Wailuku Well No. 1

PROJECT TEAM

Owner:	Maui County Department of Water Supply
Exploratory Well Contractor:	Alpha, Inc.
Production Well Contractor:	Goodfellow Bros., Inc.
Civil Engineer and Land Surveyor:	Fukumoto Engineering, Inc.
Hydro-geologist:	Glenn Bauer, Geologist
Structural Engineer:	Arnold T. Okubo & Associates, Inc.
Electrical Engineer:	ECM, Inc.
Landscape Architect:	Russel Y. Gushi Landscape Architect
Geotechnical Engineer:	Island Geotechnical Engineering, Inc.
Planning Consultant:	Munekiyo & Hiraga, Inc.

DESCRIPTION

Wailuku Well No. 1, a $2.6 million Maui County Department of Water Supply (DWS) project, involved constructing an exploratory well and developing it into a production well. Construction of the exploratory well occurred between 2012 and 2013. Construction of the production well took place between 2014 and 2016.

Construction of the exploratory well consisted of drilling, casing, and testing a 580-foot deep by 18-inch diameter well. The pump tests indicated a capacity of 1,400 gallons per minute with low drawdown of the aquifer surface. Based on the operational time of 16 hours per day, the well is capable of producing 1.3 million gallons per day. The water quality tests indicated compliance with all drinking water standards and the State Department of Health approved the use of the well as a new drinking water source. Based on the favorable test results, DWS deemed the exploratory well a success and developed it into a production well.

Development of the production well included the following components: 12,000-square foot pump station site, submersible vertical turbine deep well pump, pump discharge piping, 16-inch transmission pipeline, connection to the Iao Tank, control building, and electrical controls including supervisory control and data acquisition (SCADA) system.

The site improvements consisted a paved service yard, a 640-square foot control building housing mechanical and electrical equipment, a concrete pad for the pump discharge piping, and a drainage sump. Site improvements also included security fencing, site lighting, landscape irrigation system, and landscape plantings to screen the chain link security fencing.

A pump rated for 1,400 gallons per minute with a 4,160-volt, 3-phase, 60-hertz, 1,800-revolutions per minute, 300-horsepower submersible motor was installed. The pump discharge line included a solenoid control valve, deep well pump solenoid control valve, check valve, venturi meter, and air and vacuum valve.

Various piping systems were installed. Such systems included an 8-inch pump discharge line consisting of pump control valves with solenoid controls, connections to accommodate a future 12-inch transmission pipeline and control valve station, 16-inch transmission pipeline from the pump station to the Iao Tank, and a connection to the tank's inlet line. Piping systems also included small-diameter air lines for measuring the water level in the well, pressure sensing lines, and a sampling tap. Chlorination of water pumped from the well was handled at the Iao Tank by relocating the chlorine injector and using the existing chlorine residual analyzer.

Electrical improvements consisted of extending the distribution system to the site, providing power to the building, installing light poles and an antenna pole, and installing motor controls, instrumentation, and SCADA systems for the new well. Electrical controls allowed operating and monitoring the pump from the DWS Kahului operations facility.

ENGINEERING DIFFICULTY

New drinking water wells are usually located in undeveloped areas or on the fringes of developed areas. This project, however, is within an area with many existing and proposed residential developments. In addition to these developments, there are three nearby drinking water wells. The proximity to such developments resulted in challenges to address drinking water regulations, physical constraints, and direct connections to other projects in the area.

Before use of the new well, the State Department of Health Safe Drinking Water Branch (SDWB) must review and approve the "Engineering Report for New Drinking Water Source". The engineering report is a comprehensive document that concentrates on water quality tests results and sources of contamination. Additionally, the engineering report considers the impact of the new well on the aquifer. The report identified sources of potential contamination such as past sugarcane and pineapple cultivation, and existing and proposed residential development in the area. Despite these sources of potential contamination, the test results indicated excellent water quality and compliance with all drinking water standards. The test results of the three nearby wells also showed excellent water quality and compliance with all drinking water standards. These results along with a detailed analysis of the effects of the new well on the aquifer prompted SDWB to approve the engineering report.

Site constraints included minimizing the area of the pump station site, and providing adequate separation between the new well and existing Shaft 33. The pump station site was part of a future park site, so its area was kept to a minimum while accommodating the control building, drainage sump, service yard, and pump discharge line. An important consideration for sizing the site was to provide enough area for a large crane for removing and servicing the submersible pump. Shaft 33, constructed in 1946 and put into operation in 1948, provided irrigation water for Wailuku Sugar Company's agricultural operations. Shaft 33 consists of a portal, an inclined 730-foot long tunnel, and a large underground pump chamber with three wells. An agreement with the owner of Shaft 33 allows DWS to pump about 5 million gallons per day from one of the wells. Old plans showed that the pump chamber was close to the proposed location of Wailuku Well No. 1. An accurate location of the pump chamber was required to avoid any detrimental effects on it due to the construction of Wailuku Well No. 1. To confirm the location of the pump chamber, surveyors entered the portal, set control points in the tunnel and the pump chamber, and surveyed the pump chamber. The survey confirmed a 200-foot clearance between the pump chamber and the new well.

Design of the pump station site was difficult due to direct connections to other projects in the area. During the design of the site, the extension of Kehalani Mauka Parkway had not been constructed and only preliminary designs of the extension had been prepared. This required revisions to the pump station site upon completion of the parkway plans and further revisions upon completion of construction of the parkway. The pump station site also needed to accommodate a future transmission pipeline from the Wailuku Well No. 2, a future control valve station on the site that served Wailuku Well No. 2, and a shared transmission pipeline from the site to the Iao Tank. These changes were incorporated during construction of the project.

CONSTRUCTION DIFFICULTY

Construction of the project required special equipment, many different construction trades, and coordination with other contractors working on separate projects in the area.

Special equipment for construction of the exploratory well included a rotary drill rig and a large crane for installing about 600 feet of 18-inch diameter steel casing. Testing of the exploratory well involved installing a high-output pump in the well and running the pump with a right angle drive powered by a diesel engine. Testing also involved checking the alignment of the well by running an alignment mandrel through the casing and checking the plumbness of the well by measuring the drift of a plumb line from the center of the casing.

Construction of the production well involved general site work and special work related to the well. General site work consisted of grading, pipeline installation, asphalt paving, chain link fence installation, and installation of landscape planting and irrigation lines. Work related to the well included construction of a reinforced concrete pump pad, construction of a slab-on-grade concrete masonry unit control building with a wood-framed asphalt shingle roof, and installation of mechanical and electrical equipment. After completion of the pump pad, a large crane installed the deep well submersible pump that extends about 580 feet below the surface. Mechanical equipment at the pump station site included pump control valves with solenoid controls, and flow and pressure sensing devices on the pump discharge line. Mechanical work at Iao Tank consisted of 12-inch and 16-inch taps into the existing inlet line including check valves, and rerouting of the existing chlorine solution line. Electrical equipment included a three phase transformer and metering provided by Maui Electric Company, pump controls, SCADA equipment for monitoring and controlling the pump, antenna pole for transmitting and receiving signals, and lighting for the building and site.

The overlapping schedules of Wailuku Well No. 1, Wailuku Well No. 2, and the extension of Kehalani Mauka Parkway created additional challenges during construction. Wailuku Well No. 1 was initially designed to receive temporary overhead power from Maui Electric Company. While the project was under construction, the parkway plans were being completed, resulting in a decision to eliminate temporary overhead power and to instead provide permanent underground power to Wailuku Well No. 1. This decision extended the construction schedule of the new well because of the ongoing construction of the parkway. Construction was further pushed back due to construction of the control valve station that serves Wailuku Well No. 2 on the site of Wailuku Well No. 1. The construction of the parkway also impacted completion of the project due to a rainstorm that eroded the parkway and deposited mud on the site.

ENVIRONMENTAL CONSIDERATIONS

Construction of the project is part of an overall plan to spread out pumping in the Iao Aquifer to preserve its long-term sustainability. Instead of high withdrawals from a few wells, moderate withdrawals from many wells spread out throughout the aquifer prevents degradation of the aquifer. Spreading out pumping helps to prevent increasing the chloride content of the pumped water and lowering the water table. These wells are part of the overall plan: Wailuku Well No. 1, Wailuku Well No. 2, Iao Tank Site Well, and Waikapu Tank Site Well.

Certain features were incorporated into the project to minimize its impact on the adjoining residential areas. With a depth of about 600 feet, the well could be equipped with a vertical lineshaft pump or with a submersible pump and motor. A vertical lineshaft pump with the motor on the surface is easier to maintain, but is noisy due to the exposed motor. Although more expensive to maintain, the plans incorporated a submersible pump and motor to eliminate noise. Another feature that minimized the impact on the residential areas was the roof of the control building. To address concerns of the homeowners association, the initially-designed flat reinforced concrete roof was changed to a wood-framed gable roof with shingles to blend in with other residential buildings. To further improve the aesthetics of the project, shrubs were planted on the outside of the chain link security fence along the street to screen the site.

PUBLIC BENEFIT

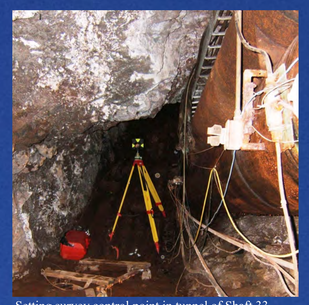
Although Shaft 33 provides substantial amounts of good quality drinking water, it is nearly 70 years old, and is difficult to operate and maintain. With a current output of about 5 million gallons per day, Shaft 33 produces about 25 percent of the daily draw from the Iao Aquifer. If a pump fails, personnel and equipment must be transported through the inclined tunnel to the underground pump chamber and the repair work must be performed in the chamber. Construction of Wailuku Well No. 1 allows DWS to phase out the use of Shaft 33, avoiding potential high repair costs and improving water distribution reliability.

Event: **HSPE MAUI CHAPTER**
2017 PROJECT OF THE YEAR COMPETITION

Sponsor: Hawaii Society of Professional Engineers
Maui Chapter

Date: January 23, 2017

By: Fukumoto Engineering, Inc.
1721 Wili Pa Loop Suite 203
Wailuku, Hawaii 96793


Setting survey control point in tunnel of Shaft 33.


Drill pipe with drill rig.


Rotary drill rig.


Right angle drive for pump powered by diesel engine.


Taking measurements during pump test.


Installing 18-inch diameter steel casing.


Lowering mandrel into casing for alignment test.


Mandrel in casing for alignment test.


Removing lifting shackles during casing installation.


Setting starter courses of CMU block for building.

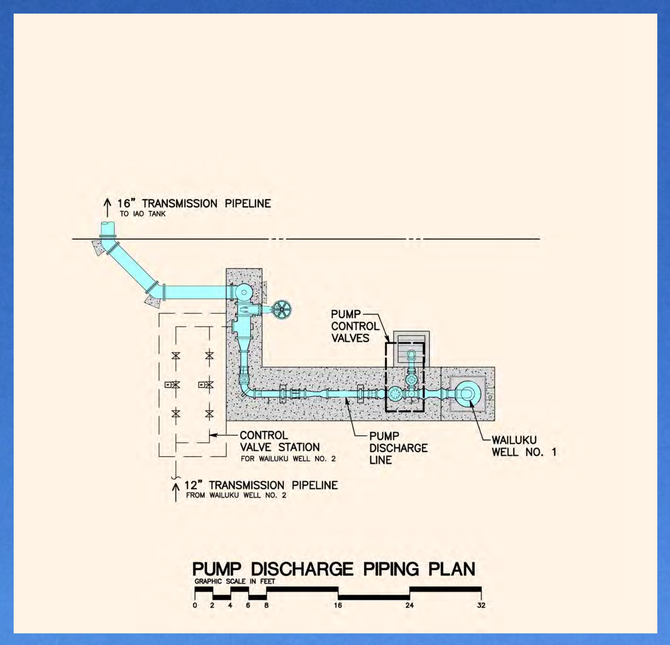

Measuring drift of plumb line for alignment test.

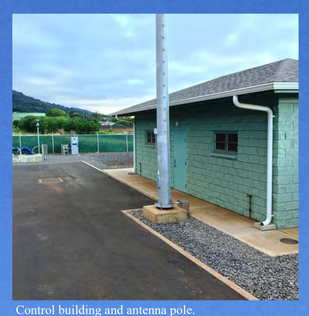

Pouring concrete header for service yard.


Drainage outlet to sump under construction.


Control valve station for Wailuku Well No. 2 and pump discharge line for Wailuku Well No. 1.


Drainage sump and building under construction.




Control building and antenna pole.


Well level sensing equipment.

Electrical metering and pump controls.