill Ave	6	8	Replace	1,350

[1] Completed from Tulare to Alameda
[2] Completed

3.6.1.1 Project Cost Estimates

Since the 2013 evaluation of pipeline projects, one and a half pipeline replacement projects have been completed. Projects P-3, and half of P-2 have been completed. Table 3-12 tabulates the approximate remaining cost of the projects listed in the 2013 report, along with an overall estimate for construction cost, contingency, design, and construction management. The cost estimates have been updated to reflect the average cost of projects recently completed or contracted, amounting to a construction cost of approximately $310 per lineal foot of water main. However, due to the conceptual nature of the proposed projects, detailed estimates should be prepared during the planning and design phases of each project. It is expected that this unit price includes all required items to fully install the pipe including material purchase, trench, compaction, roadway resurfacing and worker protections. These preliminary estimates are to provide the City with budgetary expectations.

Table 3-12: Pipeline Projects Construction Cost

Project No.	Construction Cost	Construction Contingency (30%)	Engineering & Construction Management (18%)	Total Preliminary Cost Estimate
Fire Flow Projects				
F-1	$391,900	$117,600	$70,500	$580,000
F-2	$391,900	$117,600	$70,500	$580,000
F-3	$192,900	$57,900	$34,700	$285,500
F-4	$162,300	$48,700	$29,200	$240,200
F-5	$208,200	$62,500	$37,500	$308,200
F-6	$398,000	$119,400	$71,600	$589,000
F-7	$55,100	$16,500	$9,900	$81,500
F-8	$116,300	$34,900	$20,900	$172,100
F-9	$61,200	$18,400	$11,000	$90,600
F-10	$499,000	$149,700	$89,800	$738,500
Subtotal				**$3,665,600**
Pipeline Replacement Projects				
P-1	$412,000	$123,600	$74,200	$609,800
P-2	$199,000[1]	$59,700[1]	$35,800[1]	$294,500[1]
P-3	Completed	Completed	Completed	--
P-4	$398,000	$119,400	$71,600	$589,000
P-5	$413,300	$124,000	$74,400	$611,700
P-6	$391,900	$117,600	$70,500	$580,000
P-7	$382,700	$114,800	$68,900	$566,400
P-8	$413,300	$124,000	$74,400	$611,700
Subtotal				**$3,253,300**

[1] Remaining estimated cost, as project has already been partially completed.

3.6.2 Groundwater Well Projects

Two types of groundwater well projects are proposed. The first is new supply wells to meet the City's demands. The Draft CIP includes three wells: two to supply irrigation to parks and one additional drinking water test well. As shown in Table 3-8 and Figure 3-1, the City will need additional wells in 2024, or as soon as feasible, to meet current winter demands. The Well 11 groundwater treatment project discussed in Section 3.6.3 will partially fulfill this need. In addition to this, three new supply wells and corresponding drinking water test wells and infrastructure will likely be needed. The timing of the third well will depend on per capita demand trends (see Section 3.2.2). These added supply sources can be provided via additional groundwater wells or through additional surface water storage (i.e. a reservoir) so surface water deliveries received spring through fall can be utilized during the winter months. Since the new wells will need to be located outside the existing City's water system in order to avoid groundwater that will require treatment, new infrastructure will be required. Estimates in Table 3-13 assume approximately 1 mile of infrastructure costs, but this could vary and should be investigated further in the design and planning phases of the projects.

The second type of groundwater well project is a replacement project. It is anticipated that within the next 5 years an existing well will reach the end of its serviceable life and require major rehabilitation or full replacement. These projects are all proposed as a result of this Study and are shown in Table 3-10.

3.6.2.1 Preliminary Engineer's Opinion of Probable Construction Costs

Preliminary construction costs have been prepared for each of these projects; however, during the planning and design process detailed cost estimates will be required and could possibly vary from the costs provided in Table 3-13.

Table 3-13: Groundwater Well Projects Construction Cost

Project Name	Project Description	Construction Cost	Construction Contingency (30%)	Engineering & Construction Management (18%)	Total Preliminary Cost Opinion
GW-1	Drinking Water Test Well #1	$202,700	$60,800	$36,500	$300,000
GW-2	New Well #1 (Winter Demand)	$1,500,000	$450,000	$270,000	$2,220,000
GW-3	New Well #1 Infrastructure	$1,824,300	$547,300	$328,400	$2,700,000
GW-4	Drinking Water Test Well #2	$202,700	$60,800	$36,500	$300,000
GW-5	New Well #2 (Winter Demand)	$1,500,000	$450,000	$270,000	$2,220,000
GW-6	New Well #2 Infrastructure	$1,824,300	$547,300	$328,400	$2,700,000
GW-7	Drinking Water Test Well	$202,700	$60,800	$36,500	$300,000
GW-8	Replacement Well	$1,500,000	$450,000	$270,000	$2,220,000
GW-9	New Well #3 (Winter Demand)	$1,500,000	$450,000	$270,000	$2,220,000
GW-10	New Well #3 Infrastructure	$1,824,300	$547,300	$328,400	$2,700,000
GW-11	Harvard Park Irrigation Well	$1,013,500	$304,100	$182,400	$1,500,000
GW-12	City Park Irrigation Water Well	$1,013,500	$304,100	$182,400	$1,500,000
Subtotal					$20,880,000

3.6.3 Groundwater Well Treatment Projects

The Draft CIP lists four groundwater well treatment projects, two for planning and two for construction, as shown in Table 3-10. Seen from another perspective, the Draft CIP includes three projects for Well 11 and one project for Well 14. These projects are anticipated to occur FY 2023-2024 through 2027-2028. The Planning and Construction phases for Well 11 Treatment are anticipated to occur in FY 2023-2024 and rely on the State Revolving Fund (SRF) funding sources yet to be initiated. These projects will allow the City to utilize Well 11 again as a potable water source and increase water supply and reliability. The upgrades planned for Well 14 will improve its efficiency and reliability.

3.6.3.1 Project Cost Estimates

Preliminary construction costs have been prepared for these projects; however, during the planning and design process, detailed cost estimates will be required and could possibly vary from the costs provided in Table 3-14. The recommended treatment alternative for Well 11 (WT-3) is perchlorate removal using a single-use anion exchange treatment system followed by nitrate removal using a regenerable anion exchange treatment system with on-site evaporation ponds for brine management. The estimated capital cost is $5,943,000. The estimated O&M cost is $119,690 per year plus $1.06/1,000 gallons produced.

Table 3-14: Groundwater Well Treatment Projects Construction Cost

Project Name	Project Description	Construction Cost	Construction Contingency (30%)	Engineering & Construction Management (18%)	Total Preliminary Cost Opinion
WT-1	Well 11 – Treatment Alternatives	--	--	--	$25,000[1]
WT-2	Well 11 – Treatment PS&E	--	--	$150,000	$150,000
WT-3	Well 11 - Treatment	$5,943,000	--	--	$5,943,000[1]
WT-4	Well 14 Upgrades	$150,000	--	--	$150,000

[1] Costs already included in Draft CIP from City.

3.6.4 Surface Water Treatment Projects

The CIP Matrix lists seven (7) surface water treatment projects, all construction projects, as shown in Table 3-10. Three of these projects are suggested as a result of this study. These projects are anticipated to occur in FY 2023-24 through 2025-26. Projects in the Draft CIP which fell under the SW-6 category of Appurtenances include installation of turbidimeters, pneumatic valves, magnetic flow meters, water treatment booster pumps, and a gate valve exerciser, among other projects.

3.6.4.1 Project Cost Estimates

Preliminary construction costs have been prepared for this project; however, during the planning and design process, detailed cost estimates will be required and could possibly vary from the costs provided in Table 3-15.

Table 3-15: Surface Water Treatment Projects Construction Cost

Project Name	Project Description	Construction Cost	Construction Contingency (20%)	Engineering & Construction Management (15%)	Total Preliminary Cost Estimate
SW-1	DBP Mitigation	--	--	--	$500,000[1,2]
SW-2	Filter Bank D Renovations	--	--	--	$400,000[2]
SW-3	Water Plant Upgrades	--	--	--	$100,000[2]
SW-4	Clarifier Renovations	--	--	--	$10,000[2]
SW-5	Turnout Upgrades	--	--	--	$200,000[2]
SW-6	Appurtenances (Approved CIP)	--	--	--	$1,948,800[2]
SW-7	Water Meters Digital Upgrade	--	--	--	$2,000,000[2]

[1] Discussed in section 3.7.2
[2] Costs already included in Draft CIP from City.

3.6.5 Tank Improvement Projects

The Draft CIP lists one tank improvement project, which involves renovations to the storage tank. Recent inspection reports of the existing 4.0 MG storage tank state the anode protection system of the current tank is in good working condition (see Appendix C), however evaluation of the tank's coating viability and/or structural condition should be conducted by the City annually. If coating failures on the inside or outside of the tank are observed, additional projects for recoating should be scheduled.

This project is planned to begin FY 2024-25 and conclude FY 2025-2026. No additional tank improvement projects are being proposed as a result of this Study.

3.7 Other Factors Affecting the Water System

The Social-Economic factors described below are intended to highlight a few topics that may have a current or future impact to the water system and provide the City additional awareness and information.

3.7.1 Socio-Economic Factors

The community of Lindsay has a median household income (MHI) of $37,073 and is therefore considered a Disadvantaged Community (DAC)[5]. Additionally, DWR recognizes an ‘affordability level’ for services such as water, which is 1.5% of the community’s MHI. This equates to approximately $46.34 per month as the upper limit of what water services should cost to be considered affordable. Utilizing the average water demand of 155 gpcd and an average household size of 3.29, as discussed above, the calculated average water use for a household is 15,500 gallons per month or 2,070 cubic feet (cf). The City charges $19.97[6] for the first 500cf and $1.02 per subsequent 100cf; this equates to an average household water bill of $35.99 per month, which is 1.0% of the community’s MHI. The City is currently working on a water rate study to ensure fairness in the distribution of costs amongst rate payers while providing reliable water service to the community.

It is pertinent to understand why the monthly cost is relatively high as compared with MHI. This region has significantly limited and unreliable groundwater. Most of the groundwater has some form of contamination making the groundwater source unreliable. Due to the unreliable nature of the groundwater quality within the City, new wells will either require treatment or be located a distance from the City's existing water infrastructure system; either option will considerably increase costs for rate payers. Additionally, wellhead treatment incurs a considerable yearly operations and maintenance cost to provide safe drinking water. Furthermore, the City has to rely on providing treated surface water which is substantially more costly than providing groundwater, which adds to the costs required to provide safe and reliable water in the City.

3.7.2 Water Supply

As previously discussed, the City relies jointly on surface water and groundwater. There are substantial issues that affect both water supplies; however, the City relies on surface water as much as possible due to groundwater quality issues (discussed in Section 3.7.3) and overdraft concerns in the region as a whole. Surface water has had an increase in frequency of reduced allocations due to climate and restoration flows to the San Joaquin River.

The City’s contracted allocation allows for them to receive as much as 2,500 acre-feet per year (af/year), however, USBR maintains the right to reduce the allocation annually based on climate conditions (i.e. how much snowpack is in the Sierra Nevada mountains) and the amount of water permitted to flow to the San Joaquin River, based on the criteria set forth in the 2006 settlement agreement.

---

[5] A DAC is identified as any community with an MHI less than 80% of the Statewide MHI. The DAC threshold is currently $56,982, as defined by DWR.

[6] For a 5/8” or 3/4" meter size; 1” meters have a base rate of $27.53 for the first 500 cf.

In the years between 2000 and 2022, the average annual allocation was 78%; however, in recent years between 2013 and 2022, the average allocation was 58%. These low allocations are due to the low seasonal rainfall the region has experienced. The San Joaquin River Restoration has a varying effect on the allocation, ranging from 0% to 20% reduction, based on the water year classification. Figure 3-5 shows the historical allocation to the City and Table 3-16 shows the percent reduction experienced by the City due to the San Joaquin River Restoration.

If the 40% allocation reduction used in Section 3.2.2 were applied to the surface water supply in Table 3-3 which showed firm and total capacity, the result would be the firm and total capacity in Table 3-17. Note that this reduced allocation was accounted for in Section 3.2.2, and Table 3-8 already accounts for this reduction when evaluating whether the summer or winter months' supply was the limiting supply. Table 3-17 illustrates the summer months supply during periods of surface water allocation reduction, accounting for only the present groundwater supply sources.

Figure 3-5: Historical USBR Allocation

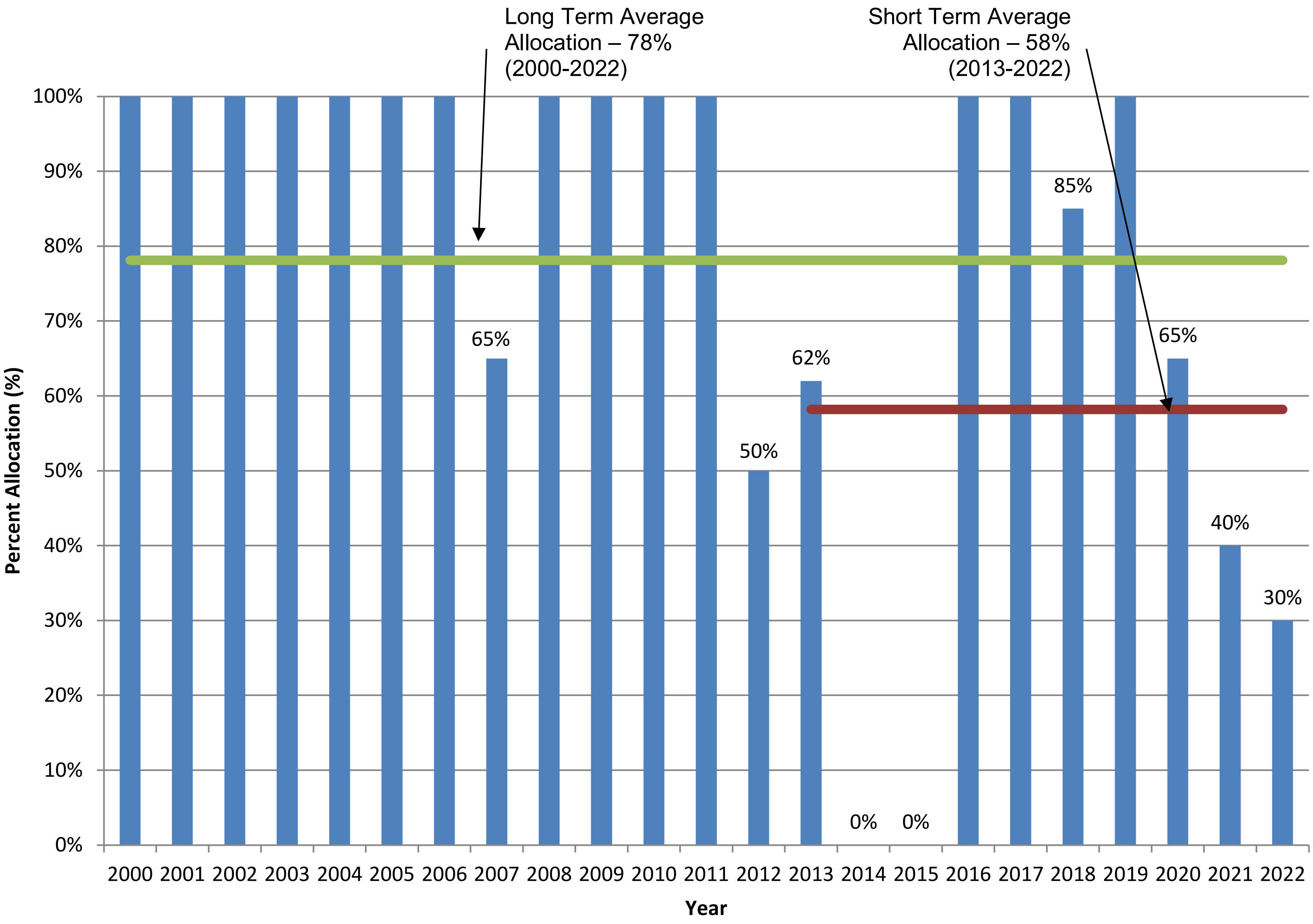


Table 3-16: Reduced USBR Allocation Due to San Joaquin River Restoration

Water Year Classification	Reduction	
	(af/year)	Percent (%)
Wet	0	0%
Normal-wet	0	0%
Normal-dry	195	8%
Dry	510	20%
Critical-High	430	17%
Critical-Low	130	5%

Table 3-17: Reduced Summer Months Supply

Reduced Summer Months Supply[1]		
	(MGD)	(gpm)
Firm Capacity[2]	2.12	1,470
Total Capacity	2.94	2,040

[1] Accounts for 40% Allocation in Surface Water Supply
[2] Excludes Well 15 (largest capacity well) for maintenance, water quality or other scenarios.

3.7.3 Water Quality

The City has several existing groundwater quality issues they are contending with, including lead and disinfection byproducts.

- The City experienced an Action Level and 90th percentile exceedance of lead in September 2021 at 4, out of 30, testing sites. The City is currently addressing this issue with additional testing, monitoring, and water system improvements.
- Disinfection byproducts (DBP), consisting of total trihalomethanes (TTHM), and haloacetic acids (HAA5), were found in exceedance of the maximum contaminant level (MCL). The City is working to collect samples, monitor the situation, and correct the issues.
- A single exceedance for turbidity was experienced by the City in March 2021. This exceedance was caused by changes in water quality in the Friant Kern Canal water supply and the City adjusted treatment operations to achieve compliance.
- Well 11 is inactive due to exceedances of the MCL for perchlorate and nitrate. The well will remain on inactive ‘emergency use only’ status until a proposed project to blend the water to reduce the perchlorate and nitrate to below the MCL level is funded and implemented.

In addition to existing water quality concerns, there are several contaminants that may become critical in the near future.

- While not officially adopted yet, the Division of Drinking Water recently announced a new draft Hexavalent Chromium (Cr6) MCL of 10 ppb (ug/L). Previously, it was regulated under the total chromium MCL. Existing water quality monitoring reports do not report this contaminant but the City will need to monitor it in the future. There may be an impact to City wells potential treatment methods include reverse osmosis or ion exchange.
- 1,2,3-Trichloropropane (1,2,3-TCP) has a primary MCL, established by the Division of Drinking Water in 2017, of 0.0005 µg/L This is a follow up of the Public Health Goal (PHG) of 0.0007 µg/L that was established in 2009. 1,2,3-TCP Since 1,2,3-TCP was used as a component in agricultural fumigants applied over large areas of California, it is reasonable to expect that the City may be impacted.

APPENDIX

552-WATER - PERFORMANCE TREND

	ACTUAL FY 2020	ACTUAL FY 2021	UNAUDITED FY 2022	ADOPTED FY 2023	PROJECTED FY 2023	PROPOSED FY 2024
552-WATER						
BEGINNING FUND BALANCE						(606,175.93)
INFLOW	1,712,499	1,670,087	1,370,000	1,742,000	1,657,407	1,703,500
OUTFLOW	1,513,756	1,661,642	2,292,600	2,731,297	1,885,827	3,003,652
TOTAL WATER	**198,743**	**8,445**	**(922,600)**	**(989,297)**	**(228,420)**	**(1,300,152)**
552-WATER | TRANSFERS						
TRANSFERS IN	-	-	880,000	710,000	710,000	1,300,152
TRANSFERS OUT	35,531	-	-	-	-	-
552-WATER | SUMMARY OF NET CHANGE						
TOTAL WATER | SUMMARY OF NET CHANGE	**163,212**	**8,445**	**(42,600)**	**(279,297)**	**481,580**	**0**

	ACTUAL FY 2020	ACTUAL FY 2021	UNAUDITED FY 2022	ADOPTED FY 2023	PROJECTED FY 2023	PROPOSED FY 2024
🟧 OUTFLOW	(1,549,287)	(1,661,642)	(2,292,600)	(2,731,297)	(1,885,827)	(3,003,652)
🟦 INFLOW	1,712,499	1,670,087	2,250,000	2,452,000	2,367,407	3,003,652
— NET	163,212	8,445	(42,600)	(279,297)	481,580	0

SUMMARY OF NET CHANGE

552-WATER	ACTUAL FY 2020	ACTUAL FY 2021	UNAUDITED FY 2022	ADOPTED FY 2023	PROJECTED FY 2023	PROPOSED FY 2024
RESERVE BALANCE						(606,176)
INFLOW	1,712,499	1,670,087	1,370,000	1,742,000	1,657,407	1,703,500
OUTFLOW	1,513,756	1,661,642	2,292,600	2,731,297	1,885,827	3,003,652
TOTAL WATER	**198,743**	**8,445**	**(922,600)**	**(989,297)**	**(228,420)**	**(1,906,328)**

552-WATER | TRANSFERS						
TRANSFERS IN	-	-	880,000	710,000	710,000	1,300,152
TRANSFERS OUT	35,531	-	-	-	-	-

552-WATER | SUMMARY OF NET CHANGE						
TOTAL WATER | SUMMARY OF NET CHANGE	**163,212**	**8,445**	**(42,600)**	**(279,297)**	**481,580**	**(606,176)**

552-WATER | INFLOW | WATER

CLASSIFICATION	**ACTUAL FY 2020**	**ACTUAL FY 2021**	**UNAUDITED FY 2022**	**ADOPTED FY 2023**	**PROJECTED FY 2023**	**PROPOSED FY 2024**
USER CHARGES						
WATER SERVICE CHARGES	1,424,825	1,428,514	1,199,600	1,533,000	1,346,822	1,400,000
PAGE/MOOR TRACT	83,866	89,705	77,900	86,000	80,007	82,000
GRANTS	-	-	-	-	-	-
WTR EMRGNCY DROUGHT PR84	-	10,581	-	-	1,630	-
GRANT FUNDS RECEIVED	-	-	70,000	110,000	-	-
SALE OF SURPLUS WATER	172,200	63,300	-	-	-	-
FEES/PENALTIES	-	-	-	-	-	-
WATER ACRE ASSESSMENT	276	-	-	-	-	-
PENALTY & MISC SRV FEES	250	150	1,800	1,000	500	500
WATER CONNECTION CHARGES	8,425	4,941	8,500	5,000	3,866	4,500
NEW UTILITY ACC. SET-UP	2,492	2,888	2,000	2,000	1,736	2,500
MISCELLANEOUS	-	-	-	-	-	-
OTHER WATER REVENUES	8,578	60,082	5,000	5,000	13,093	14,000
OTHER MISC REVENUES	11,202	42	5,000	-	-	-
REBATES/REFUNDS/REIMBURSEMENTS	-	-	-	-	-	-
REBATES/REFUND/REIMBURSMT	234	9,924	-	-	209,753	200,000
SHE WELL CONTRIBUTION	-	-	-	-	-	-
EARNED BANK INTEREST	150	(39)	200	-	-	-
TOTAL INFLOW | WATER	**1,712,499**	**1,670,087**	**1,370,000**	**1,742,000**	**1,657,407**	**1,703,500**

552-WATER | OUTFLOW | OPERATIONS

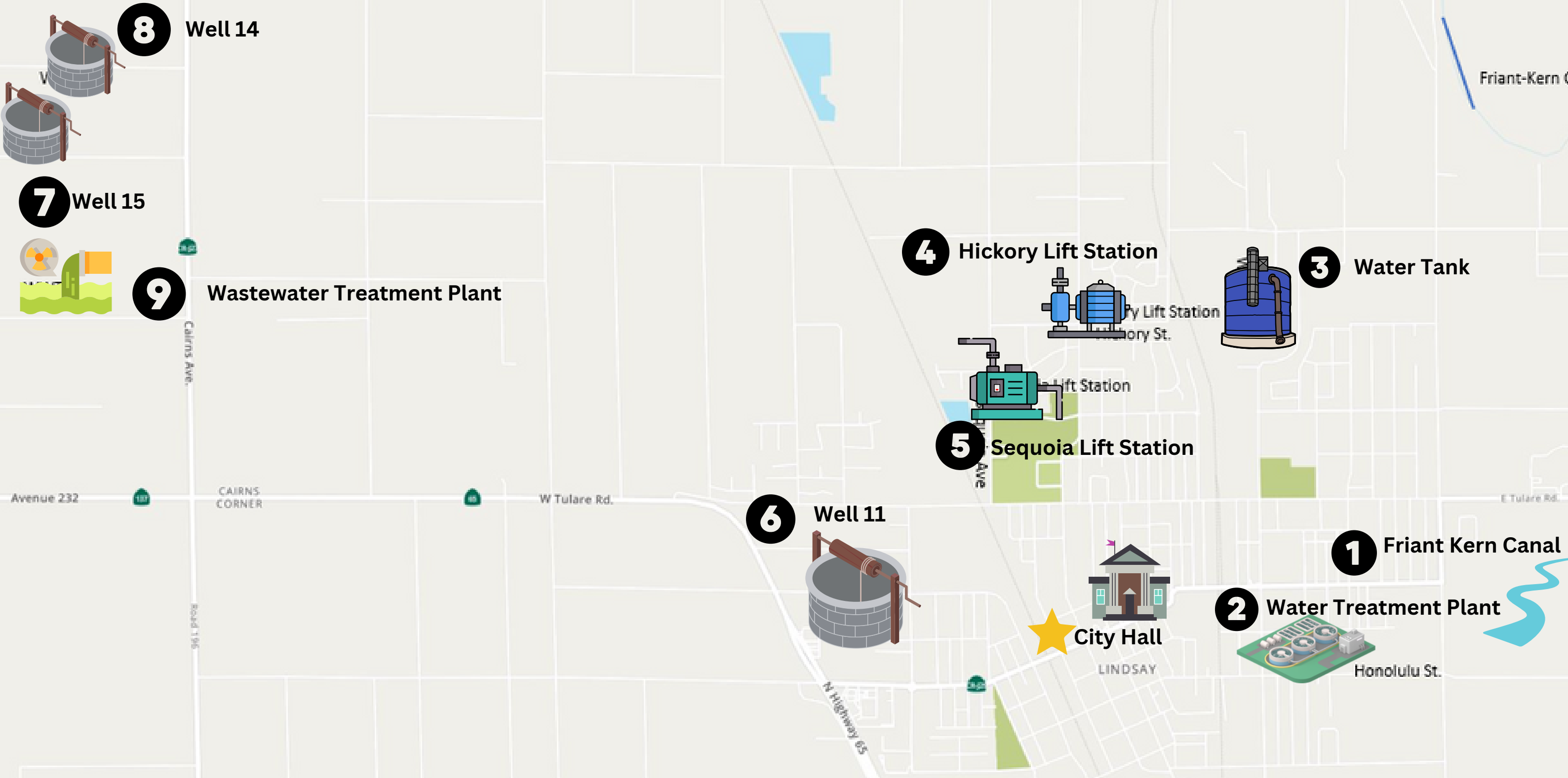
CLASSIFICATION	ACTUAL FY 2020	ACTUAL FY 2021	UNAUDITED FY 2022	ADOPTED FY 2023	PROJECTED FY 2023	PROPOSED FY 2024
WAGES/BENEFITS/INSURANCES						
AD'L SALARY:PAGER/FICA/K9	7,424	14,089	-	-	8,486	-
SALARIES - FULL TIME	287,575	281,418	531,400	462,012	348,830	596,394
SALARIES - PART TIME	6,165	4,890	-	-	9,770	-
SALARIES - OVERTIME	10,232	4,684	-	-	23,326	-
TEMPS	7,793	193	-	-	14,000	11,250
BENEFITS	156	168	-	-	184	-
FICA/MEDICARE CITY PAID	20,743	21,163	-	-	26,752	-
PERS - EPMC	1,173	1,088	-	-	-	-
PERS - EMPLOYER CONTRIBT	40,848	37,298	-	-	31,423	-
WORKER'S COMPENSATION	23,332	24,459	-	-	32,035	-
STATE UNEMPLOYMENT BENEFT	-	-	-	-	-	-
HEALTH/LIFE/DISAB INSURNC	64,313	57,838	-	-	83,284	-
BOOT ALLOWANCE	75	136	-	-	238	-
DEFERRED COMP BENEFIT	9,998	7,772	-	-	7,237	-
PERS UNFUNDED LIABILITY	69,101	72,471	90,100	102,318	98,915	94,750
RAW CANAL WATER	227,178	225,816	160,000	200,000	108,675	200,000
UTILITY CHARGES	-	-	-	-	-	-
WELLS UTILITIES	-	-	-	-	-	-
UTILITIES	159,663	184,915	175,000	225,130	224,570	225,130
PROFESSIONAL/CONTRACT SRV	-	-	-	-	-	-
PROFESSIONAL SERVICES	111,208	116,610	85,000	95,000	87,627	95,000
SGMA	-	-	55,500	55,500	-	55,500
AUDIT SERVICES	8,707	510	11,800	5,000	-	12,220
PERSONNEL SERVICES	30	-	-	-	-	-
MATLS/SUP/REPAIRS/MAINT	-	-	-	-	-	-
WELLS MATERIALS	6,192	13,594	7,200	10,500	9,470	10,500
MTNCE MATERIALS & SERVICE	7,636	6,858	8,500	8,500	7,874	8,500
TREATMENT PLANT MATERIALS	70,160	51,699	52,600	60,000	48,300	60,000
REPAIR & MTNCE SERVICES	7,102	32,412	15,000	30,000	20,707	30,000
EQUIPMENT RENTALS	-	-	-	-	3,940	-
SUPPLIES/EQUIPMENT	-	-	-	-	-	-
OFFICE SUPPLIES	133	297	3,000	-	1,131	-
DEPART OPERATING SUPPLIES	70,580	66,669	85,000	75,000	92,939	75,000
SMALL TOOLS & EQUIPMENT	6	1,747	400	-	3,490	-
LIABILITY INSURANCE	36,752	21,353	79,200	98,062	91,327	98,065
WATER SUPPLY TESTING	38,573	33,043	45,000	45,000	24,350	45,000
OTHER SERVICES & CHARGES	37,561	41,447	32,400	34,000	96,523	64,000
EMERGENCY REPAIR LINE	290	-	25,000	25,000	30,455	-
PHONE & VOICE	17,611	14,463	15,700	15,700	11,488	15,700
SOFTWARE	-	-	-	15,000	16,178	16,500
DUES, SUBSCRIPTIONS	10,627	11,718	9,500	10,000	23,854	10,000
VEHICLE FUEL/MAINTENANCE	-	-	-	-	-	-
VEHICLE FUEL AND OIL	4,225	4,845	3,000	5,000	10,051	5,000
VEHICLE REPAIR & MAINT	34,135	37,537	37,000	40,000	17,389	40,000
PERMITS / FEES / LICENSES	484	2,848	500	1,000	32,365	35,000
MEETINGS & TRAVEL	825	145	900	1,000	605	1,000
TOTAL OUTFLOW | OPERATIONS	**1,398,606**	**1,396,192**	**1,528,700**	**1,618,723**	**1,647,787**	**1,804,509**

552-WATER | OUTFLOW | DEBT SERVICING

CLASSIFICATION	ACTUAL FY 2020	ACTUAL FY 2021	UNAUDITED FY 2022	ADOPTED FY 2023	PROJECTED FY 2023	PROPOSED FY 2024
PRINCIPAL PAYMENT ON LTD	54,021	57,590	61,400	174,094	83,746	176,098
DEBT INTEREST EXPENSE	57,608	53,064	48,500	48,480	48,479	46,485
TOTAL OUTFLOW | DEBT SERVICING	**111,630**	**110,654**	**109,900**	**222,574**	**132,225**	**222,583**

552-WATER | OUTFLOW | CAPITAL OUTLAY

CLASSIFICATION	ACTUAL FY 2020	ACTUAL FY 2021	UNAUDITED FY 2022	ADOPTED FY 2023	PROJECTED FY 2023	PROPOSED FY 2024
CAPITAL OUTLAY - EQUIPMNT	0	31,663	-	205,000	61,654	30,000
CAP OULTLAY/IMPROVEMENT	3,521	45,174	500,000	520,000	-	896,560
CAPITAL O/L	-	-	154,000	-	-	-
CIP PROFESSIONAL SRVS	(0)	77,959	-	165,000	44,162	50,000
TOTAL OUTFLOW | CAPITAL OUTLAY	**3,521**	**154,796**	**654,000**	**890,000**	**105,815**	**976,560**



City of Lindsay

WATER & SEWER FACILITIES

1 FRIANT KERN CANAL

151.8-MILE-LONG CANAL THAT TRANSPORTS WATER SOUTHWARD BY GRAVITY FLOW FROM THE FRIANT DAM AT THE SAN JOAQUIN RIVER NEAR FRESNO TO THE KERN RIVER IN BAKERSFIELD.

2 WATER TREATMENT PLANT

LOCATED NEAR THE CORNERS OF HONOLULU STREET AND HARVARD AVENUE. *APN 206-012-019-000*

3 WATER TANK

LOCATED WEST OF HILLCREST DRIVE AND NORTH OF HARVARD AVENUE. APN 201-240-004-000.

4 HICKORY LIFT STATION

LOCATED ON THE NORTH EAST CORNER OF HICKORY STREET AND PARKSIDE AVENUE INTERSECTIONS.

5 SEQUOIA LIFT STATION

LOCATED OFF SEQUIOA AVENUE AND ALMOST DIRECTLY ACROSS FROM THE MONTE VISTA DRIVE INTERSECTION.

6 WELL 11

LOCATED OFF SEQUIOA AVENUE AND ALMOST DIRECTLY ACROSS FROM THE MONTE VISTA DRIVE INTERSECTION.

7 WELL 15

WELL IS CURRENTLY NOT ACTIVE. LOCATED SOUTH OF MARIPOSA STREET IN THE MARIPOSA BASIN BOUNDARIES. *APN: 199-140-038-000*

8 WELL 14

WELL IS CURRENTLY ACTIVE AND USED BY THE CITY. LOCATED SOUTH OF AVENUE 242 AND WEST OF CAIRNS AVENUE.

9 WASTEWATER TREATMENT PLANT

LOCATED WEST OF ROAD 196 AND NOTH OF AVENUE 236. ADDRESS: 23611 ROAD 196, LINDSAY, CA 93247. *APN: 197-090-018-000*

559-562-7102 | HTTPS://WWW.LINDSAY.CA.US/ | 251 E. HONOLULU ST. LINDSAY CA 93247

DROUGHT WATERING SCHEDULE

NO WATERING FROM 9AM – 9PM

Examples of Even-Numbered Properties:

- *150 N. Mirage Ave.*
- *152 Ninth St.*

Examples of Odd-Numbered Properties:

- *251 E. Honolulu St.*
- *247 Eleventh St.*

MON.	TUE.	WED.	THUR.	FRI.	SAT.	SUN.
NO WATERING	EVEN	ODD	NO WATERING	NO WATERING	EVEN	ODD

PHASE III WATER CONSERVATION METHODS WILL BE ENFORCED EFFECTIVE SEPTEMBER 1, 2023

HORARIO DE RIEGO

NO RIEGE DE 9AM – 9PM

Ejemplos De Propiedades Pares:
- *150 N. Mirage Ave.*
- *152 Ninth St.*

Ejemplos De Propiedades Impares:
- *251 E. Honolulu St.*
- *247 Eleventh St.*

LUN.	MAR.	MIE.	JUE.	VIE.	SAB.	DOM.
NO RIEGO	PAR	IMPAR	NO RIEGO	NO RIEGO	PAR	IMPAR

SE APLICARÁN LAS MEDIDAS DE CONSERVACIÓN DEL AGUA DE LA FASE III A PARTIR DEL 1° DE SEPTIEMBRE, 2023