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Preliminary Design Report Wailua Wastewater Treatment Plant Alternative Effluent Disposal System Design - FINAL

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Prepared for:

County of Kaua'i
Department of Public Works
Wastewater Management Division

K/J Project No. 1767007*00

EXHIBIT "I-112"

data from 2013 through 2017 were reviewed and analyzed for loading patterns, influent flow, BOD_5, TSS, total Kjeldahl nitrogen (TKN), and ammonia-nitrogen (NH_3-N).

An evaluation of the current and future flows indicated that present average daily flow is 0.39 million gallons per day (MGD). In addition, the evaluation used planned developments in the service area to project future service population and resultant flow. The anticipated average daily flow near the end of a 20-year planning horizon is estimated to be 1.1 MGD, with the WWTP rated for 1.5 MGD[1]. The current service population was estimated using a design BOD_5 standard per capita loading rate of 0.2 pounds per person per day (lbs/person/d). It was estimated that 4,500 equivalent persons are provided service in the Wailua-Kapaʻa service area. The projected future population in the service area is 9,100 equivalent persons. The associated projected growth in wastewater flow and load are shown in Table ES-2.

Table ES-2: Influent Flow, Loads, and Conditions

Design Parameter	Unit	Current Avg. Annual	Current Max Month	Design Avg. Dry Annual	Design Avg. Annual	Design Max Month	Design Max Day	Design Peak[(a)]
Flow	MGD	0.39	0.52	1.14	1.50	1.98	3.00	5.04
BOD_5	ppd	893	1,719	1,718	1,806	3,476	3,606	-
TSS	ppd	679	1,307	1,306	1,373	2,643	2,742	-
TKN	ppd	143	276	276	290	558	579	-
NH_3-N	ppd	103	199	198	209	401	416	-
Alkalinity	mg/L as $CaCO_3$				300			
pH	-				7.2			
Monthly Average Temperature								
Low	°C				24.7			
Typical	°C				27.0			
High	°C				28.9			

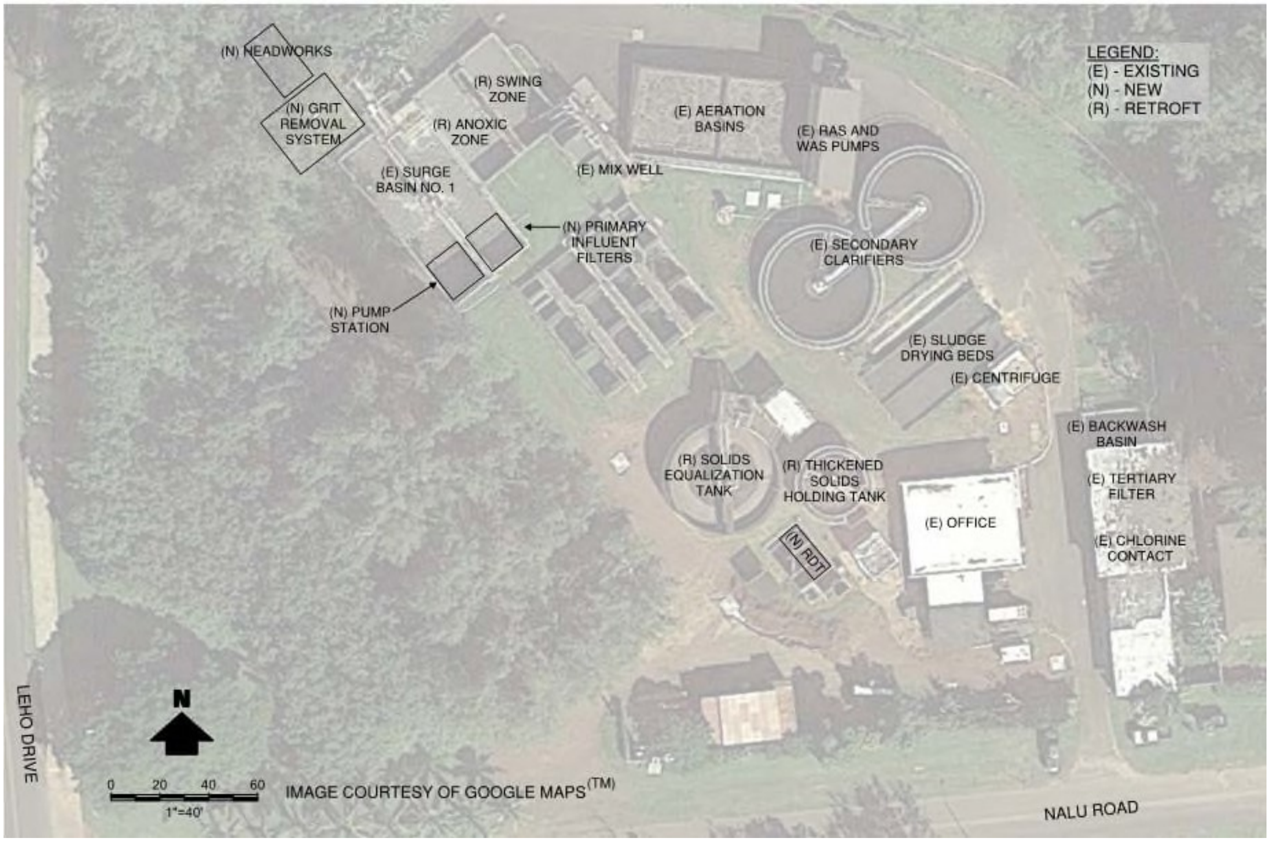
Notes:
(a) Peak flow prior to equalization.
MGD = million gallons per day
ppd = pounds per day
°C = degrees Celsius
TKN = total Kjeldahl nitrogen
$CaCO_3$ = calcium carbonate

ES.4 Proposed Project

The WWTP is rated for 1.5 MGD average daily flow[1], with a design peak flow of 5.04 MGD and a maximum day flow of 3.0 MGD. Existing WWTP processes consist of preliminary treatment and secondary treatment followed by tertiary filtration and chlorine disinfection. The treated effluent is currently either reused at the Wailua golf course for irrigation purposes or disposed of through the ocean outfall. This section briefly summarizes the proposed process improvements as described in more detail in this PDR. Figure ES-1 depicts the proposed layout of the Wailua WWTP.

[1] Rated capacity of 1.5 MGD average daily flow includes the capacity of the currently decommissioned Rapid Bloc System.

Figure ES-1: Proposed Wailua WWTP Layout



Headworks

The existing headworks poses operational challenges for the WWTP staff by passing debris under high flow conditions and hydraulics which can sometimes compromise accurate flow measurement. The existing headworks has two channels, one has a mechanical bar screen and the other has a bar rack. The WWTP does not have redundant mechanical bar screens, and as a result, if the mechanical bar screen is down for maintenance, incoming flow is directed to the manual bar rack. The manual bar rack does not function as well as the mechanical bar screen in removing debris that is coming into the Wailua WWTP. Additionally, WWTP personnel report that the Parshall flume is operating in a submerged condition which affects the ability of the WWTP to accurately measure influent flows. As a result, WMD is currently installing laser flow meters in both channels, which will be able to provide accurate measurements even in submerged conditions. Grit accumulation was also observed in the Surge Basins which indicate improper function of the aerated grit chamber.

Due to limited available space at the WWTP, the upgraded headworks and associated influent screens and grit system will be located to the west of the existing WWTP headworks. The headworks will be located on an adjacent parcel TMK: (4) 3-9-006:027 which is owned by the County through Executive Order.

Influent Screens

Influent screening will be provided through two (2) mechanical screens. The two screens will provide full redundancy for the design peak flow of 5.04 MGD. The design concept is based on 6-millimeter fine screens, such as the Huber Step Screen Vertical. As a design option, a perforated media belt filter with 6-millimeter or smaller opening screens, such as Enviro-Care FSM Filterscreens, will also be considered. The screenings will be sent to a washer and compactor before being disposed of at the Kekaha Landfill.

Grit Removal System

Grit removal design will include two stacked tray grit separation units, each sized to handle design peak flow.

Odor Control

Historically, odors have been an issue in the sewer collection system and the WWTP. There will be considerations for odor control mitigation measures during the design phase.

Surge Basin No. 1 and the Filter Feed Pump Station

Wastewater will flow from the headworks into the existing Surge Basin No. 1. Surge Basin No. 1 will serve as an equalization basin to dampen the effects of peak flows to the WWTP. A Filter Feed Pump Station located on the south side of Surge Basin No. 1 will pump wastewater to the next process unit, the Primary Filters which will be located on top of Surge Basin No. 1. The Filter Feed Pump Station will be hydraulically connected to Surge Basin No. 1 through a normally open knife gate allowing flows to pass between the two structures. Surge Basin No. 1 will be equipped with mixers to keep the solids in suspension. The need for aeration in Surge Basin No. 1 will be further considered in detailed design. The Filter Feed Pump Station will consist of two submersible pumps controlled by variable frequency drives (VFDs) and will include a shelf spare.

Primary Filters

As part of the Project, a primary filtration pilot-scale study at the Wailua WWTP successfully demonstrated that primary filtration could be used to divert a significant portion of the raw wastewater organic load out of the WWTP biological process directly into the solids handling and disposal process. The study also demonstrated that the filter effluent is biologically equalized, providing a more a stable wastewater to the biological process. The stabilized wastewater with reduced solids will improve the function of the existing aeration basins and increase the flows the WWTP can treat.

The design concept includes two primary filters to be placed aboveground (on top of Surge Basin No. 1), receiving equalized influent flow from the Filter Feed Pump Station. The effluent from the filters will flow by gravity to a proposed anoxic zone. The waste from the primary filters (backwash water, solids waste, and scum) will be pumped to a proposed Solids Equalization Tank where it will be blended with the waste activated sludge (WAS) stream for solids handling and disposal. The proposed design concept uses cloth media filters such as the Aqua Aerobics Systems, Inc AquaDisk®.

Biological Treatment Process

Computer-based biological process modeling was performed to establish design criteria for the primary filtration and the secondary process and to document the estimated process performance and operating parameters at different loading conditions. The model was used to compare and evaluate between two alternative processes for improving nutrient removal capability. The model determined that the modification of the WWTP to include a Ludzack-Ettinger Process would meet the established water quality goals, in particular regarding nitrogen reduction. The Ludzack-Ettinger process upgrades will require:

- Addition of a primary filtration system, as discussed previously.
- Conversion of Surge Basin No. 2 and 3 to an anoxic and a swing zone, respectively, to provide for denitrification and additional aeration.
- Extension of the return activated sludge (RAS) line back to the anoxic zone to provide for returning RAS flow to the anoxic zone for denitrification and alkalinity recovery. The RAS and WAS pumps will be replaced to accommodate higher capacities and add redundancy so that it will be easier to control and change RAS and WAS flow rates.
- Expansion of blower and diffuser capacity for the aeration basins to support full nitrification for future design flow and loading conditions. The expansion of the blower and diffuser capacity in the aeration basins will be coordinated with Fukunaga and Associates which will be included in their *Wailua WWTP Process, Disinfection and Electrical Improvements Phase 2* project.
- Based on the peak day solids loading rate, each clarifier can handle approximately 1 MGD. As peak day flows approach 2 MGD, the need for a third secondary clarifier and associated return activated (RAS) pump will be considered. The addition of a third clarifier will be coordinated with Fukunaga and Associates which will be included in their *Wailua WWTP Process, Disinfection and Electrical Improvements Phase 2* project.

To support these upgrades, a submersible mixer or jet mixer will be installed in the anoxic zone to provide the required mixing. The swing zone will be operated either as an anoxic or aerobic zone. As such, a jet aspirator or jet aerator will be installed in the swing zone for mixing and/or aeration depending on the type of process needed within the swing zone.

Two submersible pumps (including one redundant pump) will be installed in the swing zone to discharge into the Mix Well.

Effluent Reuse and Disposal

As stated previously, meeting the nitrogen limitations for ocean discharge was determined to be very costly from the capital and operation and maintenance perspective with no long-term guarantee that the requirements would not become more restrictive in the future. Hence, it was decided that it would be in the long-term best interest of the County to eliminate discharge through the ocean outfall and instead reuse the WWTP effluent as R-2 recycled water for irrigation purposes coupled with surface spreading basins as the backup disposal method.

As such, the existing ocean outfall will be abandoned in favor of the proposed effluent reuse practice of Wailua Golf Course irrigation for typical reuse with three backup surface spreading locations at the Wailua Golf Course, as well as a disposal alternative using a spreading basin at the Wailua WWTP for effluent that does not meet R-2 recycled water standards.

It should be noted that the existing tertiary filter is a key back-up component allowing the WWTP to meet R-2 recycled water standards but there is no redundant tertiary filter. Therefore, when the filter is down for maintenance the Wailua WWTP may run the risk of not producing R-2 recycled water. A redundant tertiary filter is proposed in the *Wailua WWTP Process, Disinfection and Electrical Improvements Phase 2* project being designed by Fukunaga and Associates.

Typical Effluent Reuse

The typical effluent reuse practice will be to continue conveying R-2 recycled water to the Wailua Golf Course's 2 million-gallon holding pond for golf course irrigation use. The irrigation holding pond supplies the irrigation pump station which feeds the golf course sprinkler system.

Backup Effluent Reuse

Backup effluent reuse options will be needed for periods where R-2 recycled water production exceeds golf course irrigation demand, such as during rain events.

Backup effluent reuse of R-2 recycled water will consist of three effluent disposal areas: the Wailua Golf Course Driving Range, the normally dry pond on the 16th hole, and the proposed Sandy Area Disposal Basin near the 17th hole. Manual control valves will be operated by the golf course staff to manage flows as they see fit.

The proposed construction method for the needed pipeline extensions includes horizontal directional drilling (HDD) to install an overflow pipeline from the irrigation holding pond to the sandy area and extending the R-2 recycled water force main from the irrigation holding pond to the Driving Range. A berm will be constructed on three sides of the driving range with gun sprinklers located to disperse the recycled water through spray irrigation, as shown on Figure ES-2.

Figure ES-2: Wailua Golf Course Driving Range Disposal Option

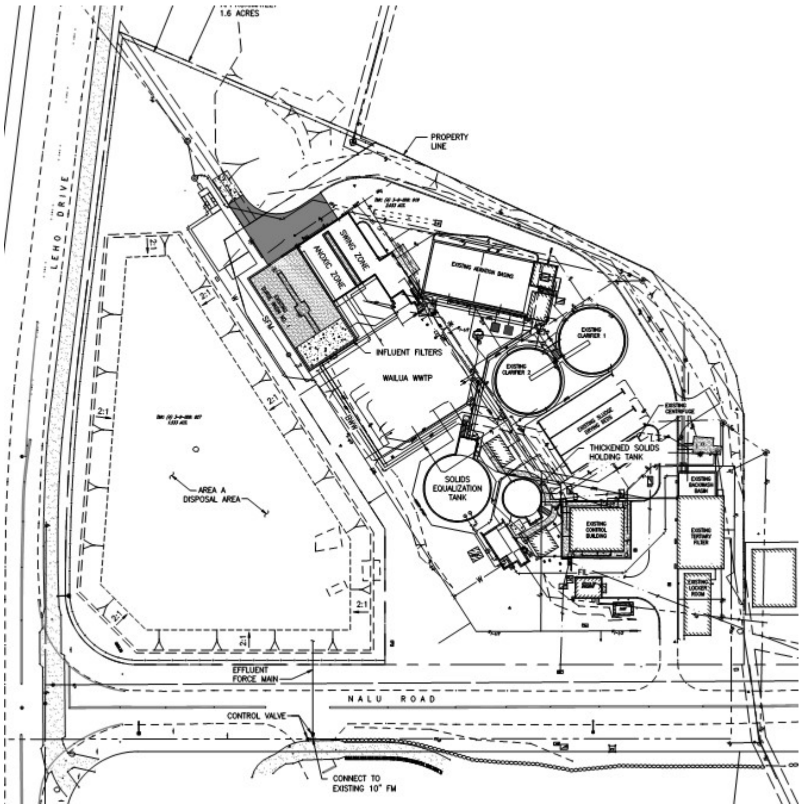
Should the golf course staff choose, valves could be operated to instead divert the flow to the Sandy Area Disposal Basin near the 17th hole. The Sandy Area Disposal Basin is a naturally depressed area that is located away from public accessibility. Because the 17th hole is regarded by the Wailua Golf Course as the signature hole, the Sandy Area Disposal Basin will be set back behind the tree line to limit visibility to the public. The normally dry pond on the 16th hole, will continue to serve as irrigation holding pond overflow. Figure ES-3 depicts 16th and 17th hole disposal options.

Figure ES-3: 16th and 17th Hole Disposal Option

Substandard Effluent Disposal

The effluent disposal system needs to account for periods where the WWTP fails to achieve R-2 recycled water quality effluent. It is not suitable to discharge substandard effluent to the Wailua Golf Course irrigation system. Instead, substandard effluent will be disposed of at Area A located in at TMK: (4) 3-9-006:027 which is owned by the County of Kaua'i by Executive Order. Area A is located just mauka of the Wailua WWTP. The site is currently overgrown with trees and low brush which will be grubbed as needed to promote storage and infiltration. The site will be graded and circumscribed by a berm and secured by fence. Figure ES-4 depicts the proposed Area A disposal option.

Figure ES-4: Area A Disposal Option



<u>Cultural and Historical Concerns</u>

The Wailua region has cultural and historical sites that must be considered in evaluating the proposed effluent disposal practices. The proposed effluent disposal practices were developed in collaboration with WMD and Department of Parks and Recreation leadership to take the cultural and historic resources into consideration. Cultural and historical impacts will be further mitigated through the Environmental Assessment process scheduled to begin as part of the subsequent design work.

Solids Management

The current solids management strategy at the Wailua WWTP requires the hauling of solids to the Kekaha Landfill. The tipping fees alone for landfilling the solids from Wailua WWTP cost the County approximately $42,000 per year. A solids management strategy that diverts the biological solids waste stream away from the landfill to beneficial land application would eliminate these tipping fees along with the other costs associated with the considerable transportation effort. An evaluation performed as part of this project compared the alternative strategy against the current strategy and found that by hauling the biological solids to the Līhuʻe WWTP for digestion and disposal, the County could realize considerable cost savings.

The design concept of the proposed solids management strategy consists of collecting solids from the various WWTP processes including: backwash, solids waste and scum from the primary filters and WAS and scum from the secondary clarifiers and blending these solids streams in the Solids Equalization Tank (repurposed Aerobic Digester). A new rotary drum thickener (RDT) will be installed to replace the existing dissolved air flotation thickener (DAFT) to thicken solids prior to hauling to the Līhu‘e WWTP for anaerobic digestion. The solids will be pumped from the Solids Equalization Tank to the RDT, elevated on a platform, to thicken the solids. The thickened solids will be held in the Solids Holding Tank (repurposed DAFT tank) and pumped into a haul truck for transport and disposal at the Līhu‘e WWTP.

Estimated Construction Cost

An engineer's estimate of probable construction cost at this conceptual planning stage for the effluent disposal and WWTP process upgrades, is estimated at $17,300,000 with a level of accuracy of -30% and +50% which is consistent with the American Association of Cost Engineers (AACE) for 10% level of design. The level of accuracy will improve with further levels of design per AACE the cost estimating guidelines. Going forward, the project will be divided into two projects, process upgrades and effluent disposal, with the breakdown in cost provided in Table ES-3. Further breakdown with more detail of the process upgrade construction costs is provided in Table ES-4.

Table ES-3: Estimated Construction Cost

	-30%	Total	+50%
Process Upgrades	$10,200,000	$14,500,000	$21,800,000
Effluent Disposal	$2,000,000	$2,800,000[a]	$4,200,000
Total	$12,200,000	$17,300,000	$26,000,000

Notes:
(a) Assumes 6" depth of excavation over Area A. Excavation of 2 feet, would result in an additional cost of approximately $1,000,000 for excavation, hauling, disposal, and landfill fees.

Table ES-4: Process Upgrade Construction Cost Breakdown

Component	Total[a]
Headworks Upgrades	$3,170,000
Primary Filter and Biological Process Upgrades	$5,330,000
Solids Process Upgrades	$1,670,000
Electrical and Instrumentation Upgrades	$1,830,000
Site Demo and Site Work	$2,500,000
Total	$14,500,000

Notes:
(a) Costs shown here represent costs including mark-ups.

A significant component of the effluent disposal costs is the depth of excavation and disposal of materials from Area A. At this stage of design, there is insufficient information (such as boring logs and infiltration rates) to accurately estimate the required depth of excavation. Presented in this cost estimate, is an assumed six-inch excavation over a 1-acre area representing Area A. Additional excavation up to two-feet would result in an additional $1,000,000 construction cost.

Specifically not included in this project and excluded from the cost estimate is the refurbishing of the existing Wailua Golf Course irrigation pump house, electrical cabinets, and structure.

Note that the estimate does not include an Owner's contingency for unforeseen costs, or costs associated with engineering, construction administration, or permitting.