City of Malibu
Incorporated March 28, 1991

2017 CCWTF Project Report

Prepared by:

RMC water and environment
Woodard & Curran
National Experience. Local Focus.

September 22, 2017

Table of Contents

List of Tables

List of Figures

Appendices

Page Intentionally Left Blank

Chapter 1 Purpose of Report

This report presents the basis of design for the Civic Center Wastewater Treatment Facility. It is intended to serve as a guide for the City as it expands the project from Phase 1, which is under construction, through Phases 2 and 3. Each of these phases will extend centralized wastewater and recycled water services to a greater portion of the Civic Center area of Malibu. These extensions of service will require expansion of the following components of the project:

- Wastewater treatment plant
- Wastewater sewer collection system, including pipelines and pump stations
- Recycled water distribution system, including pipelines, booster pump stations, and storage facilities
- Groundwater injection wells (for disposal of treated effluent that is not recycled)

1.1 Organization of Report

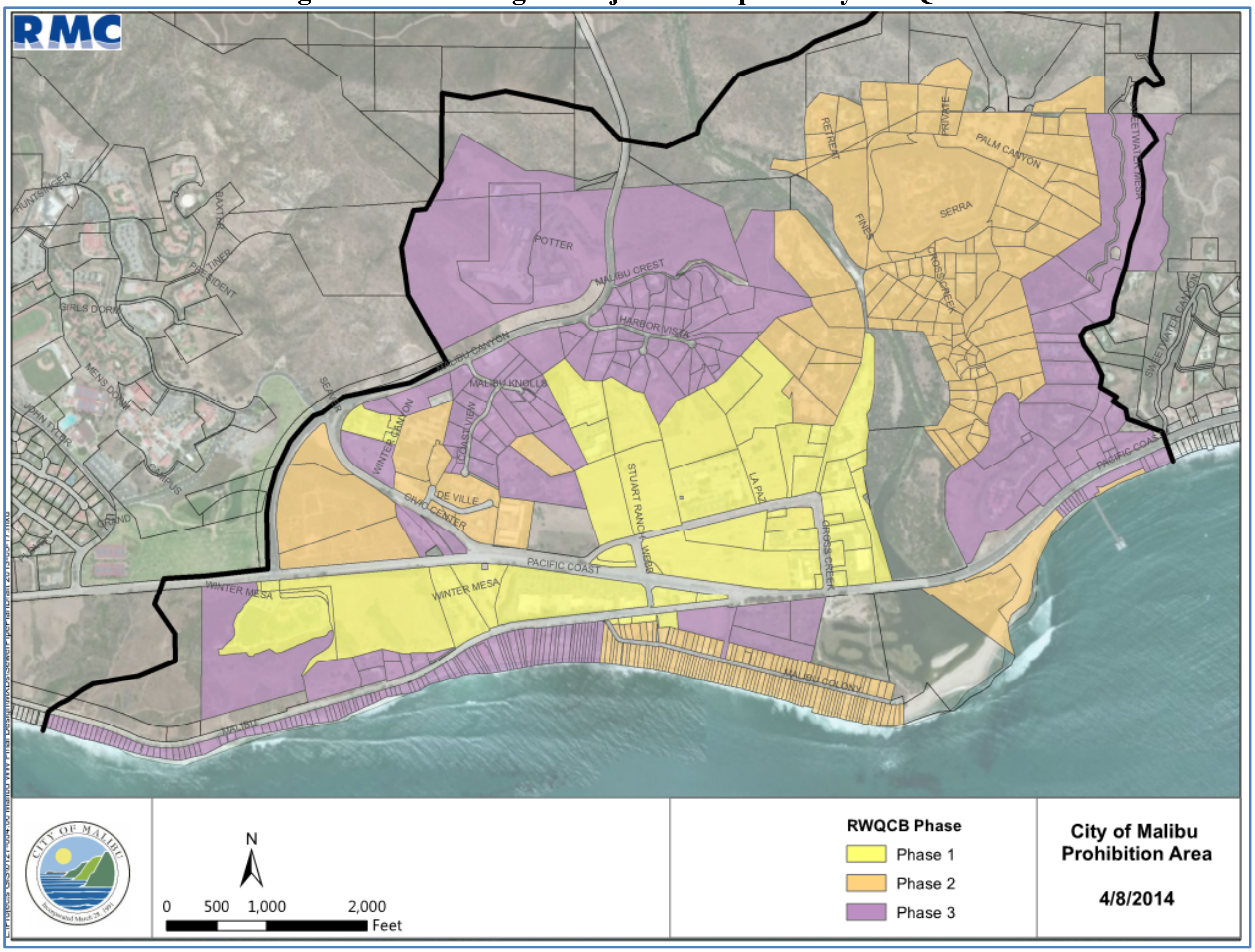
This report is organized into the following sections:

- Chapter 1 Purpose of Report
- Chapter 2 Overview of Project Phases
- Chapter 3 Recycled Water Demand Estimates
- Chapter 4 Basis of Design – Project Infrastructure
    - Chapter 4.1 Basis of Design – Treatment Plant
    - Chapter 4.2 Basis of Design – Sewer Collection System
    - Chapter 4.3 Basis of Design – Recycled Water Distribution System
    - Chapter 4.4 Basis of Design – Groundwater Injection Wells

Chapter 2 Overview of Project Phases

The project will be implemented in three phases (shown in Figure 2.1) to progressively provide wastewater and recycled water services to the Prohibition Zone established by the RWQCB. The map is excerpted from the Regional Water Quality Control Board's WDR/WRR permit for the project.

Figure 2.1 – Phasing of Project as Required By RWQCB



2.1 Flows and Loads by Project Phase

The estimated wastewater flows and loads for each phase of the project were estimated on a parcel-by-parcel basis, based on whether they were single family residential, residential condominium, or commercial developments. The basis of the flow and load estimates and projections is discussed in Appendix A – Malibu Flow Assumption TM and presented in detail in Appendix B – Master Flow and Load List. The Master Flow and Load List details the estimates made for each parcel that will be served by Phases 1, 2, and 3 of the project. The flows and loads listed for Phase 1 generally follow the assumptions in the Malibu Flow Assumption TM, but have been updated to reflect last minute changes made to several parcels during the establishment of the Phase 1 assessment district.

The results of these estimates are summarized in Table 2.1 below.

Table 2.1 - Estimated Flows and Loads by Project Phase

Type	Number of Connections Served[a]	Average Flow (Gallons/day)	Average BOD (lbs/day)
Phase 1			
Residential	6	7,486	20
Residential-Condo	0	0	0
Commercial	42	150,120	612
Public Open Space	3	220	1
Phase 1 subtotal	51	157,826[b]	632[b]
Phase 2			
Residential	235	83,443	218
Residential-Condo	163	32,600	85
Commercial	9	46,942	161
Public Open Space	4	200	0
Phase 2 subtotal	411	163,786	464
Phase 1 + 2 subtotal	462	321,612	1,096
Phase 3			
Residential	204	74,659	195
Residential-Condo	0	0	0
Commercial	21	47,824	134
Public Open Space	6	0	0
Phase 3 subtotal	231	122,483	329
Other			
Public Open Space	15	0	0
Grand Total	**708**	**443,494**	**1,426**

Footnotes:

a. Number of connections listed reflects merged parcels, and therefore may not reflect the number of parcels listed in Assessment District
b. Flow and loads for Phase 1 adjusted to match Assessment District

Chapter 3 Recycled Water Demand Estimates

As part of the RWQCB requirements (Milestone 2 of the MOU with the RWQCB) leading up to the permitting of the project, the City of Malibu was required to develop an estimate of the potential demand for recycled water within the Prohibition Zone that RWQCB established in the City. In December 2011, the City submitted a report titled, 'City of Malibu Recycled Water Use and Storage Study' which is attached to this report as Appendix C. The 2011 report also estimated the benefits of seasonal recycled water storage at Pepperdine University wherein Title 22 effluent from the City of Malibu treatment plant would be stored during winter months when irrigation demand was low. The stored effluent would be used to meet summer peak irrigation demands. This arrangement would increase the amount of effluent available for recycling when viewed on an annual basis.

As shown in Table 3.1 below, the 2011 report estimated that Phase 1 would only achieve about four percent reuse of the treated effluent. This would rise to approximately 60 percent reuse by Phase 3. These estimates incorporated the estimated probability that a given parcel, or land use area, would undertake effluent reuse. The individual probability estimates ranged from 30 percent to 100 percent. Since the 2011 report was written, southern California has experienced a severe drought which has increased the probability that a given parcel would undertake effluent reuse, which will substantially increase the amount of reuse.

The drought has also caused several large potential Phase 2 and Phase 3 reuse customers to request recycled water supply in Phase 1. For example, the 2011 report estimated the potential Perenchio golf course irrigation demand at 19,000 gallons per day in Phase 3 and gave it a 30% chance of occurring based on feedback from the owners of the golf course. Because of the drought, the owners have signed a contract with the City what would supply the golf course with up to 15,000 gallons per day in Phase 1. Similarly, Bluffs Park was estimated to use recycle water in Phase 3, but has now moved into Phase 1. This has the effect of increasing the probability of recycling 12,000 gallons per day from 30 percent to 100 percent and having it occur in Phase 1.

As a result of the above, the City may now be in the enviable position of having more recycled demand (in Phase 1) than there is water supply from the treatment plant. This change in timing and magnitude of recycled water demand will greatly reduce the reliance on the injection wells for effluent disposal, and will reduce the demand for potable water.

The 2011 report remains a valuable reference document for estimating future recycled water demands, but needs to be updated to reflect the changed demand conditions that have occurred since it was written.

Table 3.1 – Recycled Water Demand vs Wastewater Flow, Estimated in 2011

Project Phase	Average Day Recycled Water Demand, gpd	Cumulative Average Day Recycled Water Demand[a]	Cumulative Average Daily Wastewater Flow[b]	Percent of Average Daily Flow Used on Peak Day
Phase 1	8,890	8,890	211,000	4
Phase 2	152,150	161,040	350,000	46
Phase 3	138,230	299,270	502,000	60
Total	299,270	na	na	na

Footnotes:

a. Cumulative demand = running total, phase by phase
b. Cumulative flow = running total, phase by phase

Chapter 4 Basis of Design – Project Infrastructure

The project infrastructure includes the following major components:

- Wastewater treatment plant
- Sewer collection system and pump stations
- Recycled water distribution system, booster pump stations, and storage tank(s)
- Groundwater injection wells (for disposal of treated effluent that is not recycled)

The locations of these facilities for Phases 1, 2, 3 are shown in Figure 4.1 below.

Figure 4.1 – Location of Project Infrastructure, Phases 1, 2, 3 (From RWQCB WDR/WRR Permit)

4.1 Basis of Design – Treatment Plant

The treatment plant is designed to be expanded in three phases to approximately match the increase in flows and organic (BOD)loads associated with each of the project phases described previously. The capacity of each of the phases is presented in Table 4.1 below.

Table 4.1 – Treatment Plant Capacity by Expansion Phase (from Construction Dwg. G-6)

Flows and Loads	Units	Phase1, initial	Phase 1, buildout	Phase 2, buildout	Phase 3, buildout
Average annual flow	Gal/day	95,900	190,900	361,000	506,600
Max. day flow	Gal/day	142,500	276,000	534,000	754,000
Peak hour flow	Gal/day	333,000	644,000	1,247,000	1,758,000
Average BOD loading	Lbs/day	308	595	1,150	1,373
Max. day BOD loading	Lbs/day	461	668	1,291	1,495
Average TSS loading	Lbs/day	210	405	784	1,098
Max. day TSS loading	Lbs/day	314	523	1,011	1,295
Average TKN loading	Lbs/day	51	98	190	231
Max. day TKN loading	Lbs/day	76	111	214	251
Average NH_3 loading	Lbs/day	42	82	159	181
Max. day NH_3 loading	Lbs/day	64	93	179	199

Treatment Capacity Versus Projected Flow and Loads

To meet the deadlines of the RWQCB for project implementation, the design of plant was commenced prior to finalization of the flow and load estimates for the various phases. Towards the end of design, the flow and load estimates were refined based on review of water use records for existing commercial development in the Civic Center Area and residential areas of Malibu Colony (see Table 2.1). These refined flow estimates were generally less than envisioned at the start of design. However, the projected average BOD loadings estimated for buildout conditions in Phases 1, 2, and 3 are slightly higher (four to six percent) than envisioned during design. To meet these slightly higher BOD loadings, if they actually occur, the mixed liquor concentration of the biological reactors can be increased from the 7200 mg/L assumed in design, to 7630 mg/L. This is a very modest change to operations, and well within the maximum mixed liquor concentration of 12,000 mg/L that some designers use.

Basis of Flow and Load Estimates

The flow and load estimates are estimates only; there was no previous centralized wastewater system that could be measured to obtain aggregated flow and loads from existing development. Rather, estimates were made using text book values for unit flow rates and organic loadings from the various types of development, and BOD sampling from existing Malibu commercial developments. In addition, flow rates and organic load estimated for future development were taken from the plans submitted to the City of Malibu Planning Department.

The unit flow and load rates used to estimate residential and commercial flows and loads are described in the Malibu Flow Assumption Technical Memorandum in Appendix A and the Master Flow and Load List in Appendix B.

Description of Treatment Process

The wastewater treatment processes of the Civic Center Facility include coarse and fine mechanical screening and grit removal for preliminary treatment of the influent wastewater. The effluent after the preliminary treatment flows to an equalization basin. The effluent of an equalization basin flows to a Membrane Bioreactor (MBR) consisting of biological reactors and membrane-based solids removal. The MBR provides carbonaceous oxidation, nitrification/denitrification and solids removal to meet the limits of the WDR/WRR. Disinfection of the treated effluent is achieved by Ultraviolet (UV) disinfection. Disinfection is followed by the addition of chlorine to maintain a chlorine residual in the distribution system to minimize microorganism re-growth and bio-fouling in the pipelines and injection wells. Treated, disinfected effluent is recycled within the community via the recycled water distribution system. Effluent that is not used for landscape irrigation and/or land disposal via injection, can be discharged at two percolation ponds as a backup measure.

The following are the major treatment components in the treatment. They are listed in the order that ‘follows the flow’ in Figure 4.2 – Treatment Plant Process Flow Diagram, which was taken from Plan G-5 of the construction drawings for the treatment plant.

- Coarse Screen - Coarse screen used in the wastewater treatment plant removes solids, including typically wood, plastic materials, and rags.

- Grit Removal - Grit removal is used to remove as much sand and silt as possible to prevent wear on pumps, accumulations in bioreactor and membrane reactor, and clogging of sludge piping.

- Fine Screen - Fine screen with 2 millimeter openings removes inert solids before entering the bioreactor.

- Flow Equalization - Flow equalization basin provides a relatively constant flow rate to the subsequent treatment operations and processes.

- Bioreactor - The bacteria species Nitrosomonas and Nitrobacter in the bioreactor provide nitrification. Nitrosomonas and Mtrobacter convert ammonia to nitrite and nitrite to nitrate, respectively. Psudomonas bacteria convert nitrite and nitrate to nitrogen.

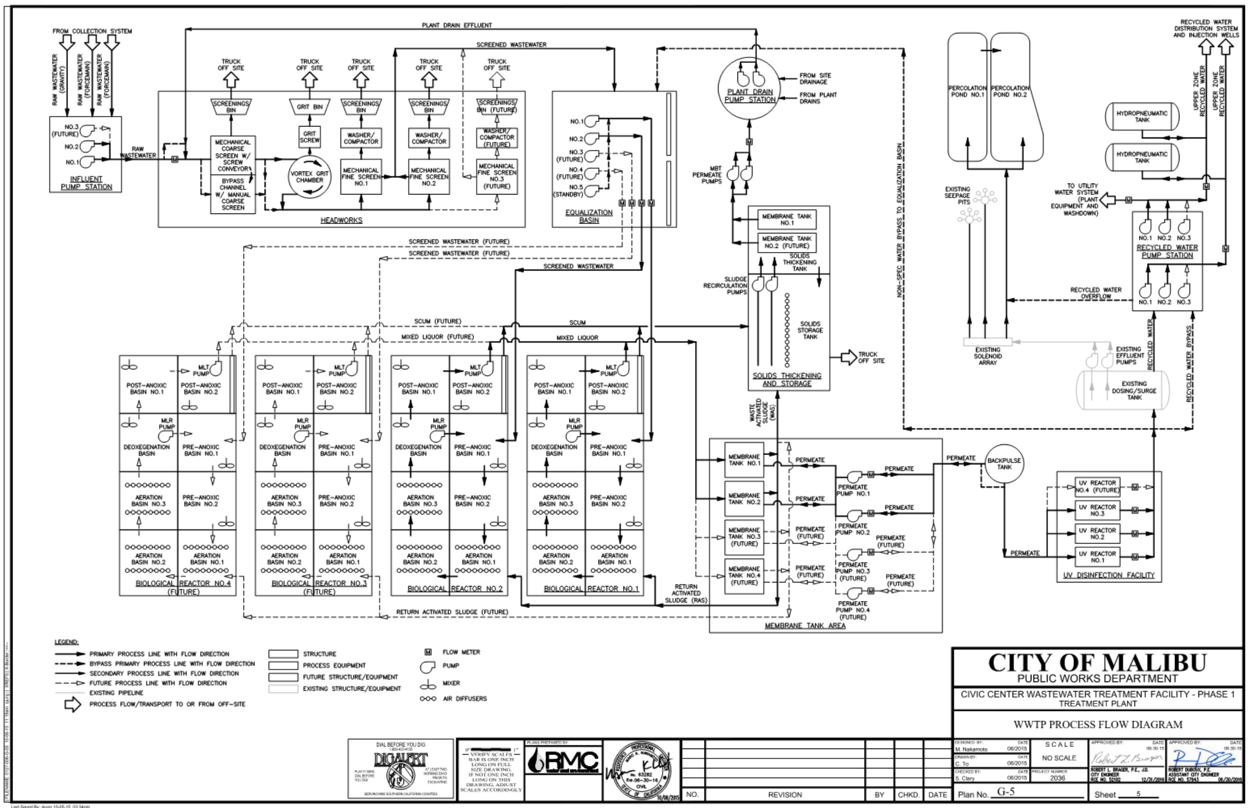
- Membrane Tank/Reactor - Membrane reactor provides further carbonaceous oxidation and suspended solids removal.

- UV Disinfection - UV radiation penetrates an organism's cell wall, and destroys/retards the cell's ability to reproduce.

- Chlorination - Chlorination with sodium hypochlorite is used to minimize biofouling of the wells and re-growth of bacteria, pathogens, and viruses in the pipelines and injection wells.

The capacities and number of units for each of the above processes are listed in detail on Plan No. G-6 WWTP Design Criteria of the construction documents.

Figure 4.2 – Treatment Plant Process Flow Diagram (Plan No. G-5)



4.1.1 RWQCB Permit Limits for Treatment

RWQCB Permit Limits

The treatment plant must comply with the capacity and treatment limits described in the RWQCB's Order No. R4-2015-0051 WDR/WRR (see Appendix D). This permit allows discharge to the ground water injection wells and to recycled water users. [The capacity limits of Phase 1 and 2, as stipulated in that permit, are presented in Table 4.2 below.]

Table 4.2 – Capacity Limits in Table 8 (pg. 17) of WDR/WRR Permit

Table 8 – Maximum Discharge Quantities of Effluent and Maximum Quantities of Recycled Water Applications at Phase I and Phase II		
Phase	**Maximum Volume Discharge from Civic Center Facility for Groundwater Injection and Recycled Water Used for Irrigation (GPD)**	**Groundwater Percolation as Backup (GPD)**
I	191,000	50,000
II	361,000	100,000

Phase 1 Treatment Plant Capacity

The design of the treatment plant used a modular approach to the sizing of the biological reactor/membrane trains, which are the 'heart' of the treatment plant. Phase 1 of the treatment plant has one pair of biological reactor/membrane trains that is sized to treat an average daily flow of 190,900 gallons/day and an average daily BOD load of 595 pounds/day. This combination of flow and load equates to an average BOD concentration of 373 mg/L.

The biological reactor/membrane trains were designed conservatively to accommodate peak day flows and loads as discussed below.

Redundant blowers, and on-shelf spare mixers have been provided to back up the equipment most prone to failure. However, redundant 'spare' biological reactor tanks have not been provided. The biological reactor tanks have very little equipment other than aeration diffusers within the tanks, and therefore loss of a biological reactor train will be infrequent.

In the event of losing a biological reactor train (or tank), the capacity of the surviving train is designed to be 'pushed' to accommodate the flow and load, by any combination of increasing the mixed liquor concentration, shortening the hydraulic retention time, and making full use of the post anoxic denitrification zone. For example, the biological reactors were designed assuming a mixed liquor concentration of 7,200 mg/L at average conditions. This concentration can be 'pushed' to as high as 12,000 mg/L for short durations to allow maintenance and repair a biological reactor. This mixed liquor concentration would allow one biological reactor train to treat a peak day BOD load of up to 690 pounds per day. This capacity would be sufficient for the expected peak day BOD load at buildout conditions for Phase 1 of the project. (See Table 4.1 above.)

Similarly, the membrane trains were designed with conservative flux rates, which allows the membrane trains to be 'pushed' should one membrane train be lost to equipment failure or maintenance/repair activity. They were designed for a peak day flux rate of 9.7 gallons per day per square foot of membrane at buildout flows for Phase 1. Loss of one membrane train (during Phase 1) would result in short term flux rates of 19.4 gallons per day per square foot, which is an acceptable short term rate.

Expansion of Treatment Plant for Phase 2 and Phase 3

As flows and loads to the treatment plant increase towards the Phase 1 capacities listed in Table 4.1, the plant will need to be expanded. The treatment plant equipment and processes that will need expansion are presented in Table 4.3 below.

Table 4.3 – Quantity of Treatment Process Units Needed to Meet Phase 2 and Phase 3

Process Unit	Phase 1[a, c] (installed)	Phase 2[b, c] (future)	Phase 3[b, c] (future)
Influent Pumps	1 duty + 1 standby	2 duty + 1 standby	2 duty + 1 standby
6 mm Coarse Screen	1 duty + bypass	1 duty + bypass	1 duty + bypass
Vortex Grit Removal	1 duty + bypass	1 duty + bypass	1 duty + bypass
2 mm Fine Screens	1 duty + 1 standby	1 duty + 1 standby	2 duty + 1 standby
Intermediate Pumps (in EQ basin)	2 duty + 1 standby	3 duty + 1 standby	4 duty + 1 standby
Biological Reactor	2 duty[f]	3 duty[d,f]	4 duty[e,f]
Aeration Blower	1 duty + 1 standby	2 duty + 1 standby	3 duty + 1 standby
Membrane Train/Tank	2 duty[f]	3 duty[f]	4 duty[f]
Permeate Pumps	2 duty[f]	3 duty[f]	4 duty[f]
UV Disinfection	2 duty + 1 standby	2 duty + 1 standby	3 duty + 1 standby
Solids Thickening Membrane	1 duty	2 duty	2 duty

Footnotes:

a. The units listed were installed as part of Phase 1
b. Number of units listed is total number to be installed at that phase and includes units from previous phase(s)
c. Total number of units = duty + standby (ie, 2 duty + 1 standby = 3 units)
d. For Phase 2, three duty biological reactors will be needed, but construction phasing will probably construct the structure for reactors 3 and 4, but only equip reactor 3 with diffusers and blower capacity.
e. For Phase 3, biological reactor 4 would be equipped with diffusers and blower capacity.
f. Standby capacity provided by 'pushing' flux rate on surviving train(s) – see text.

RWQCB Permit Requirements for Treated Effluent

The RWQCB has issued a WDR/WRR permit for the plant. The WDR portion of the permit pertains to treatment capacity and effluent quality allowed for groundwater injection of the effluent. The WRR portion of the permit pertains to the degree of treatment and effluent quality needed for unrestricted non-potable reuse of the effluent.

The treatment capacity limits in the permit for Phase 1 and Phase 2 of the project are presented in Table 4.3 below. Capacity limits for Phase 3 are not stated in the permit because water quality sampling in Malibu Lagoon and nearby beaches will determine whether Phase 3 is needed.

In Table 4.3, the column titled, 'Groundwater Percolation as Backup (GPD)' refers to the percolation ponds that are constructed as part of the Phase 1 project. These are considered for use as backup disposal capacity if there is an operational problem with the ground water injection wells or recycled water distribution system. The use of the ponds for percolation disposal will trigger groundwater monitoring as described in the RWQCB permit.

Presented in Table 4.4 below are the effluent water quality limits that the plant must meet for ground water injection and water recycling of the treated effluent.

Table 4.4 – Effluent Water Quality Limits from Table 9 (pg. 17) of WDR/WRR Permit

Table 9 – Effluent/Recycled Water Limits

Constituents	Units	Monthly Average	Weekly Average	Daily Maximum	Instantaneous Minimum [1]	Instantaneous Minimum [2]
Oil and grease	mg/L	10 [3]	---	15 [3]	---	---
Total suspended solids	mg/L	15 [3]	40 [3]	45 [3]	---	---
	% removal	≥ 85 [4]	---	---	---	---
$BOD_{5@20^\circ C}$	mg/L	20 [3]	30 [3]	45 [3]	---	---
	% removal	≥ 85 [4]	---	---	---	---
pH	pH units	---	---	---	6.5 [3, 5]	8.5 [3, 5]
MBAS	mg/L	0.5 [6]	---	---	---	---
Nitrate + Nitrite as Nitrogen	mg/L	8 [7]	---	---	---	---
Nitrate as Nitrogen	mg/L	8 [7]	---	---	---	---
Nitrite as Nitrogen	mg/L	1 [8]	---	---	---	---
Total Dissolved Solids	mg/L	2,000 [8]	---	---	---	---
Sulfate	mg/L	500 [8]	---	---	---	---
Chloride	mg/L	500 [8]	---	---	---	---
Boron	mg/L	2.0 [8]	---	---	---	---

[1]. Instantaneous Minimum Effluent Limit: The lowest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous minimum limit).

[2]. Instantaneous Maximum Effluent Limit: The highest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous maximum limit).

[3]. Limits are based on best professional judgment. Limits adopted by this Regional Board exist in the permits for tertiary-treated wastewater treatment plants.

[4]. Limits are based on secondary treatment requirements, 40 CFR section 133.102.

[5]. Excursion from this range shall not be considered a violation provided the duration is not more than 10 minutes in a 24-hour period, and pH shall at all times be within 6 to 9.

[6]. Basin Plan Title 22 Drinking Water Standard for methylene blue activated substances (MBAS.

[7]. Limits are determined based on the model results, and to be consistent with State Water Board Resolution No. 68-16.

[8]. Basin Plan Groundwater Quality Objective.

Title 22 Treatment Requirements for Recycled Water

In addition to the above presented water quality limits, the treatment plant must comply with the following Title 22 requirements, which allow unrestricted non-potable reuse of the effluent:

- Recycled water used for irrigation and waste disposal via aquifer injection and groundwater percolation shall be limited to tertiary-treated and disinfected effluent that has been filtered and subsequently disinfected with UV that meets the following criteria:

- UV disinfection shall comply with the 'Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse' (August 2012) published by the National Water Research Institute, which specifies for permeability of membrane filtration that:
  - The design UV dose shall be at least 80 millijoules per cm^2 under maximum daily flow: and
  - The filtered effluent UV transmittance shall be 65% or greater at 254 nanometer.
- The effluent shall be, at all times, adequately disinfected and oxidized. In the event that the effluent exceeds any of the following, based on daily grab samples, the City shall suspend recycled water applications, until such time that the cause of failure has been identified and corrected. Any failure to meet the total coliform limits shall be reported to the DDW and the Regional Board in the next quarterly report.
  - A 7-day median of 2.2 MPN per 100 milliliters for two consecutive days
  - 23 MPN per 100 milliliters in more than one sample in any 30-day period
  - 240 MPN per 100 milliliters in any sample
- Filtered wastewater shall be oxidized wastewater that has been passed through a membrane so that the turbidity of the filtered wastewater does not exceed any of the following:
  - 0.2 Nephelometric Turbidity Unit (NTU) more than 5 percent of the time within a 24-hour period
  - 0.5 NTU at any time

In addition to the above requirements regarding treatment plant performance, the City must also conduct ground water monitoring to ensure protection of the ground water basin. The groundwater quality limits that must be met are presented in Table 4.5 below. The locations of the monitoring wells are shown in RWQCB permit (see Appendix D).

Title 22 Engineer's Report

An Engineer's Report was prepared, submitted and approved by the Division of Drinking Water as required by CCR Title 22, Division 4, Chapter 3, Article 7 (aka 'Title 22') for Phase 1 of the project. The report outlines the requirements that City of Malibu will adhere to in the production, distribution, and use of recycled effluent. The level of treatment provided by Phase 1 (disinfected tertiary treatment) allows for unrestricted non-potable reuse. As the project moves into Phase 2 and Phase 3, Supplemental Engineer's Report(s) will need to be prepared and submitted to the Division of Drinking Water for review and approval.

The Title 22 Engineer's Report for Phase 1 is presented in Appendix E of this report.

Table 4.5 – Groundwater Limits from Table 10 of RWQCB WDR/WRR Permit

Table 10 – Groundwater Limits				
Constituents	**Units**	**Monthly Average**	**7-Day Average**	**Single Sample Maximum**
Nitrate + Nitrite as Nitrogen (for Civic Center Gravels)	mg/L	5 [1]	---	---
Nitrate + Nitrite as Nitrogen (for Shallow Alluvium)	mg/L	10 [2]	---	---
Total Dissolved Solids	mg/L	2,000 [3]	---	---
Sulfate	mg/L	500 [3]	---	---
Chloride	mg/L	500 [3]	---	---
Boron	mg/L	2.0 [3]	---	---
Total coliform	MPN/100mL	---	1.1[3]	---
Fecal coliform	MPN/100mL	---	1.1[3]	---

[1]. Limit for deep Well Nos. MCWP-MW09 and MCWP-MW04D is based on the anti-degradation analysis summarized in the report titled "*Assimilative Capacity and Antidegradation Analysis for Proposed Injection Dispersal*", dated May 15, 2014

[2]. Limit for shallow Well Nos. SMBRP-9, TY-MW-1, MCWP-MW04S, MCWP-MW07S, SMBRP-12, and LAMW-5S is based on Basin Plan Groundwater Quality Objectives.

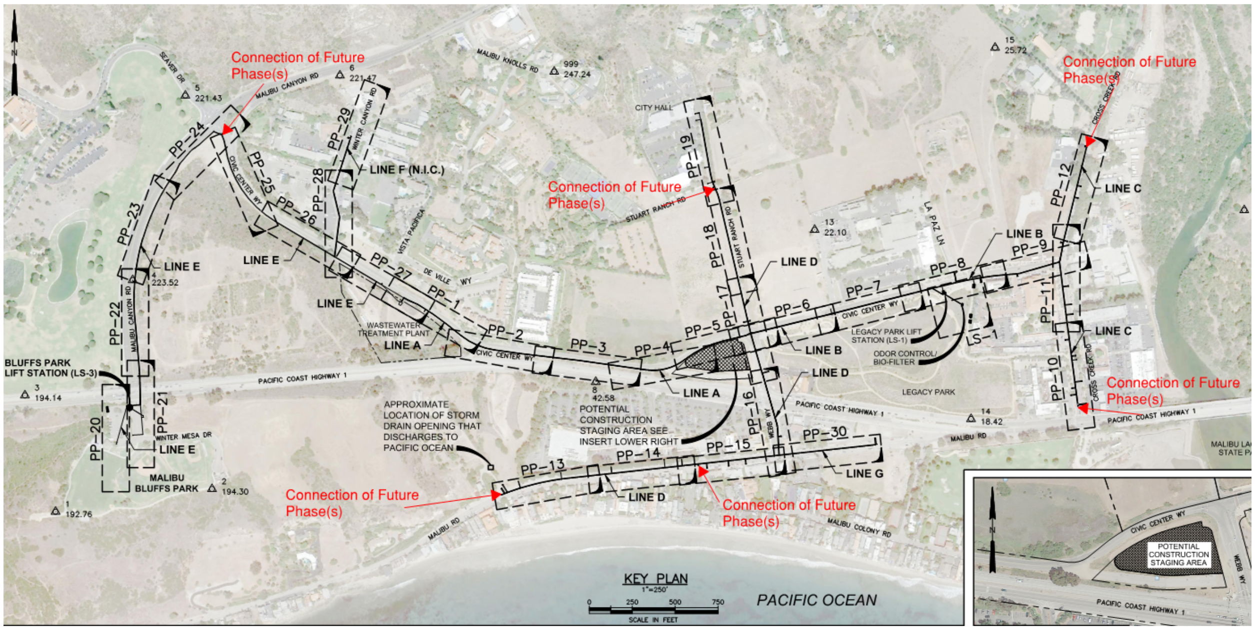
[3]. Basin Plan Groundwater Quality Objectives.

2. The City shall monitor groundwater in both the Shallow Alluvium and Civic Center Gravels for a minimum of two years prior to operation of the Civic Center Facility to establish ambient groundwater quality in both aquifers. The City shall demonstrate that the discharges from the Civic Center Facility do not contribute to the degradation of groundwater quality above either the limits specified in Table 10 or ambient groundwater quality as established by monitoring. This shall be accomplished by compliance with the effluent limits on Table 9.

4.2 Basis of Design – Sewer Collection System

The overall layout of the sewer collection system for all three phases of the project was presented in Figure 4.1, above. The layout of Phase 1 of the system is shown in Figure 4.3 below, which is taken from Plan G-3 of the construction documents.

Figure 4.3 – Layout of Phase 1 Sewer Collection System with Connection Points for Expansion



Sizing of Sewer Collection System

The sewer collection system was designed to serve Phase 1 flows, with eventual expansion to serve estimated Phase 2 and 3 flows. Because Phase1 sewers are closest to the treatment plant, they become the 'backbone' for the eventual expansion of service to future phases. Therefore, the Phase 1 sewers and the Legacy Park pump station were oversized to accommodate estimated build out conditions of the future phases. Also shown in Figure 4.3 are the connection points for expansion of the system to future phases.

In general, the sewer collection pipelines were designed to provide a capacity of at least 2.5 times the estimated average daily flow generated in the upstream areas of service to accommodate diurnal peaking. However, the actual capacity of the sewer system pipelines exceeds this criterion by a wide margin due to use of a minimum diameter of 8-inches, 'rounding the calculated diameter up' to the next available pipe diameter, and/or use of a steep ground slope when available.

The sewer pipelines that begin on Malibu Road, in front of the injection wells, and continue north on Webb Way, and then east to the Legacy Park Pump Station are sized to accommodate back flushing of the injection wells. This flowrate is estimated to be 560 gallons per minute and should be programmed to occur during night hours (when wastewater flows are low) to avoid overloading the pumps at Legacy Pump Station that could occur if a well was back flushed during the diurnal peak in wastewater flow (i.e. peak restaurant and commercial flows).

Design Provisions for 'Bottle Tight' Sewer Collection System

The collection system was designed to be as bottle tight as possible to prevent infiltration of brackish groundwater, and to minimize flows to the treatment plant and injection wells. Brackish water would introduce dissolved salts to the system, which could severely limit reuse of treated effluent for landscape irrigation and cooling tower use. To minimize the infiltration of groundwater, the sewer collection system is designed with heat fusion welded joints and the manholes are equipped with flexible watertight connections for the inlet and outlet pipes. As the system is expanded into Phase 2 and 3, these types of measures should be continued.

The City also received approval from the Department of Drinking Water to construct recycled water distribution mains and sewer mains in the same trench with closer than normally allowed separation. The basis of this approval is that the sewer main was 'jointless' due to the heat fusion welded joints. This approval by Department of Drinking Water is not required by law, but was obtained to maintain good relationships with the regulatory agencies while the City was negotiating its RWQCB permit.

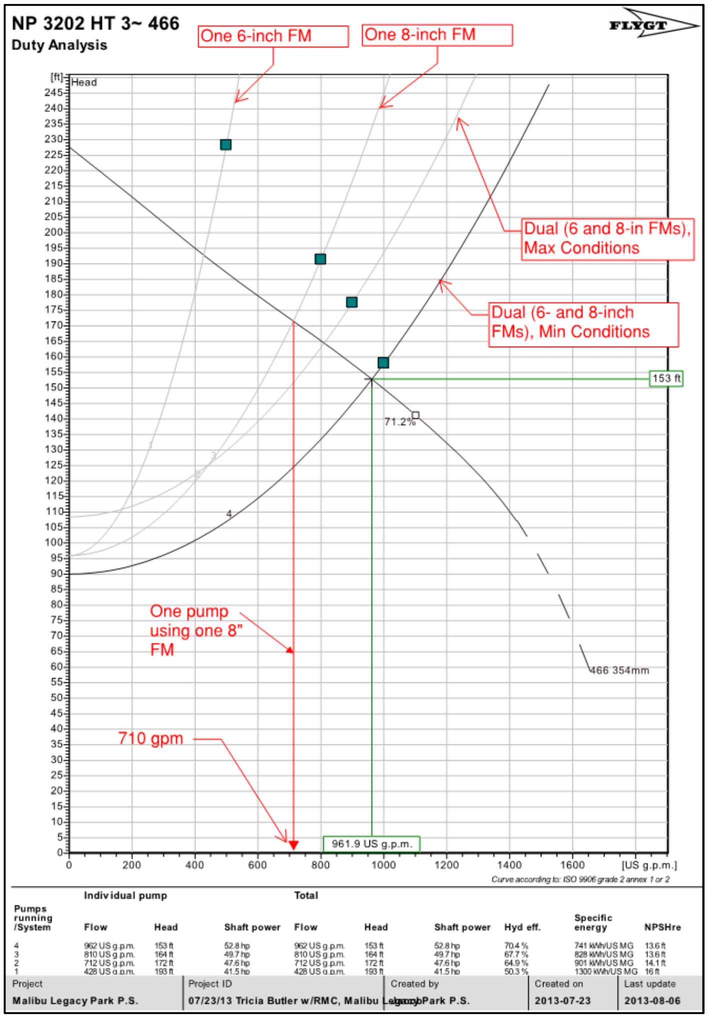
Capacity of Legacy Park Pump Station

Legacy Park Pump Station was constructed with two submersible pumps, with variable speed drive, and with provisions for the future addition of a third pump to meet expansion needs in Phase 2 and 3 of the project. The pump station is also constructed with twin 8-inch forcemains to provide redundancy and capacity to meet the span of flows from early project implementation to Phase 3 buildout conditions.

The pump and system head curves for the Legacy Park Pump Station are shown in Figure 4.4 below. As shown in that figure, the capacity of the pump station using one pump and one 8-inch forcemain is approximately 710 gallons per minute at full speed. (The figure shows other forcemain combinations that were analyzed during design.) As described elsewhere in this report, this pump station is sized to convey the backwash flow from the injection wells. The design assumed that the backwash would occur during nighttime hours, when wastewater flows are at a minimum. [Note: the single main pump capacity is different than the 780 gpm capacity shown on Plan G-6 WWTP Design Criteria due to variations in assumed water levels in the wet well, discharge elevation at the treatment plant, and final forcemain internal diameter.]

Using two forcemains and two pumps would double the capacity of the pump station to over 1400 gallons per minute. The pump station is designed to allow the installation of a third pump (two duty, plus one standby unit) as the project is expanded to Phase 2 and 3.

Figure 4.4 – Pump and System Curves for Legacy Park Pump Station.

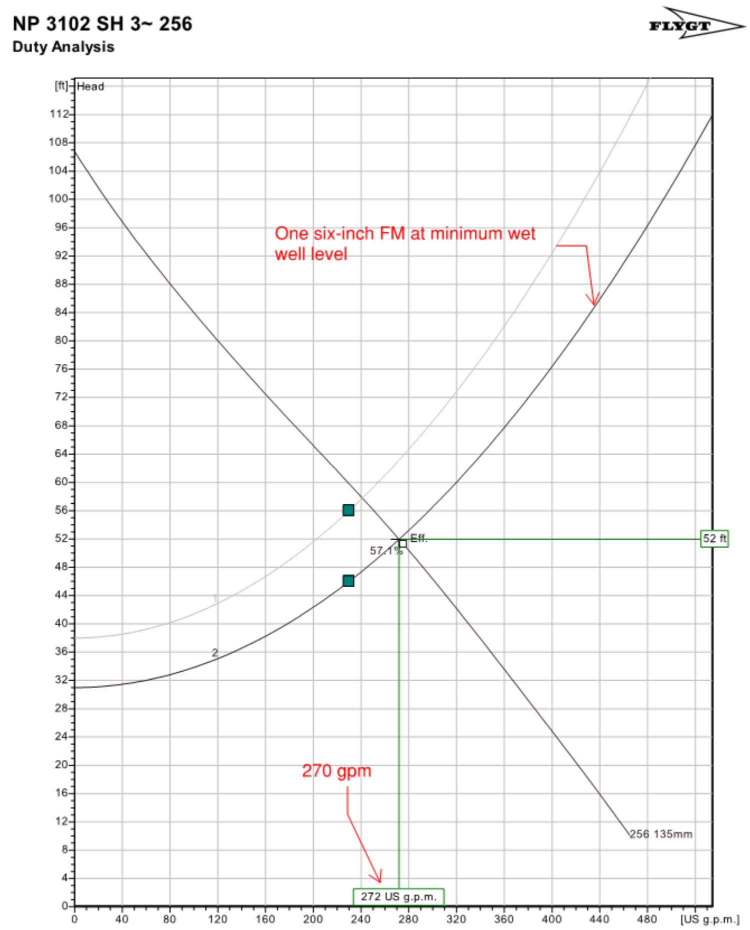


Capacity of Bluffs Park Pump Station

The Bluffs Park Pump Station is a package pump station with two fixed speed submersible pumps (one duty, plus one standby pump). Because the pump station's forcemain crosses under Pacific Coast Highway, twin 6-inch forcemains were provided for redundancy purposes.

The capacity of the pump station is approximately 270 gallons per minute, using one 6-inch forcemain. Its wet well has a volume of approximately 820 gallons. The system head curve for this pump station is shown in Figure 4.5 below. [Note: this capacity is different than the 250 gpm capacity shown on Plan G-6 WWTP Design Criteria due to variations in assumed water levels in the wet well and final forcemain internal diameter.]

Figure 4.5 – Pump and System Curves for Bluffs Park Pump Station



	Individual pump			Total					
Pumps running /System	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
2	272 US g.p.m.	52 ft	6.24 hp	272 US g.p.m.	52 ft	6.24 hp	57.1 %	350 kWh/US MG	11.5 ft
1	241 US g.p.m.	57.8 ft	6.26 hp	241 US g.p.m.	57.8 ft	6.26 hp	56.3 %	396 kWh/US MG	10.1 ft

Project	Project ID	Created by	Created on	Last update
Bluffs Park Lift Station	8/29/2013 Tricia Butler w/RMC, Bluffs Park Lift Station		2013-08-29	2013-08-29

4.3 Basis of Design – Recycled Water Distribution System

The recycled water distribution system constructed in Phase 1 consists of distribution pipelines, two booster pump stations, and a storage tank. These components are described in the following sections.

4.3.1 Distribution Pipelines

The distribution pipelines generally follow the layout of the sewer collection system to allow return of Title 22 treated effluent to all properties that are connected to the sewer collection system. The system is designed to be expanded as Phase 2 and 3 of the project are implemented. Distribution pipelines near the treatment plant have been oversized to allow for this extension of service in future phases.

The recycled water distribution system also conveys treated effluent to the groundwater injection wells. Pressure control valves at each well maintain back pressure in the distribution system while also reducing the pressure of water fed to the wells.

There are two pressure zones in the distribution system: the Upper Zone which serves parcels ‘uphill’ from the treatment plant and the Lower Zone which serves parcels ‘downhill’ from the plant.

The crossing of Pacific Coast Highway includes twin 8-inch distribution pipelines to provide a spare, redundant crossing. This line is critical because it is the connection to the injection wells that provide effluent disposal to all flows that are not recycled.

4.3.2 Distribution Pump Stations

A distribution pump station for each pressure zone is located at the treatment plant. Both pump stations are variable speed drive and are connected to a hydropneumatic tank that minimizes cycling of the pump station when low flow rates are experienced in the distribution systems.

Upper Zone Pump Station

The upper zone pump station is designed to provide up to approximately 120 to 140 gallons per minute with a delivery pressure of 80 psi at Bluffs Park. This capacity is sufficient to supply 43,000 to 50,000 gallons over the course of a six-hour irrigation period, which is deemed adequate to supply irrigation to Bluffs Park, the new homes in the Crummer development (adjacent to Bluffs Park), the proposed memorial park on Malibu Canyon Rd, plus additional reuse demand in Phase 2 and 3.

Phase 1 constructed one duty, plus one standby pump. Provisions are in place to install a third pump to meet the expansion needs of Phase 2 and Phase 3.

Lower Zone Pump Station

The lower zone pump station is designed to provide up to approximately 300 to 575 gallons per minute (432,000 to 828,000 gallons per day). The lower zone pump station provides flow to the recycled water users in the lower zone and flow to the groundwater injection wells. During periods of zero recycled water use, this pump station will convey all treated flow to the injection wells.

This pump station was designed to provide a delivery pressure of approximately 50 psi at City Hall, the highest connection in Phase 1 in the lower zone. Delivery pressure along Malibu Road, the lowest connected area in the lower zone, is approximately 78 psi. As noted elsewhere in this report, this pressure is reduced at each injection well to a lower pressure suitable for injection via pressure reducing/back pressure control valves at each well.

Phase 1 constructed one duty, plus one standby pump. Provisions are in place to install a third pump to meet the expansion needs of Phase 2 and Phase 3.

Additional Pump Stations for Phase 2 and Phase 3

Additional booster pump stations will be needed on the recycled water distribution system as the project expands into Phase 2 and 3. These pump stations were not located during the design of Phase 1, and therefore the locations and capacities of the future booster pump stations will have to be assessed during the design of future phases.

4.3.3 Recycled Water Storage

Existing Water Storage

As part of Phase 1 of the project, 50,000 gallons of recycled water storage is provided at the treatment plant via the re-purposed dosing/surge tank from the existing trickling filter plant at the site. The purpose of this tank is to store recycled water throughout the day so that irrigation demands (presumed to occur predominately during night time hours) can be met. This volume was considered adequate at the start of design for the recycled water demand envisioned at that time for the startup of Phase 1.

Additional Water Storage

As Phase 1 flows increase towards buildout, and as Phase 2 and 3 are implemented, the volume of storage should be increased, if the amount of water recycling is to be maximized.

An example of this is the proposed memorial park on Malibu Canyon Road, which was not envisioned until after design was completed. This proposed development would require up to 22,000 gallons per day of irrigation flow, which would be used during night time hours. This single development would use more than 40 percent of the storage being constructed in Phase 1, leaving an inadequate amount of storage for night time irrigation of Bluffs Park (12,000 gallons/night), Perenchio golf course (15,000 gallons/night), Legacy Park, and other night time irrigation demands. To remedy this situation, the City is negotiating with the developers of the memorial park that they provide an additional 18,000 gallons of storage to the system (located at the treatment plant or at the memorial park).

In a similar manner to the above example, as additional night time irrigation users are connected to the system, and as the project moves into Phase 2 and Phase 3, additional recycled water storage will be needed. The additional storage should be located out in the distribution system. Design of Phase 1 facilities did not ‘locate’ or size these storages because it will be dependent upon the type of recycled water users that are to be served (night time irrigation vs. daytime cooling water use), their phasing, and their locations.

4.4 Basis of Design – Groundwater Injection Wells

The groundwater injection wells were designed with a capacity sufficient to dispose of all treated effluent if recycled water use falls to zero, as might occur during the wet season of an el Nino year. Two related goals were assessed to estimate the maximum injection capacity of the injection well facilities:

- Ensure that the injected water would migrate to the ocean, and not Malibu Lagoon
- Prevent unacceptable raising of the water table (groundwater mounding effects)

Extensive groundwater modeling was conducted to estimate optimized locations and injection capacities that were estimated to achieve the above two goals. Soil borings and hydraulic field testing were conducted to build and calibrate the modeling.

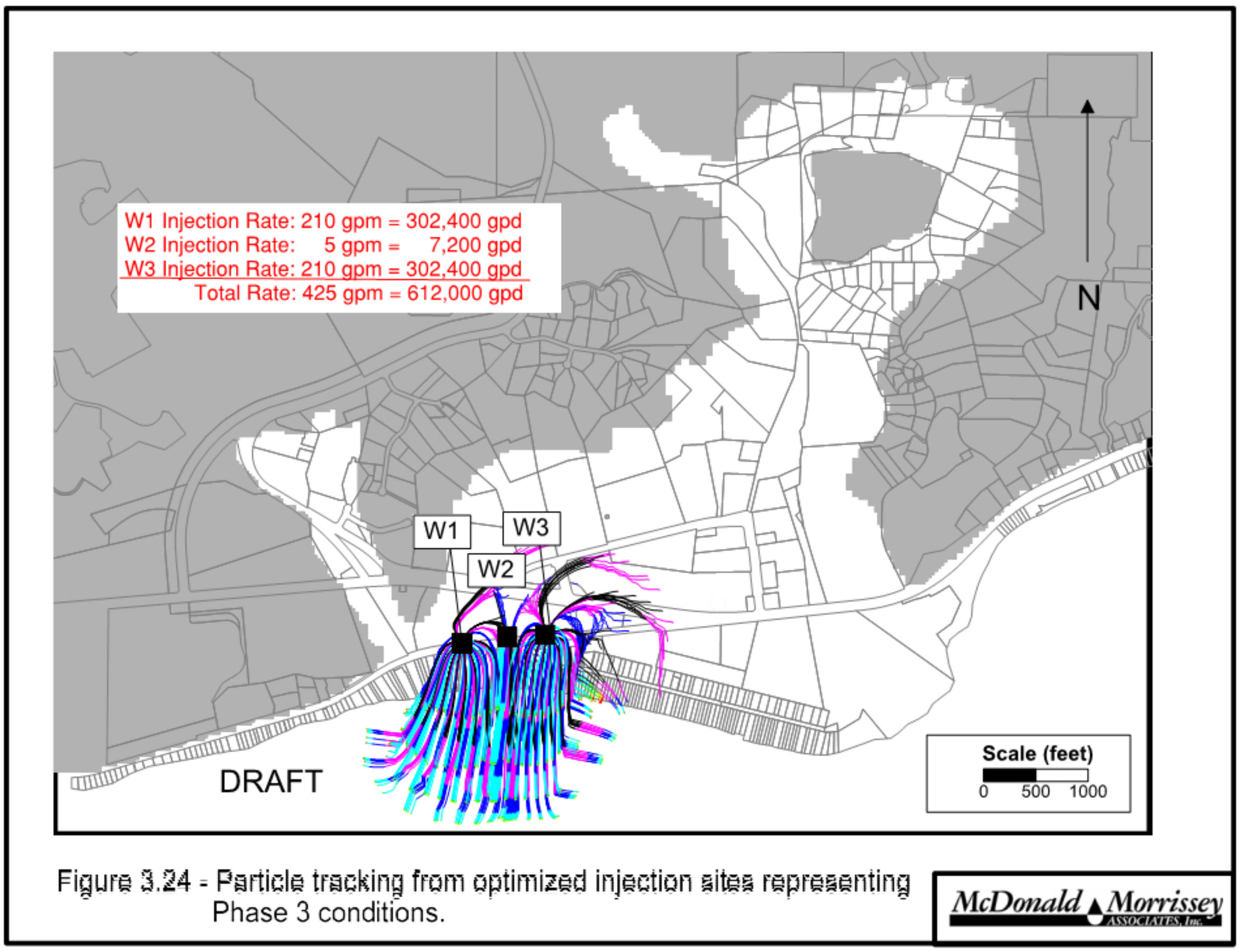
The results of the modeling effort are presented in Appendix E – Groundwater Modeling Analysis of Proposed Wastewater Dispersal – City of Malibu, Malibu, California by McDonald Morrissey. The capacity estimates based on this modeling are presented in Table 4.6 below.

Table 4.6 – Capacity Limit of Injection Wells to Ensure Migration to Ocean

Phase	Total Injection Capacity, gallons/day	Number of Duty Wells	Location
1	311,000	1	Along Malibu Road
2	498,000	2	Along Malibu Road
3	612,000	3	Along Malibu Road

The fate of water injected at the Phase 3 rate shown in Table 4.6, is shown in Figure 4.6 below (excerpted from McDonald Morrissey). As shown in that figure, three duty injection wells were needed to achieve an injection capacity sufficient to meet Phase 3 flow rates. Most of the Phase 3 injection capacity shown in Table HHH is achieved with only two wells: Injection Well #1 and #3 provide 604,800 gallons/day capacity (see page 57 of McDonald Morrissey).

Figure 4.6 – Groundwater Modeling Results Assuming 612,000 Gallons/day Injection



Although groundwater modeling indicated that one duty well was needed for Phase 1 flows, three wells were constructed to provide a wide margin of safety (in terms of capacity) for the first phase, in the event that well performance proved to be less than predicted during design.

The wells are supplied water from the recycled water distribution system. Pressure control valves at each well head maintain back pressure in the distribution system and reduce the pressure of water fed to the wells. These well head control valves open to feed the wells when the downstream pressure (relative to the control valve) drops below a set point (initially set for 5 psi) and the upstream pressure in the distribution system exceeds a set point (initially set for 78 psi).

The wells are also equipped with 'down hole' flow control valves that regulate the injection flowrate to a maximum value that can be adjusted in the control software. The 'down hole' flow control valves are tied to the injection flow meter at each well. If the injection flow rate exceeds the preset maximum for the well, the 'down hole' flow control valve will partially close to reduce the injection flowrate, and the control software will open a second injection well to take the excess flow. For Phase 1, a single injection well will probably be sufficient to dispose of all water generated. During this time, the maximum flowrate for each well should not exceed the values shown in Table 4.7 (Injection Capacity of Wells as Proven During Construction). In future phases, when effluent flow rates have increased, simultaneous operation of more than one well will be needed, and the individual maximum set points will have to be reduced so that the total no two wells can inject more than approximately 600,000 gallons/day to avoid transmission of injected water to Malibu Lagoon. (This is an estimate based on the results shown in Figure 4.6 which depicts results of 604,000 gallons/day via two wells and a trivial amount via a third well.)

Capacity of Individual Wells as Tested During Construction

The three initial injection wells have been constructed and the injection capacity of each well has been tested individually with potable water. The results are presented in Table 4.7 below. Based on the results shown in that table, it may be possible that these first three wells are sufficient for all phases of the project. However, the results in Table 4.7 were achieved testing one well at a time with potable water. Injection with plant effluent may reduce the injection capacity due to precipitation 'clogging' of the aquifer. Although geochemical analysis estimates this risk to be low, the City should monitor the injection performance of the wells to confirm this analysis. (See Appendix F – Geochemistry Evaluation for the City of Malibu Legacy Park Area Injection Well Project by Glanzman Geochemical LLC.)

Table 4.7 – Injection Capacity of Wells as Proven During Construction

Well No.	Estimated Injection Capacity, gallons/minute	Estimated Injection Capacity, gallons/day
IW-1	424	611,000
IW-2	393	566,000
IW-3	284	409,000

The injection capacities listed in Table 4.7 reflect testing of the constructed wells, one well at a time, and do not reflect the injection capacities of two or three wells operating simultaneously, as would be required in Phase 3. Additional groundwater modeling, using the test results from the constructed wells, would be needed to estimate whether the injection capacities listed in Table 4.6 could be increased.

Appendix A - Malibu Flow Assumption TM

Appendix B - Master Flow and Load List

Appendix C - City of Malibu Recycled Water Use and Storage Study

Appendix D - RWQCB Order No. R4-2015-0051 WDR/WRR Permit

Appendix E - Title 22 Engineer's Report

Appendix F - Groundwater Modeling Analysis

Appendix G - Geochemistry Evaluation