8.0 HYDRAULIC MODEL CALIBRATION

8.1 HYDRAULIC MODEL UPDATES

The City provided the current hydraulic model from the previous Master Plan and hydraulic modeling effort, which was last updated in 2010, and is in InfoWater software provided by Innovyze. To update the hydraulic model, the most recent GIS database and available as-built plans were obtained from the City for projects and improvements completed since the 2010 WMP. For updates to pump facilities and controls, workshops were conducted with the City engineering staff and operations staff to verify current operations.

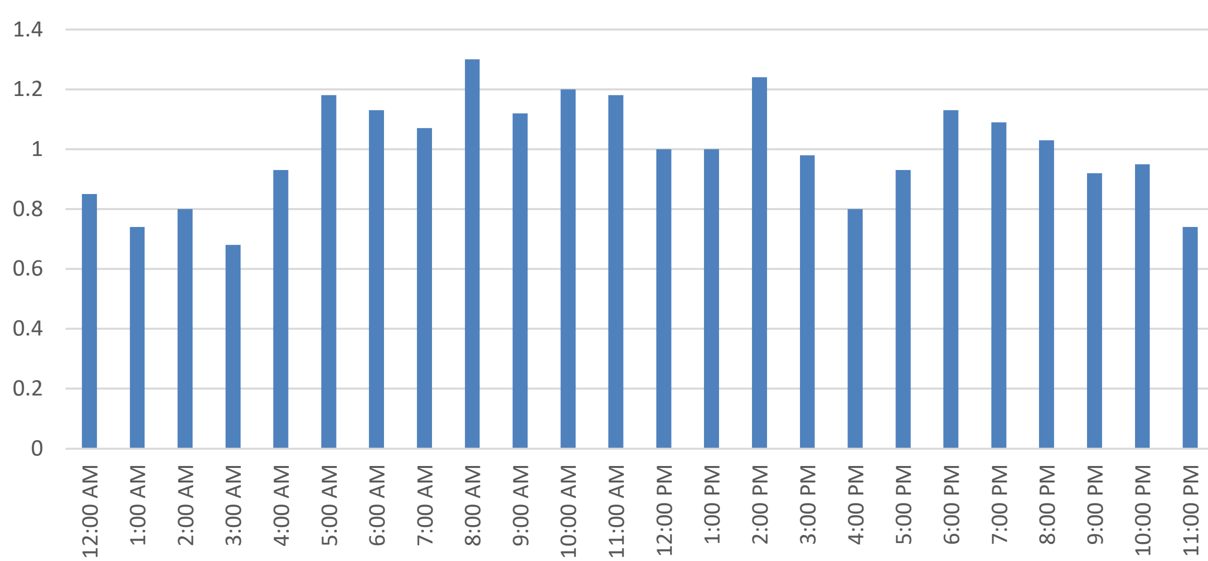
Demands

The water demand distribution was based on ADDs, MDDs, and diurnal demand patterns updated for this Master Plan as described in Chapter 5.

Diurnal Demand Pattern

A diurnal demand pattern was developed based on the SCADA information provided by the City for the field-testing day. The diurnal pattern shown in Figure 8-1 represents the system-wide pattern based on the production data from the groundwater wells and imported water connection.

Figure 8-1 – Diurnal Demand Pattern



Pump Station Controls

Peck Booster Pump Station - Under existing conditions and for calibration of the model, Peck Facility booster pumps were off since the Peck Facility was under construction. For future planning years, Peck

Facility was turned on in the model and pump controls were applied. The design plans and controls were used to add the proposed Peck Facility in the model.

Block 35 Booster Pump Station - These pumps are used primarily to provide sufficient water and pressure to the system during high demand periods. For existing conditions, water is supplied to the system from MWD. Water bypasses the Block 35 Pump Station to serve the system when demands are low, or system pressures as provided by MWD are above the Block 35 Pump Station pump discharge pressure set point. The Block 35 Pump Station pumps are equipped with variable speed drives and are controlled by the discharge pressure. When demand increases and pressures drop below the Block 35 Pump Station set point, one pump will turn on. Additional pumps turn on as pressures continue to drop and additional flow is needed to maintain the discharge pressure set point. The Block 35 Pump Station is also enabled or disabled based on the Block 35 Ground Level Tank water level. For future planning years, pump controls are adjusted to the model to reflect the existing conditions and future planning years accordingly.

During the period when this Master Plan was completed, the Peck Facility was under construction and the Block 35 Elevated Tank was offline, and pumps at Block 35 operated on pressure controls to provide adequate pressure to the system. Historically the system has been running on pressure controls only when the Block 35 Elevated Tank was taken out of service; otherwise, the elevated tank sets the pressures in the system and the Peck Pump Station is controlled by the water level in the Block 35 Elevated Tank.

The pumps at Larsson Pump Station are set to maintain a discharge pressure of 57 psi. Additional pumps are set to turn on if the discharge pressure falls below 53 psi.

The pump at Second Street Pump Station serves the higher-pressure zone and is set to maintain a discharge pressure of approximately 50 psi, about 7 psi below Larsson Pump Station’s pressure set points, serving as a back-up for the higher zone.

Valve Controls

Flow control valves are included in the model to represent the MWD flow from the 45-inch transmission main and the automatic flow control valves that lead to the Peck and Block 35 facilities. These valve settings are updated in the model to match existing demand conditions, SCADA information for calibration, and operational scenarios. Even with Peck Facility offline for construction, flow can still be provided to the system through the flow control valve and 14-inch pipeline that leads to the Peck Facility.

8.2 HYDRAULIC MODEL CALIBRATION

Once the hydraulic model was updated, field testing was performed to collect flow and pressure data to calibrate the model. Field test locations are summarized in Table 8-1. The hydraulic model was calibrated to improve the accuracy of the model in predicting current system performance, which can then be used to identify any system deficiencies and recommend pipelines and facilities to address these system deficiencies. The results of the field pressure recordings and corresponding pressures from the hydraulic model for the hydrants and the data loggers are summarized in Tables 8-2 and 8-3, respectively. The difference between calibration and field test results averaged 4 percent for hydrants and 6 percent for loggers, which is within the 5 to 10 percent range for accurately calibrating a model.

8.2.1 Field Testing

Field testing was conducted on January 19, 2021, from 8AM to 4PM. A total of 11 locations were tested for the low (Main) and high (Larsson) pressure zones. Additionally, four pressure loggers were provided at other locations within the tested pressure zones. The locations of the tests and loggers are listed in Table 8-1 and shown in Figure 8-2.

Table 8-1 – Hydrant Flow Testing Locations and Conditions

Test No.	Test	Zone	Type	Location	Flow Hydrant No.
1	Test A & B	Main	Flow	2208 Faymont Avenue	446
			Residual	2208 Harkness St	449
2	Test A & B	Main		1800Rosecrans Avenue	514
			Residual	1800F Rosecrans Ave	513
3	Test A & B	Main		22 Fairway Drive	539
			Residual	2 San Miguel Ct	540
4	Test A & B	Main		598 36th Street	215
			Residual	599 35th St	218
5	Test A & B	Main		4419 Highland Avenue	315
			Residual	318 45th St	319
6	Test A & B	Main		3020 Alma Avenue	279
			Residual	3201 Highland Ave	282
7	Test A & B	Main		604 15th Street	162
			Residual	1428 N Ardmore Ave	163
8	Test A	Larsson		828 8th Street	343
			Residual	712 Pacific Ave	344
9	Test A	Main		100 Manhattan Avenue	378
			Residual	121 Neptune Ave	379
10	Test A	Larsson		1221 Tennyson Street	64
			Residual	1203 Artesia Blvd	69
11	Test A & B	Main		1760 Nelson Avenue	22
			Residual	1769 Nelson Ave	23

Two tests were performed at each location under the following operation conditions, except for tests 8, 9, and 10.

- Test A – Normal operations
  - Water is supplied from MWD and flow is split towards Peck Facility and Block 35 Facility, even though Peck Facility was offline
- Test B – Supply to Block 35 Facility only
  - Water is supplied from MWD and flow is split towards Block 35 Facility

Detailed data collected in the field is provided in Appendix A for each hydrant flow test.

Reservoir
Groundwater Well
Import Water Turnout
Interagency Connection (Intertie)
Pressure Monitoring Station
Flow Control Valve
Booster Pump Station (BPS)
Hill Zone
Main Zone
City of Manhattan Beach
Outside Agency Pipeline
Flow Hydrant
Logger Hydrant
Pressure Hydrant

Existing Pipelines

Less than 10" Diameter
10" Diameter and Greater
Well Transmission Main
MWD Distribution Main

Note:
CWS = California Water Service
ES = City of El Segundo
MWD = Metropolitan Water District

N

1,500 750 0 1,500 Feet

Date: 12/6/2021

TITLE:

Figure 8-2 – Hydrant Flow Testing Locations

PROJECT:
City of Manhattan Beach Water Master Plan

COORDINATE SYSTEM:
NAD 1983 StatePlane California V FIPS 0405 Feet

Stantec

\\US0300-ppfss01\workgroup\1840\active\184031379\gis_MXDs\Figure 8-2. Hydrant-Testing-Locations_TblL.mxd Revised: 2021-12-09 By: apinjanyan

8.2.2 Hydraulic Model Calibration

Model calibration is the process of comparing model results with field results and adjusting model parameters where appropriate until the model results match corresponding field measurement data, within an acceptable difference. Typical adjustments include adjustments to system connectivity, operational controls, facility configurations, diurnal patterns, elevations, and roughness coefficients for pipelines. Several indicators are used to determine if the model accurately simulates field conditions: water levels in storage tanks, supply flows, and static and residual pressures from fire flow tests. This also acts as the “debugging” phase for the hydraulic model where modeling discrepancies or data input errors are discovered and corrected.

The hydraulic model is calibrated based on steady-state conditions simulating fire hydrant flow tests in the model to match results from the day(s) of field testing. Typically, the model is calibrated under MDD conditions. This rationale being that a water distribution system under MDD conditions is stressed to a greater extent and, as such, a more accurate model can be developed. However, due to project schedule limitations, field testing was completed in January, which reflected ADD conditions, and the model was calibrated under ADD conditions. The hydraulic model has been calibrated for average day conditions only without Peck Reservoir and Pump Station operating. It is recommended that the model be calibrated for MDD conditions during the summer months and with Peck Reservoir and Pump Station operational. Once the model is calibrated, the water system should be re-evaluated at that time for all MDD scenarios.

Field Data

City operation staff provided 24-hour SCADA information for the day of the field testing. The SCADA data included the following facilities and data for every minute for that 24-hour period:

- MWD
    - MWD total supply flow
    - MWD flow toward Peck Facilities
    - MWD downstream pressure
- Grandview discharge pressure
- Block 35 Facility
    - Reservoir level
    - Pump discharge pressure
    - Pump discharge flow
- Larsson Pump Station
    - Pump discharge and suction pressure
- Second Street Pump Station
    - Pump discharge and suction pressure

The model was updated with a calibration scenario containing steady-state simulations for each of the 11 test locations to reflecting operations conditions for Test A and Test B as described in the field-testing section. For each test location, the model simulates two scenarios, one "static" simulation prior to the hydrant being opened to flow and one "dynamic" simulating the hydrant flowing where the flow and residual pressure can be evaluated. For each flow test simulation, the model results are compared with the field measurements. It is considered acceptable to match field results within 10 percent tolerance.

The initial step in the calibration process was to update the demands in the system to match the demands for the day and time of the tests. This was done by analyzing the boundary supply conditions and production facilities from the SCADA information. Once the demands were updated in the model, each flow test simulation was calibrated for the boundary conditions for the pressure zone of the test to match tank levels, wells, and pump stations status in the SCADA readings. After the demands and boundary conditions were satisfactorily calibrated, pressure logger and static readings were compared with field data, and ground elevations at each hydrant data point was verified.

The model was ultimately calibrated to match field pressure and flow data at the test locations by adjusting the c-factors, or roughness coefficient, of the pipelines. The c-factor has a direct impact on the pipe head loss and therefore the resulting pressures at upstream and downstream model junction nodes. The c-factor is estimated based on pipe material and pipe age, or year of installation. An older pipe with small diameter and many service connections will be estimated to have a lower c-factor than a large new diameter pipe with no connections and smooth pipe material such as PVC. These model c-factors were adjusted accordingly for the model results to match the field testing results within the acceptable tolerance of 10 percent.

Calibration Results

Table 8-2 and Table 8-3 show the results of the field pressure recordings and corresponding pressures from the hydraulic model for the hydrants and the data loggers. Hydrant tests 4, 5 and 7 resulted in percentage differences higher than 10. Test 5 and 7 locations resulted in up to 20 psi higher residual pressures in the model compared to the field data. This may be due to valves in the area that may not be fully opened or unknowingly closed. The area also contains older pipes and tuberculation may be worse at these locations than is reasonably assumed for similar pipes in the surrounding area. The average difference between field pressures and hydraulic model pressures for the hydrants and data loggers were 6 percent and 4 percent respectively. These results are within 10 percent tolerance, which meets the calibration criteria.

Recommendation for Pipe Coupons

As shown in Table 8-2, the model results are consistently higher at test locations 4, 5 and 7. It is recommended that operations staff test the valves in the area of these tests to verify that all valves in the system are fully open. If these are found to be fully open, pipe coupons should be conducted for the pipelines in the area to determine the amount of tuberculation inside the pipe. These locations would include the pipelines in Highland Avenue, Crest Drive, Blanche Road, Ardmore Avenue and 15th Street.

Table 8-2 – Hydrant Results

Field Test Tab	Test Number	Test	Test	Time	Flow Hydrant ID	Residual Hydrant ID	Flow Hydrant (psi)	Flow Hydrant (gpm)	Residual Hydrant (psi)	Model Flow Hydrant (gpm)	Model Residual Hydrant (psi)	% difference from Model to Field
test-1	1A	static	start	8:13 AM	FH 446	FH 449			93		94	0.9%
test-1	1A	residual	end	8:16 AM	FH 446	FH 449	26	2,021	76	2,021	82	6.9%
test-1	1B	static	start	8:28 AM	FH 446	FH 449			97		98	0.8%
test-1	1B	residual	end	8:30 AM	FH 446	FH 449	29	2,134	79	2,021	80	1.4%
test-2	2A	static	start	8:56 AM	FH 514	FH 513			97		98	0.8%
test-2	2A	residual	end	8:58 AM	FH 514	FH 513	39	2,475	67	2,475	72	6.7%
test-2	2B	static	start	9:05 AM	FH 514	FH 513			92		92	0.1%
test-2	2B	residual	end	9:07 AM	FH 514	FH 513	39	2,475	68	2,475	70	2.7%
test-3	3A	static	start	9:28 AM	FH 539	FH 540			97		98	1.3%
test-3	3A	residual	end	9:31 AM	FH 539	FH 540	34	2,311	82	2,315	85	4.0%
test-3	3B	static	start	9:41 AM	FH 539	FH 540			94		94	0.0%
test-3	3B	residual	end	9:42 AM	FH 539	FH 540	33	2,276	79	2,315	84	6.2%
test-4	4B	static	start	10:04 AM	FH 215	FH 218			86		86	0.1%
test-4	4B	residual	end	10:06 AM	FH 215	FH 218	29	2,134	68	2,280	70	2.6%
test-4	4A	static	start	10:15 AM	FH 215	FH 218			84		75	11.9%
test-4	4A	residual	end	10:17 AM	FH 215	FH 218	30	2,170	70	2,170	70	0.3%
test-5	5A	static	start	10:40 AM	FH 315	FH 319			69		71	2.6%
test-5	5A	residual	end	10:42 AM	FH 315	FH 319	30	2,170	33	2,170	50	34.0%
test-5	5B	static	start	10:51 AM	FH 315	FH 319			69		70	1.7%
test-5	5B	residual	end	10:53 AM	FH 315	FH 319	30	2,170	32	2,170	51	37.3%
test-6	6B	static	start	11:26 AM	FH 279	FH 282			79		81	2.5%
test-6	6B	residual	end	11:28 AM	FH 279	FH 282	18	1,681	69	2,170	74	6.1%
test-6	6A	static	start	11:43 AM	FH 279	FH 282			82		82	0.1%
test-6	6A	residual	end	11:45 AM	FH 279	FH 282	18	1,681	70	1,681	75	7.0%
test-9	9A	static	start	12:45 PM	FH 378	FH 379			117		117	0.1%
test-9	9A	residual	end	12:47 PM	FH 378	FH 379	46	2,688	99	2,688	104	4.9%
test-11	11A	static	start	1:17 PM	FH 22	FH 23			93		92	0.9%
test-11	11A	residual	end	1:19 PM	FH 22	FH 23	31	2,206	77	2,206	71	7.8%
test-11	11B	static	start	1:33 PM	FH 22	FH 23			91		94	3.2%
test-11	11B	residual	end	1:35 PM	FH 22	FH 23	22	1,859	79	2,206	77	2.4%
test-10	10A	static	start	2:32 PM	FH 64	FH 69			81		85	5.2%
test-10	10A	residual	end	2:34 PM	FH 64	FH 69	45	1,126	63	1,126	67	5.9%
test-8	8A	static	start	2:56 PM	FH 343	FH 344			83		88	5.8%
test-8	8A	residual	end	2:58 PM	FH 343	FH 344	36	1,007	73	1,007	73	0.5%
test-7	7A	static	start	3:20 PM	FH 162	FH 163			77		79	3.0%
test-7	7A	residual	end	3:22 PM	FH 162	FH 163	13	1,429	60	1,434	73	17.9%
test-7	7B	static	start	3:38 PM	FH 162	FH 163			82		84	2.9%
test-7	7B	residual	end	3:40 PM	FH 162	FH 163	13	1,429	58	1,434	73	20.5%
											Average	**6%**

Table 8-3 – Logger Results

Field Test Tab	Test Number	Test	Test	Time	Logger Hydrant 1 (psi)	Logger Hydrant 2 (psi)	Logger Hydrant 3 (psi)	Logger Hydrant 4 (psi)	Model Logger Hydrant 1 (psi)	Model Logger Hydrant 2 (psi)	Model Logger Hydrant 3 (psi)	Model Logger Hydrant 4 (psi)	% difference from Model to Field Model Logger Hydrant 1	% difference from Model to Field Model Logger Hydrant 2	% difference from Model to Field Model Logger Hydrant 3	% difference from Model to Field Model Logger Hydrant 4
test-1	1A	static	start	8:13 AM	80.8	90	71	64	84	95	74	67	4%	5%	4%	5%
test-1	1A	residual	end	8:16 AM	78.1	92	70	62	83	95	74	66	6%	3%	5%	6%
test-1	1B	static	start	8:28 AM	85.4	93	76	68.3	89	100	78	71	4%	7%	3%	4%
test-1	1B	residual	end	8:30 AM	77.8	92	71	61.1	83	96	74	66	6%	4%	5%	7%
test-2	2A	static	start	8:56 AM	87.6	97	78	70.9	88	100	78	71	1%	3%	0%	1%
test-2	2A	residual	end	8:58 AM	78.1	91	69	60.7	82	94	72	64	4%	3%	4%	6%
test-2	2B	static	start	9:05 AM	83	85	71	63.2	83	87	73	66	0%	3%	2%	4%
test-2	2B	residual	end	9:07 AM	77	85	70	59.7	80	93	72	63	3%	9%	3%	5%
test-3	3A	static	start	9:28 AM	84.6	86	75	67.8	89	91	78	72	4%	6%	4%	5%
test-3	3A	residual	end	9:31 AM	78.6	84	70	61.7	81	86	72	64	3%	3%	3%	4%
test-3	3B	static	start	9:41 AM	82.9	84	74	65.4	84	89	75	67	2%	5%	1%	3%
test-3	3B	residual	end	9:42 AM	75.2	82	68	56.8	80	86	73	63	6%	5%	7%	10%
test-4	4B	static	start	10:04 AM	86	85	76	68	88	91	78	70	2%	6%	2%	3%
test-4	4B	residual	end	10:06 AM	73.3	83	71	60	77	86	73	63	5%	3%	2%	4%
test-4	4A	static	start	10:15 AM	72.4	81	66	58.3	77	82	66	60	6%	2%	0%	2%
test-4	4A	residual	end	10:17 AM	75	85	71	61.4	79	87	73	65	6%	3%	3%	5%
test-5	5A	static	start	10:40 AM	86	85	76	69.5	89	93	78	72	3%	8%	3%	4%
test-5	5A	residual	end	10:42 AM	75.1	84	71	62.1	79	89	73	65	5%	6%	3%	5%
test-5	5B	static	start	10:51 AM	86.8	85	77	70.2	88	92	78	71	2%	7%	1%	2%
test-5	5B	residual	end	10:53 AM	75.5	84	72	62.4	80	89	75	66	5%	6%	4%	5%
test-6	6B	static	start	11:26 AM	84.3	85	75	67.7	88	92	78	71	4%	8%	3%	4%
test-6	6B	residual	end	11:28 AM	76.3	84	70	62.8	81	89	75	66	6%	6%	7%	5%
test-6	6A	static	start	11:43 AM	87.9	86	77	71.2	89	93	78	72	1%	8%	1%	1%
test-6	6A	residual	end	11:45 AM	77.9	86	72	64.3	83	90	75	68	6%	5%	4%	6%
test-9	9A	static	start	12:45 PM	88	86	77	70.9	88	92	77	71	0%	7%	0%	0%
test-9	9A	residual	end	12:47 PM	77.2	83	69	60.7	82	87	73	65	6%	4%	5%	7%
test-11	11A	static	start	1:17 PM	90.1	89	75	72.6	89	91	79	72	1%	2%	5%	0%
test-11	11A	residual	end	1:19 PM	81.6	86	69	64.2	83	91	69	66	2%	6%	1%	3%
test-11	11B	static	start	1:33 PM	88	89	78	71.1	91	95	80	74	3%	7%	3%	3%
test-11	11B	residual	end	1:35 PM	82.1	88	72	64.9	85	89	72	68	3%	2%	1%	4%
test-10	10A	static	start	2:32 PM	87.2	90	77	69.3	89	96	79	72	2%	6%	2%	4%
test-10	10A	residual	end	2:34 PM	82.9	79	73	66.3	87	79	77	70	5%	0%	5%	6%
test-8	8A	static	start	2:56 PM	87.3	91	77	70	89	94	79	72	2%	3%	2%	3%
test-8	8A	residual	end	2:58 PM	84.2	84	74	67	88	85	77	71	5%	1%	4%	6%
test-7	7A	static	start	3:20 PM	84.5	88	74	67.3	87	91	76	70	3%	4%	3%	3%
test-7	7A	residual	end	3:22 PM	80.4	87	71	64	85	90	75	68	5%	3%	5%	6%
test-7	7B	static	start	3:38 PM	90.1	89	80	72.3	92	97	81	75	2%	8%	2%	3%
test-7	7B	residual	end	3:40 PM	80.9	87	73	64.1	84	90	75	68	4%	4%	3%	5%
															Average	**4%**